FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Enhancing the City Catalyst Platform to Support Agility and Co-Creation in Open Innovation for Cities

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Mestrado em Engenharia Informática e Computação

Supervisor: Ademar Aguiar

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Abstract

Cities have an important role to play in sustainable development. Over half of the world's population lives in cities (55%, as of 2018 [31]) and this figure is expected to continue to increase (up to 68%, by 2050 [31]). This increase in urban areas comes with unprecedented challenges: increasing energy consumption and greenhouse gases emissions, sustaining a good quality of life for citizens and continuing to foster a competitive market for industries and innovative SMEs.

The City Catalyst project aims to develop an Open Innovation platform that promotes collective intelligence, transparency and an efficient resolution of problems affecting citizens and industries. City Catalyst is an R&D project funded by Portugal 2020 and the European Commission involving the cities of Porto, Aveiro, Guimarães, Famalicão and Cascais, in a consortium with other 18 organisations from academia and industry [14].

We aim to contribute to the success of City Catalyst by designing a set of tools and features to better support an Agile approach for Co-Creation of Open Innovation, in order to improve transparency and efficiency in urban management. These tools and features not only cover the execution of product ideas, but rather carry across all the phases of the innovation process, from the definition of outcomes to tracking and visualization, involving different stakeholders. We have analysed current web platforms that foster Open Innovation, Co-Creation and Agility in order to gather their key features to support these three concepts. We have then proposed a set of innovative technological solutions and services that: 1) enhance integrated urban management; and, 2) are catalysts for innovation and sustainable development.

We believe that the designed features facilitate the management of Open Innovation in cities by easing the sharing of knowledge between cities' several actors - academia, citizens, businesses and city councils - to construct better and more intelligent solutions. As a consequence, we expect to influence the design and implementation of the City Catalyst's web platform.

Keywords: Agile innovation, Open Innovation, Co-Creation, Collective intelligence.

Resumo

As cidades têm um papel importante a desempenhar no desenvolvimento sustentável. Mais de metade da população mundial vive em cidades (55%, em 2018 [31]), sendo esperada a continuação do crescimento deste valor (68%, até 2050 [31]). O crescimento das áreas urbanas traz desafios sem precedentes: aumento do consumo de energia e das emissões dos gases com efeito de estufa, sustentação de uma boa qualidade de vida para cidadãos urbanos e a fomentação de um mercado competitivo empresarial.

O projeto City Catalyst visa desenvolver uma plataforma de Inovação Aberta promotora da inteligência coletiva, da transparência e da resolução eficiente dos problemas que afetam cidadãos e empresas em áreas urbanas. O City Catalyst é um projeto de I&D[1] financiado pelo Portugal 2020 e pela Comissão Europeia que envolve as cidades do Porto, Aveiro, Guimarães, Famalicão e Cascais em consórcio com outras 18 organizações académicas e industriais [14].

O nosso objetivo é contribuir para o sucesso do projeto City Catalyst ao desenhar um conjunto de ferramentas e recursos para apoiar uma abordagem Ágil para Cocriação de Inovação Aberta, de modo a fomentar o melhoramento da transparência e da eficiência na gestão urbana. As ferramentas e recursos desenhados não englobam apenas a execução de ideias para produtos, mas sim transpõem todas as fases do processo de inovação, desde a definição dos resultados esperados até à monitorização e visualização, envolvendo diferentes *stakeholders*. Analisamos plataformas *web* atuais que promovem Inovação Aberta, Cocriação e Agilidade com o objetivo de identificar as suas principais funcionalidades de apoio a estes três conceitos. Consequentemente, propusemos um conjunto de funcionalidades e ferramentas inovadoras que: 1) potenciam a gestão urbana integrada; e, 2) são catalisadores de inovação e desenvolvimento sustentável.

Acreditamos que as funcionalidades desenhadas facilitam a gestão da Inovação Aberta em cidades ao simplificar a partilha de conhecimento entre os diversos atores urbanos – academia, cidadãos, empresas e municípios – com o objetivo de construir melhores e mais inteligentes soluções. Deste modo, esperamos influenciar o *design* e a implementação da plataforma *web* do City Catalyst.

Palavras-chave: Inovação Ágil , Inovação Aberta, Cocriação, Inteligência Coletiva.

[1] Investigação e Desenvolvimento.

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Filipa Senra

"The frog in the well knows nothing of the sea."

Japanese Proverb

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Abbreviations

DART	Dialog, Access, Risk-benefits or Risk assessment, and Transparency
GMO	Genetically Modified Organisms
IID	Iterative and Incremental development
IT	Information technology
NGO	Non-governmental Organization
NS	Not supported
OI	Open Innovation
OIDP	Open Innovation Digital Platforms
OII	Open Innovation Intermediary
OIPRL	Open Innovation Platform Regione Lombardia
R&D	Research and Development
RDI	Research, Development and Innovation
SME	Small and Medium Enterprises
XP	Extreme Programming

Chapter 1

Introduction

Today, most of the world's population lives in urban areas: around 55 percent in 2018 [31]. This number is expected to increase to 68 percent by 2050 [31]. "The urban population of the world has grown rapidly from 751 million in 1950 to 4.2 billion in 2018. Asia, despite its relatively lower level of urbanization, is home to 54 percent of the world's urban population, followed by Europe and Africa with 13 percent each" [29].

Cities, or more accurately, urban areas, are one of the most versatile spaces in human civilization. In many nations, they are the driving force of technological development and economic growth [22][p. 1]. However, rapid increases in urban areas come with challenges, ones we have seen before, but also new ones that arise from our new modern world [22][p. 1].

It is well known that cities are a breading growth for "poverty, inequality, environmental hazards, and communicable diseases" [22][p. 1]. Still, problems in urban areas don't just affect the poorest. Obesity is also linked with urban areas, due to the lack of physical space and the type of sedentary work that is predominant in cities [22][p. 2]. An issue that affects both the rich and the poor in the 21st century is the environmental impact in and the pollution of urban areas [22][pp. 2-3]. Currently, urban areas consume nearly 75 percent of the global primary energy supply and produce 70 percent of greenhouse gases emissions [46].

To accommodate the increase in cities' population, urban infrastructure and services will need to be considerably expanded, resulting in a significant rise in urban energy consumption, the emission of greenhouse gases and other resources, further putting additional pressure on already fragile urban environments.

1.1 Context

Cities play a critical role in their long-term, sustainable development and growth if they intend to mitigate the challenges that come with their expansion. If well managed, cities can still provide their citizens access to secure and sustainable energy, excellent living standards and a (mostly) pollution-free environment in spite of their fast expansion.

Cities should aspire to become smart and holistic, decentralized and participatory, where management is based on data generated by the city as a whole and driven by collaborative governance with the goal of sustainable growth [14][26, pp. 688-692][27, p. 286]. Smart cities aim to make informed collective decisions based on data that will lead to more efficient services, public networks, water supply and residue management, among others [26, pp. 688-692][27, p. 288]. In short, this view of Smart City has the goal to lead to an overall better and more efficient public management where city development is guided by citizens' interests first [14][26, p. 691][27, p. 286].

In the holistic view of a Smart City, decentralized and participatory, the sharing of knowledge and public infrastructure [14][26, p. 692][27, p. 285] and the stimulation of the four main groups of cities' stakeholders [14][26, p. 690][27, p. 286] – people, government, companies/industries and universities [26, p. 690] – is fundamental in the construction of adequate solutions of rapid adoption and dynamism. In order words, the solutions for a Smart City should be Co-Created in an Open Innovation and Agile environment [14].

These types of Open, Co-Created and Agile solutions associated with Smart Cities are expected to be the superior answer to the new and dynamic challenges that come with the dramatic increase of urban areas.

1.2 Motivation

In response to the increasing large urban areas and the challenges that come with them, the European Commission has launched in 2013 the European Innovation Partnership on Smart Cities and Communities in order to improve the quality of life of its citizens, increase competitiveness in industry and innovative SMEs as well as contribute to sustainability and to the European energy and climate change targets.

Therefore, cities have the responsibility to invest in solutions that allow the efficient use of energy resources, minimise their environmental impact and seek to increase the quality of life of their inhabitants.

The City Catalyst project aims to contribute to the European Commission challenge, i.e. the European Innovation Partnership on Smart Cities and Communities. It intends to develop an Open Innovation Digital Platform that promotes collective intelligence and transparency as well as creates an efficient problem-solving framework for cities. The objective of the City Catalyst project is to aid cities in becoming Smart Cities and so help them provide a good sustainable growing environment for their citizens and their business fabric [14].

One of many deliverables of the City Catalyst project is a digital platform where all city stakeholders can Co-Create in an Open Innovation and Agile environment, assisting cities in becoming smart, decentralized and participatory.

City Catalyst is funded by Portugal 2020 and the European Commission and it has a consortium of 5 major Portuguese cities – Porto, Aveiro, Guimarães, Famalicão and Cascais – and other 18 organisations from academia and industry [14].

1.3 Objectives

This dissertation aims to design a set of tools and features to better support Co-Creation and Agility in an Open Innovation environment in Cities. We believe that increasing the openness of cities will lead to improved transparency and efficiency in urban management.

These tools and features cover all phases of the value creation process: from the definition of the problem to the review, tracking and visualization of the proposed solutions' impact. This work proposes tools and features that aim to enhance integrated urban management, and be catalysts and facilitators for innovation and sustainable development.

We have also created click-through prototypes for these tools and features in order to get better and more accurate feedback from City Catalyst platform stakeholders by contextualizing the proposed features with the already planned platform.

1.4 Strategy and Expected Results

The work presented in this dissertation aims to propose a set of tools that aid Co-Creation, Agile and Open Innovation activities in the City Catalyst platform. Our contributions to achieving this goal are three-fold: 1) Analysis of the concepts of Open Innovation, Co-Creation and Agility, their associated activities and digital platforms that support these activities (Chapter 2); 2) Proposal of features to enhance the City Catalyst Platform taking into account the carried out analysis on Open Innovation, Co-Creation and Agility (Chapter 5); and, 3) Validation of these features with City Catalyst partners (Chapter 6).

We begin by analysing the background of the main three concepts – Co-Creation, Agility and Open Innovation – in Chapter 2. For each of these concepts, we define them, analyse their origins and how they are currently relevant for organizations using them. We also present real use cases of these three concepts in several areas, including urban management. We follow by theoretically analysing the concept of Open Innovation Digital Platforms: its definition and the capabilities one should possess to support Co-Creation and Agility in Open Innovation. Similarly to the concepts of Co-Creation, Agile and Open Innovation, we also analyse real examples of OIDPs in several areas including platforms targeting Municipalities and Urban Management.

Armed with the conclusions drawn from the concepts of Open Innovation, Agility and Co-Creation and related activities, examples of Open Innovation Digital platforms (Section 2.8) and the planned development for the City Catalyst platform (Chapter 3), we proposed seven groups of features to enhance the platform (Chapter 5). All the proposed features aim to resolve problems that teams Co-Creating for Cities in an OI and Agile environment may have or to support the activities of these teams on the platform.

Finally, the last contribution of this work is the validation of the proposed features with City Catalyst partners (Chapter 6), where we have validated both the need and the proposed features themselves in the context of the already planned City Catalyst Open Innovation Digital platform.

1.5 Document Structure.

This dissertation is structured in seven chapters, briefly described below:

Introduction. The definition of the context, motivation, objectives, strategy, expected results and document structure.

Background. Definition, origins and current context of Open Innovation, Co-Creation and Agile. Relevant examples of how Open Innovation, Co-Creation and Agility are implemented by organizations and cities. Definition of OIDP and identification of its capabilities to support Co-Creation and Agility in an Open Innovation environment. Relevant examples of general and city OIDPs and features comparison.

City Catalyst: Open Innovation Platform. Description of the planned City Catalyst Open Innovation Platform, including requisites, modules, actors, and system architecture.

Facilitating Decentralized, Participatory and Sustainable Cities. Identification of the problems related to our research topic. Description of the planned contribution. The approach used in the development of this work.

Supporting Co-Creation, Agility and Open Innovation in the City Catalyst Platform. Description of seven groups of features to enhance the City Catalyst Platform to better support Agility, Co-Creation and Open Innovation.

Validation. A detailed description of the evaluation process, i.e. survey.

Conclusions. Overview of the work developed and the main conclusions drawn.

Chapter 2

Background

In this chapter, we provide a comprehensive overview of the concepts of Open Innovation, Co-Creation, Agility and Open Innovation Digital Platforms, in order to analyse the current knowledge of our research topic.

Firstly, we describe Open Innovation, Co-Creation and Agility by providing for each a definition, origins and current context. We then present examples of how these three concepts are applied in the real world by all types of organizations, including municipalities. After, we theoretically analyse Open Innovation Digital Platforms, their definition and their necessary capabilities to support Co-Creation in Open Innovation environments. In addition, we analyse examples of real OIDPs, both general and targeting city's problems. We then compare the features of the analysed OIDPs in two components: 1) Who can launch and participate in challenges; and, 2) Each phase of the value creation process – Problem Definition, Finding Participants, External collaboration, and, Leveraging and measuring of the collaboration results. Finally, we summarize the key takeaway points of the carried-out analysis, including the most interesting features of OIDPs, and how we believe they contribute to the formulating of the problem and hypothesis this dissertation intends to address.

2.1 Open Innovation

2.1.1 Definition

Open Innovation (OI) refers to the ability for valuable ideas to come from both inside and outside the organization, and for those ideas to reach market from both inside and outside the organization as well [6, p. 43][24, p. 1]. In the Open Innovation paradigm, external ideas and external paths to market are given the same weight as internal ideas and internal paths to market [6, p. 43].

2.1.2 Origins

In the early 20th century, the paradigm for technological innovation was based on research and development done in-house: organizations funded their research labs, which generated intellectual

property that was developed and monetized by the organization, allowing it to further invest in the research process. Chesbrough [6, p. 21] names this paradigm as Close Innovation.

By the end of the 20th century, the close innovation paradigm began to be overlooked in favour of Open Innovation. Chesbrough [6, pp. 34-40] identifies four erosion factors for the close innovation paradigm:

1. The growing availability and mobility of skilled people;
2. The growing presence of Venture Capital, that attracts talent to pursue a carrier path in start-ups;
3. The impossibility of ideas to be inventoried on the shelf due to the risk that other companies, such as start-ups backed by venture capital, beat them to market; and,
4. The increasing capability of external suppliers to support companies in new ventures.

The combination of these factors as well as the rise of technologies that allow easier communication between individuals, such as the internet, increases organizations' permeability, allowing ideas and intellectual property to escape the "fortified towers of internal R&D [...] to suppliers, customers, partners, universities, start-ups, consultants, and other third parties" [6, p. 34].

The Open Innovation paradigm is designed to accept and profit from these eroding factors: it believes in an R&D strategy as a symbiosis of internal research and development, and intellectual property derived from the environment [6, p. 43][24, p. 1].

2.1.3 Current context

Currently, most organizations find themselves in a fertile innovation environment, filled with a plethora of knowledge from academia, start-ups and even well-established companies [6, pp. 44-45].

There has been a rise in excellent university scientific research, not bounded by geography or language [6, p. 44]. This diversity of geography and language doesn't just apply to academia, but also to companies: there is far more distribution of patents in terms of who holds them, if they are individuals or organizations; and, in the latter, the type of organizations, their size and geographical location [6, p. 45]. We are facing the end of the knowledge monopolies, and so organizations can (and must) look outside their environment to find knowledge.

If an organization decides they want to expand into a new area, expertise is easily available for hiring and does not need lengthy internal training or the promise of a lifetime job [6, p. 49]. New ideas can also be sourced from a diverse menu of discoveries at a variety of universities, from other companies such as venture capital start-ups or even from skilled suppliers applying their own exceptional skills [6, p. 49].

Organizations no longer need to "reinvent the wheel"[6, p. 49], as they may rely on external sources to perform the task or create the product more efficiently. External sources can even deliver better, more efficient and cheaper "wheels". In an environment where knowledge is abundant, it

may be the smarter choice for organizations to dedicate themselves to what they are good at, and leave the other areas to be dealt with by external partners [6, p. 49][18, pp. 135-136]. Outsourcing, an integral part of today's global economy [18, pp. 135-136], is an application of this philosophy.

Having access to external knowledge does not mean that organizations shouldn't have a driving internal R&D. What it means is that organizations should organize their internal R&D to take into account this new open paradigm [6, p. 53]:

1. To identify, understand, select from, and connect to the wealth of available external knowledge;
2. To fill in the missing pieces of knowledge not being externally developed;
3. To integrate internal and external knowledge to form more complex combinations of knowledge, to create new systems and architectures; and,
4. To generate additional revenues and profits from selling research outputs to other firms for use in their own systems.

In short, organizations should profit from the best of both worlds: capitalize on outside knowledge as well as generate additional revenues from their own knowledge and research.

2.2 Co-Creation

2.2.1 Definition

Co-Creation refers to the "joint creation of value by the [organization] and its stakeholders; allowing stakeholders to Co-construct the service or product to suit their context" [40, p. 8]. Co-Creation is not organizations trying to please the stakeholders, but rather allowing the stakeholders to take an active role in jointly defining the problem and constructing the problem solution to suit their unique needs [40, p. 8].

2.2.2 Origins

In the classic view of the process of value creation, organizations and stakeholders take distinct roles, producing and consuming, respectively [39, p. 5]. Organizations unilaterally create value, relying solely on their internal knowledge sources [33, p. 558]. In this organization-centric view, refined during the 20th century, an organization can be customer-oriented without the customer having an active role in the value creation process [33, p. 559]. Rather, organizations can still be customer-oriented, but keep customers (or stakeholders) at "arms-length"; listing to their feedback, but not involving them in the value creation process.

By the beginning of the 21st century, new market forces emerged, "such as the ever-shortening product life cycle, [and] service-focused competitive advantage" [33, p. 558]. These were fulled by new technologies that allow for global communities to be interconnected and interdependent [33, pp. 558-559]. In such a dynamic and fast-pacing environment, continuous innovation is

crucial [33, p. 558]. To achieve innovation goals, organizations can no longer solely rely on internal knowledge sources and innovation [33, p. 558].

Additionally, customers are now more informed and conscious of their negotiating power, creating pressure on businesses to be more transparent, open and collaborative in the value creation process [33, p. 558][40, pp. 7-8][39, p. 5].

Co-Creation emerges as a way for the ever more demanding and connected stakeholder (or consumer) to take a central seat at the table. Organizations must move away from the classic view of value creation, organization-centric, and seek to Co-Create value with stakeholders, focusing on stakeholders' experiences, individual-centric, merging both organizations and stakeholders' roles of producing and consuming [33, pp. 558-559][40, pp. 7-8][39, p. 5].

2.2.3 Current context

As organizations find themselves in environments that may benefit from involving stakeholders in the creation process, they also find themselves asking what a system that promotes Co-Creation of value looks like. The interaction between organization and stakeholders is now the locus of value creation [39, p. 6].

Prahalad and Ramaswam [40, 39] have outlined the building blocks of interactions between an organization and its stockholders using the DART model [39, p. 6][40, p. 8]: **D**ialog, **A**ccess, **R**isk-benefits or **r**isk assessment, and **T**ransparency. The DART model aims to challenge the traditional position managers have taken in value creation, a close and distant position, often employed in the tobacco, GMO and financial industries, by opening the channels of communication and access to stakeholders and communities [40, p. 9].

Dialog

Dialogue entails interaction, involvement, and a willingness to act on both the organizations' and stakeholders' sides [40, pp. 6-7][40, pp. 9-10]. It's more than just listening to stakeholders: it also entails shared learning and communication between both sides on an equal footing [40, pp. 6-7][40, pp. 9-10]. Furthermore, dialogue helps to build and sustain a strong and loyal community [40, pp. 6-7][40, pp. 9-10].

Access

Access promotes dialogue and requires organizations to optimize when, where, and how stakeholders are given the chance to Co-Create value [3, pp. 43-44][40, pp. 6-7][40, pp. 9-10]. Organizations should not view stakeholders as outsiders, but rather as collaborators and so should provide full access[1] to processes and resources that are used to create and deliver their product or service offerings [3, pp. 43-44][40, pp. 6-7][40, pp. 9-10]. Having full access to the value creation process facilitates the meaningful participation of stakeholders [3, pp. 43-44][40, pp. 6-7][40, pp. 9-10].

[1] Or as much access an organization can provide taking into account legal and competitive concerns.

Risk-benefits or Risk assessment

Risk here refers to the possibility of harm to the stakeholders [40, pp. 6-7][40, pp. 9-10, 14]. If stakeholders are Co-Creators, should they also shoulder accountability for the risks of a project? Being that Co-Creation is a two-way street, stakeholders must take some responsibility for the risks they consciously accept [40, pp. 6-7][40, pp. 9-10, 14]. As stakeholders increasingly take more important roles in the value creation process, they will demand that organizations provide them with comprehensive risk information, including not only statistics but also methodology [40, pp. 6-7][40, pp. 9-10, 14]. Armed with risk assessment information, stakeholders are able to analyze the personal and social risks associated with projects and make informed decisions [40, pp. 6-7][40, pp. 9-10, 14].

Transparency

Organizations have long benefited from the knowledge asymmetry that exists between them and the individual stakeholder [40, pp. 6-7][40, pp. 9-10]. That asymmetry is quickly vanishing: prices, expenses, and profit margins can no longer be regarded to be opaque. Due to ubiquitous connectedness, an individual customer may obtain as much information as they require from other consumers, other companies and other stakeholders [40, pp. 6-7][40, pp. 9-10]. Therefore, creating greater degrees of transparency between organizations and their stakeholders is becoming increasingly desirable to contribute to meaningful dialogues between all parties [40, pp. 6-7][40, pp. 9-10].

The DART building blocks are, naturally, interconnected in their definitions and together form guidelines to enable better communication between organizations and stakeholders. Managers can combine them in different ways to create different capabilities depending on the project at hand [3, pp. 43-44][40, pp. 6-7][40, pp. 9-10].

2.3 Agile

2.3.1 Definition

Agile is the ability to create and adapt to change. It's a strategy for coping with, and eventually excelling in a volatile and uncertain environment [4][20, pp. 1-2]. Agile project management and project development is an iterative method that helps teams offer value to stakeholders faster and with fewer headaches [4][20, pp. 1-2][8].

An Agile team provides work in tiny, digestible chunks rather than relying on a big launch [4][20, pp. 1-2][8]. Teams have a natural mechanism for adjusting to change fast since requirements, strategies, and outcomes are assessed on a regular basis by consulting their stakeholders during the entire value creation process [4][20, pp. 1-2][8].

2.3.2 Origins

Even though the Agile term was popularized in 2001 by Bennekum, *et al.*'s manifesto [4], "its practised and published roots go back decades" [23, p. 2]. The Agile practices were also previously known as iterative and incremental development (IID) [23, p. 2].

The beginning of IID can be dated back to the 1930s – for example with the work of Walter Shewhart, a quality expert at Bell Labs – and "many examples of IID date back to 1970s and 1980s, the most active but least known part of IID's history" [23, p. 2]. IID practices came up as a natural need to make (software) development less painful and more responsive to changes, "to avoid a single-pass sequential, document-driven, gated-step approach" [23, p. 2].

The Agile term became popularized by the Agile manifesto written by seventeen professionals in 2001 [4]. They aimed to promote modern, simple IID methods and principles and so establish ideals and fundamental concepts in order to improve software development [4][20, pp. 1-10]. The manifesto has been extensively accepted by developers, in software-development businesses, and even outside the realm of technology and software [4][20, p. 1].

When developers or managers want to do Agile development, within or outside of the software realm, they frequently refer to the Agile manifesto [4] and its four core principles:

> We are uncovering better ways of developing software by doing it and helping others do it. Through this work we have come to value:
>
> - **Individuals and interactions** over processes and tools
> - **Working software** over comprehensive documentation
> - **Customer collaboration** over contract negotiation
> - **Responding to change** over following a plan
>
> That is, while there is value in the items on the right, we value the items on the left more.

Note that even if the manifesto was written with software development in mind, it can and has been successfully applied to other areas [4][20, pp. 3-4].

2.3.3 Current context

Since the publication of the Agile manifesto over 21 years ago [4], Agile development continues to spark conversation and has led to a wide range of publications to analyse different theoretical and practical approaches [20, pp. 4-5].

We can analyse how Agile or better how the Agile manifesto is being practised, by looking at the Annual State of Agile report (in the latest 15th edition), the world's largest and longest-running survey that "details notable trends and issues in Agile adoption and practice as identified by more than 1,380 global respondents" [12].

According to the survey, Scrum is the most popular Agile strategy with 66% identifying it as the methodology they follow most closely, with an additional 15% following Scrum derivations (ScrumBan 9% and Scrum/XP 6%) (Figure 2.1).

We can also see that organizations don't just apply Agile methodologies to software or technology activities, but also to other non-traditional areas such as operations, marketing, security, among others (Figure 2.2).

Since the inception of the Annual State of Agile report in 2007, a key few trends can be identified [12, pp. 7, 14-21]:

1. Most notably, Scrum increased from 40% of respondents answering in the first survey as the Agile methodology they follow most closely to 66% in the 15th edition;

2. Other approaches such as extreme programming (XP) dropped from use by almost a quarter of respondents to less than 1% in the 15th edition; and,

3. Key activities including daily standups and retrospectives have been increasingly at the heart of Agile approaches, supported by sprint planning and reviews.

In sum, organizations seem to be converging on the adoption of Scrum or Scrum-related methodologies.

To also be noted that organizations regard success as accelerated delivery speed, improved quality, reduce risk and increased customer satisfaction (among others); metrics that reflect the Agile core principles and their direct impact on customer experience [12, p. 9][4].

2.4 Examples of OI, Co-Creation and Agility in the real world

We have collected six examples of how Open Innovation, Co-Creation and Agility are applied by real organizations. These examples paint a picture of how and why these three concepts influence business decisions and how interconnected they are to each other.

2.4.1 Online marketplaces, i.e. eBay and Amazon

Popular online marketplaces such as eBay and Amazon have searched to Co-Create value with their partners and customers [40, p. 10][21, pp. 38-43]. Both companies create and develop the technology that hosts million of product listings; while customers provide value by writing reviews; and, at the same time, partners also provide value by writing listings, supplying images of their products and, in the case of eBay and some cases on Amazon, completing the exchange process off-site [40, p. 10][21, pp. 38-43]. In the case of Amazon, the company also provides an affiliate marketing program which enables them to involve customers in the value chain by allowing managers to measure the number of sales through affiliates [21, p. 42].

Figure 2.1: Which Agile methodology do you follow most closely at the team level? [12, p. 13]

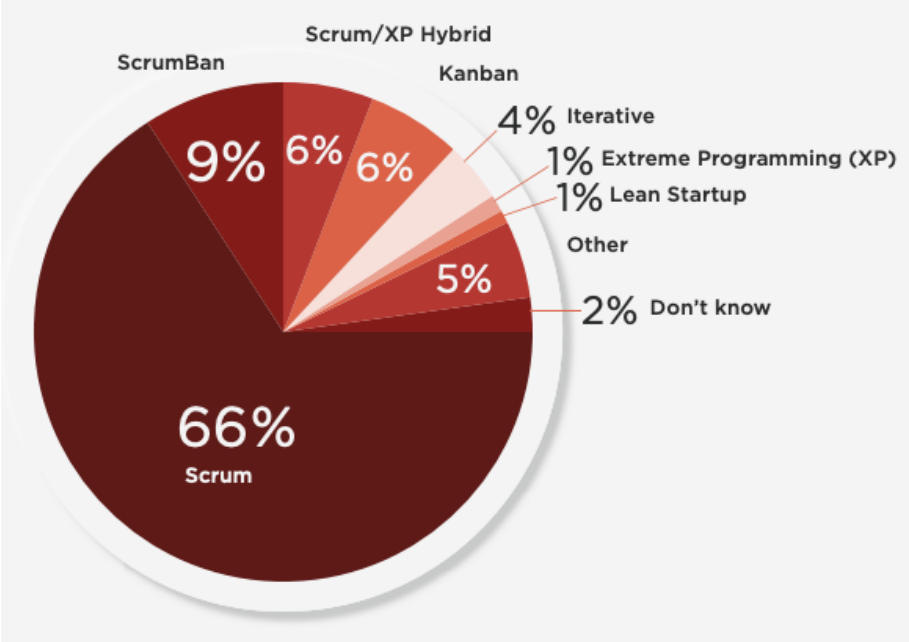
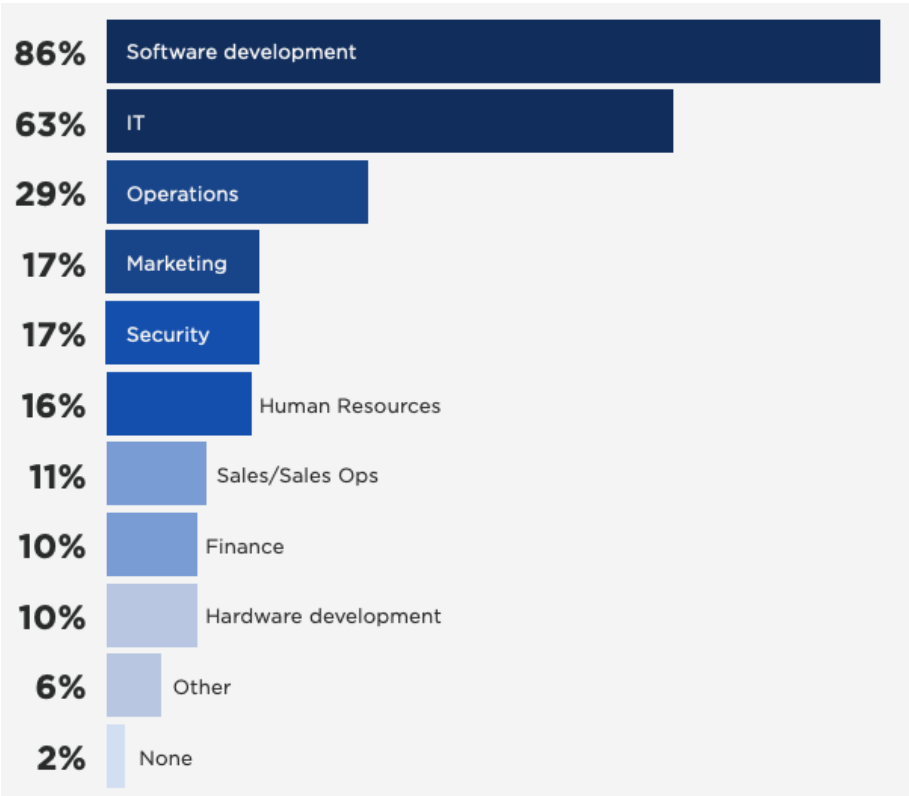


Figure 2.2: Which areas of your organization have adopted Agile principles and practices? [12, p. 7]



2.4.2 Cisco

Just before the beginning of the 21st century, Cisco Systems, the leading maker of computer networking equipment, recognized that its customer base had relevant and important capabilities, and so it created Cisco Connections Online [39, p. 7]. This platform aimed to provide a "suite of interactive, networked services with quick open access to Cisco's Information, resources and systems" [39, p. 7] and it also allowed customers to talk to one another, helping them to solve each other's technical problems, improving Cisco experience for everyone [39, p. 7]. This network has now evolved to be the Cisco Community[2]. Back in 2004, Cisco Systems continued to work closely with its customers by allowing them to Co-Create features on routers they have purchased to reduce downstream installation costs [39, pp. 39-40]. Co-Created products accounted for around 42% of Ciscos' $3.8 billion in revenue in 1998 [39, p. 40].

More recently, in 2017, Cisco created the Cisco DevNet Co-Creation framework that allows Cisco teams to work collaboratively to assist with and Co-Create innovation projects in various areas [7].

Cisco Systems has also moved from a waterfall method in its Subscription Billing Platform (SBP) project to an Agile approach named Scaled Agile Framework (SAFe) [30]. The SAFe allows teams to collaborate on building and testing small features within one component and then deliver these features to be integrated into the system and to be tested [30]. With the first release of the SBP with the new Agile framework, defects were reduced by 40% when compared to the previous waterfall releases and defect removal efficiency increased by 14% due to the improved team collaboration [30].

2.4.3 Samsung

Samsung wants to focus its innovation efforts on Internet of Things platform technologies, such as the ARTIK platform project [28, p. 2]. For IoT platforms to be as valuable as possible to future users, they also need complementary IoT hardware and software applications [28, p. 2]. Samsung, for its IoT ARTIK project, decided to utilize Open Innovation so partners can easily create complementary IoT applications as well as allow them to Co-design and Co-Create components of the platform itself [28, pp. 2-4].

2.4.4 Special case for cities

Public institutions are increasingly partaking in Open Innovation strategies, notably with international corporations, to better serve their citizens with innovative services [17, p. 52]. This trend can also be thought to have taken place partially due to the increasing interest of policymakers in Smart City programs, programs that promote Open Innovation and Co-Creation [14][17, p. 52].

We have compiled three examples of partnerships of public organisations with private firms. Most of the projects that we have compiled have as a context Smart City initiatives, and so should

[2] https://community.cisco.com

be analyzed through the perspective of a more radical change rather than incremental advances [17, p. 52].

2.4.4.1 Málaga Region

The Málaga region in Spain has over the years been a hot spot for Open Innovation, much of it being driven by the city itself [17, p. 59][16][32]. The Málaga city council has partnered with other organizations to Co-Create a small pilot for an electrical and thermal energy control system, under the E+ project with IBM and DNV KEMA, among others as partners [13, p. 39][17, p. 59], and in renewable energies and smart metering, in Smart City Malaga Project lead by Endesa [10][17, p. 59].

2.4.4.2 Rio de Janeiro Operations Center

Back in December 2010, Rio de Janeiro opened its Operations Center in a close partnership with IBM and its Smart City lab [43]. The "Centro de Operações", which reportedly cost $14 million dollars [43], aimed to aid the city to monitor and optimize the function of all parts of the urban landscape and alert emergency units in case of emergencies such as strong rains, traffic accidents and landslides [43][17, p. 56]. The close partnership with IBM's Smart City lab and the Rio de Janeiro city council allowed for the first time the IBM team dedicated to Co-Creation and Open Innovation to construct a project of such a large magnitude [17, p. 56]. A commercial version of the software deployed in the Rio de Janeiro Operations Center has also been adopted by Madrid, Beijing and Minneapolis [17, p. 56].

2.4.4.3 Co-Create with citizens, communities, academia and business fabric

Enabling citizens, communities, academia and business fabric to have active participation in the creation value process will evidently support and enhance the city's projects and the city itself [34].

Traditionally, cities and governments have involved citizens in projects and decisions through project review meetings open to all the community, participatory budgeting where citizens have a direct say on how money is allocated, public debates concerning matters important to community members or directly consulting community leaders.

With the advent of technology and cities moving towards smart initiatives, there has been a significant push to digitalize these initiatives [34, p. 154][44, p. 2]. Various e-participation tools can be used, from more simple, like social media or video conferencing, to more complex solutions, like tailored or commercial Open Innovation Digital Platforms [44, p. 3]. We cover the latter in Section 2.5.

2.5 Open Innovation Digital Platforms

2.5.1 Definition

Open Innovation Digital Platforms (OIDPs) are virtual environments in which a large number of organizations and individuals, many of whom may be unknown and undefined, interact to solve specific, predetermined Open Innovation challenges by applying knowledge creation, exchange and integration processes [1, p. 7]. The value creation process and in this case the Open Innovation process is shaped by its environment, and so it is shaped by how OIDPs "foster continuous interaction and higher participation among all participants" in the platform [2, p. 1496]. Abbate, Codini, and Aquilani [2] propose that OIDPs can be thought of as a type of Open Innovation intermediary (OII) due to the critical role they play in stimulating, establishing, and maintaining successful collaborations and relationships among the various organizations and individuals that make up the knowledge and innovation ecosystem within the platform.

2.5.2 OIDPs' capabilities to support Co-Creation and Agility in OI

As OIDPs can be considered a special kind of Open Innovation intermediary, OIDPs should support the interactive coupled Open Innovation process essential for Co-Creation activities.

Piller and West [36] propose a process model for interactive coupled Open Innovation process that includes four different phases: problem definition, finding participants, external collaboration, and leveraging and measuring the collaboration results. OIDPs should support all four phases of this model.

We can align these four phases with specific dynamic capabilities – sensing, seizing, scanning, integrating, and transformative – required to encourage and support the interactive coupled Open Innovation processes essential for Co-Creation activities of an OIDP [45, 1] (Figure 2.3).

Sensing and Seizing capabilities for problem definition

The problem definition phase refers to the problem formulation so that it reflects what we are attempting to solve by including external partners in the Co-Creation process and identifying the rules of engagement, the resource allocation and strategic commitment [36, p. 40].

OIDPs can utilize sensing and seizing capabilities to use and interpret accurately the information gathered and received by all entities in order to help define the innovation problem and the related internal resources needed [1, pp. 8-9].

Scanning and Seizing capabilities for finding participants

The finding participants phase refers to identifying as well as retaining and motivating a critical mass of collaborators with the right characteristics [36, p. 40].

Scanning and seizing capabilities allows OIDPs to directly attract, motivate and integrate valuable participants and external knowledge sources in innovation projects [1, p. 9].

Integrating and Transformative capabilities for external collaboration

The external collaboration phase refers to "creating and implementing the processes for collaboration (...), providing suitable tools (...) that facilitate the collaboration process" [36, p. 40] as well as selecting the most promising ideas from dozens or hundreds of prospective participants [36, p. 40]. These external interactions mean that an organization should be prepared to open itself to its external partners to empower them with the organization's knowledge [36, pp. 40-41].

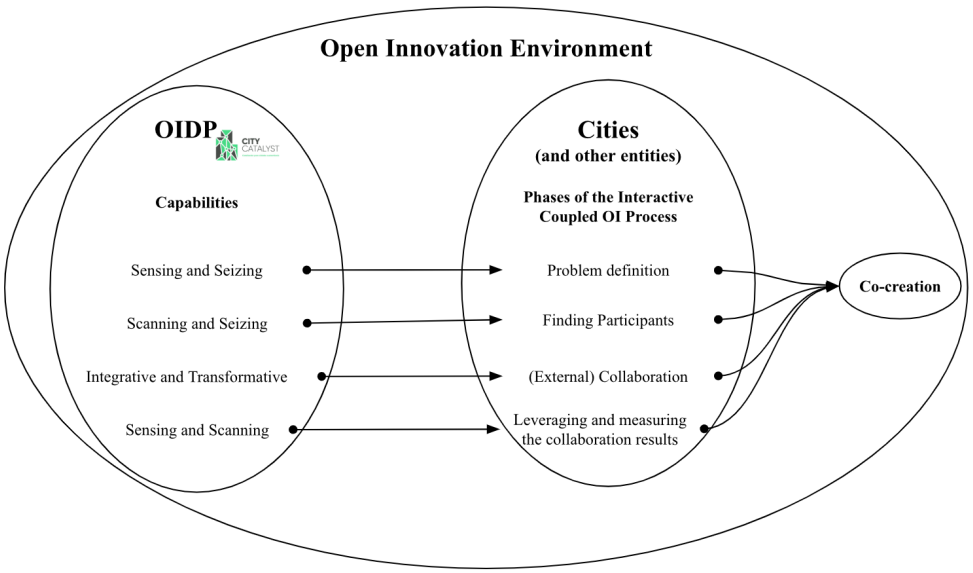
OIDPs' integrating and transformative capabilities help organizations to sustain ongoing interactions between themselves and their partners as well as assist top management and internal resources in designing structures and processes that motivate open attitudes with partners [1].

Integrating, Sensing and Scanning capabilities for leveraging and measuring the collaboration results

Once completed the collaborative effort, the challenge of realizing the benefits of this effort by integrating it as well as measuring the impact of such integration remains [36, p. 46].

OIDP's integrating capabilities aid organizations to collaborate with participants to better integrate the created innovation. OIDP's Sensing and Scanning capabilities allow organizations to collect the impact of the created innovation and its integration. Due to the collection and analysis of the innovation's impact, it is possible to go back to the previous phases if necessary, adjust or even create a new solution, find different participants or, more radically, redefine the original problem.

Figure 2.3: OIDP's capabilities for Co-Creation processes in an OI Environment.



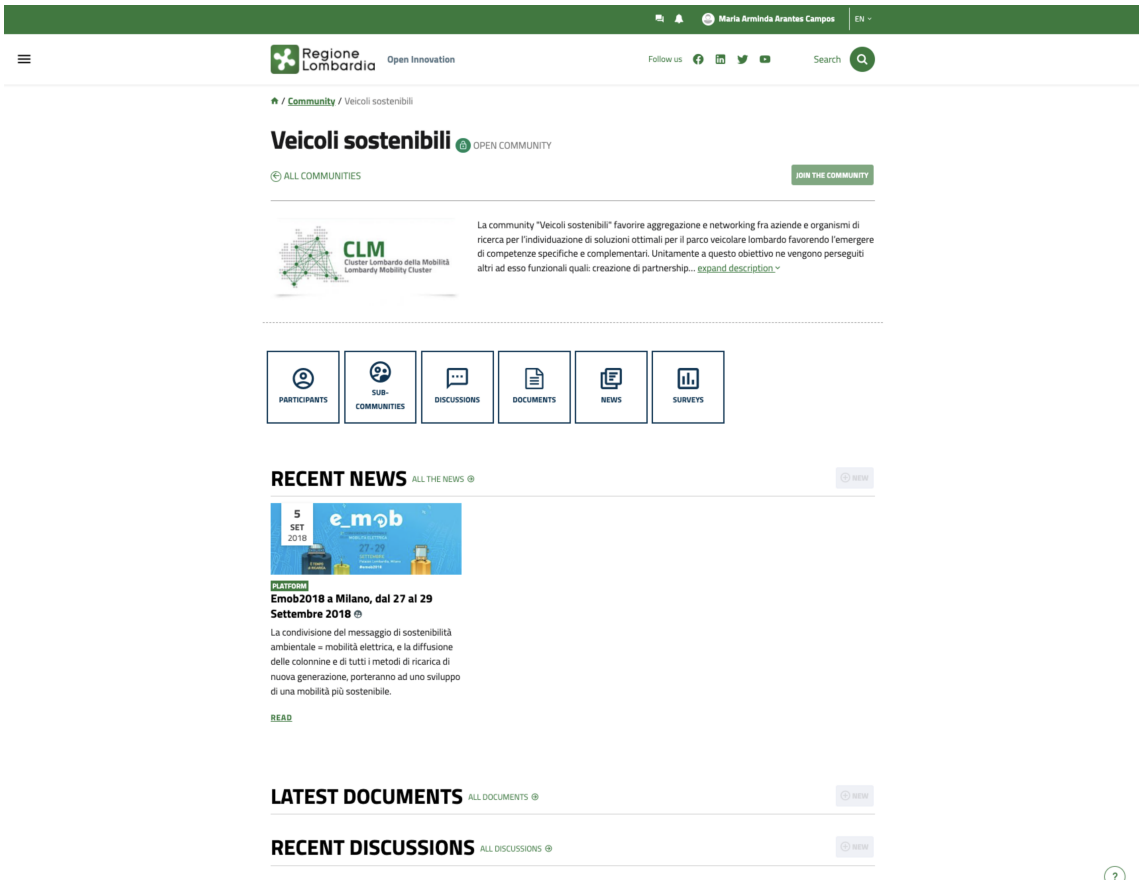
2.6 Examples of OIDPs in the real world

We have collected a few examples of real Open Innovation Digital Platforms used by organizations to connect with different parties to Co-Create projects in an Open Innovation environment. The examples gathered range from platforms that intend to connect individuals from all types of areas to ones developed to assist Open Innovation and Co-Creation in a specific knowledge area such as urban management.

2.6.1 Open Innovation Platform Regione Lombardia

The Open Innovation Platform Regione Lombardia[3] is a collaborative tool promoted by the Lombardia Region with the goal to stimulate and support the development of Open Innovation ecosystems [1]. The platform aims to interconnect the innovation and research capabilities in Lombardia, promoting the open movement of information, and leading to the generation of ideas and solutions at a regional, national and international level [1] (Figure 2.4).

Figure 2.4: Home Page of a Community in OIPRL[3].

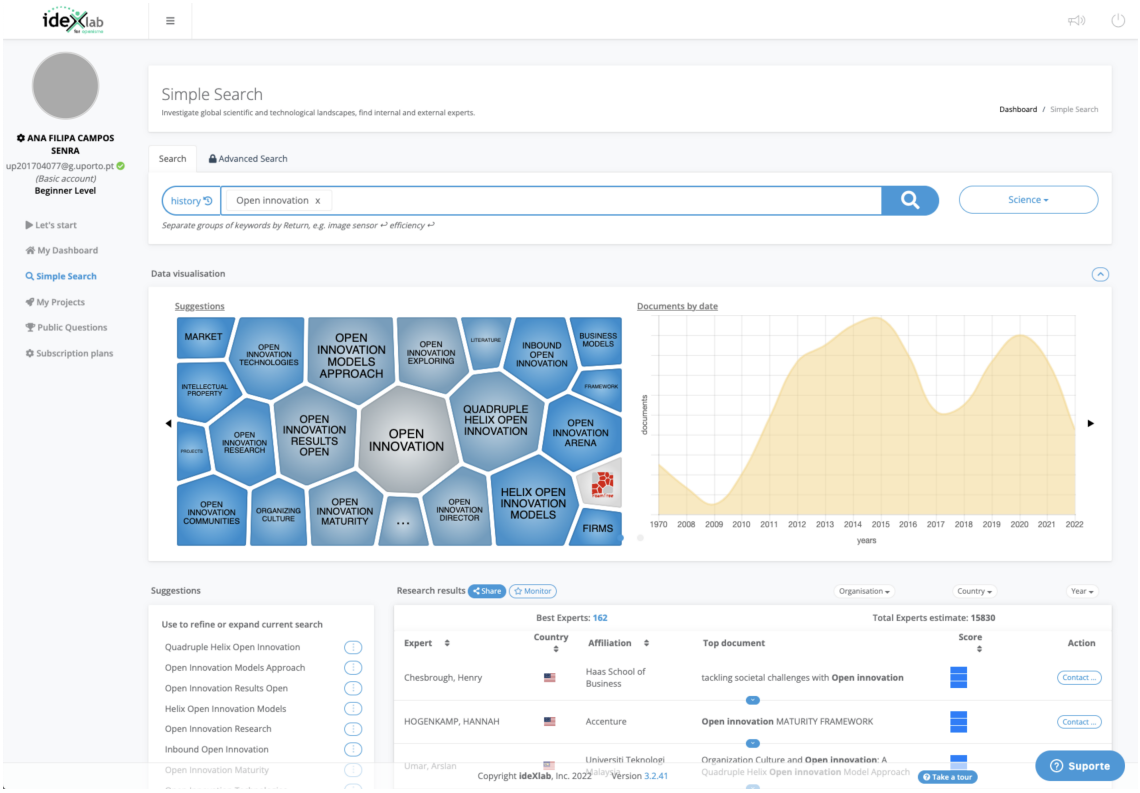


[3] www.openinnovation.regione.lombardia.it

2.6.2 IdeXlab

IdeXlab[4] is an e-innovation platform that allows the scientific community to innovate faster by detecting and contacting the best experts or the most relevant companies. More than just connecting users with other participants, organizations and projects already on the platform, it also scans scientific publications, patents, companies and startups descriptions to provide users with external knowledge (Figure 2.5).

Figure 2.5: Search for *Open Innovation* in IdeXlab[4].



2.6.3 Viima

Viima[5] is an all-in-one innovation platform that helps users gather ideas and develop them into innovations. It also aims to go further than simply gathering ideas by providing tools for prioritizing and picking the right ideas to work on and analysing the innovation process in order to find and eliminate bottlenecks (Figure 2.6).

[4] www.idexlab.com
[5] www.viima.com
[6] Source: https://www.viima.com/microsoft-teams-idea-management

Figure 2.6: General view of a project in Viima[6].

2.6.4 Crowdspring

Launched in 2008, Crowdspring[7] is a design Open Innovation digital marketplace where users can connect with thousands of designers who submit their designs based on the customer's requirements. After designers submit their first iteration, the customer and the designers enter a Co-Creation phase where they adapt the final project based on the feedback from both parties (Figure 2.7)

2.6.5 Kaggle

Kaggle[9] is an online community of data scientists and machine learning engineers that processes raw data collected and submitted by organisations. Users discover and publish datasets, analyse and create models in a web-based data-science environment, work with other data scientists and machine learning engineers, and join competitions to solve data science challenges (Figure 2.8).

2.6.6 Special case for cities

We have gathered four examples of Open Innovation Digital Platforms that were developed for (and by) cities. Although some of these platforms enable organizations and individuals not in the city council to create challenges and projects, they all require these challenges to be related to the

[7] www.crowdspring.com
[8] Source: https://www.crowdspring.com/1to1-projects/
[9] www.kaggle.com

Figure 2.7: Short overview on how Crowdspring 1-to-1 projects work[8].

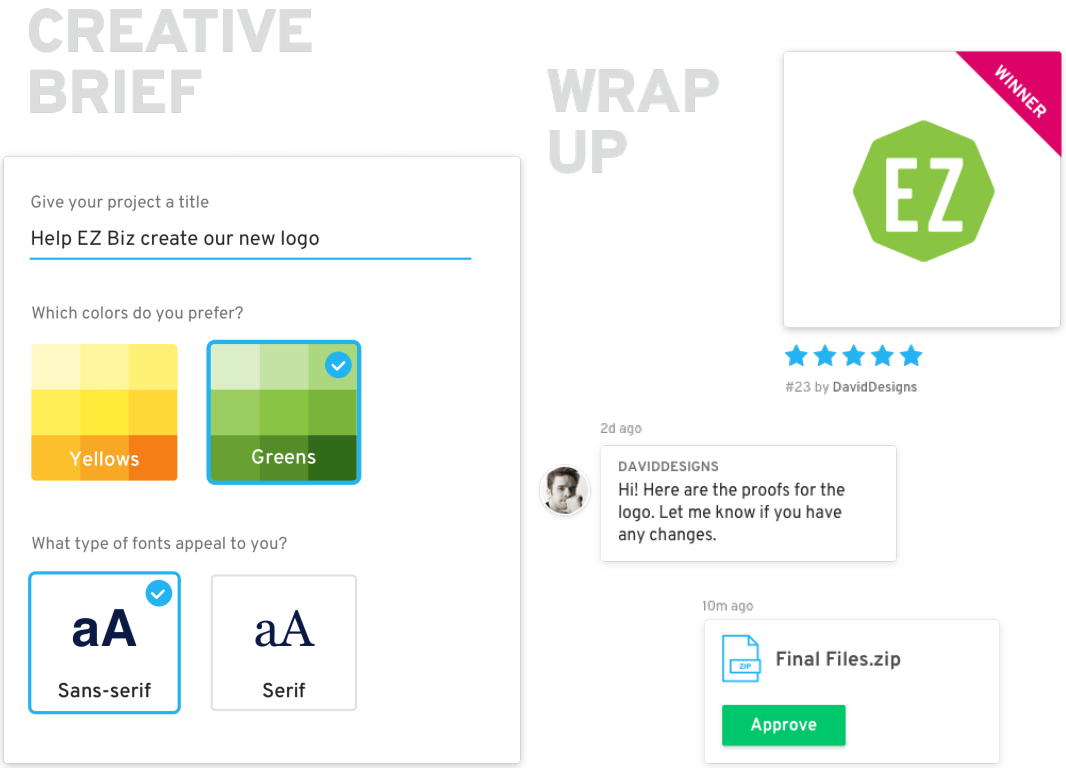
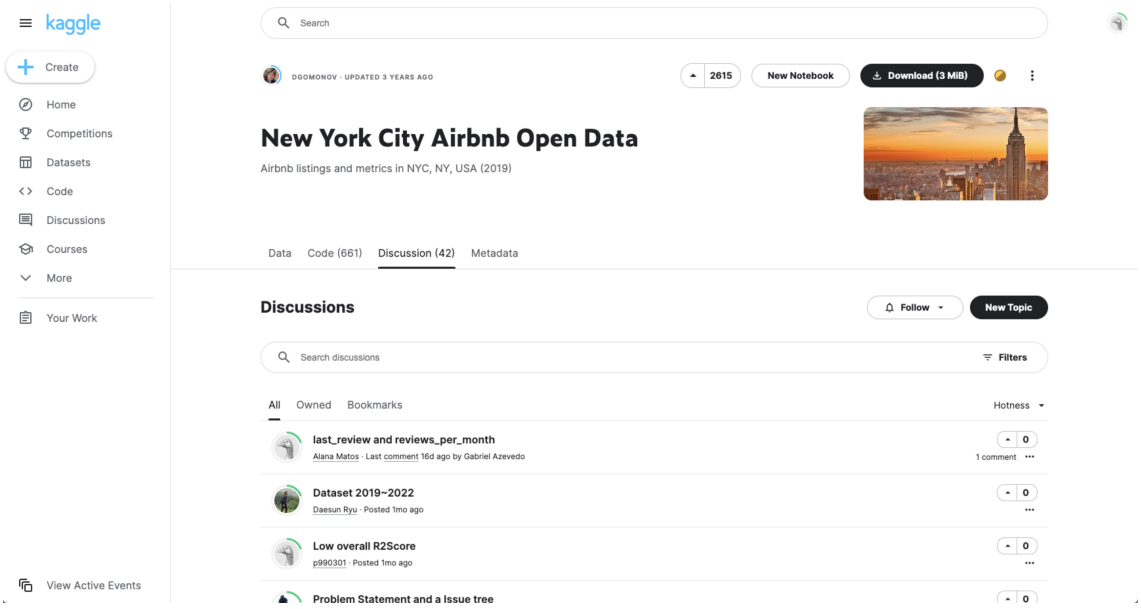


Figure 2.8: Discussion tab at a Dataset in Kaggle[9].

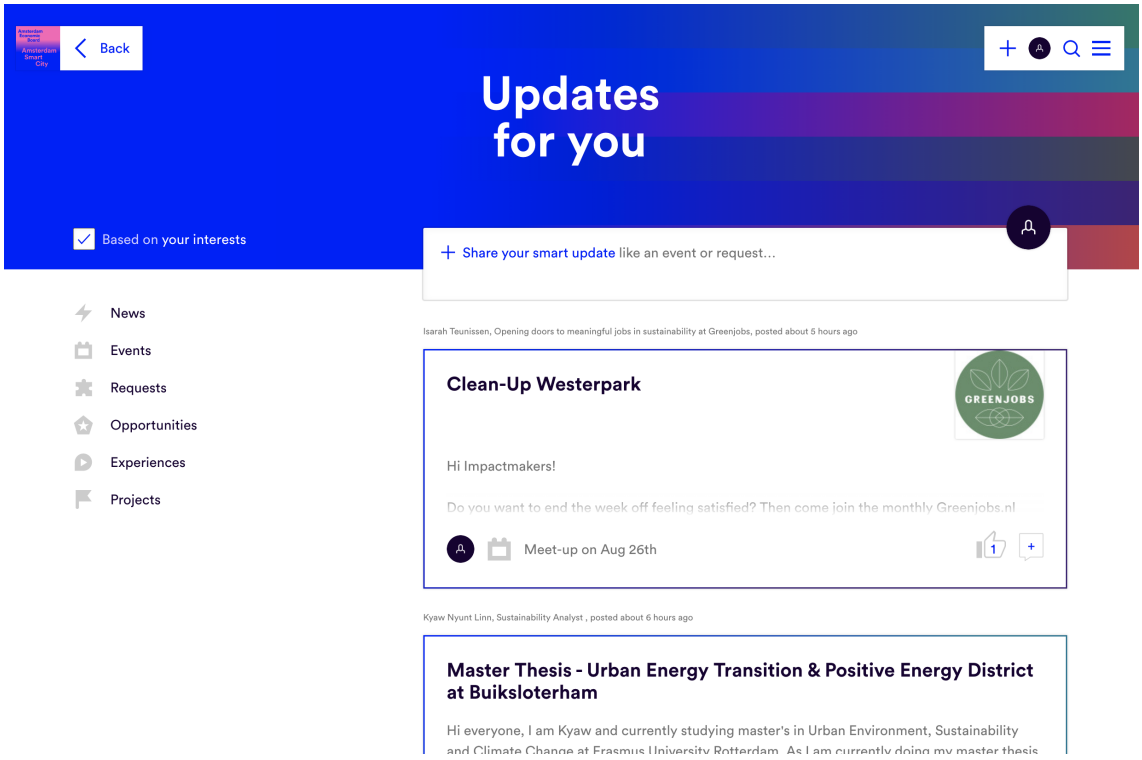


city or city region. To note, that we could only find platforms that encourage Co-Creation and Open Innovation but none that had Agility taken into account.

2.6.6.1 Amsterdam Smart City

Amsterdam Smart City has an Open Innovation platform[10] where companies, knowledge institutions, governments and active residents come together, interact and collaborate on challenges and solutions for the Amsterdam region. Individuals and organizations are invited to share news, events, requests and projects always related in some way to Amsterdam (Figure 2.9).

Figure 2.9: Update mural in Amsterdam Smart City Open Innovation Platform[10].

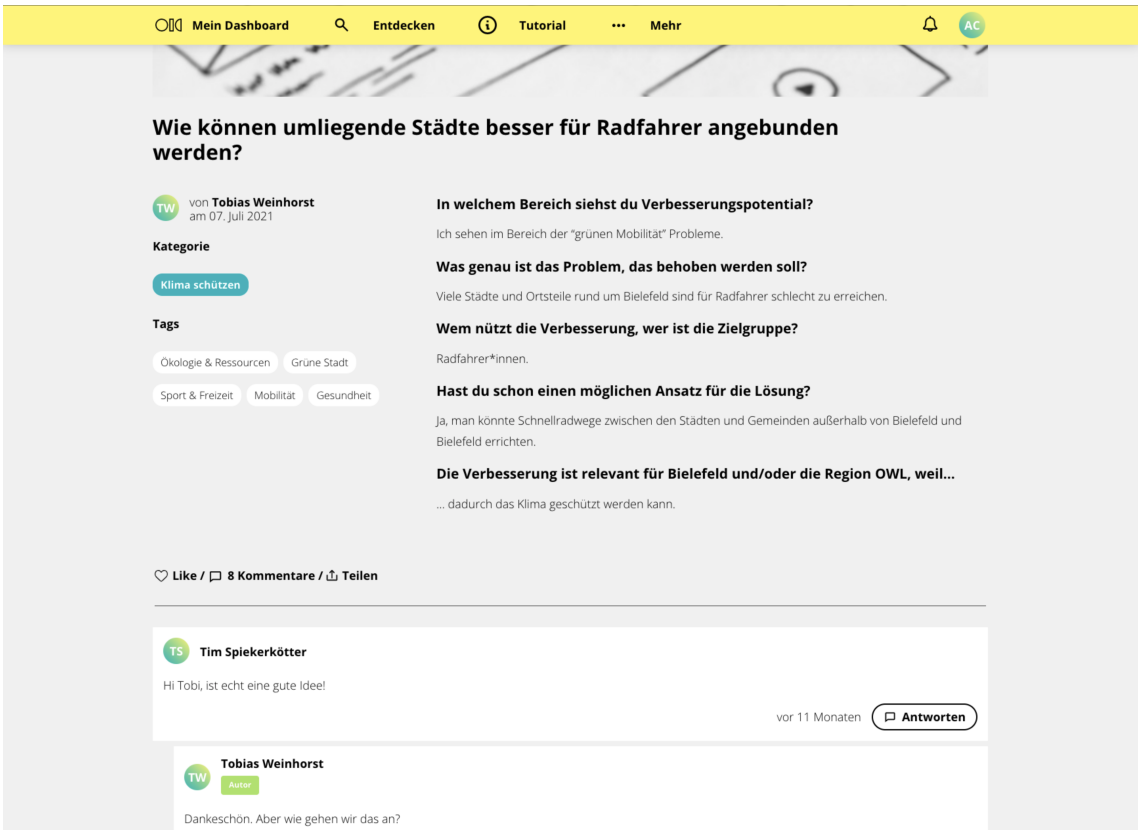


2.6.6.2 Open Innovation City Community

Born from the Open Innovation City Bielefeld initiative, Open Innovation City Community[11] is a platform where innovative ideas and solutions for Bielefeld and the Ostwestfalen-Lippe region are developed and jointly implemented in an open exchange. Although most of the challenges in the platform are around the city or region itself, it is also possible for private individuals and organizations to publish their own innovative ideas (Figure 2.10).

[10] www.amsterdamsmartcity.com
[11] www.openinnovationcity.de/vernetzung/open-innovation-city-community

Figure 2.10: Challenge post in Open Innovation City Community[11].



2.6.6.3 Testbed Helsinki

As a part of Helsinki's 2017-2020 strategy to be the most functional city in the world, Testbed Helsinki[12] is an initiative for organizations and RDI actors to find development and testing opportunities for new products and services offered by the City of Helsinki. The city creates and supports development and testing platforms, known as testbeds, which can be physical or virtual environments where the development and testing of new products can be done with partners of the city (Figure 2.11).

2.6.6.4 Decide Madrid

Launched in 2015, Decide Madrid[13] was the first platform that enable the e-participation of citizens, associations, NGOs and companies in policy for the Madrid municipality [37]. Participants can "make proposals, vote in citizen consultations, propose participatory budget projects, decide on municipal regulations and [be part of] open debates" [37] (Figure 2.12).

[12] https://testbed.helsinki/en
[13] www.decide.madrid.es

Figure 2.11: Promotion for Testbeds related to *Build Environment* [12].

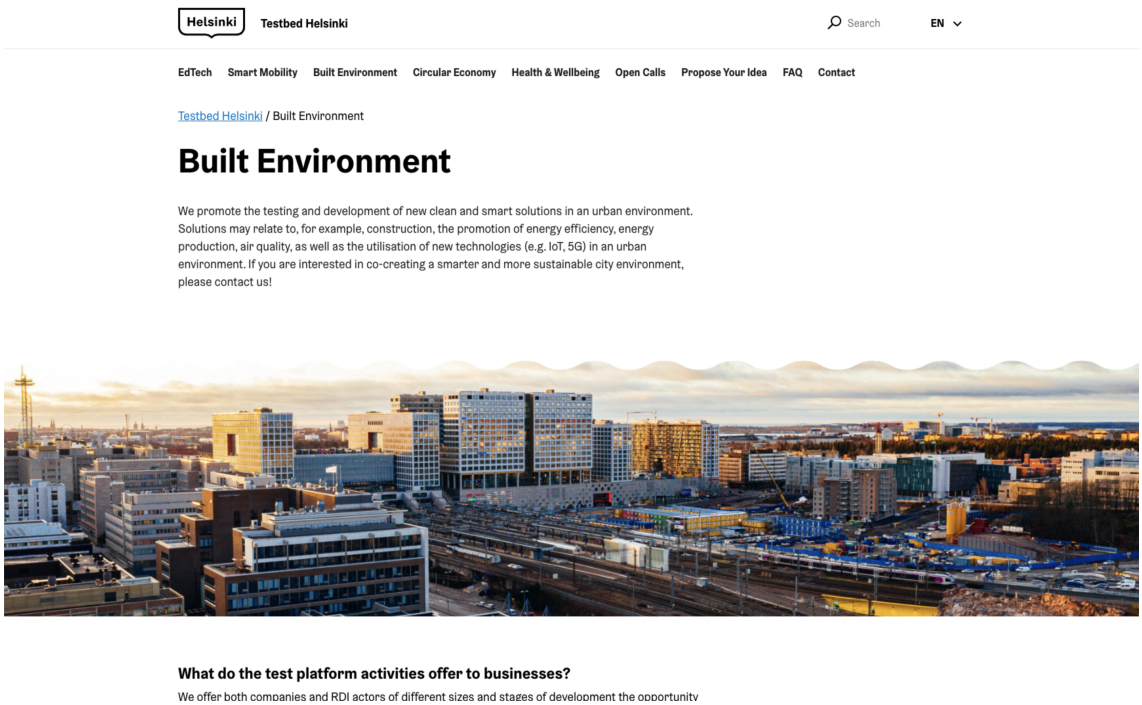


Figure 2.12: Debate page in Decide Madrid [13].

2.7 Comparing OIDPs' features

We have compared the nine platforms presented in Section 2.6 in five different areas: 1) Who can launch and participate in challenges; and support for the four different phases of the Interactive Coupled Open Innovation process, i.e. value creation process: 2) Collaboration in the Problem Definition; 3) Finding Participants; 4) External Collaboration, and; 5) Levering and Measuring the Collaboration Results. Our findings are summarized in Table 2.1.

2.7.1 Who can launch and participate in challenges

Most platforms allow any registered user to launch challenges. However, Open Innovation Platform Regione Lombardia[3] and Tesbed Helsinki[12] preapprove challenges before they are made public. In the case of Decide Madrid[13], only Madrid stakeholders – the city itself, Madrid citizens and organizations that influence the Madrid region – can launch challenges.

Regarding who can participate in challenges, platforms fall into two categories: 1) everyone can participate if they can register on the platform; or, 2) only the challenger and the participants the creator has chosen can participate. Open Innovation Platform Regione Lombardia, IdeXLab[4], Viima[5], Crowdspring[7] and Testedbed Helsinki require project managers' approval for participation in any stage of the innovation process. Kaggle[9], Amsterdam Smart City[10], Open Innovation City Community[11] and Decide Madrid allow any authorised user of the platform to participate in the innovation process to various degrees. Decide Madrid allows full participation in any project, while Kangle provides different access levels for different types of innovation challenges.

2.7.2 Problem Definition

Seven of the seven platforms – Open Innovation Platform Regione Lombardia[3], IdeXlab[4], Viima[5], Crowdspring[7], Kaggle[9], Amsterdam Smart City[10], and Testbed Helsinki[12] – rely solely on the challenger for the problem definition. They assume that when the challenge reaches the platform it is already fully defined. Although some platforms don't support the collaboration for problem definition, they recognize this shortcoming. The Open Innovation Platform Regione Lombardia incentivizes participants to collaboratively work on the problem definition, by promoting open events by various institutions and having a sort of "tutorship" to guide individuals on the best approach to publish a challenge on the platform [2][pp. 1440-1441]. Amsterdam Smart City[10] also promotes events in its platform.

Open Innovation City Community[11] and Decide Madrid[13] both support problem definition. For Open Innovation City Community, there is a specific and clear workflow to publish an idea and request collaboration to turn it into a challenge. This idea-to-challenge workflow is independent of the workflow aimed to resolve a challenge, and features a comment section for collaboration. In Decide Madrid, the request for collaboration for problem definition isn't as clear as in OI City Community, however, there is a space where individuals post and debate ideas, with the intention to refine their ideas into proper proposals.

OIDPs	Aimed at City Management	Who can launch a challenge	Who can participate in challenges	Collaboration for problem definition	Finding participants	External collaboration	Leveraging and Measuring the collaboration results
Open Innovation Platform Regione Lombardia	No	Everyone (preapproved by platform staff)	Challenger Chosen participants	NS, but collaboration promoted within the platform	Manual selection Algorithm suggestions	Communities Plugins Documents section News section Project Management Section Monitoring service prototype	NS
IdeXlab	No	Everyone (license)	Challenger Chosen participants	NS	Algorithm suggestions Organic search	Contact participants External knowledge with data mining	NS
Viima	No	Everyone (freemium)	Challenger Chosen participants	NS	NS	Custom processes Discussion, Monitoring & Prioritization features	Tracking of ideas' implementation Tracking of business impact Business impact analytics visualization tool
Crowdspring	No	Everyone	Challenger Chosen participants	NS	Algorithm suggestions Manual selection	Feedback loop	NS
Kaggle	No	Everyone	Everyone	NS	Algorithm suggestions Organic search Competitions	Discussion tab & Open Code/Datasets Policy	NS
Amsterdam Smart City	Yes	Everyone	Everyone	NS	Algorithm suggestions Organic search	Discussions under all types of posts.	NS
Open Innovation City Community	Yes	Everyone	Everyone	Supported, if collaboration for idea definition requested NS, otherwise	Algorithm suggestions Organic search	Discussions under all types of posts.	NS
Testbed Helsinki	Yes	Everyone (preapproved by managers)	Challenger The City of Helsinki Chosen participants	NS	Publicized in platform	NS	NS
Decide Madrid	Yes	The City of Madrid Madrid citizens Madrid associations Madrid NGOs Madrid companies	Madrid citizens Madrid associations Madrid NGOs Madrid companies	Supported, if collaboration for idea definition requested NS, otherwise	Algorithm suggestions Organic search	Open debates in forums & communities Questionnaires Voting consultations Participatory budget projects	NS

Table 2.1: Summary of the comparative analysis of the different OIDPs.

2.7.3 Finding Participants

Most of the platforms for Open Innovation focus on this stage: their foremost objective is connecting individuals and so foment open collaboration. Apart from Viima[5], all other platforms support the finding participants phase and give it significant importance, i.e. Open Innovation Platform Regione Lombardia[3], IdeXlab[4], Viima[5], Crowdspring[7], Kaggle[9], Amsterdam Smart City[10], Testbed Helsinki[12] and Decide Madrid[13].

Platforms usually implement algorithms to cross information given by individuals upon registration and the problem definition to match participants to projects and showcase, in a timeline, projects, for participants, and potential collaborators, for project managers.

Although most platforms implement an algorithm to showcase matches to users, some don't. This is the case for Testbed Helsinki. It bets on heavily curating the ideas they showcase on the platform and in hopes that potential participants contact project managers in order to collaborate.

Apart from matching individuals to projects or, in the specific case of Testbed Helsinki, strongly curating ideas, platforms also provide advanced search features that allow users to find projects or other individuals according to keywords, interests and other criteria.

2.7.4 External collaboration

Open Innovation Platform Regione Lombardia[3], IdeXlab[4], Crowdspring[7], Kaggle[9], Amsterdam Smart City[10], Open Innovation City Community[11] and Decide Madrid[13] all support the external collaboration phase.

OIPRL has many tools to support the collaboration between individuals such as communities to discuss ideas, a documents section, a news section, plugins (e.g. for conference calls), a project management section and a monitoring service prototype [2][pp. 1441-1442]. IdeXlab allows for the contact between users and more interestingly serves users with external knowledge sources that have been collected by the platform with data mining. Viima allows flexibility by allowing managers to customise processes. It also has monitoring and discussing features. Crowdspring supports a feedback loop between client and partners that allow the exchange of messages, documents and ideas. Kaggle, Decide Madrid, Amsterdam Smart City and Open Innovation City Community have forum like features. Kaggle also features an Open Policy that allow multiple users to add their contributions to datasets and code. Decide Madrid offers further options for users to Co-Create such as questionnaires, voting consultations and participatory budget projects [37].

All of these features were born to support unique flows of the Co-Creation process for the challenges launched on the different platforms.

2.7.5 Leveraging and measuring the collaboration results

The grand majority of the analysed platforms don't support the leveraging and measuring of collaboration results. They tend to focus on the collaboration between participants to form ideas and

come up with solutions and assume that there is no further need for collaboration beyond this point.

Only Viima[5] offers some sort of support for the levering and measuring of the collaboration results, although being quite limited. Viima supports the tracking of the implementation, by allowing to personalize the state of an idea. Regarding measuring the impact of the collaboration result, Viima allows some support for tracking the business or financial impact of the implemented and estimated value of the OI portfolio. Viima, like the other platforms, also doesn't support any other type of impact or even the aid in the collection, storage and organization of data of any kind.

2.8 Summary

In this chapter, we analysed three key concepts – Open Innovation, Co-Creation and Agility – to understand this work's research scope. We have also provided examples of the application of these three concepts in the real world. In addition, we analysed the concept of Open Innovation Digital Platforms: its definition, what dynamic capabilities they should support, and how do these relate to the phases of the interactive coupled Open Innovation process. Finally, and perhaps most importantly, we analyse how the OIDPs capabilities and couple OI phases have been translated into features by existing Open Innovation platforms.

None of the analysed Open Innovation Digital Platforms (see Section 2.6) was developed targeting Agile teams' workflows. However, they showcased some interesting features related to Co-Creation and Open Innovation:

1. **Collaboration in Problem Definition.** Workflow from idea to a challenge; Forum-like discussion areas to find new ideas and generate debate in order to refine future problem definitions.

2. **Finding participants.** Organically; Through algorithms that match individuals to projects based on common interests.

3. **External collaboration.** Support for restricted project areas that contain a document, news, (forum-like) discussion and survey sections; Completely Open discussion forums; Platform-wide voting consultations; Participatory Budget Proposals.

4. **Leveraging and measuring the collaboration results.** Personalise development state of sub-tasks; Tracking of business or financial impact of the implemented innovations and estimated value of the OI portfolio.

With the information described in this chapter (Chapter 2) and after analysing the planned development efforts for the City Catalyst Open Innovation Platform (Chapter 3), we propose seven groups of features (Chapter 5) to enhance the current planned City Catalyst Platform in order to better support and encourage activities related to Co-Creation, Open Innovation and in particular Agility.

Chapter 3

City Catalyst: Open Innovation Platform

In this chapter, we describe the planned City Catalyst Open Innovation Platform. Some modules required so the platform is fully in line with its overall goals are still being planned and so they are not included in this chapter.

We start by giving a general description of the platform, including the overall goals and high-level requirements. We follow by describing the five planned modules – User Management, Challenges and Solutions, Project Management, Communication and Empowerment –, the actors, the low-level requirements and the system architecture.

3.1 Description

The City Catalyst Open Innovation platform aims to promote innovation ecosystems dedicated to the development of smart and sustainable cities. The platform, aimed at cities, intends to foster collective intelligence and act as an intermediary for the creation of innovative products, processes and services that contribute to the increased sustainability of cities.

The overall goals for the City Catalyst Open Innovation platform are:

- Boost collective intelligence by searching for new and innovative solutions in the context of smart and sustainable cities;
- Foster the creation of innovation ecosystems in cities;
- Involve all stakeholders in the development process (quadruple helix[1]) of new products or services, promoting Open Innovation through the application of concepts such as user-driven innovation, agile, co-design, crowd-sourcing and living labs;

[1]The quadruple helix framework describes university-industry-government-civil-society interactions within a knowledge economy [35][p. 17].

- Create an innovation support network promoting companies with services related to business creation, innovation, market analysis, among others;
- Promote the empowerment of all stakeholders, namely citizens, within the scope of Open Innovation; and,
- Monitor the innovation and efficiency of the promoted actions.

The City Catalyst Open Innovation platform will act as an intermediary in the Open Innovation and Co-Creation process. To successfully play this active intermediary role in the OI and Co-Creation process, a few high-level requirements have been identified as necessary:

- Identify urban challenges in the context of smart and sustainable cities;
- Promote the Co-Creation of innovative products, processes and services;
- Empowering companies to participate in Open Innovation and Entrepreneurship;
- Publicize the main actions, opportunities and events within the scope of the innovation platform;
- Match users to relevant challenges and projects;
- Support and monitor the Co-Creation and Open Innovation efforts;
- Provide access to living labs for validation of new solutions; and,
- Monitor the effect of the Co-Created solutions.

The platform will be a web application, that has companies, academia and government agents as its target audience. Users should be able to use the platform without any prior training.

We describe in more detail how these identified services will be translated into features for the first iteration of the City Catalyst Platform in Sections 3.2, 3.3, and 3.4.

The development of the platform will be carried out in several phases, adding new and adapting current functionalities as user feedback is gathered. The first iteration of the platform will consist of creating a digital environment that allows the creation and later development of an Open Innovation Challenge. Tersely, in this first iteration of the platform, various challenges will be launched in the context of smart and sustainable cities, allowing solvers to submit their proposals and later develop them.

3.2 Modules

The platform will, in the first iteration, have five modules: User Management, Challenges and Solutions, Project Management, Communication, and Empowerment. It has already been identified the necessity for two extra modules for: 1) Monitoring the impact of the platform and the solutions created within it; and 2) Developing an algorithm to match users to relevant challenges and projects. However, both modules will be implemented in later iterations of the platform. It is also expected that new modules and changes to current ones will be identified as user feedback is collected through the various iterations.

3.2.1 User Management

The user management module horizontally transverses the entire system and all other modules depend on it. It handles users' profiles and so it determines access permissions to other modules. The development priority of this module is high.

3.2.2 Challenges and Solutions

The challenges and solutions module's main objective is to boost Open Innovation. Municipalities or municipalities' representatives will be able to publish opportunities for innovation. The community will then propose solutions for these challenges based on their capabilities. During the publication process, the municipality will associate one or more appraisers who will be responsible for evaluating solutions, adding challengers to better prioritize and select the winning solutions. There will also be the possibility for municipalities to directly create a solution. The development priority of this module is high.

This module captures the two first phases of the interactive coupled OI process, problem definition and finding participants, and so it possesses sensing, seizing and scanning dynamic capabilities (Figure 3.1).

3.2.3 Project Management

After the application phase, the municipality or the stakeholders representing the municipality will be able to follow the progress of the work of the winning teams through the project management module. In this module, it will be possible to create milestones, submit deliverables and interact with the project's mentor. The development priority of this module is medium.

The Project Management module captures the third phase of the interactive coupled OI process, external collaboration, and so it possesses integrative and transformative dynamic capabilities (Figure 3.1).

3.2.4 Communication

The communication module aims to help the dissemination of content regarding the platform and the challenges and solutions it hosts. The content management will be carried out by the authorized

entities and its visualization will be public. In this module, it will be possible to create, edit and remove messages, view and search them and add comments to messages. The development priority of this module is medium.

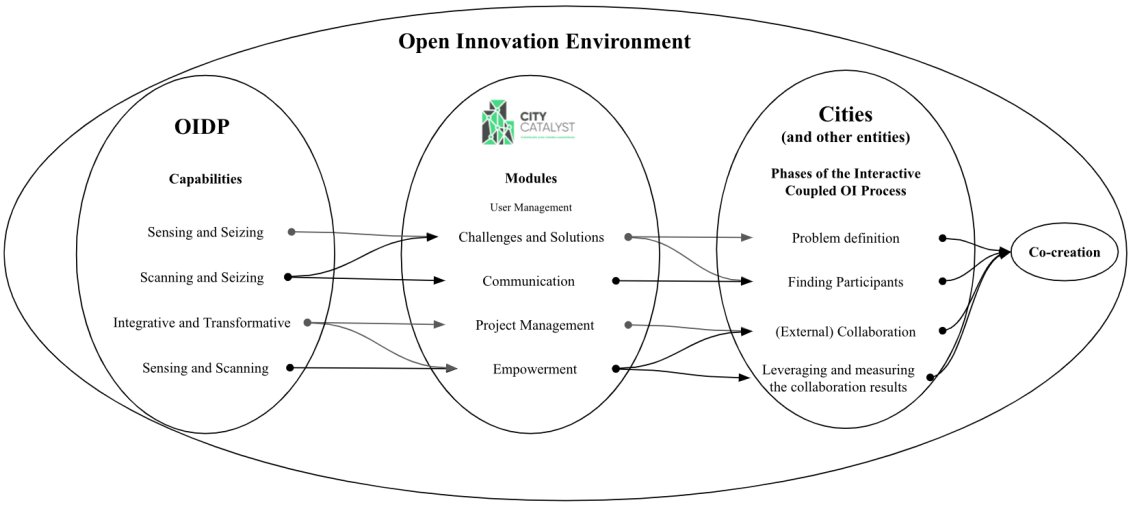
This module captures the second phase of the interactive coupled OI process, finding participants, and so it possesses seizing and scanning dynamic capabilities (Figure 3.1).

3.2.5 Empowerment

The empowerment module intends to promote training, qualification and awareness-raising initiatives. Through this module, authorized entities will be able to manage events such as open days, promote courses and webinars, and a network of service providers (i.e. accelerators, incubators, living labs). The development priority of this module is low.

This module captures the penultimate and part of the last phase of the interactive coupled OI process, external collaboration and leveraging the collaboration, and so it possesses integrative, transformative, sensing and scanning dynamic capabilities (Figure 3.1).

Figure 3.1: Relation between City Catalyst Modules, OIDP's dynamic capabilities and the phases of the interactive coupled OI process, also known as the value creation process.



3.3 Actors

The platform will have seven different actors: Admin, Lead user, Companies, Academia, Appraiser, Mentor and General user.

Admin System managers with permissions to add/change/delete users and to browse freely within the platform.

Lead user Government Agents that represent municipalities. Lead users have the power to launch challenges, create Appraiser and Mentor users, and accept a solution submitted for a challenge.

Companies Organizations with commercial purposes have the power to be able to submit answers to challenges and execute them if they are accepted.[2]

Academia Universities, Polytechnic Centers, and other academic institutions have the power to submit answers to challenges and to execute them if they are accepted.[2]

Appraiser Created by Lead users, they have the power to analyze and give an evaluation to a proposed solution to a challenge.

Mentor Created by Lead users, they have the power to monitor the execution of an approved solution, i.e. project.

General user Any user that does not fit on any of the other roles with only permission to see public content on the platform.

3.4 Low-level Requirements

The low-level requirements have been gathered with the help of the platform stakeholders for each of the five modules: user management, challenges and solutions, project management, communication, and empowerment. Each requirement has been assigned a priority from high to medium and low. Each level corresponds to the urgency of the requirement implementation, and so it is expected that each priority level's requirements closely resemble which features will be implemented for each iteration of the platform.

All of the functional requirements can be consulted in a functional requirements specification document in Annex A as well as in a user story format in Annex B.

A User Stories Map (Figure 3.2), a SiteMap (Figure 3.3) and a High-Fidelity Wireframes (Figure 3.4) have been created to allow the simple visualization of the low-level requirements for the City Catalyst Open Innovation platform. Both the SiteMap and the High-Fidelity Wireframes were designed only for the first iteration of the platform.

The User Management module will handle the registration on the platform: login, visualization and management of user profiles, Lead user requests and visualization and management of entities.

The Challenges and Solutions module will handle the features related to challenges and solutions: create and manage challenges and solutions and evaluate solutions.

[2]Hereafter, the terms *Entity* and *Entities* are utilized to reference both the Companies and Academia roles.

The Project Management module is responsible for the features related to the development of the accepted solutions, i.e. projects. The platform will allow the management of projects: teams will be able to manage milestones and deliverables along with receive guidance from invited mentors.

The Communication module will allow authorized users to create, publish, manage, see and comment platform-wide messages/communications to publicise challenges, solutions and projects.

The Empowerment module is responsible for creating and managing events and providers responsible for living labs and incubators.

3.5 System architecture

The platform will be developed in several independent modules (see Section 3.2). Each module will have a database (e.g. MySQL), an API (e.g. Express.js) and a micro front-end service in JavaScript (e.g. Angular, React, Vue). Single-Spa[3] will be utilized to bound together with the different modules in the same web application, giving the user a fluid experience (Figure 3.5).

Using Single-Spa will allow the different modules to be developed completely independently and autonomously from each other, using different technologies and hosted in different locations. However, the chosen technology for the front-end component of each module must be in JavaScript, so that it is compatible with Single-Spa.

The rationale behind the decision to develop the modules almost completely independently from each other comes from the fact that each module will be managed by different teams at different companies. Utilizing Single-Spa and so allowing a high degree of independence between modules will allow an easier and faster development process since the different teams don't need to coordinate closely with each other and so can employ their preferred technologies and procedures.

[3] https://Single-Spa.js.org

Figure 3.2: User Stories Mapping.

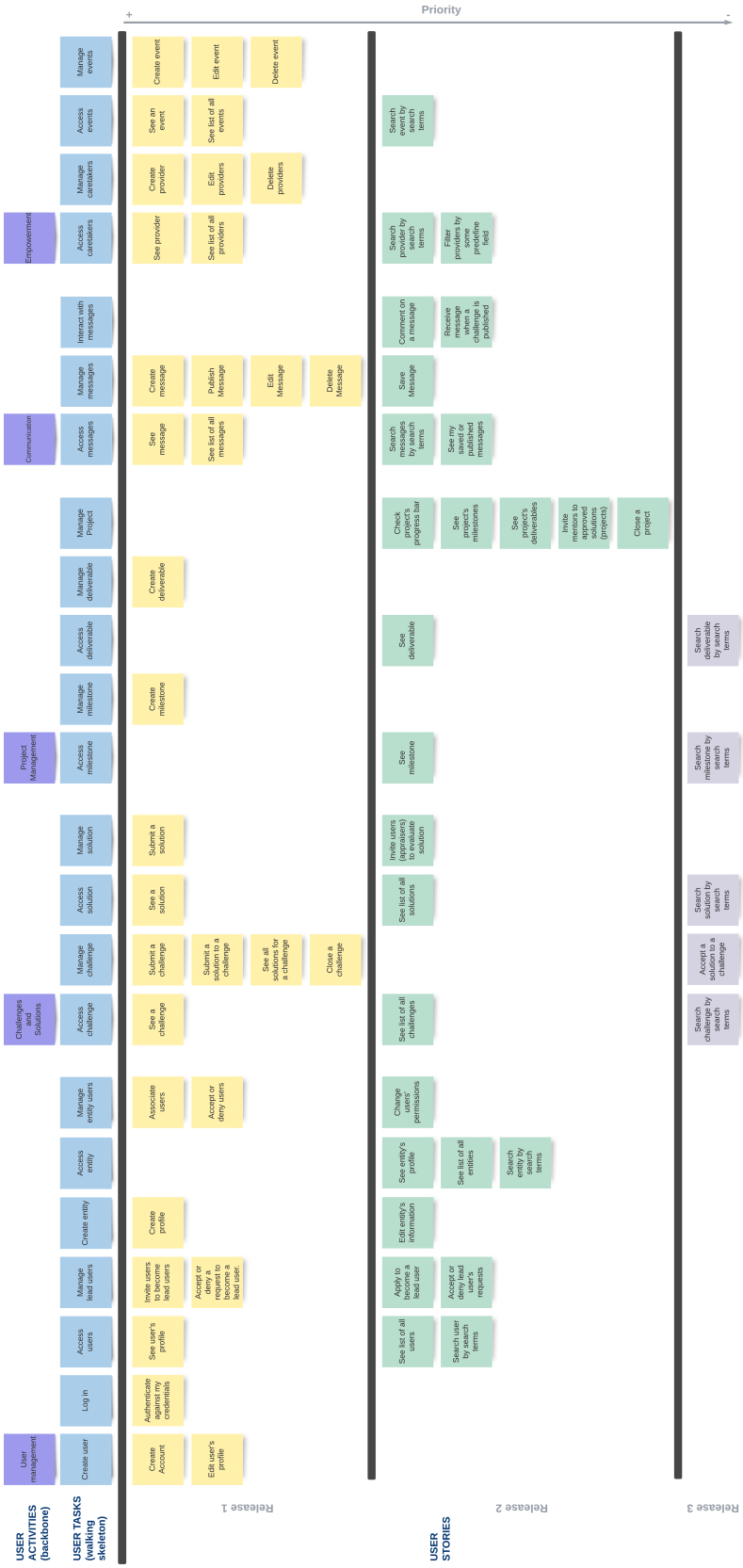


Figure 3.3: SiteMap.

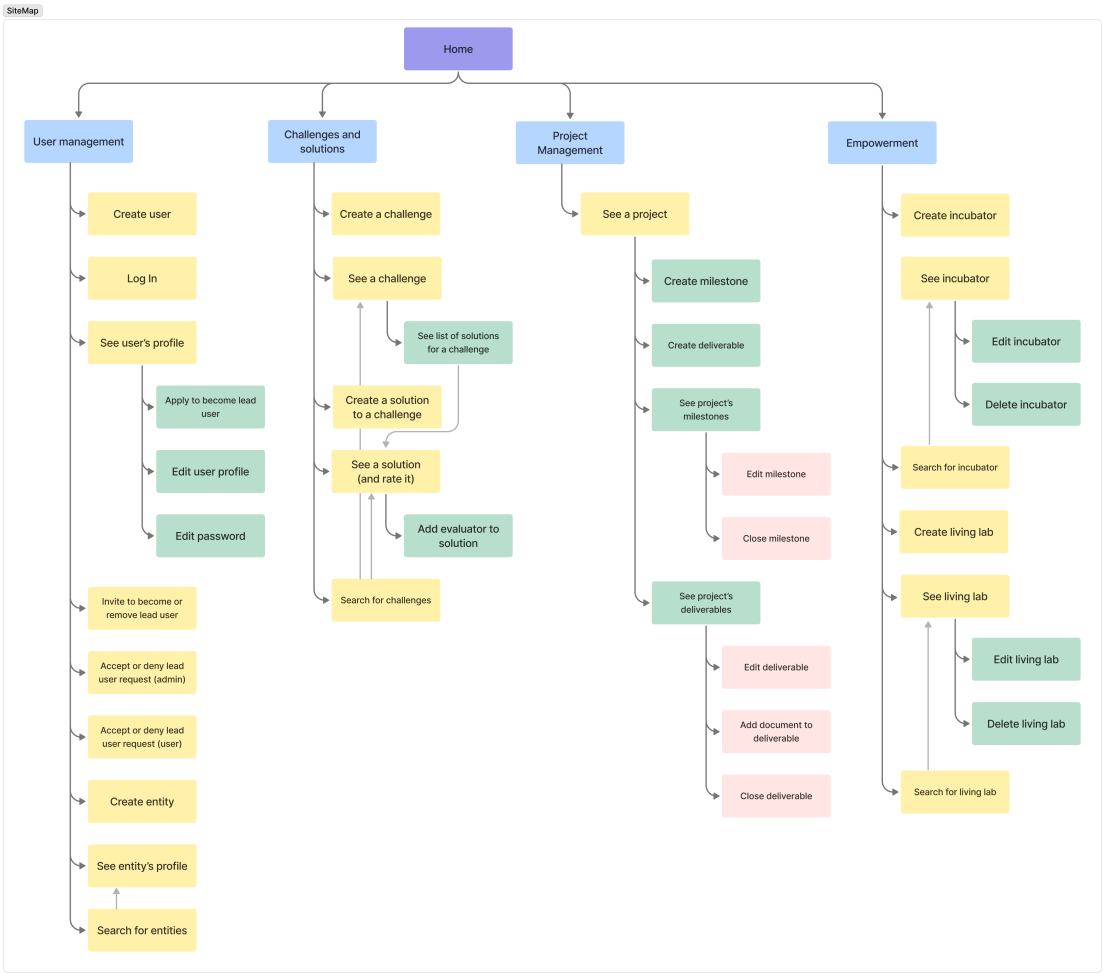


Figure 3.4: High-Fidelity Wireframes [14].

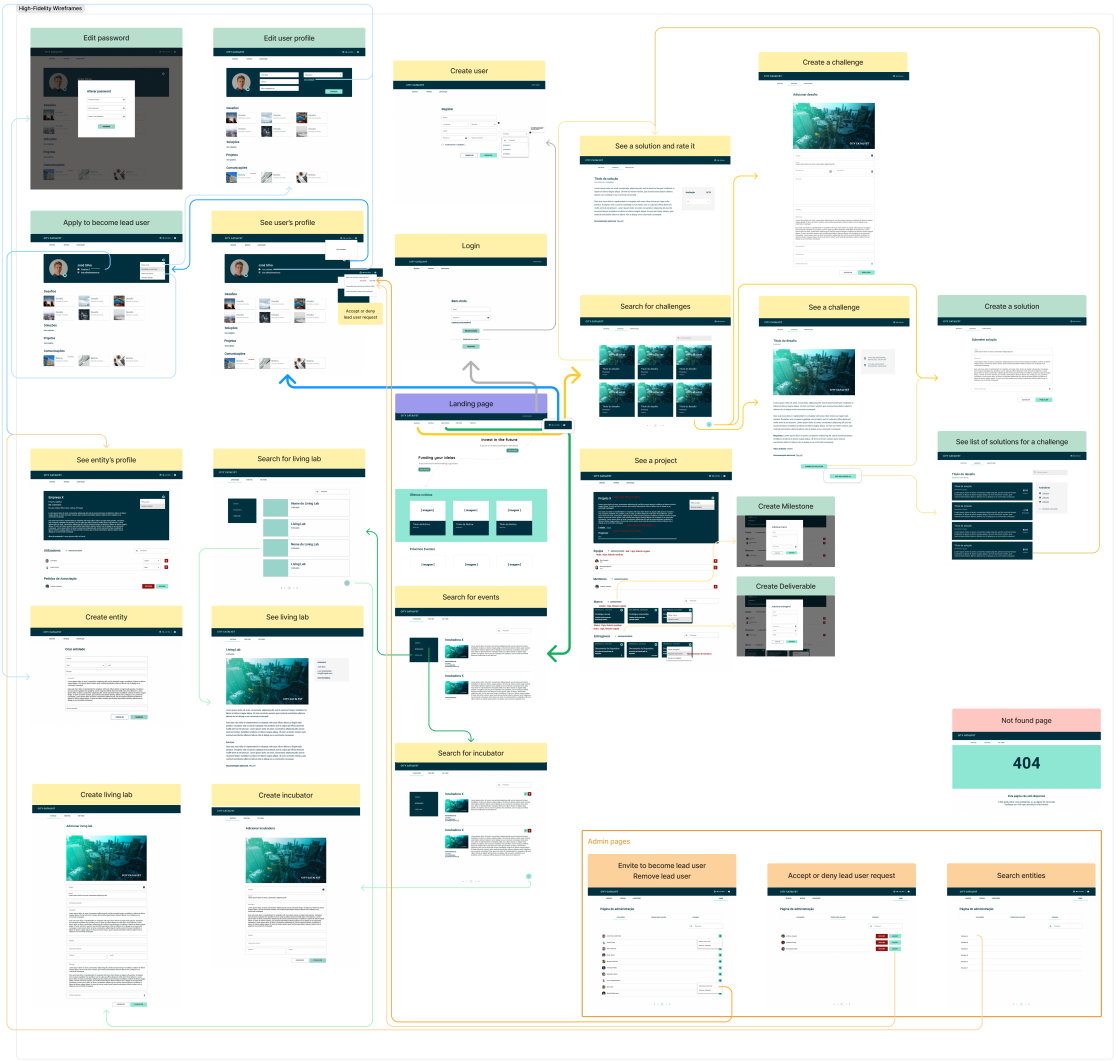
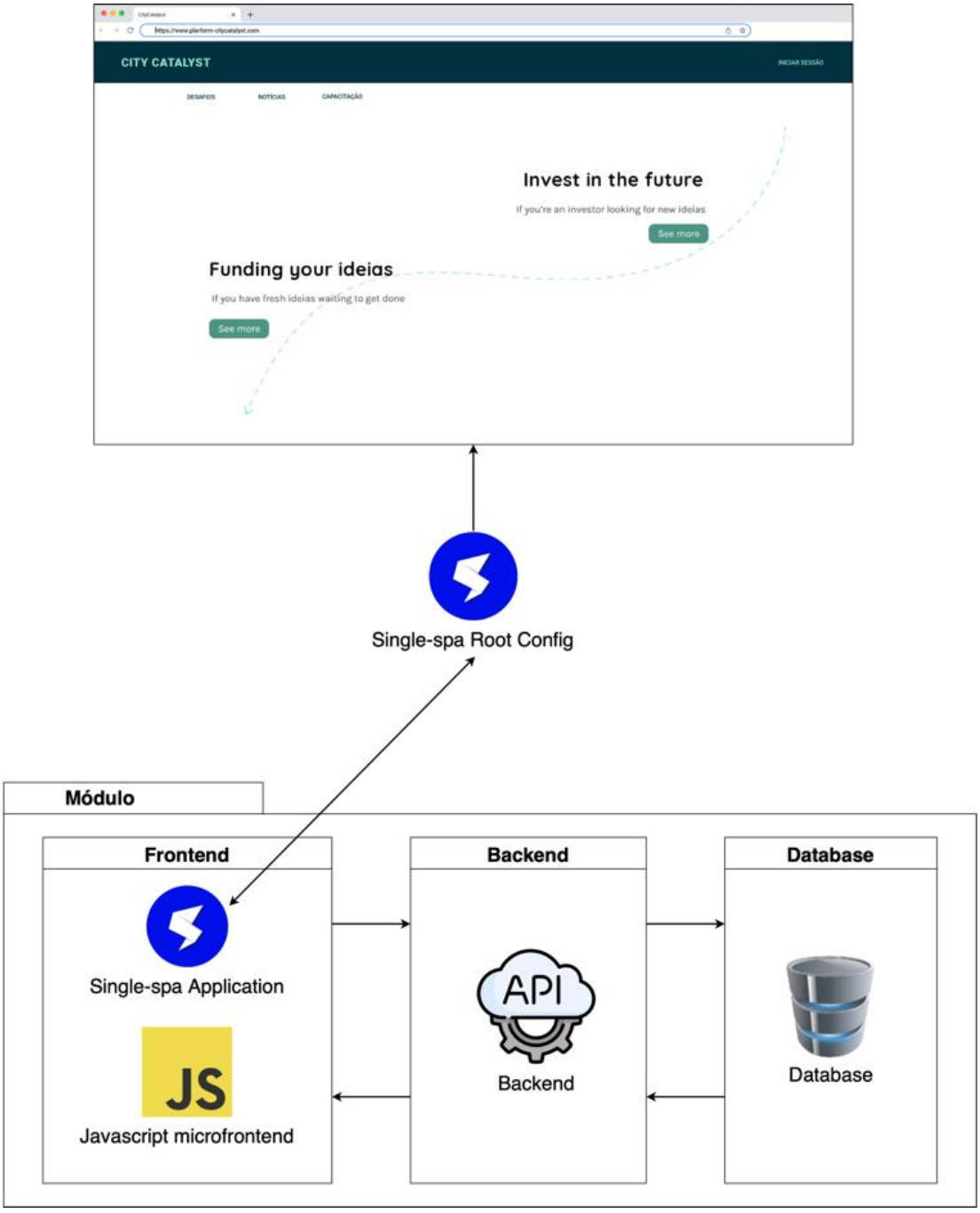


Figure 3.5: Diagram of a simplified version of the system architecture [38].



Chapter 4

Facilitating Decentralized, Participatory and Sustainable Cities

In this chapter, we identify the problems related to our research topic, our planned contributions to address these problems and the approach used in the development of this work. In particular, we describe the problems of cities that lead us to want to support Open Innovation, Co-Creation and Agile workflows in the City Catalyst Platform (Section 4.1), and what our planned contribution is for the support of these activities in the platform (Section 4.2). Ultimately, we describe the methodology used in the development of this work (Section 4.3).

4.1 Problem statement

Cities continue to demonstrate accelerated growth. Currently, urban areas house 55 percent of the world's population [31]. This number is expected to 68 percent by 2050 [31]. Accommodating massive amounts of individuals in a small area comes with advantages but also challenges.

Cities are the most versatile spaces in human civilizations, and they are a fertile ground for innovation and economic growth. Nevertheless, serving large amounts of people in a small area means that cities need to strike delicate balances in infrastructure projects, the services provided and the city's ecological footprint [22][pp. 1-3][29]. To incentivise and assist cities in addressing their challenges in a smarter, more efficient and collective manner, The European Commission launched the European Innovation Partnership on Smart Cities and Communities [14].

In the context of the European Innovation Partnership on Smart Cities and Communities challenge, the City Catalyst project aims to assist cities to become smart, decentralized and participatory [14][26, pp. 688-692][27, p. 286] to address cities' complex issues by providing a platform aimed at urban management where Open Innovation, Co-Creation and Agility can foster [14].

4.2 Planned contribution

The City Catalyst Open Innovation platform aims to be an instrument for cities to expose and define their problem, find an adequate solution provided by academia and companies and implement the chosen solution, solving cities' problems in an efficient, smart and collective manner [14].

This work intends to identify and describe interesting features outside of the current scope of the City Catalyst platform (Chapter 3) in order to improve the experience for cities, academia, enterprises and stakeholders' representatives to solve challenges. The proposed features are based on the analysed Open Innovation, Co-Creation, Agile workflows and Open Innovation Digital Platforms in Chapter 2, as well as in the Mobius Loop Framework [25].

4.2.1 Open Innovation, Co-Creation and Agile workflows and their support

Teams that operate in Open Innovation, Co-Creation and Agile environments are characterized by a set of attributes. These attributes may translate into distinct activities in function of teams' preferences, environments and action areas. However, they will tend to converge into overall similar approaches.

The City Catalyst platform should support the activities performed by these teams related to Open Innovation, Co-Creation and Agility so they are able and encouraged to:

- Employ transparency for superior collaboration;
- Communicate in all phases with stakeholders, developers and challengers;
- Value outcomes (and impact) over features;
- Make choices quickly and easily; and,
- Respond to change over following a plan.

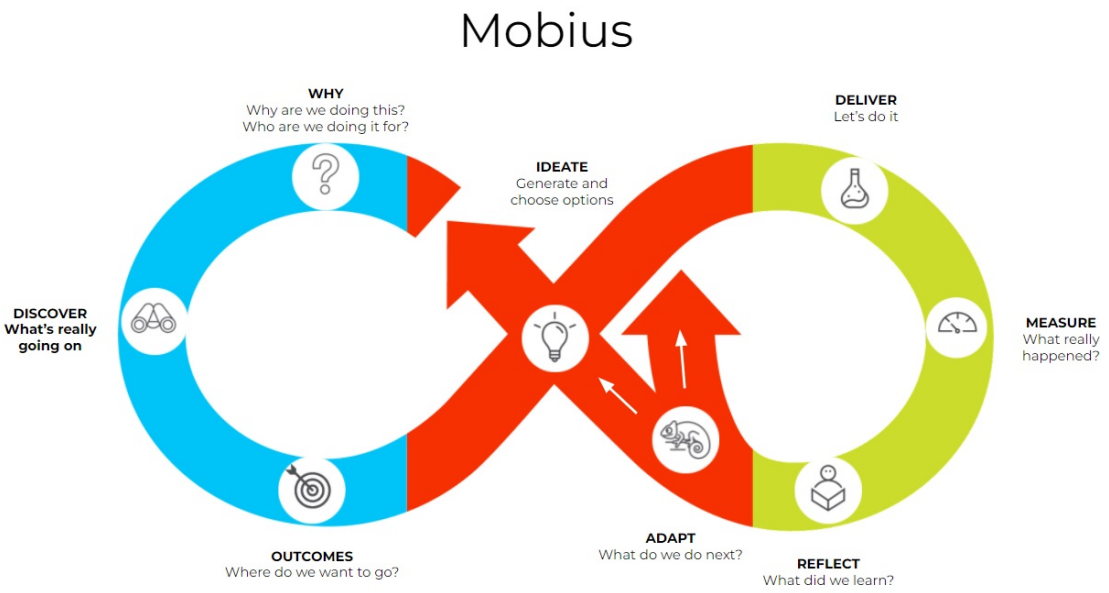
The suggested features of this work (Chapter 5) are inspired by OI, Co-Creation and Agility concepts (Chapter 2), but also from other Open Innovation Digital Platforms and how they have supported these activities (Section 2.8).

4.2.2 Mobius Loop Framework

The Mobius Loop framework is an Agile approach for problem-solving and aims to act as an accelerator for outcomes that truly matter, by improving speed and efficiency, so teams build less, get to market faster, and make a tangible impact [25]; all attributes desired by solutions for Smart Cities.

The Mobius Loop Framework describes two key concepts [25]: a flow that iteratively traverses discovery, ideation and delivery (Figure 4.1); as well as the Mobius trigger cards, that represent specific practices for each of the phases (Figure 4.2). Both of these concepts guide teams to more

Figure 4.1: Overview of the Mobius Loop [25].



easily and more efficiently utilize Agility successfully in their projects and so deliver impactful solutions consistently [25].

Concurrently with the development of this work, the Mobius Loop Framework was analysed and adapted for Open Innovation and Agility in Cities, particularly in the context of the City Catalyst Project [11]. From the work related to the Mobius Loop Framework, a set of trigger cards was selected as being of interest to be utilized in the context of City Catalyst's projects [11]. A further selection was made so to identify Mobius trigger cards suitable to be (partially or fully) supported by the City Catalyst Platform:

- Frame the Problem (Discover phase);
- Impact Tracker (Discover phase);
- Design Sprint (Options phase);
- Design Studio (Options phase);
- Generate Ideas (Options phase);
- Options Pipeline (Options phase);
- Retrospective (Deliver phase);
- Minimum Viable Product (Deliver phase); and,
- Quick Win (Deliver phase).

Figure 4.2: A few examples of Mobius trigger cards [25].

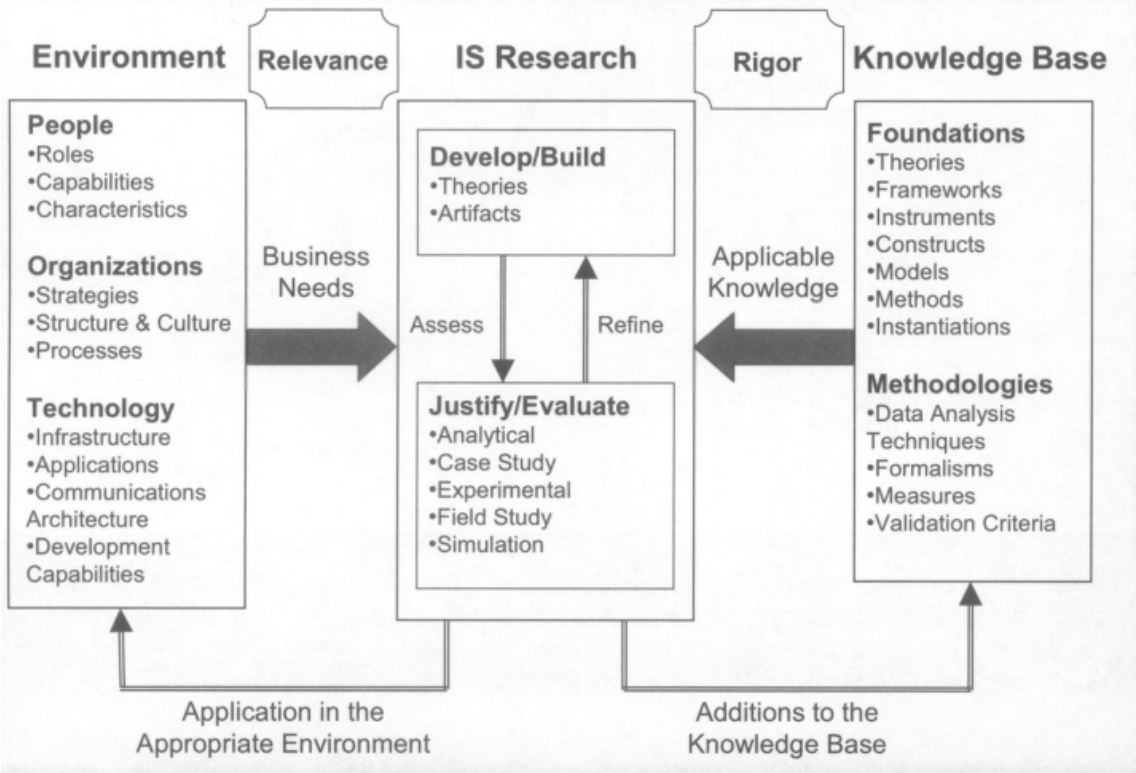
Ergo, this selection of Mobius trigger cards has also influenced the suggested features of this work (Chapter 5), so the City Catalyst Open Innovation Platform better supports Agility and related activities.

4.3 Methodology

The Design Science Research Methodology describes "a concise conceptual framework and a clear set of guidelines for understanding, executing and evaluating research" [19][p. 75] with the goal of assisting researchers in creating new and innovative artifacts to solve identified problems [19][p. 75]. The framework (Figure 4.3) describes the "boundaries of design science within the Information Systems discipline" [19][p. 77] while the guidelines (Table 4.1) describe how to "conduct and evaluate good design-science research" [19][p. 77].

This methodology aligns with this work's research goals since we intend to design features, i.e. create new and innovative artifacts, to support Open Innovation, Co-Creation and Agility activities in the City Catalyst Platform, i.e. to solve an identified problem. Hence, we have followed this methodology to explore and understand the problem space (Chapter 2) and subsequently come up with artifacts (Chapter 5) and validate them next to stakeholders (Chapter 6).

Figure 4.3: Information Systems Research Framework [19][p. 80].



Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Table 4.1: Design-Science Research Guidelines [19][p. 83].

Chapter 5

Supporting Co-Creation, Agility and Open Innovation in the City Catalyst Platform

In this chapter, we present a set of features grouped thematically to enhance the City Catalyst Platform to support Agility and Co-Creation in Open Innovation for Cities. Each of the seven groups of features was inspired by the concepts of Open Innovation, Co-Creation and Agility, Open Innovation Digital Platforms and the Mobius Loop Framework (Section 4.2).

Each section presents a short introductory summary of the motivation for the presented features, followed by: 1) a detailed account of the inspiration for the features' group; 2) a high-level definition of the features, including 2.1) their location on the platform, 2.2) the associated user stories and 2.3) Mock-ups having as base the already developed mock-ups for the first iteration of the City Catalyst platform; and, finally 5) the low-level requirements.

5.1 Framing the challenge

When creating a challenge in the platform, cities need to profoundly reflect on the problem at hand, so that they are able to thoroughly come up with a clear and succinct problem statement and accurately frame their challenge. A good and clear challenge statement will decrease the possibility of the acceptance and implementation of ideas that deviate from the ideal solution to the challenge.

In the City Catalyst platform, solvers will understand challenges nearly fully through their written descriptions on the platform. Therefore, it is even more critical that challengers are encouraged to allocate proper time and resources to describe their challenge in the most unambiguous and clear way possible, so as to avoid the acceptance and implementation of ideas that deviate from the ideal solution for the challenge.

5.1.1 Inspiration

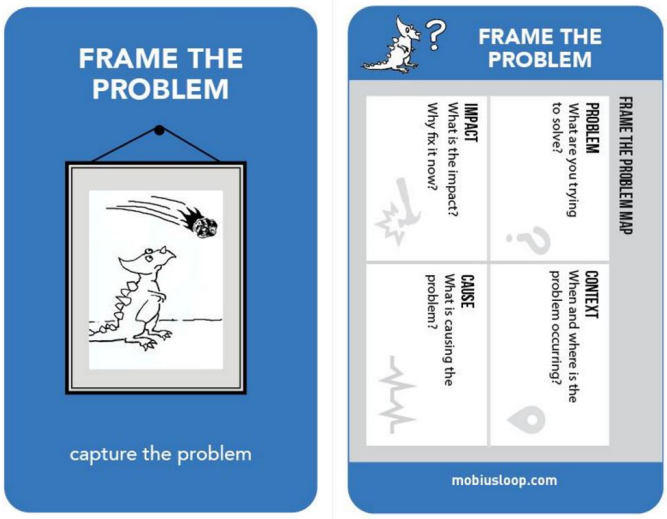
Framing the challenge was inspired by the Mobius Loop Trigger Card *Frame the Problem* (Figure 5.1). This card guides users to fully describe the problem at hand, so everyone, themselves and others, understands the problem in the same way.

While detailing the problem, its context, impact and cause may be time and resource-consuming, a problem well described will avoid ambiguities between everyone involved in a project: the challengers, developers and stakeholders. This means that everyone starts working on the project with an equal mindset avoiding problems related to misunderstood concepts and unrealistic expectations.

The later misunderstandings are caught in the value creation process the higher the cost of fixing them is, even for Agile teams [5][pp. 59-60]. Agile teams are differentiated from traditional development teams for having a short feedback loop and so having less pain related to changing requirements [5][p. 59]. Requirements changes always carry cost[1] [5][pp. 59-60]. For more traditional teams using waterfall mythology, the cost of requirements changes grows exponentially with time [5][pp. 59-60] (Figure 5.2). Agile teams are less sensitive to requirements changes, particularly during later stages of projects: the cost of change increases logarithmically with time up until the analysis and design phase, and linearly as implementation begins [5][pp. 59-60] (Figure 5.2).

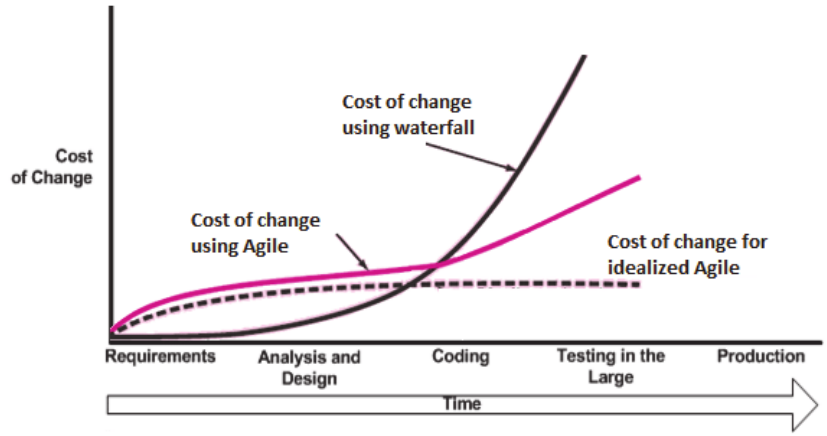
Hence, even for Agile teams, changing requirements always carries a cost, and changing requirements due to misunderstandings of concepts and expectations should be avoided if possible by, for instance, having a well-defined problem from the start of the value creation process.

Figure 5.1: Frame the problem – Mobius trigger card [25].



[1] In this context, cost should be understood as time, quality and monetary funds [5][pp. 58].

Figure 5.2: Cost change curve of traditional and Agile methodology [5][p. 60].



5.1.2 Description

In order to assist and guide the challenger on accurately and thoroughly framing their challenge, we recommend the addition of four extra optional fields to better describe a challenge:

1. **Problem.** What are you trying to solve?
2. **Context.** When and where is the problem occurring?
3. **Impact.** What is the impact? Why fix it now?
4. **Cause.** What is causing the problem?

These fields should also be accompanied by a helper where the challengers can consult a short summary and an (few) example(s) of what each field should hold.

Location in the platform

The four new fields will be added to the Challenge Creation and Challenge view pages in the Challenges and Solutions module. The helpers will be only added to the Challenge Creation page next to the four extra fields.

User Stories

US-DS14 As a Lead User, I want to provide information about the problem, context, impact and cause when creating a challenge so that I can properly frame my challenge.

US-DS15 As a Lead User, I want to have helpers regarding the problem, context, impact and cause fields when creating a challenge so that I can correctly fill them.

US-DS16 As a General User, I want to see the problem, context, impact and cause sections when viewing a challenge so that I can correctly understand a challenge.

Mock-ups for the creation and visualization of a challenge with the four extra fields can be found in Figures 5.3, and 5.4.

Figure 5.3: Mock-up for creating a challenge with Problem, Context, Impact and Cause fields with helpers.

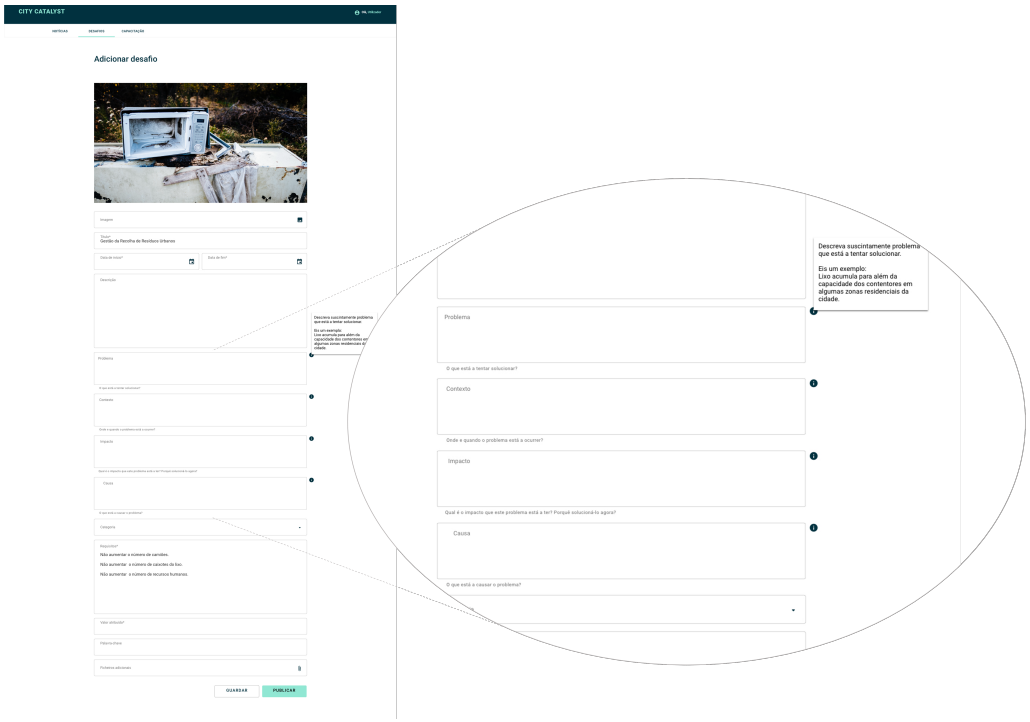


Figure 5.4: Mock-up for viewing a challenge with Problem, Context, Impact and Cause fields.

5.1.3 Low-level requirements

ID	DS14
User Story ID	US-DS14
Description	Publish a new challenge with problem, context, impact and cause fields.
Entries	Internet connection. Access credentials. Challenge data.
Processing	A Lead user accesses the functionality of creating a new challenge. The user fills out the data relative to the challenge with the already existing fields (title, description, ...) and four new optional fields: problem, context, impact and cause. The lead user publishes the challenge.
Outputs	The challenge is published on the platform and it can be accessed in the challenges' list. A notification regarding the new challenge is sent to the users.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead users

ID	DS15
User Story ID	US-DS15
Description	See helpers next to the problem, context, impact and cause fields when creating a challenge.
Entries	Internet connection. Access credentials.
Processing	A Lead user accesses the functionality of creating a new challenge. The user clicks on a helper button next to one of the optional fields: problem, context, impact and cause.
Outputs	The user is able to information regarding the field (to whom the helper belongs) and best use case examples.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead users

ID	DS16
User Story ID	US-DS16
Description	See the problem, context, impact and cause fields when seeing a challenge.
Entries	Internet connection.
Processing	The user accesses the challenges list. The user selects a challenge.
Outputs	The user is able to information regarding the challenge, namely the problem, context, impact and cause fields if they were field out.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General users

5.2 Defining the expected impact

All projects aim to maximize the value delivered, also known as impact, to stakeholders. Agility goes even a step further by actively preaching that value should be prioritized over the amount of work done [4]. All different types of value creation processes measure value (or impact) in their feedback loop, to monitor the project's progress: if the project is on time and if it's in the right direction. Therefore, impact measurement can expand all phases of the value creation progress: 1) from the very beginning, when possible solutions are being created, evaluated and chosen; 2) to the development phase, to monitor the development efforts; and, 3) to the end, to evaluate the final finished solution or project and its impact.

5.2.1 Inspiration

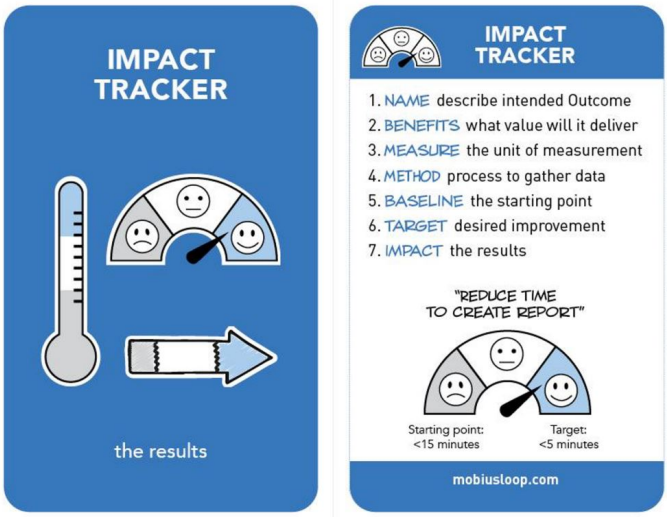
Defining the expected impact is inspired by Viima and the Mobius Loop Trigger Card *Impact Tracker* (Figure 5.5). This card helps project developers keep track of the project results and so analyze if the project is producing the expected value at a specific phase in the value creation process.

Agile teams employ short development cycles where at the end they monitor the project's progress and make adjustments to requirements, team dynamics, and others, if necessary [4][20, pp. 1-2][8]. For more traditional teams, monitoring impact is also employed, usually less frequently. For teams to know if they are on the right path, they need not only stakeholders' feedback but also metrics that measure the success of the solutions implemented, i.e. that measure the output of value of the solution (being) developed. The success of the impact tracking is intimately connected with the evaluation metrics employed to measure the created value: if they measure useful impact, if they are easy to measure frequently and if they are transparent and easy to understand by all project stakeholders. The *Impact Tracker* card helps developers define evaluation metrics with these characteristics: why is this metric important, what is its impact, how to measure it, and how we define success for the metric.

Viima incorporates in its Open Innovation Platform the tracking of business and financial impact of users' portfolios and implemented innovations.

In the City Catalyst platform, challengers and later on developers and stakeholders can look at defined expected outcomes, i.e. expected impact, as guides to 1) Help solvers understand what should be the expected impact of their proposed solutions; 2) Evaluate and chose a proposed solution; 3) Monitor project development; and, 4) Evaluate a project's success. Therefore, having a way in the platform to document and share the expected impact of a challenge and project will instigate challengers and developers to measure the value they are creating and ultimately guide solutions to provide the maximum possible desired impact to stakeholders.

Figure 5.5: Impact Tracker – Mobius trigger card [25].



5.2.2 Description

To aid teams in assessing if they are making progress in the right direction, the City Catalyst platform should be able to support the definition of the expected impact based on a list of expected outcomes for a challenge or project. Each expected outcome can be defined as follow:

1. **Name.** Short description of expected outcome.
2. **Benefits.** What value will it deliver
3. **Measurement.** Unit of measurement.
4. **Method.** Process to gather data.
5. **Baseline.** Start point.
6. **Target.** Desired improvement; End point.
7. **Impact.** The real results at the current point of development of the project.

The list of expected outcomes should accompany a project from its birth, i.e. from the challenge, to its conclusion, i.e. the measurement of the collaboration results at the end of a project.

Location in the platform

The expected impact will be added in the Challenge Creation and Challenge view pages in the Challenges and Solutions module; in the Project view and edit pages in the Project Management module; and, in the upcoming monitoring module[2].

[2]Development of the Monitoring module has not yet begun and it will not be part of the first release of the platform.

User Stories

US-DS17 As a Lead User, I want to add expected outcomes to a challenge, so that I can inform challenge solvers about the expected value their solution should have, help appraisers evaluate proposed solutions, and help me choose a solution.

US-DS18 As a General User, I want to see the expected outcomes when seeing a challenge, so that I can understand what should be the impact of possible solutions.

US-EP10 As an Entity, I want to add expected outcomes to a project, so that I can keep track of the progress and direction of the development effort as well as eventually evaluate its success.

US-EP11 As an Entity, Lead User or Mentor, I want to see the expected outcomes of a project, so that I can monitor the progress and direction of the development effort.

Mock-ups for the visualization of the expected impact in a challenge and a project can be found in Figure 5.6. A mock-up to view an expected outcome can be found in Figure 5.7.

Figure 5.6: Mock-ups for viewing a challenge and a project with the expected impact defined.

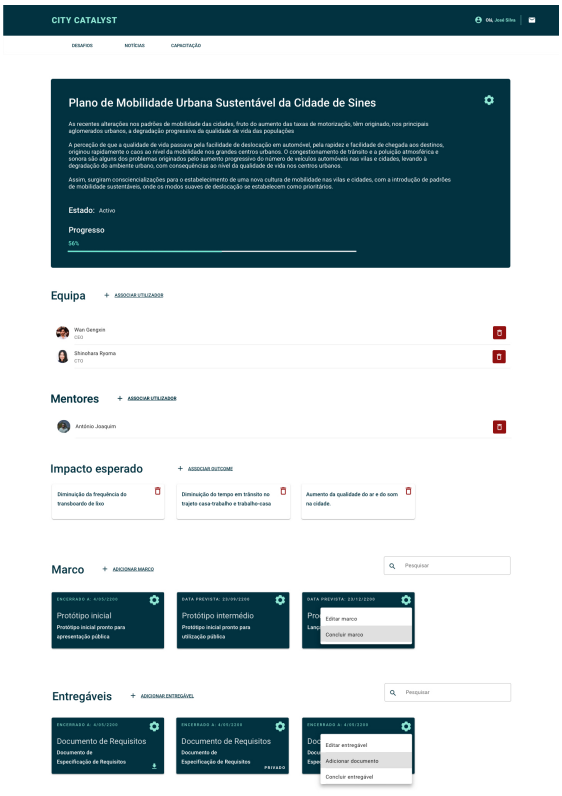
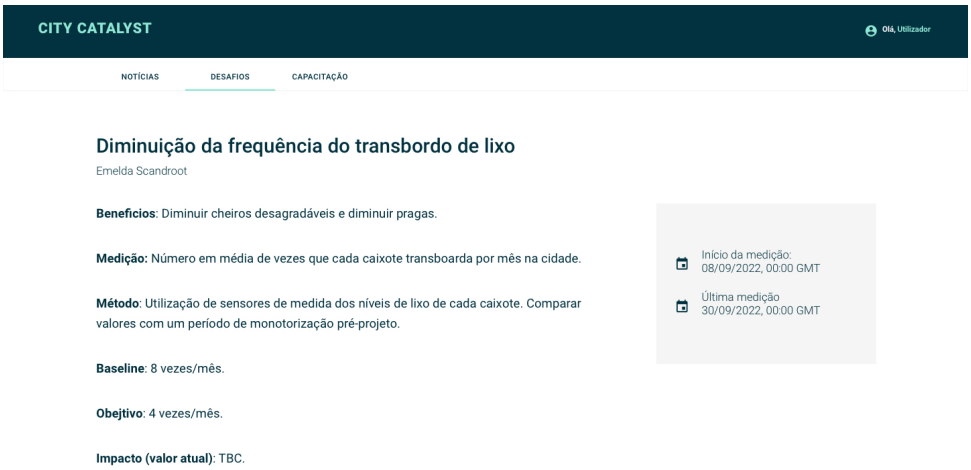


Figure 5.7: Mock-up to view an expected outcome of a challenge or solution.



5.2.3 Low-level requirements

ID	DS17
User Story ID	US-DS17
Description	Add an expected outcome to a challenge.
Entries	Internet connection. Access credentials. Expected outcome data.
Processing	A Lead user accesses the functionality of creating a new expected outcome for a challenge. The user fills out the data relative to the outcome: name (mandatory), benefits, measurement, method, baseline and target. The lead user adds the outcome.
Outputs	The outcome is published on the platform and it can be accessed on the challenge view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead users

ID	DS18
User Story ID	US-DS18
Description	See the expected outcomes when seeing a challenge.
Entries	Internet connection.
Processing	The user accesses the challenges list. The user selects a challenge.
Outputs	The user is able to see information regarding the challenge, namely the expected outcomes.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General users

ID	EP10
User Story ID	US-EP10
Description	Add an expected outcome to a project.
Entries	Internet connection. Access credentials. Expected outcome data.
Processing	A Lead user accesses the functionality of creating a new expected outcome for a project. The user fills out the data relative to the outcome: name (mandatory), benefits, measurement, method, baseline, target and impact. The lead user adds the outcome.
Outputs	The outcome is published on the platform and it can be accessed on the project view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP11
User Story ID	US-EP11
Description	See an expected outcome of a project.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead user or Mentor accesses the expected outcomes list of a project. The user selects an outcome.
Outputs	The user is able to see information regarding the expected outcome.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead users and Mentors.

5.3 Associate events to challenges and projects

During the entire value creation process, there is a need for constant communication between stakeholders, challengers and solvers. Collaboration efforts are important throughout the entire value creation process:

1. **Problem definition.** To find out if the problem is real, if it is affecting real citizens, and if it's properly defined.
2. **Find Participants.** To promote the challenge or project.
3. **External collaboration.** To, for example, gather feedback from stakeholders or to perform design sprints.
4. **Leveraging and measuring the collaboration results.** To implement the final solution and measure its impact.

The support for event promotion has already been planned within the City Catalyst platform. However, it is important to both contextualize event participants on why the event was created, and promote events within challenges and projects.

5.3.1 Inspiration

The association of events to challenges and projects is inspired by the Open Innovation Platform Regione Lombardia and by the Mobius Loop Trigger Cards *Design Sprint*, *Design Studio* and *Generate Ideas* (Figure 5.8, 5.9 and 5.10).

Problems affecting cities can be complex and of difficult elicitation and development [14]. Although project participants can Co-Create value asynchronous, oftentimes, synchronous events, face-to-face or not, are needed in order for participants to collaborate successfully. On the other hand, project participants may need to consult other individuals that are not directly connected with the project. Events (i.e. meetings) allow for project members to perform design sprints, design studios and generate ideas with project participants and stakeholders not directly involved in the project.

The Open Innovation Platform Regione Lombardia supports the publication of events and the event page points users to the owner community. The City Catalyst platform already has plans for supporting event promotion. Nonetheless, the association between events and challenges or projects will allow 1) for participants in the events to better contextualize them and 2) to promote the events next to challenge and project participants.

5.3.2 Definition

The collaboration activity in all of the four phases – problem definition, finding participants, external collaboration, and leveraging and measurement of the collaboration results – of the Interactive

Figure 5.8: Design Sprint – Mobius trigger card [25].

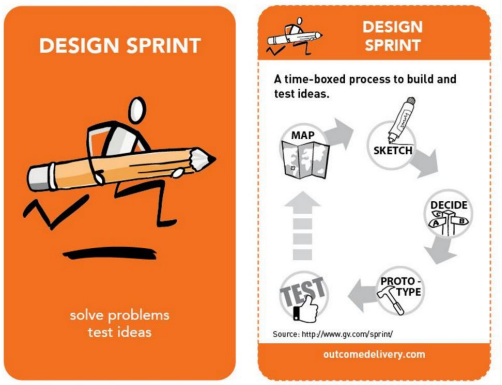


Figure 5.9: Design Studio – Mobius trigger card [25].

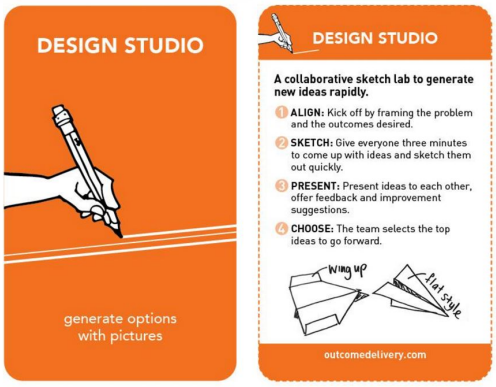
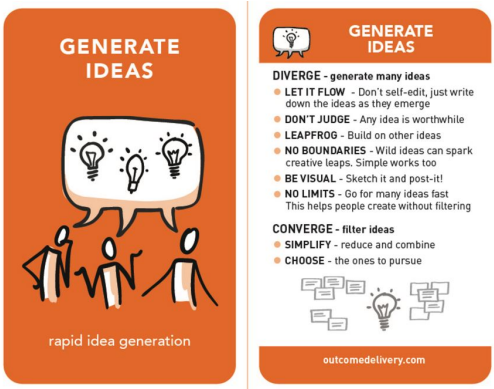


Figure 5.10: Generate Ideas – Mobius trigger card [25].



Coupled Open Innovation Process can benefit from the promotion of events within the City Catalyst platform.

The creation and promotion of events is already been planned as a feature of the platform, however the City Catalyst Platform should also support the viewing of:

1. **Challenges** in an **event** view page.
2. **Projects** in an **event** view page.
3. **Events** in a **challenge** view page.
4. **Events** in a **project** view page.

Location in the platform

The association of an event to a challenge or project will be added in the Event Creation and Event view pages in the Empowerment module; in the Challenge Creation and Challenge view

pages in the Challenges and Solutions module; in the Project view and edit pages in the Project Management module; and, in the upcoming monitoring module[2].

User Stories

US-CA14 As a Lead User, I want to associate a challenge to an event, so that I can give context to the event.

US-CA15 As an Entity, I want to associate a project to an event, so that I can give context to the event.

US-CA16 As a General User, I want to see challenges associated with an event, so that I understand why an event is being held.

US-CA17 As a General User, I want to see projects associated with an event, so that I understand why an event is being held.

US-DS19 As a Lead User, I want to associate an event with a challenge, so that participants are aware that an event associated with their challenge is being held.

US-DS20 As a Lead User, As a General User, I want to see events associated with a challenge, so that I'm aware of which events are being held for the challenge.

US-EP12 As an Entity, I want to associate an event to a project, so that participants are aware that an event associated with their project is being held.

US-EP13 As an Entity, Lead User or Mentor, I want to see events associated with a project, so that I'm aware of which events are being held for the project.

Mock-ups for the visualization of events in a challenge and a project can be found in Figure 5.11. A mock-up to view the associated challenges and projects in an event can be found in Figure 5.12.

Figure 5.11: Mock-ups for viewing events in a challenge and a project.

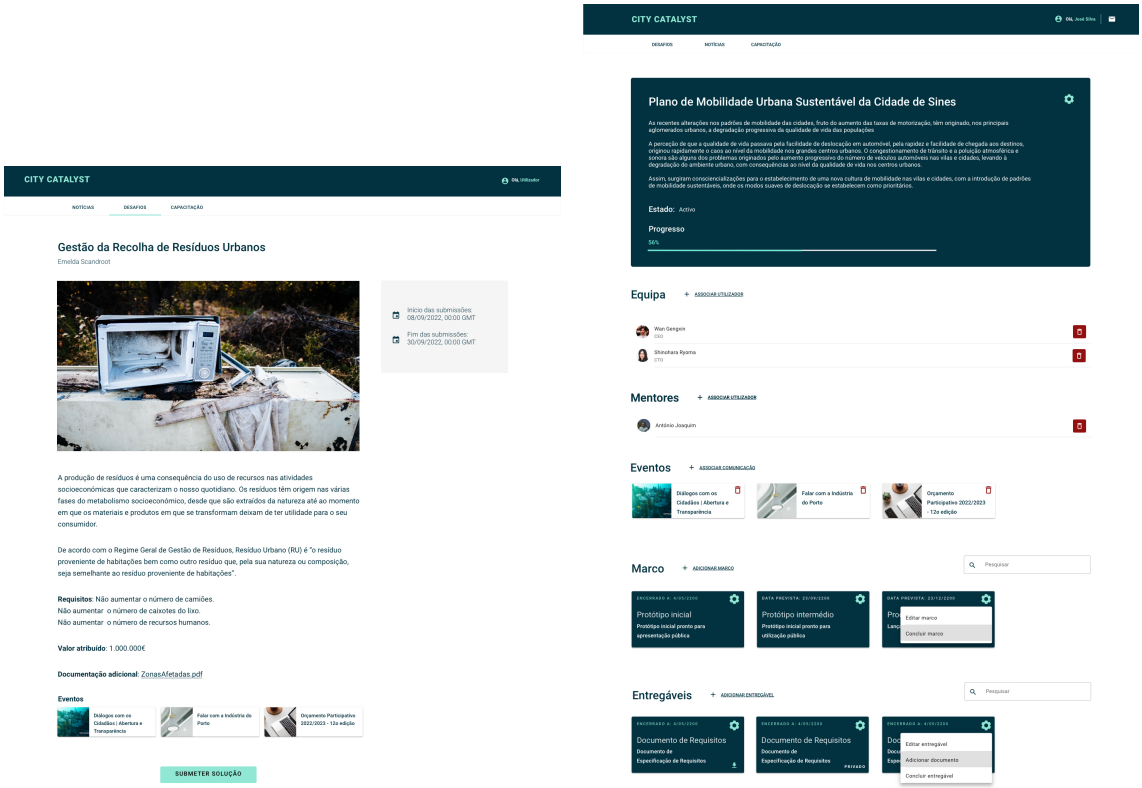
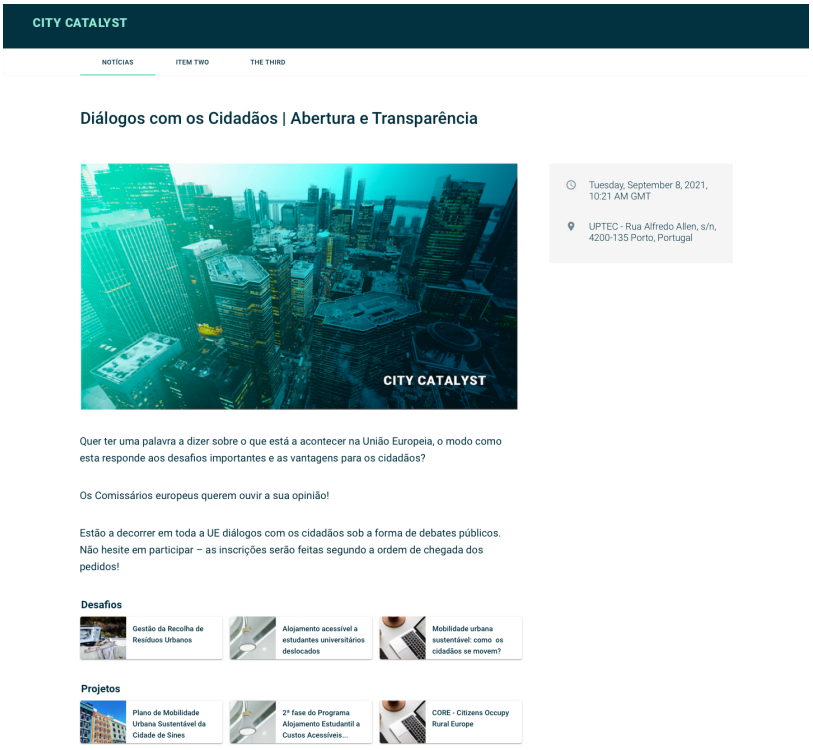


Figure 5.12: Mock-up to view associated challenges and projects of an event.



5.3.3 Low-level requirements

ID	CA14
User Story ID	US-CA14
Description	Associate a challenge to an event.
Entries	Internet connection. Access credentials. Challenge to be associated.
Processing	A Lead user accesses the functionality of associating a challenge to an event. The user chooses the challenge to associate with the event. The lead user associates the chosen challenge with the event.
Outputs	The challenge is now associated with the event and the event can be seen in the challenge view page and the challenge can be seen in the event view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If the user doesn't have permission to associate a specific challenge to the event, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead users

ID	CA15
User Story ID	US-CA15
Description	Associate a project to an event.
Entries	Internet connection. Access credentials. Project to be associated.
Processing	A Lead user accesses the functionality of associating a project to an event. The user chooses the project to associate with the event. The lead user associates the chosen project with the event.
Outputs	The project is now associated with the event and the event can be seen in the project view page and the project can be seen in the event view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If the user doesn't have permission to associate a specific project with the event, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead users

ID	CA16
User Story ID	US-CA16
Description	See associated challenges when seeing an event.
Entries	Internet connection.
Processing	The user accesses an event.
Outputs	The user sees a list of challenges associated with the event. The user is able to click on a challenge and is redirected to the challenge view page.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General Users

ID	CA17
User Story ID	US-CA17
Description	See associated projects when seeing an event.
Entries	Internet connection.
Processing	The user accesses an event.
Outputs	The user sees a list of projects associated with an event. The user is able to click on a project and is redirected to the project view page.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General Users

ID	DS19
User Story ID	US-DS19
Description	Associate an event to a challenge.
Entries	Internet connection. Access credentials. Event to be associated.
Processing	A Lead user accesses the functionality of associating an event to a challenge. The user chooses the event to associate with the challenge. The lead user associates the chosen event with the challenge.
Outputs	The event is now associated with the challenge and the event can be seen in the challenge view page and the challenge can be seen in the event view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If the user doesn't have permission to associate a specific event with a challenge, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead users

ID	DS20
User Story ID	US-DS20
Description	See associated events when seeing a challenge.
Entries	Internet connection.
Processing	The user accesses a challenge.
Outputs	The user sees the past and upcoming events of a challenge. The user is able to click on an event and is redirected to the event page.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General Users

ID	EP12
User Story ID	US-EP12
Description	Associate an event to a project.
Entries	Internet connection. Access credentials. Event to be associated.
Processing	A Lead user accesses the functionality of associating an event to a project. The user chooses the event to associate with the project. The lead user associates the chosen event with the project.
Outputs	The event is now associated with the project and the event can be seen in the project view page and the project can be seen in the event view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If the user doesn't have permission to associate a specific event to a project, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP13
User Story ID	US-EP13
Description	See associated events when seeing a project.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead User or Mentor accesses a project.
Outputs	The user sees the past and upcoming events of a project. The user is able to click on an event and is redirected to the event page.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead users and Mentors.

5.4 Expanding proposed solutions' score

Decision-making is one of the most important activities in any project. Project participants frequently at any stage of the value creation process find themselves at crossroads having to choose the correct path to guide the development efforts in the right direction. It is, then, paramount that teams are able to employ prioritization methods that allow them to make quick and in an Agile manner informed decisions.

The City Catalyst project has already planned to assist challengers on one of the most critical points of the value creation process: choosing the most appropriate solution for their challenge. The platform will allow appraisers to evaluate proposed options, aiding challengers in choosing the best solution possible. However, this feature can be expanded to better support decision-making by suggesting a simple, Agile and non-restrictive prioritization framework and incentivizing better context for evaluations.

5.4.1 Inspiration

Expanding proposed solutions' score is inspired by the Mobius Loop Trigger Card *Options Pipeline* (Figure 5.13). This card advises developers on utilizing the ICE Scoring Model as a method to prioritize options in a quick and Agile manner.

All teams, including Agile teams, are confronted with many options to solve problems or to guide progress through the value creation process. Agile projects, with their short feedback loops, confront possible changes more often as developers along with stakeholders constantly evaluate the project's trajectory [4][20, pp. 1-2][8]. Having a straightforward, quick and nimble process to assess possible options is crucial. The ICE Scoring Model offers a simple framework to make informed decisions by evaluating options in **I**mpact, **C**onfidence and **E**ase.

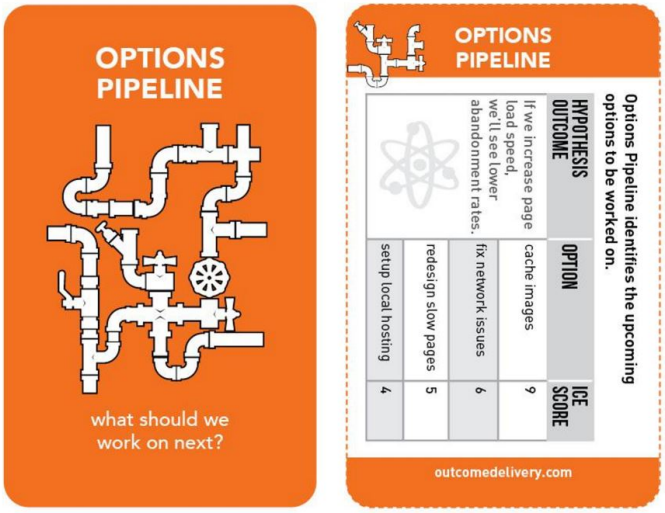
In the City Catalyst project, appraisers evaluate solutions to a challenge to advise the challengers on the best-proposed solution. Incentivizing appraisers to breakdown their evaluations accomplishes three goals: 1) Guides challengers to utilize a simple, straightforward but non-restrictive evaluation framework; 2) Provides extra context to challengers about the evaluation; and, 3) Encourages appraisers to evaluate three of the most important metrics in project success: Impact[3], Confidence and Ease.

5.4.2 Definition

In order to help decide what proposed solutions are the most adequate for a challenge, the City Catalyst platform already has a planned feature to assign scores by appraisers for each proposed solution. However, there is only the plan for a simple score to be assigned. We propose the extension of this feature to provide appraisers with the ability to evaluate each solution more extensively, by utilizing the ICE Scoring Model[15] to calculate an evaluation for each solution:

[3] If the proposed features under *Defining the expected impact* (Section 5.2) are implemented, challengers can grade proposed solutions taking into account the challenge expected outcomes.

Figure 5.13: Options Pipeline – Mobius trigger card [25].



1. **Impact.** How does this solution impact the stakeholders of the city? If possible[3], how well is this solution going to meet the expected impact?

2. **Confidence.** How confident can we be that this solution will be well received by the stakeholders? How risky is it to invest time and resources into this solution?

3. **Ease.** How much time and effort will be required to develop this solution in terms of workload, workflow, testing and launching?

4. **Overall ICE score.** Automatic score calculated from the scores of the ICE parameters.

5. **Open text field and annexes.** Allow appraisers to explain why and how they have chosen the scores for each category.

Appraisers should try their very best to analyse each factor independently so that each parameter is not weighted more than the other.

Helpers next to each field are a must to explain the ranking system for each one of them [15]:

1. **Impact.** 1: Very low impact; 2–5: Minimal impact; 6–8: Measurable impact; and, 8–10: Significant impact.

2. **Confidence.** 1: Very low confidence; 2-5: Minimal confidence; 6-8: Measurable confidence; and, 8-10: Significant confidence.

3. **Ease.** 1-2: Long time frame; 3-5: Significant time frame; 6-7: Minimal time frame; and, 8-10: Short time frame.

4. **Overall ICE score.** Can be the multiplication of all of the parameters (Impact * Confidence * Ease), the sum of all of the parameters (Impact + Confidence + Ease), or even the average, ([Impact + Confidence + Ease]/3).

Armed with the overall ICE scores and the details behind each of the scores, challengers will be able to rank and compare all of the proposed solutions and make a quicker, more objective, informed decision on which solutions to choose to develop.

Location in the platform

The expanded proposed solutions' score will be added to the Solution view page in the Challenges and Solutions module. The helpers will be also added to the Solutions view page next to each parameter.

User Stories

US-DS21-1 As a Lead User, I want to see evaluations for challenge solutions based on the ICE scoring model, so that I can make a quicker, more objective and informed decision on which solutions to choose.

US-DS21-2 As a Lead User, I want to know why an appraiser attributed a certain evaluation to a challenge's solution so that I can make an informed decision on which solutions to choose.

US-DS22 As a Lead User or Appraiser, I want to have helpers regarding the parameters of a solution evaluation, so that I can better understand each parameter and provide a correct evaluation.

A mock-up for the expansion of a proposed solutions' Score with the ICE scoring model, a text field and annexes can be found in Figure 5.14.

Figure 5.14: Mock-up to view and submit a score a proposed solution with the ICE scoring model, a text field and annexes.

5.4.3 Low-level requirements

ID	DS21
User Story ID	US-DS21-1, US-DS21-2
Description	Evaluate a solution based on the ICE scoring model.
Entries	Internet connection. Access credentials. Solution data.
Processing	A Lead user or Appraiser accesses their profile and selects a challenge they administrate. The user accesses the solutions' list of the challenge and selects one. The user evaluates a solution based on its Impact, Confidence, and Ease (from 1 to 10). The user fills out an optional text field and/or uploads an annexe, if they find it necessary. The user submits the solution evaluation.
Outputs	The solution has a new evaluation including the Impact, Confidence, Ease, the overall automatic score, the optional field and annexes.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead users or Appraisers.

ID	DS22
User Story ID	US-DS22
Description	See helpers next to the parameters of an evaluation.
Entries	Internet connection. Access credentials.
Processing	A Lead user or Appraiser accesses their profile and selects a challenge they administrate. The user accesses the solutions' list of the challenge and selects one. The user clicks on a helper button next to one of the fields: Impact, Confidence, Ease and Overall ICE score.
Outputs	The user is able to see information regarding the field (to whom the helper belongs).
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead users or Appraisers.

5.5 Communication between users

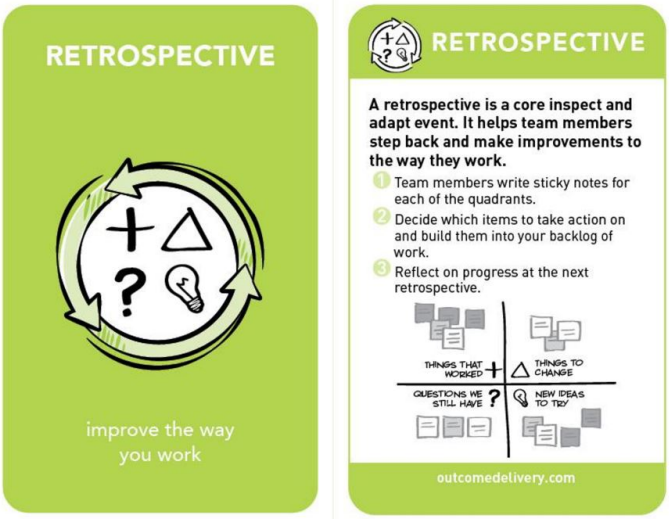
In an Open Innovation, Co-Creative and Agile environment, communication between all participants during the value creation process is of the utmost importance. The City Catalyst platform acts as an intermediary between participants and so should facilitate the spreading of knowledge via direct communication between its users.

5.5.1 Inspiration

The features proposed under the *Communication between users* are inspired by Decide Madrid, Open Innovation Platform Regione Lombardia, Kaggle, Amsterdam Smart City and Open Innovation City Community, all Open Innovation Digital Platforms (Section 2.4), as well as by the Mobius Loop Trigger Cards *Generate Ideas* and *Retrospective* (Figures 5.10 and 5.15).

Both *Generate Ideas* and *Retrospective* cards describe common activities performed by development teams, including Agile teams. Generating ideas (i.e. brainstorming) and retrospective conversations (e.g. at the end of sprints) describe activities performed by teams in order to collaborate and Co-Create. These collaborative actions can be done in person or remotely. The City Catalyst platform as an intermediary in the OI value creation process should enable its users to (at least partially) partake in these collaborative activities by supporting communication and discussion within the platform between all users[4] – challengers, developers, stakeholders, city citizens, academia, enterprises and city representatives.

Figure 5.15: Retrospective – Mobius trigger card [25].



[4] Refers to one of the overall goals of the City Catalyst Platform: involving all stakeholders in the development process; Quadruple helix (Section 3.1).

A few of the analysed Open Innovation Digital Platforms in Section 2.4 – Decide Madrid, Open Innovation Platform Regione Lombardia, Kaggle, Amsterdam Smart City and Open Innovation City Community – have a large focus on enabling their users to actively communicate and participate in discussions with each other.

In OIPRL, each community, an almost homologue for the City Catalyst's project, has a discussions tab where participants create posts and subsequently discuss a topic related to the community. Decide Madrid has platform-wide debates that consist of posts where users grant their support for an idea and have written discussions about it. Decide Madrid also harbours proposals, a brother to City Catalyst solutions, where users share their solutions to a problem in their community. Decide Madrid proposals have a target number of support votes in order to be carried out by the city and a comment section that incentivizes discussion around and improvement of the proposal. Kaggle offers a similar forum feature to OIPRL: forum-like discussions created under communities or open to all platform users. Both Amsterdam Smart City and Open Innovation City Community support comment sections under all types of posts, such as challenges and proposed solutions.

All of these platforms support interaction between users through like or up and downvotes and comment sections in all types of posts (i.e. forums, code, proposals, discussions), news articles, documents, among others.

Both Decide Madrid and OIPRL have a way to perform surveys on the platform: OIPRL inside communities and Decide Madrid opened to all users but created by the Madrid municipality itself.

All of these features across the three platforms are utilized by users to communicate with each other through the platform. In short, Open Innovation Digital platforms can be considered intermediaries in the value creation process and should support ways for their users to perform the most elementary and important activity in Co-Creation and Open Innovation: interaction with others. As such, the City Catalyst platform should support similar features to the analysed platforms to successful encourage Co-Creation and Agile practices in an Open Innovation environment.

5.5.2 Definition

The encouragement of synchronous communication between participants is already planned for the first iteration of the platform in form of living labs, incubators and events that publicizes synchronous meetings. However, it lingers a necessity of allowing users to easily communicate asynchronously on the platform. There are two different main ways users can express their opinions asynchronously online: directly via text, e.g. forums and comment sections, or indirectly via voting, such as likes, up and downvotes, and surveys.

In a forum, individuals can contribute with their ideas about a topic. It is useful to identify a specific innovation need, find partners for projects, discuss and find new ideas, gather if there is interest in a certain topic and much more. The City Catalyst platform can benefit from several types of forum-like discussions: 1) Independent forum; 2) Forums inside projects, and 3) Comment sections on challenges, solutions, deliverables and milestones. Forums can also be accompanied by a system of up and downvotes, so users can show support or disapproval of certain ideas.

Surveys can be used to identify interest or disinterest in predefined ideas. What differentiates them from forums is how data can be collected. While forums are a community experience with active discussions, surveys aim to quickly collect large amounts of data and to more easily, when compared to forums, extract insights and feedback for projects.

Challenges can also benefit from having an approved or disproved vote so that citizens can also easily show their support for a certain project.

Succinctly, the City Catalyst Platform could benefit from adding different types of communication between users:

1. **Independent forum.** Generate debate, assess interest and find new ideas.
2. **Forum inside projects.** Encourage general discussions within the project's team.
3. **Comment section in Challenges and Solutions.** Stimulate collaboration in the problem definition and external collaboration phases.
4. **Comment section in Deliverables and Milestones.** Allow discussion for these two types of artefacts and give context on possible changes.
5. **Up and downvotes in forums.** Show support or disapproval of certain ideas.
6. **Surveys.** Quickly gather insights and feedback from stakeholders, namely citizens.
7. **Show approval or disapproval for challenges.** Allow citizens to easily show support for challenges they want to see resolved.

Location in the platform

The features under *Communication between users* will be added in several modules of the platform. The independent forum and surveys will be new pages under the Challenges and Solutions module. Forums inside projects will also be a new page under the Project Management module. The comment sections for challenges, solutions, deliverables and milestones will be added to their respective view pages under the Challenges and Solutions and Project Management modules.

User Stories

Independent forum

US-DS23 As an Entity or Lead user, I want to publish posts on the independent forum, so that I can generate debate, assess interest and find new ideas.

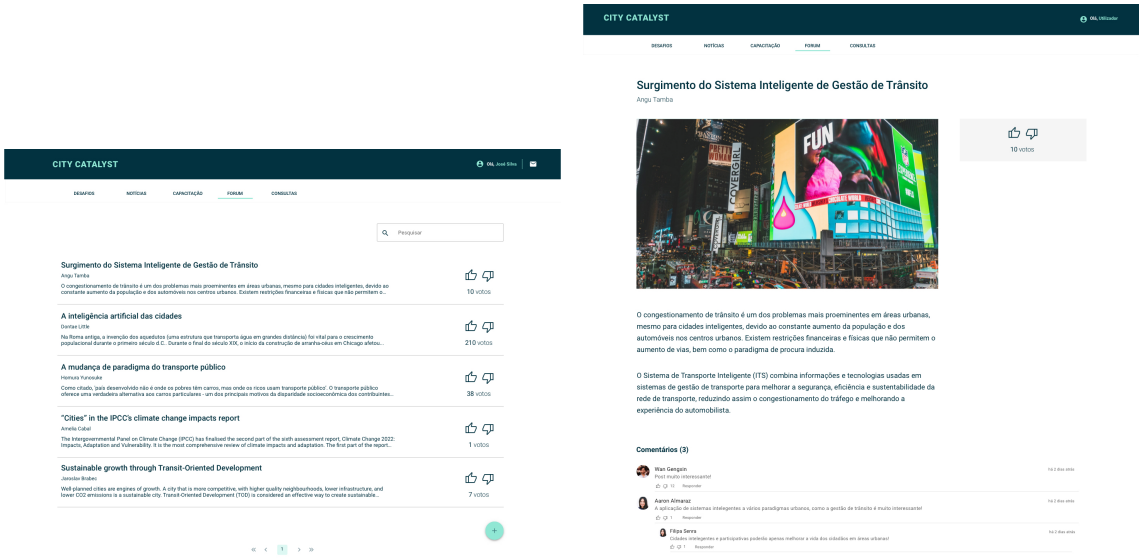
US-DS24 As a user, I want to comment on posts on the independent forum, so that I can share my ideas about a topic.

US-DS25 As a user, I want to up or downvote posts on the independent forum, so that I can quickly share my approval or disapproval about a topic.

US-DS31 As a user, I want to view a post on the independent forum, so that I can learn from the discussion taking place on the post.

Mock-ups for the visualization of the Independent Forum and its posts can be found in Figure 5.16.

Figure 5.16: Mock-ups for viewing the Independent Forum and the posts within it.



Projects' forums

US-EP14 As an Entity, Lead User or Mentor, I want to publish posts on a project, so that I can encourage general discussion within the project's team.

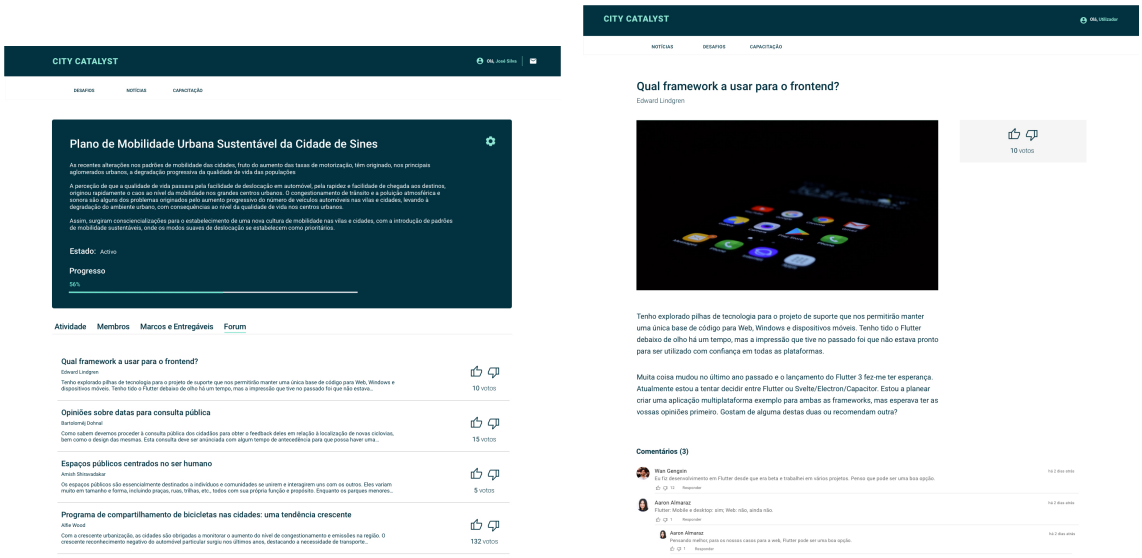
US-EP15 As an Entity, Lead User or Mentor, I want to comment on posts in a project's forum, so that I can share my ideas about a topic.

US-EP16 As an Entity, Lead User or Mentor, I want to up or downvote posts on a project's forum, so that I can quickly share my approval or disapproval about a topic.

US-EP19 As an Entity, Lead User or Mentor, I want to view a post on a project's forum, so that I can learn from the discussion taking place on the post.

Mock-ups for the visualization of a Project's Forum and its posts can be found in Figure 5.16.

Figure 5.17: Mock-ups for viewing a Project's Forum and the posts within it.



Comment Section in Challenges and Solutions

US-DS26 As a user, I want to comment on a challenge, so that I can contribute to the discussion about a challenge and so help improve a challenge definition.

US-DS32 As a user, I want to view the comment section on a challenge, so that I can learn from the discussion about the challenge.

US-DS27 As an Entity, Lead User or Appraiser, I want to comment on a solution, so that I can contribute to the discussion about a proposed solution and so help improve it.

US-DS33 As an Entity, Lead user or Appraiser, I want to view the comment section on a solution, so that I can learn from the discussion about the solution.

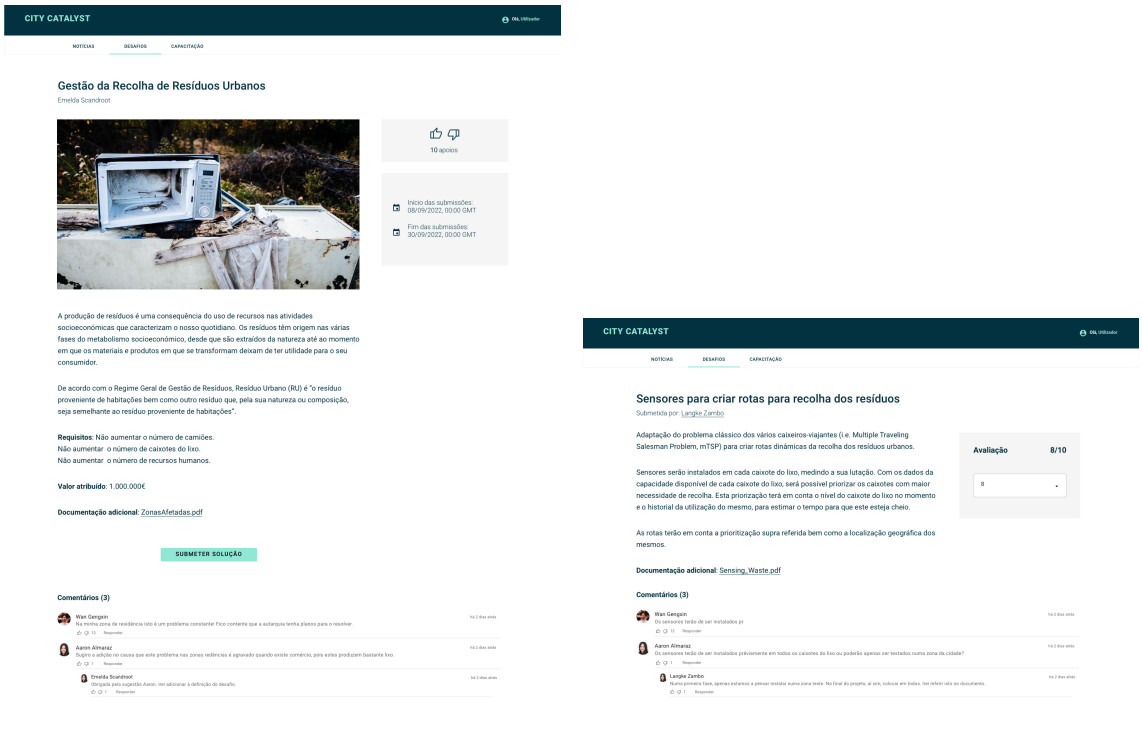
Mock-ups for the addition of comment sections in Challenges and Solutions can be found in Figure 5.18.

Comment Section in Deliverables and Milestones

US-EP17 As an Entity, Lead User or Mentor, I want to comment on a deliverable, so that I can have a discussion with other developers and give context to the artefact.

US-EP20 As an Entity, Lead User or Mentor, I want to view the comment section on a deliverable, so that I can learn from the discussion about the deliverable.

Figure 5.18: Mock-ups for comment section in Challenges and Solutions and approval score in a Challenge (left side).

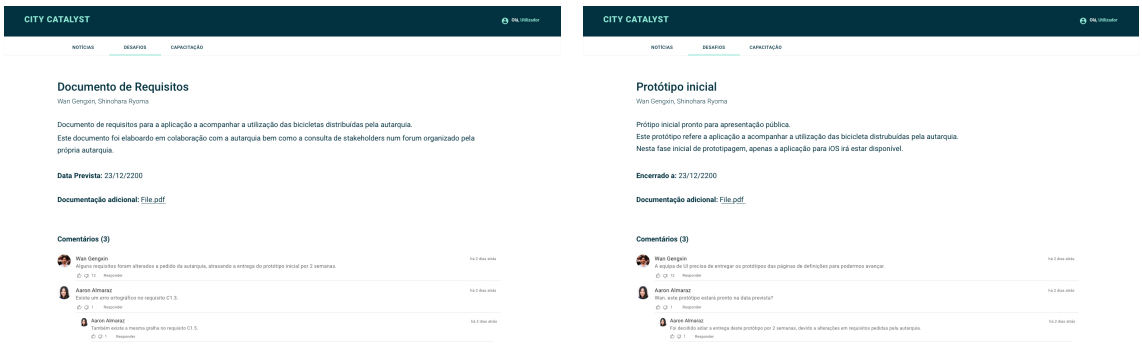


US-EP18 As an Entity, Lead User or Mentor, I want to comment on a milestone, so that I can have a discussion with other developers and give context to the artefact.

US-EP21 As an Entity, Lead User or Mentor, I want to view the comment section on a milestone, so that I can learn from the discussion about the milestone.

Mock-ups for the addition of comment sections in Deliverables and Milestones can be found in Figure 5.19.

Figure 5.19: Mock-ups for comment section in Deliverables and Milestones.



Surveys

US-DS28 As an Entity or Lead User, I want to create surveys, so that I can quickly gather insights and feedback from stakeholders (i.e. citizens).

US-DS29 As a user, I want to respond to surveys, so that I can give my insights and feedback about a topic.

US-DS35 As an Entity or Lead user, owner of a survey, I want to see the survey responses, so that I can quickly gather insights about the topic queried in the survey.

Mock-ups for the visualization of surveys can be found in Figures 5.20, and 5.21.

Challenge approval score

US-DS30 As a user, I want to show my approval or disapproval for a challenge, so that I can easily support a challenge I want to see resolved.

Mock-ups for viewing and giving approval or disapproval to a challenge can be found in Figure 5.18.

5.5.3 Low-level requirements

ID	DS23
User Story ID	US-DS23
Description	Publish a post on the independent forum.
Entries	Internet connection. Access credentials. Information to post
Processing	An Entity or a Lead user accesses the functionality of publishing a new post in the independent forum. The user fills the data relative to the post: Title, Description, and at least one Keyword. The user can also add images if necessary. The user publishes the post in the independent forum.
Outputs	The post is published on the platform and it is listed in the independent forum.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead users.

Figure 5.20: Mock-up to view a list of surveys.

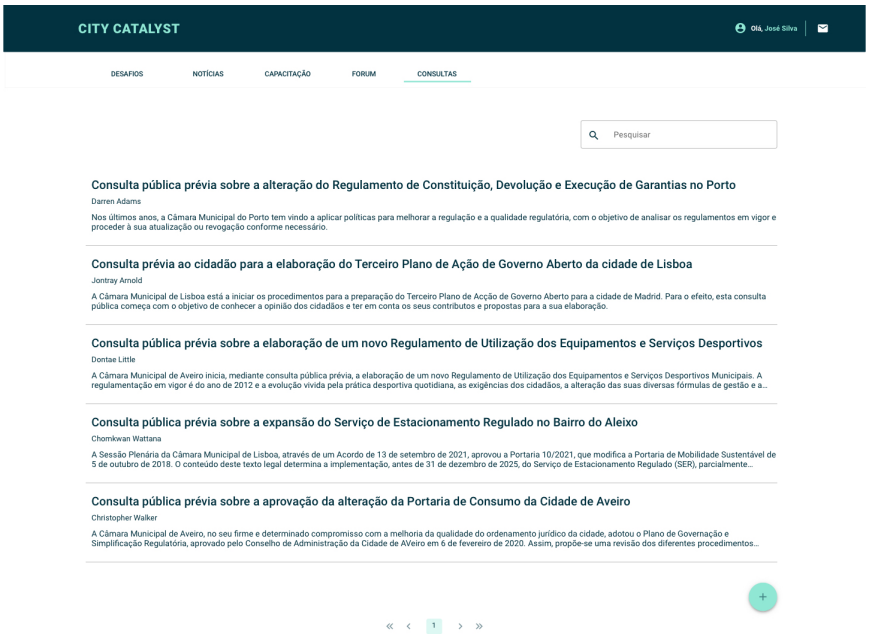
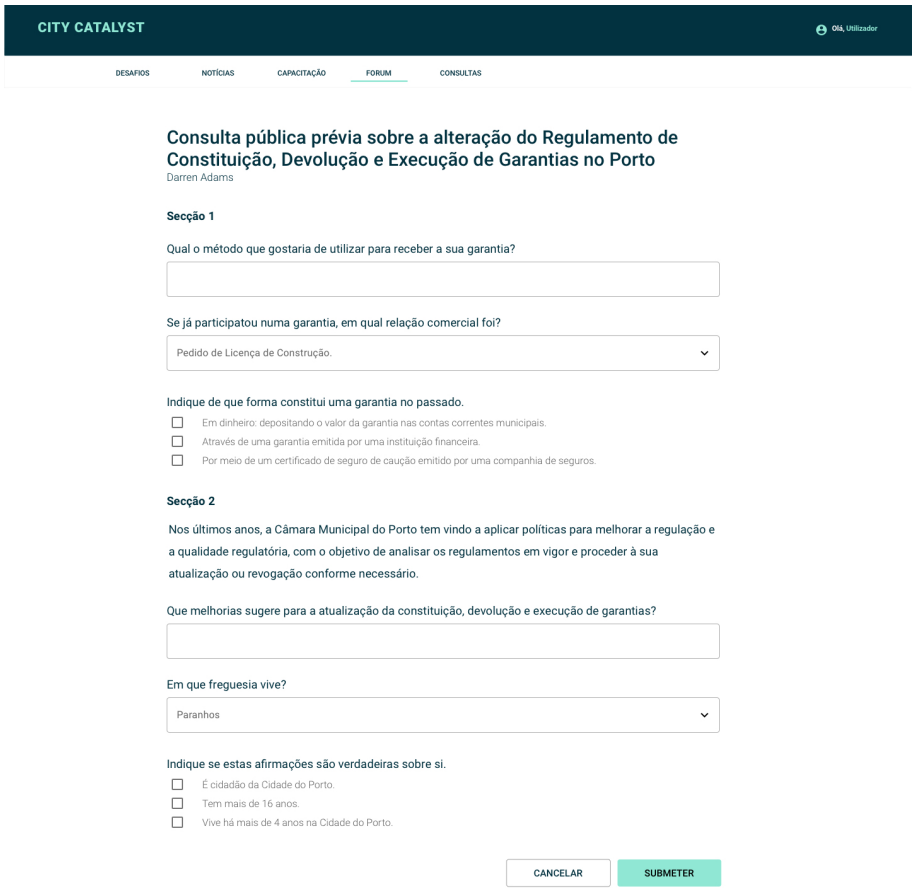


Figure 5.21: Mock-ups to view a survey.



ID	DS24
User Story ID	US-DS24
Description	Comment a post on the independent forum.
Entries	Internet connection. Access credentials. Text to comment.
Processing	A user accesses a post in the independent forum. The user finds the comment section and decides if they want to respond to a comment or start a new comment thread. The user fills in the appropriate text area to publish a comment. The user leaves a comment on the post.
Outputs	The comment is published in the post in the independent forum.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Public user.

ID	DS25
User Story ID	US-DS25
Description	Up or downvote a post on the independent forum.
Entries	Internet connection. Access credentials.
Processing	A user accesses a post in the independent forum. The user up or downvotes a post.
Outputs	The score of the post decreases by one in case of a downvote or increases by one in case of an upvote.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Public user.

ID	DS31
User Story ID	US-DS31
Description	View a post in the independent forum
Entries	Internet connection.
Processing	A user accesses a post in the independent forum.
Outputs	The user sees the post with its Title, Description, Images and Keywords as well as its overall score and comment section.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Public user.

ID	EP14
User Story ID	US-EP14
Description	Publish a post on a project.
Entries	Internet connection. Access credentials. Information to post.
Processing	An Entity, Lead user or Mentor accesses the functionality of publishing a new post in a project they are in. The user fills the data relative to the post: Title, Description, Images, and Keywords. The user publishes the post in the project.
Outputs	The post is published in the project and it is listed in the project's forum.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP15
User Story ID	US-EP15
Description	Comment on a post on a project's forum.
Entries	Internet connection. Access credentials. Text to comment.
Processing	An Entity, Lead user or Mentor accesses a post in a project's forum they are in. The user finds the comment section and decides if they want to respond to a comment or start a new comment thread. The user fills in the appropriate text area to publish a comment. The user leaves a comment on the post.
Outputs	The comment is published in the post in the project's forum.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP16
User Story ID	US-EP16
Description	Up or downvote a post on a project.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead user or Mentor accesses a post in a project they are in. The user up or downvotes a post.
Outputs	The score of the post decreases by one in case of a downvote or increases by one in case of an upvote.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP19
User Story ID	US-EP19
Description	View a post in a project's forum.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead user or Mentor accesses a post in a project they are in.
Outputs	The user sees the post with its Title, Description, Images and Keywords as well as its overall score and comment section.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	DS26
User Story ID	US-DS26
Description	Comment a Challenge.
Entries	Internet connection. Access credentials. Text to comment.
Processing	A user accesses a challenge. The user finds the comment section and decides if they want to respond to a comment or start a new comment thread. The user fills in the appropriate text area to publish a comment. The user leaves a comment on a challenge.
Outputs	The comment is published in the challenge.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General Users.

ID	DS32
User Story ID	US-DS32
Description	See comments for a Challenge.
Entries	Internet connection. Access credentials.
Processing	A user accesses a challenge.
Outputs	The user sees all comments for the challenge.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General Users.

ID	DS27
User Story ID	US-DS27
Description	Comment a Solution.
Entries	Internet connection. Access credentials. Text to comment.
Processing	An Entity, Lead user or Appraiser accesses a solution. The user finds the comment section and decides if they want to respond to a comment or start a new comment thread. The user fills in the appropriate text area to publish a comment. The user leaves a comment on a solution.
Outputs	The comment is published in the solution.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Appraisers.

ID	DS33
User Story ID	US-DS33
Description	See comments for a Solution.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead user or Appraiser accesses a solution.
Outputs	The user sees all comments for the solution.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead users and Appraisers.

ID	EP17
User Story ID	US-EP17
Description	Comment a Deliverable.
Entries	Internet connection. Access credentials. Text to comment.
Processing	An Entity, Lead User or Mentor accesses a deliverable under a project they are a part of. The user finds the comment section and decides if they want to respond to a comment or start a new comment thread. The user fills in the appropriate text area to publish a comment. The user leaves a comment on a deliverable.
Outputs	The comment is published in the deliverable.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP20
User Story ID	US-EP20
Description	See comments for a Deliverable.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead user or Mentor accesses a deliverable under a project they are a part of.
Outputs	The user sees all comments for the deliverable.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead users and Mentors.

ID	EP18
User Story ID	US-EP18
Description	Comment a Milestone.
Entries	Internet connection. Access credentials. Text to comment.
Processing	An Entity, Lead User or Mentor accesses a milestone under a project they are a part of. The user finds the comment section and decides if they want to respond to a comment or start a new comment thread. The user fills in the appropriate text area to publish a comment. The user leaves a comment on a milestone.
Outputs	The comment is published in the milestone.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP21
User Story ID	US-EP21
Description	See comments for a Milestone.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead user or Mentor accesses a Milestone under a project they are a part of.
Outputs	The user sees all comments for the milestone.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead users and Mentors.

ID	DS28
User Story ID	US-DS28
Description	Create a survey.
Entries	Internet connection. Access credentials. Information for the survey
Processing	An Entity or a Lead user accesses the functionality of creating a survey. The user fills the data relative to the survey: if the survey is anonymous or not; and, for each question, the question text, if it is an open or closed answer, and if the latter, the answer options. The user publishes the survey.
Outputs	The survey is published on the platform and it is listed in the surveys section.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead users.

ID	DS29
User Story ID	US-DS29
Description	Respond to a survey.
Entries	Internet connection. Access credentials. Information to respond to the survey
Processing	A user accesses a survey to respond. The user fills out the survey. The user responds to the survey.
Outputs	The response to the survey is now published on the platform and it can only be seen by the author of the survey.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Public users.

ID	DS35
User Story ID	US-DS35
Description	See survey responses.
Entries	Internet connection. Access credentials.
Processing	An Entity or Lead user accesses the functionality of viewing the results of a survey they created.
Outputs	The user sees all the individual responses for the survey as well as a recap of the responses for each question.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead users.

ID	DS30
User Story ID	US-DS30
Description	Give approval or disapproval to a challenge.
Entries	Internet connection. Access credentials.
Processing	A user accesses a challenge. The user gives their approval or disapproval to a challenge.
Outputs	The challenge score decreases by one in case of a disapproval or increases by one in case of an approval.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Public user.

ID	DS34
User Story ID	US-DS30
Description	See approval score for a challenge.
Entries	Internet connection.
Processing	A user accesses a challenge.
Outputs	The user sees the approval score of the challenges (difference between approvals and disapprovals for the challenge).
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Public user.

5.6 Expand deliverables and milestones

Agile is characterized by delivering work in tiny, digestible chunks rather than relying on big launches [4][20, pp. 1-2][8]. In the City Catalyst platform, we can think of these chunks as deliverables that teams hand over in short time intervals that together form milestones that in turn jointly result in the final solution to a challenge.

Milestones are used to mark memorable events during project development and usually are viewed by clients. They are used as a way to keep track of a project's development and to gather feedback from stakeholders at key points. A milestone is a great opportunity to pause and assess if the work is walking in the right direction and if the value is being outputted at the expected pace. The ensemble of the project's milestones can also be viewed as a roadmap. Therefore, it offers an overview of the project's evolution. A milestone differs from a deliverable because it offers a big picture of the project's development and its current state, while deliverables can be viewed as isolated blocks that only together offer significant value.

Although it is already planned for incorporation of both milestones and deliverables as aids in project management in the City Catalyst platform, we believe they should be expanded to realize their full potential.

5.6.1 Inspiration

The features proposed to expand the functionality of deliverables and milestones are inspired by Viima and the Mobius Loop Trigger Cards *MVP*, *Quick Win* and *Retrospective* (Figures 5.22, 5.23 and 5.15). The activities described by these three cards are extremely common among Agile teams to plan and coordinate the development work.

The Minimum Viable Product (MVP) is a technique that incentivises teams to deliver value as quickly as possible by creating a simple product and increment on it rather than attempting to deliver the final complex product in one go [25]. Quick Win describes a lean approach to development by encouraging choices that maximize value and minimise effort and cost, and so encourage rapid improvements in short periods of time [25]. Retrospective describes the philosophy of Agile teams to stop from time to time and reflex on their work by pointing out the positives, i.e. what they should continue to do, and the negatives, i.e. what they should stop. [25].

Viima allows setting the state of an idea in order to monitor the project's development.

The City Catalyst platform has planned to incorporate the concepts of deliverables and milestones. These concepts can be connected with the activities described above. Milestones are the perfect opportunities to execute retrospectives or they can mark an MVP. Deliverables can be viewed as chunks of work that make up retrospectives or MVPs. To prioritize low-effort-high-reward activities, teams should associate an effort with each deliverable and milestone. It should also be easy to find out who is responsible for retrospectives and MVPs and so who is responsible for deliverables and milestones. It should also be possible to review past and sometimes absolute deliverables and milestones during retrospectives. In order to more easily keep track

of the project's development state, it should be possible to set the state of both deliverables and milestones.

Figure 5.22: Minimum Viable Product (MVP) – Mobius trigger card [25].

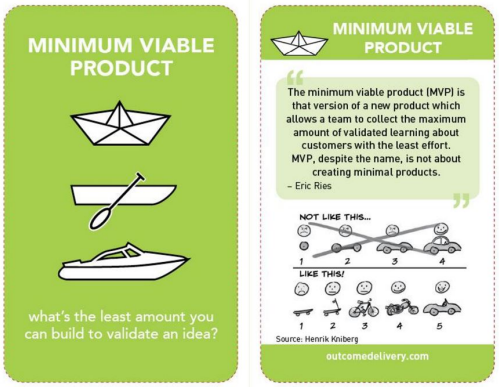
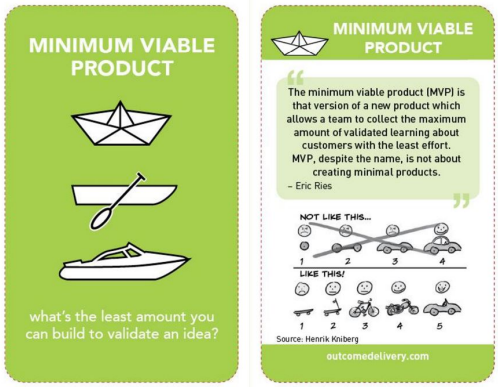


Figure 5.23: Quick Win – Mobius trigger card [25].



5.6.2 Definition

In order for the concepts of deliverables and milestones to be of greater use for Agile teams in the City Catalyst platform, their expansion to support some activities is recommended:

1. **Association of deliverables with milestones.** Milestones are composed of several deliverables, and so we should be able to track which deliverables belong to which milestones.

2. **Deliverable and Milestone's state.** Since Milestones and so deliverables are used to keep track of the projects' development state, we should be able to track their status: new, in progress, completed. A Milestone state should be related to its deliverables: if all of its deliverables are completed, then the milestone is also completed.

3. **Deliverable and Milestone's effort.** Agile development often utilizes effort estimation to prioritize tasks and allocate adequate resources. The effort for a milestone should be the sum of the effort of all of its deliverables.

4. **Association of individuals to deliverables and milestones.** It is also important that individuals are clearly aware of their and others' responsibilities, so collaboration is effortlessly done and responsibilities are easily tracked.

5. **Cancellation of deliverables and milestones.** Agile environments are recognized by changing requirements, and so there should be a way to cancel, but not delete, deliverables and milestones that are no longer adequate, i.e. absolute. Cancel over delete so all participants can be aware of changing requirements.

Location in the Platform

The expanded deliverables and milestones will be added to the Project, Milestone and Deliverable's view page in the Project Management module.

User Stories

Association of deliverables with milestones

US-EP22 As an Entity, I want to associate a deliverable with a milestone, so that developers can understand what is necessary for a milestone to be complete and give context to the deliverable.

US-EP23 As an Entity, I want to associate a milestone with a deliverable, so that developers understand what is entailed for a milestone to be complete and give context to the deliverable.

Deliverable and Milestone's state

US-EP24 As an Entity, I want to add a state – new, in progress or completed – to a deliverable, so the project's state is easier to track.

US-EP25 As an Entity, I want the state of a milestone to reflect the state of its deliverables, so I can understand how close a milestone is to being finished.

Deliverable and Milestone's effort

US-EP26 As an Entity, I want to add effort to a deliverable, so that the project's team is able to allocate appropriate resources to it.

US-EP27 As an Entity, I want the effort of a milestone to reflect the effort of its deliverables, so that the project's team is able to understand how complex a milestone is.

Association of individuals to deliverables and milestones

US-EP28 As an Entity, I want to add another entity or myself to a deliverable, so that it is easy to know who is responsible for which deliverable.

US-EP29 As an Entity, I want to add another entity or myself to a milestone, so that it is easy to know who is responsible for which milestone.

Cancellation of deliverables and milestones

US-EP30 As an Entity, I want to cancel a deliverable if it is no longer necessary, i.e. obsolete, so that active deliverables reflex the current reality of the project.

US-EP31 As an Entity, I want to cancel a milestone if it is no longer necessary, i.e. obsolete, so that active milestones reflex the current reality of the project.

View deliverables and milestones with state, effort, cancellation, association of deliverables with milestones and association of individuals

US-EP32 As an Entity, Lead User or Mentor, I want to see a deliverable with its associated milestone, state, effort users and if it has or not been cancelled, so that I can fully understand the deliverable and its context and so that I am able to allocate appropriate resources.

US-EP33 As an Entity, Lead User or Mentor, I want to see a milestone with its associated deliverables, state, effort users and if it has or not been cancelled, so that I can fully understand the milestone and its context and so that I am able to allocate appropriate resources.

Mock-ups for the visualization of a deliverable and a milestone with state, effort, cancellation, association of deliverables with milestones and association of individuals can be found in Figures 5.24, 5.25 and 5.26.

5.6.3 Low-level requirements

ID	EP22
User Story ID	US-EP22
Description	Associate a deliverable to a milestone.
Entries	Internet connection. Access credentials. Deliverable to be associated.
Processing	An Entity accesses the functionality of associating a deliverable to a milestone. The user chooses the deliverable to associate with the milestone. The lead user associates the chosen deliverable with the milestone.
Outputs	The deliverable is now associated with the milestone and the deliverable can be seen in the milestone view page and the milestone can be seen in the deliverable view page.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

Figure 5.24: Mock-up for viewing a list of deliverables and milestones in a project with state, effort, cancellation and association of individuals.

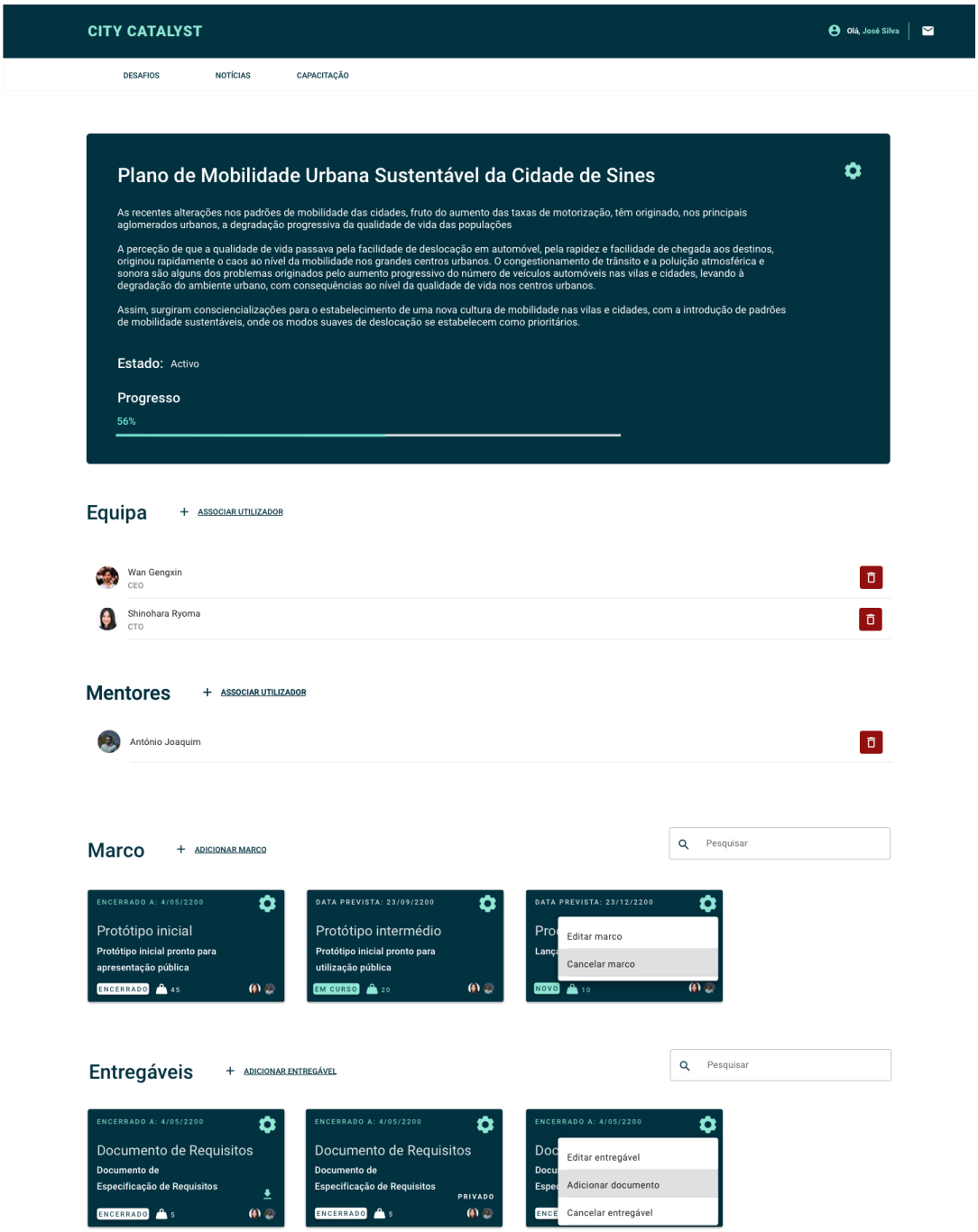


Figure 5.25: Mock-up for viewing a deliverable with state, effort, cancellation, association of deliverables with milestones and association of individuals.

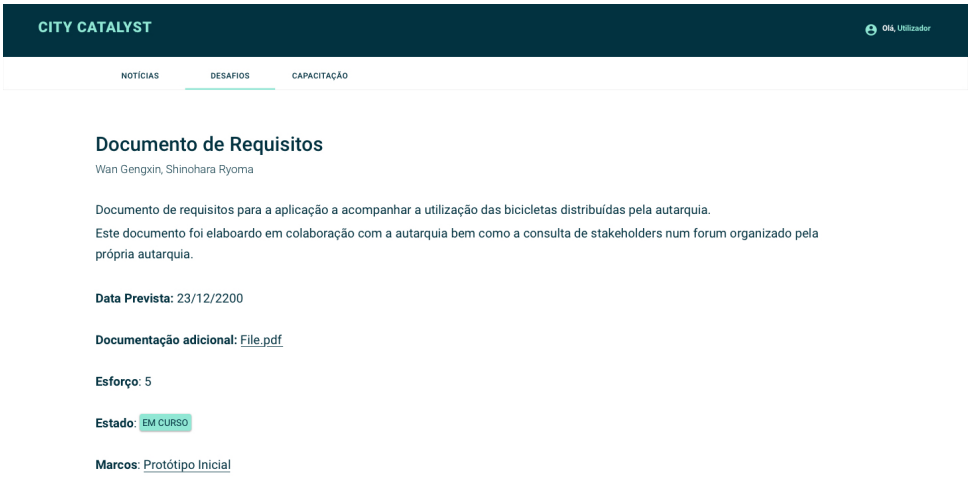
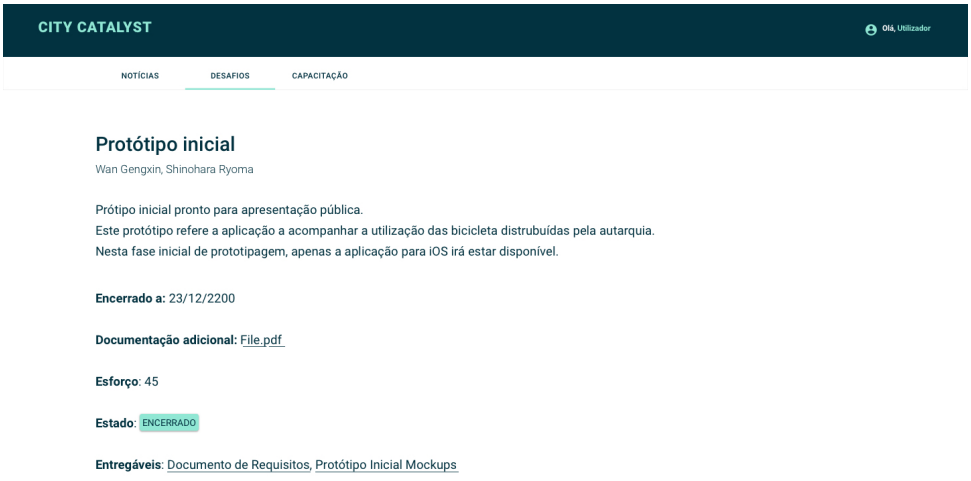


Figure 5.26: Mock-up for viewing a milestone with state, effort, cancellation, association of deliverables milestones and association of individuals.



ID	EP23
User Story ID	US-EP23
Description	Associate a milestone with a deliverable.
Entries	Internet connection. Access credentials. Milestone to be associated.
Processing	An Entity accesses the functionality of associating a milestone to a deliverable. The user chooses the milestone to associate with the deliverable. The lead user associates the chosen milestone with the deliverable.
Outputs	The milestone is now associated with the deliverable and the deliverable can be seen in the milestone view page and the milestone can be seen in the deliverable view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP24
User Story ID	US-EP24
Description	Set deliverable state.
Entries	Internet connection. Access credentials. Deliverable State.
Processing	An Entity accesses the functionality of setting a deliverable state. The user chooses the state of a deliverable: new, in progress, or completed. The default when a deliverable is newly created is new. The lead user associates the chosen state with the deliverable.
Outputs	The deliverable is now on the newly chosen state and the state can be seen on the deliverable view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP25
User Story ID	US-EP25
Description	Automatic change of milestone state.
Entries	Internet connection.
Processing	One of the milestone's deliverables changes state.
Outputs	The milestone has now a new state: if all deliverables are new, then the milestone is new; if one of the deliverables is in progress, then the milestone is in progress; and, if all of the deliverables are completed, then the milestone is completed.
Error treatment	N/A
Permissions	N/A

ID	EP26
User Story ID	US-EP26
Description	Add effort to a deliverable.
Entries	Internet connection. Access credentials. Deliverable effort.
Processing	An Entity accesses the functionality of adding effort to a deliverable. The entity adds the effort to the deliverable.
Outputs	The deliverable has now an effort value and it can be seen on the deliverable view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If mandatory data is missing, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP27
User Story ID	US-EP27
Description	Automatic change of milestone effort.
Entries	Internet connection.
Processing	One of the milestone's deliverables effort changes.
Outputs	The milestone has now a new effort. The effort for a milestone is the sum of the effort of all of its deliverables. If a deliverable doesn't have an effort, it is assumed that its effort is zero.
Error treatment	N/A
Permissions	N/A

ID	EP28
User Story ID	US-EP28
Description	Associate user with deliverable.
Entries	Internet connection. Access credentials. User (i.e. entity) to be associated.
Processing	An Entity accesses the functionality of associating an entity to a deliverable. The entity adds another entity or itself to a deliverable.
Outputs	The chosen entity is now associated with the deliverable and the entity can be seen on the deliverable view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP29
User Story ID	US-EP29
Description	Associate user with milestone.
Entries	Internet connection. Access credentials. User (i.e. entity) to be associated.
Processing	An Entity accesses the functionality of associating an entity to a milestone. The entity adds another entity or itself to a milestone.
Outputs	The chosen entity is now associated with the milestone and the entity can be seen on the milestone view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP30
User Story ID	US-EP30
Description	Cancel deliverable.
Entries	Internet connection. Access credentials.
Processing	An Entity accesses the functionality of cancelling a deliverable. The entity cancels the deliverable.
Outputs	The deliverable is now cancelled and it cannot be seen by the project-associated users if they don't search for it. The deliverable view page shows that the deliverable is cancelled.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP31
User Story ID	US-EP31
Description	Cancel milestone.
Entries	Internet connection. Access credentials.
Processing	An Entity accesses the functionality of cancelling a milestone. The entity cancels the milestone.
Outputs	The milestone is now cancelled and it cannot be seen by the project-associated users if they don't search for it. The milestone view page shows that the milestone is cancelled.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities

ID	EP32
User Story ID	US-EP32
Description	View deliverable with its associated milestone, state, effort, users and if it has or not been cancelled.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead User or mentor accesses a deliverable.
Outputs	The user can see the deliverable's associated milestone, state, effort, associated users and if it has or has not been cancelled.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead users and Mentors

ID	EP33
User Story ID	US-EP33
Description	View milestone with its associated deliverables, state, effort, users and if it has or not been cancelled.
Entries	Internet connection. Access credentials.
Processing	An Entity, Lead User or mentor accesses a milestone.
Outputs	The user can see the milestone's associated deliverables, state, effort, associated users and if it has or has not been cancelled.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead users and Mentors

5.7 Expand project

Agile teams have a strong relationship with the stakeholders and the project is constantly evolving around the stakeholders' feedback. As much as stakeholders can, they should be privy to all project resources (i.e. information), so they can provide good and complete feedback. Developers should also be aware of the project's big picture, and not be isolated from what they are actively working on. The City Catalyst platform should support and encourage all project participants to have access to as much information as possible about the project.

5.7.1 Inspiration

The features proposed to expand the functionalities of the project section are inspired by Open Innovation Platform Regione Lombardia and Kaggle, both Open Innovation Digital Platforms, and the Mobius Loop Trigger Card *Retrospective* (Figure 5.15).

The trigger card *Retrospective* describes a common activity performed by Agile teams: from time to time, to assess what has and hasn't worked from the perspective of internal efficiency, but also what needs to be adapted change going forward [25].

The OIPRL allows users to associate documents in communities to facilitate knowledge exchange. The platform also welcomes users in communities with a sort of mural where the latest changes for each category (e.g. recent news, latest documents, recent discussions) are displayed. Kaggle constructs a personalise newsfeed for each user to know the latest developments in their communities (e.g. new comments, latest project updates in my communities, and new communities to explore).

The City Catalyst platform can be enhanced to assist project participants and stakeholders to collaborate with less friction in retrospective sessions and when collecting feedback from stakeholders. Giving stakeholders access to the project resources will enable them to more easily provide feedback to the developers. Having a mural where all participants can keep up to date on what is changing in the project, will make participants more informed for retrospectives, discover new information and make them aware of where to the project value has shifted.

5.7.2 Definition

In the City Catalyst platform, two types of users are planned to have access to the project's resources the platform: the team (i.e. developers), and mentors. Having an extra role so stakeholders have access to the project resources can be very advantageous. Stakeholders in Agile teams are frequently giving feedback. If they have access to the project resources, they can give more easily, more quickly and more complete feedback on deliverables or milestones.

Agile development welcomes change and evolution. Keeping up with all the changes can become a challenge for the development team. The platform should offer an easy way to keep track of the progression of milestones, deliverables and other project changes so developers are

aware of what and when changes are made. A mural with the project's history (e.g. what has been completed, if it was on time, what has been edited) can be of immense value to the developers.

Additionally, having the ability to associate documents with the overall project can be very useful for developers, mentors and possibly stakeholders to quickly have access to major project documents in a very practical and centralized location.

In short, the City Catalyst Platform could benefit from the support for the following activities in a project:

1. **Stakeholders access.** Allow stakeholders to access project resources so they can more easily provide feedback to the developers.

2. **Mural.** Give participants an easy way to keep track of all the project changes.

3. **Centralize document deposit.** Make participants' life easier by having a centralised place where they can deposit major project documents.

Location in the platform

The features proposed to expand the project concept in the platform will be added to the Project's view page in the Project Management module.

User Stories

US-EP34 As an Entity or Lead User, I want to add a stakeholder to a project I am part of so that stakeholders are able to access project resources and more easily provide useful and complete feedback.

US-EP35 As an Entity, Lead User or Mentor, I want to see a mural with project changes, so that I can easily understand what is happening in the project.

US-EP36 As an Entity or Lead User, I want to add documents to a project, so that I can provide other participants with useful documents.

US-EP37 As an Entity, Lead User or Mentor, I want to see and download documents associated with a project, so that I can easily access major project documents.

Mock-ups for the visualization of a project with a mural, stakeholders and a centralised document deposit can be found in Figures 5.27, 5.28 and 5.29.

Figure 5.27: Mock-up of a project with a mural.

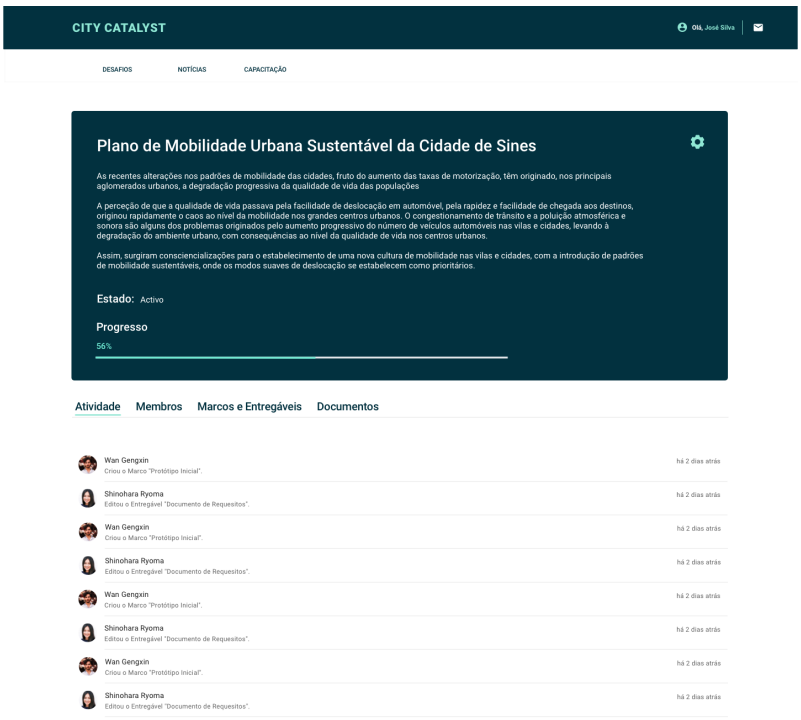


Figure 5.28: Mock-ups of a project with stakeholders.

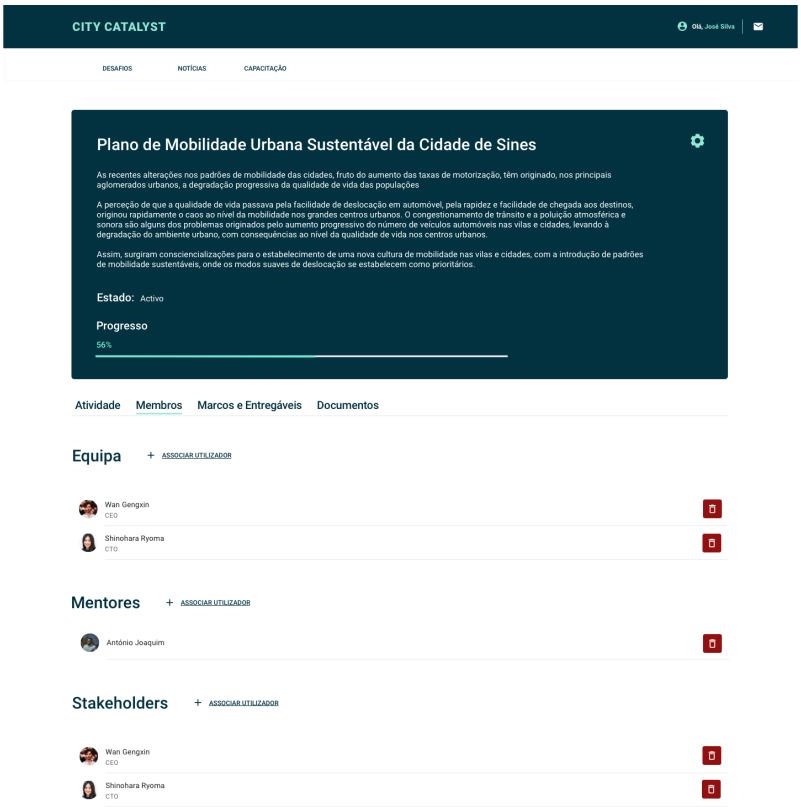
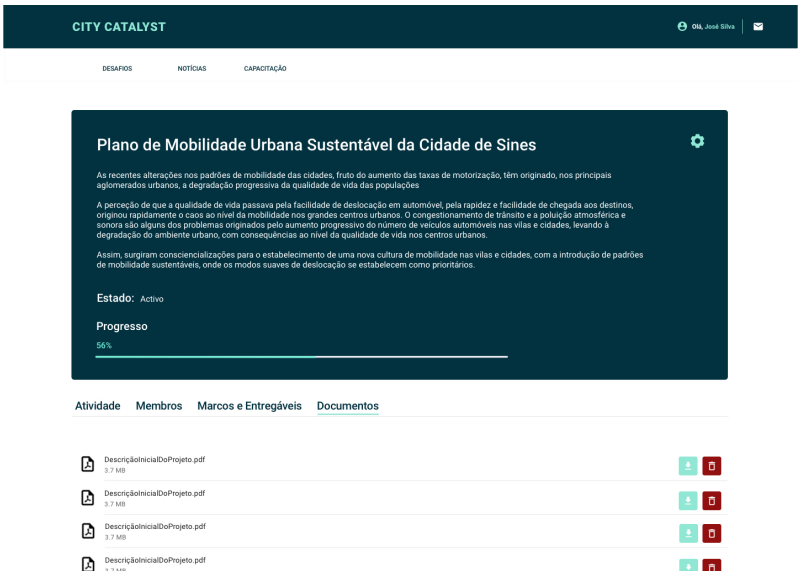


Figure 5.29: Mock-ups of a project with a centralised document deposit.



5.7.3 Low-level requirements

ID	EP34
User Story ID	US-EP34
Description	Add stakeholder to project.
Entries	Internet connection. Project User to be added as a stakeholder.
Processing	An Entity or Lead user accesses the functionality to add new stakeholders to the project. The user selects the user they want to add to the project. The user adds a stakeholder to the project.
Outputs	The user is now added to the project and can see the project resources.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead users.

ID	EP35
User Story ID	US-EP35
Description	Update projects' mural when something changes.
Entries	Internet connection. Project. Update that occurred.
Processing	Something related to the project is created or updated (e.g. a new milestone or deliverable is created, a milestone or deliverable is updated or a new user is added to the project).
Outputs	The project's mural now reflects the latest update along with older updates.
Error treatment	N/A.
Permissions	N/A.

ID	EP36
User Story ID	US-EP36
Description	Add document to the project.
Entries	Internet connection. Access credentials. Project. Document to be uploaded.
Processing	An Entity or Lead user accesses the functionality to add a new document to the project. The user selects the document they want to add to the project. The user adds a document to the project.
Outputs	The document is now added to the project and project users can see and download the document on the project view page.
Error treatment	If the access credentials are invalid, then an error message is shown. If the added data is invalid, an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead users.

ID	EP37
User Story ID	US-EP37
Description	See and download documents associated with the project.
Entries	Internet connection. Access credentials. Project.
Processing	An Entity, Lead User or mentor accesses a project.
Outputs	The user can see the project's associated documents and they are able to download them.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead users and Mentors.

5.8 Summary

In this chapter, we have introduced seven groups of features to better support Agility, Co-Creation, and Open Innovation in the City Catalyst platform. For each group of features we 1) Explain their inspiration; 2) Provide a high-level description, including user stories and the platform's affected modules; and, 3) Describe the features' working details through low-level requirements.

Each of the seven groups of features aims to resolve certain problems or support certain activities around the concepts of Agility, Co-Creation and OI that may arise during the entire value creation process. Hence, we can map each group of features to the identified activities and problems in Section 4.2.1 that lack support in the planned City Catalyst platform:

- **Employ transparency for superior collaboration:** Framing the challenge, and Expand project;
- **Communicate in all phases with stakeholders, developers and challengers:** Associate events to challenges and projects, and Communication between users;
- **Value outcomes (and impact) over features:** Defining the Impact;
- **Make choices quickly and easily:** Expand proposed solutions; and,
- **Respond to change over following a plan:** Expand deliverables and milestones.

We can also map the seven groups of features to the phases of the interactive coupled OI process, also known as the value creation process, they may impact (Figure 5.30):

1. **Framing the challenge:** Problem definition;
2. **Defining the Impact:** Finding participants, External Collaboration, Leveraging and measuring the collaboration results;
3. **Associate events to challenges and projects:** Problem definition, Finding Participants, External Collaboration and Leveraging and Measuring the collaboration results;
4. **Expanding proposed solutions:** Finding Participants;
5. **Communication between users:** Problem definition, Finding Participants, External Collaboration and Leveraging and Measuring the collaboration results;
6. **Expand deliverables and milestones:** External Collaboration and Leveraging and Measuring the collaboration results; and,
7. **Expand project:** External Collaboration.

We have also created a User Stories Map for our suggested features (Figure 5.31 or full version in Annex D) so we can easily visualize what modules will be impacted by each group of features.

Figure 5.30: Relation between this work proposed features to support Co-Creation, Agility and Open Innovation in the City Catalyst Platform and the phases of the interactive coupled OI process, also known as the value creation process.

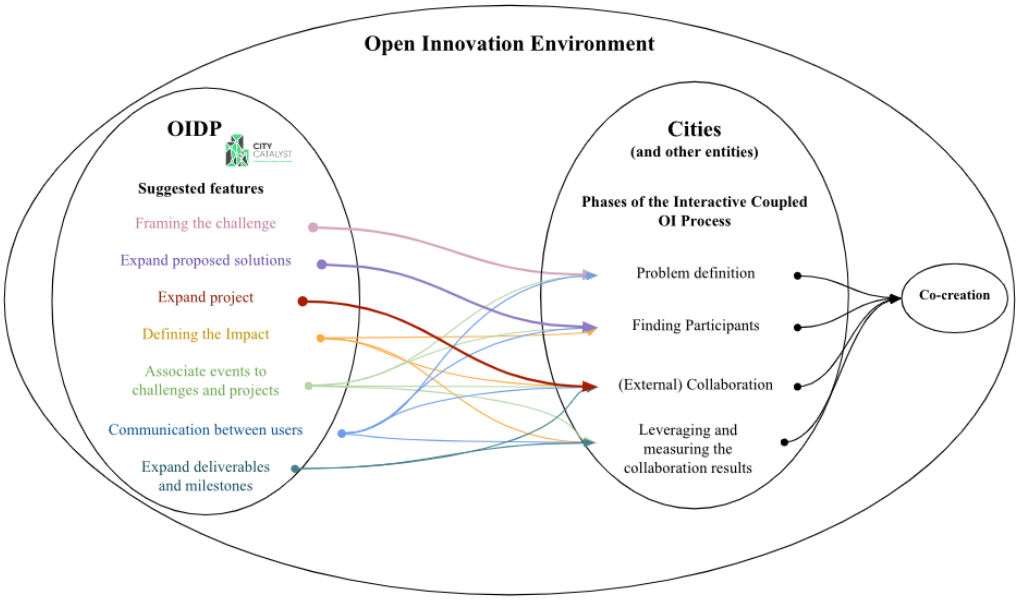
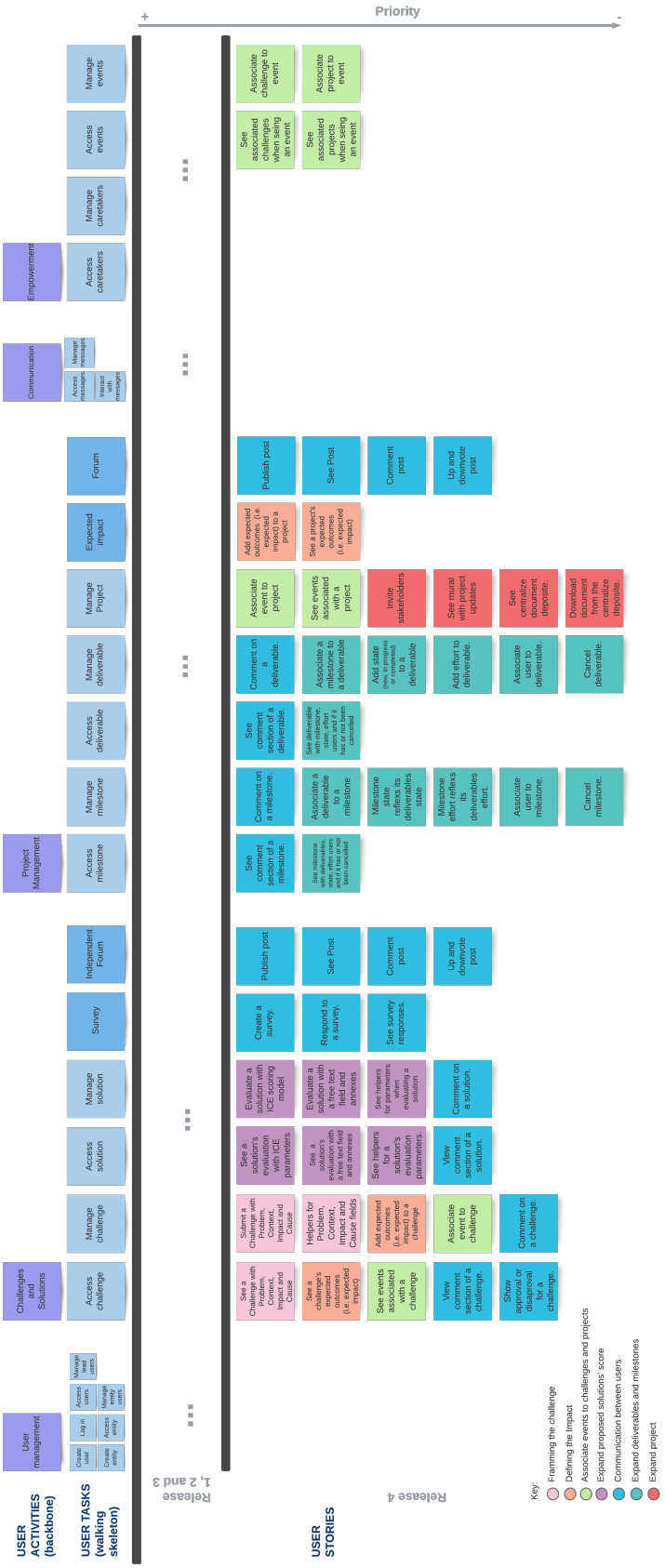


Figure 5.31: Suggested User Stories Mapping.



Chapter 6

Validation

The objective of this work was to propose groups of features to enhance the City Catalyst Platform to better support Agility and Co-Creation in Open Innovation for Cities. To validate both the necessity and the proposed features themselves, we asked City Catalyst partners working on PPS4[1] as respondents to a survey in which the main focus of the analysis is their experiences working on previous projects non-related to City Catalyst and their opinion of the proposed features taking into account their knowledge of the City Catalyst platform scope. Furthermore, we used their opinions to better understand what could be improved on and what features seemed the most interesting to implement in the platform.

6.1 Click-through prototypes

To aid in the validation of this work, click-through prototypes were elaborated of the features proposed in Chapter 5. A click-through prototype "depicts the elements on the pages of a Web site or the screens of an app [...] [and] links various screens through hotspots."[41]. Having as a base the mockups already elaborated for the first iteration of the platform, we came up with prototypes for the proposed features to allow PPS4 participants to have a better understanding of the proposed features and how they would fit with the rest of the platform when validating them.

6.2 Experiment Design

A survey is a technique employed to gather information from a sample of individuals, usually a fraction of the population being studied, and learn, from the information gathered, about the population as a whole [42][p. 30]. We chose to perform a survey to validate this work given "the numerous options available for instruments and data collection" [42][p. 30].

We designed an online self-administered questionnaire (Annex C) as the survey primary instrument to collect information from the respondents. In this questionnaire, we aimed to collect

[1] PPS4, a module of the larger City Catalyst Project, aims to develop an Open Innovation platform, in the context of smart and sustainable cities, involving the quadruple helix and promoting collective intelligence [14].

data in order to analyse the opinion of City Catalyst participants, namely the ones working on the PPS4[1] module, regarding the seven groups of features proposed in Chapter 5.

Our goal is to be able to generalize the survey findings to understand the impact of this work's proposed features on the future users of the City Catalyst platform and their Co-Creation, Agility and Open Innovation activities.

6.2.1 Reasoning

We aim to validate two key components of this work: the reasons why the proposed features were born; and if our proposed features bring value by solving the identified problem or assisting the identified activity. In essence, our goal is twofold: to validate why the features may help platform users and how they will they do it.

To validate the two components of the proposed features (i.e. the why and how), we build a questionnaire (Annex C) where participants were asked to:

1. Identify if they have encountered certain problems or if they had partaken in certain activities that lead to the features; and,

2. Give their opinion on the features themselves after observing animated images of the click-through prototypes (Section 6.1).

We employed three types of answers: a linear scale, from 1 to 5, labelled "*Highly disagree*" and "*Highly Agree*" respectively; multiple-choice; and, checkbox. We also allocated spaces at each stage for users to give their free written opinions.

6.2.2 Subjects

The survey is not focused on specific individuals that have special knowledge about Co-Creation, Agility and Open Innovation, since we do not specifically ask about these concepts. However, since the problems or activities we are targeting to solve or support are related to these concepts, individuals with prior knowledge about them will be able to provide better answers. We should also consider the already defined characteristics of the platform such as its users and stakeholders (i.e. city councils, academia, companies) and planned features. PPS4[1] participants have been involved in requirements elicitation for the platform and so are familiar with stakeholders requisites, problems and workflows; with the City Catalyst platform's planned features; and, with the concepts of Co-Creation and Open Innovation. Hence, they are able to represent stakeholders' and future users' interests and contextualize our proposed changes with the planned platform.

PPS4 participants are very diverse, having distinct technical backgrounds and being involved with the City Catalyst project for different lengths of time. Hence, to better understand the results and the possible bias brought by their role and (lack of) knowledge regarding the platform, we asked participants 1) How long they have been involved with the project; and, 2) What their role is in the project. Both of these questions were optional.

6.2.3 Attributes of interest

Our overall goal is to evaluate how our features enhance the City Catalyst platform to better support Co-Creation, Agile and Open Innovation activities. More specifically, as stated in Section 6.2.1, we intend to validate two key components of our proposed features: why were they proposed and how they solve a problem or assist an activity.

Consequently, our main attribute of interest is to assess participants' opinions on how well this work's proposed features can assist platform users when performing Co-Creation, Open Innovation and Agile activities. We also intend to understand why, how and how well the proposed features assist these activities by analysing their:

- **Relevance.** Have you encountered a certain problem before? Have you performed a certain activity before?
- **Impact.** How does a problem or an activity impact a project?
- **Understandability.** Does a specific user type understand the proposed feature?
- **Usefulness.** Is the proposed feature useful for users? Does the proposed feature resolve the identified problem? Does the proposed feature assist or encourage the identified activity?

6.2.4 Tasks

We asked participants to answer questions grouped in nine sections in the survey. The first section was optional, regarding the participant's profile, and it served to better understand the participant's background. The following seven sections aimed to gather the participant's opinions on the groups of featured proposed in Chapter 5. The last section aimed to understand the participant's outlook of the presented proposed features as a whole.

Below, we describe each of the nine sections of the questionnaire (Annex C) in greater detail:

Participant's profile (Optional)

In this section, the participant was asked to describe their background: their role and how long they have been involved in the project.

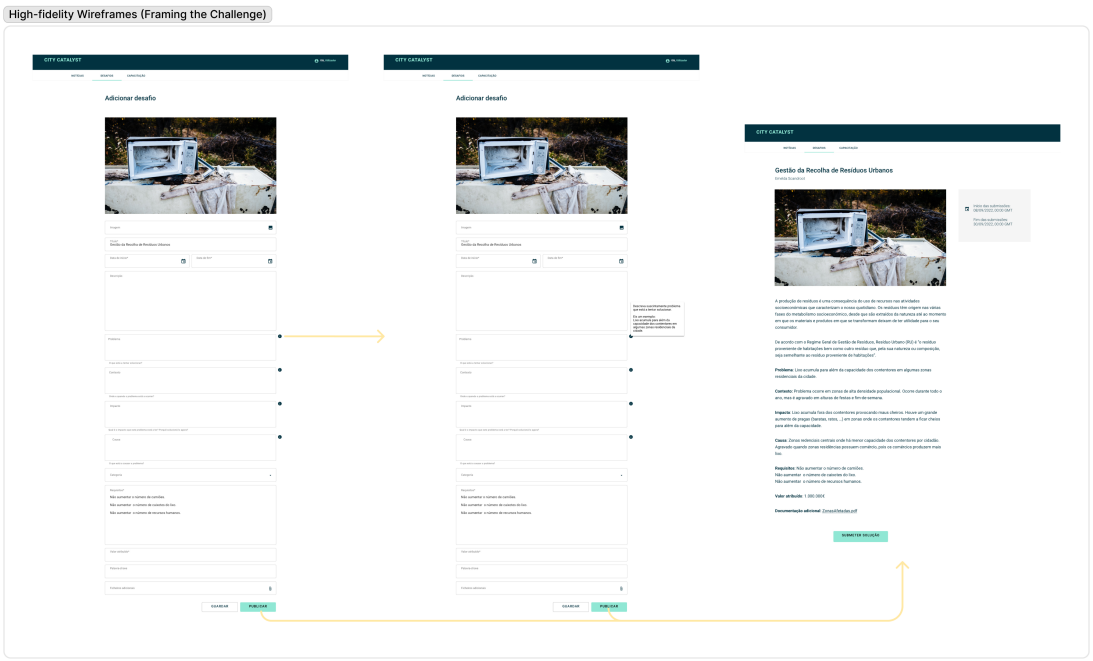
Framing the challenge

We asked the participant if and, if they have, why they had experienced requirements changes due to misunderstandings during the problem definition phase. We also enquired if they believe more time and resources should be allocated to defining a problem and about their opinion on the cost of requirement changes due to misunderstandings at the problem definition phases.

Following these questions, we presented the participant with animated images (Figure 6.1) of a challenge being created and viewed with four extra fields: Problem, Context, Impact and Cause. We then asked a series of questions regarding these animated images to ascertain:

1. If users understand the extra fields; and,
2. If there is value in adding them:
   (a) If the extra fields encourage challengers to clearly describe their challenge; and,
   (b) If they bring helpful clarity to a challenge definition.

Figure 6.1: High-Fidelity Wireframes for the suggested features under *Framing the challenge*.



Defining the expected impact

We asked the participant if they had ever monitored a project's impact during the entire value creation process and if they find this activity useful to achieve a good end result. The participant was also asked their opinion regarding having a project's outcomes (i.e. impact) predefined and how they may help to monitor project progress, to evaluate possible solutions and to assess the end result. We also enquired about useful elements to define an expected outcome, and which phases would benefit from having predefined expected outcomes.

Following these questions, the participant was presented with an animated image of a challenge with expected impact (i.e. outcomes) defined and a view page for an outcome (Figure 6.2). We also presented the participant with a similar animated image for a project. We then enquired the participant about the definition of the expected impact for a challenge and for a project:

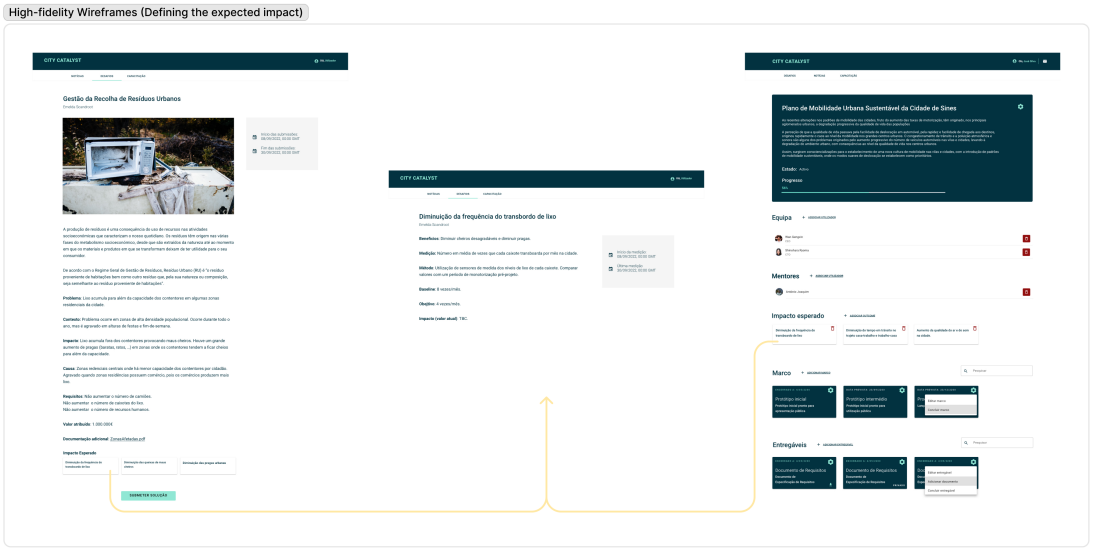
1. If it is clear to users that the set of all expected outcomes is the expected impact; and,
2. If there is value in adding expected outcomes to a challenge or a project:

(a) If the expected impact definition brings helpful clarity to a challenge, and so helps solvers propose adequate solutions; and,

(b) If it helps to track the progress and direction of the development effort of a project; and,

(c) If aids in the assessment of a project when it has been concluded, i.e. if it has reached its goals.

Figure 6.2: High-Fidelity Wireframes for the suggested features under *Defining the expected impact*.



Associate events to challenges and projects

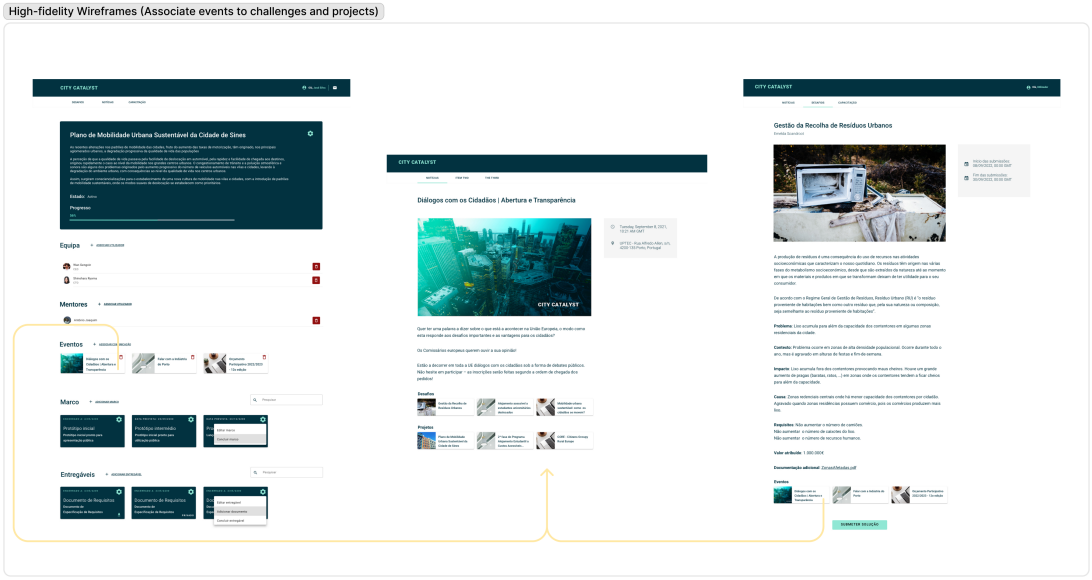
In this section, we focused on the need to communicate synchronously with stakeholders and other project participants. We assessed the need to communicate with stakeholders and others, as well as the methods to do so. We also enquire the participant about the possibility to promote events within a platform.

Afterwards, we present the participant with an animated image (Figure 6.3) depicting an event with a challenge and project associated. We then ask the participant a few questions to ascertain:

1. If it's useful to see the challenge and/or a project that prompted an event in order to provide context regarding the event.

2. If promoting an event within a challenge and/or project brings more users to participate in it.

Figure 6.3: High-Fidelity Wireframes for the suggested features under *Associate events to challenges and projects*.



Expand proposed solutions' score

In this section, we begin by asking the participant if they have previously experienced difficulty in prioritizing options quickly and in an Agile manner. We also enquire what ranking systems they have used to prioritise options. We then follow by asking participants if they desire transparency when working with experts that are evaluating possible project solutions to better understand their evaluation. Following these questions, the participant was presented with an animated image (Figure 6.4) showcasing a solution and evaluation parameters for that solution – impact, confidence, ease – as well as a free text field and the possibility to add annexes. The participant was then asked a series of questions to ascertain:

1. If users understand the impact, confidence and ease fields; and,

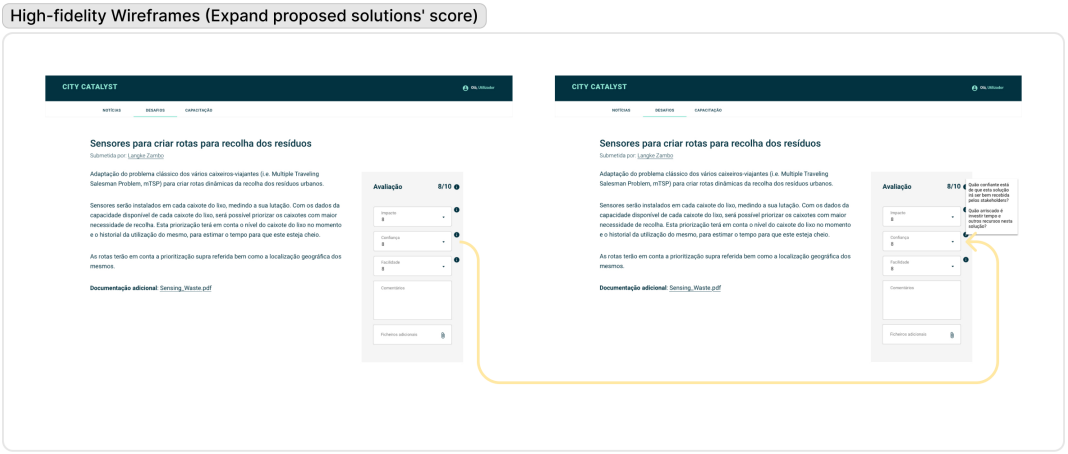
2. If there is value in adding the five fields:

   (a) If adding the five fields allows a challenger to understand why an appraiser evaluated a solution a certain way;

   (b) If challengers are able to make informed decisions by having the score deconstructed in three parameters (i.e. impact, confidence, and ease); and,

   (c) If having an explanation of an evaluation in text-form (i.e. text-field and annexes) allows challengers to better understand the given evaluation.

Figure 6.4: High-Fidelity Wireframes for the suggested features under *Expand Proposed Solutions' score*.



Communication between users

Participants were asked about the value of asynchronous communication between platform users: between all types of users; project participants; challengers or solvers and projects' stakeholders; and, entities or government agents and citizens.

We then present the participants with several animated images (Figure 6.5) showcasing: an independent forum, a forum within a project, comment sections in a challenge, in a proposed solution, in a milestone and in a deliverable and a survey. Next, participants were enquired about each of the animated images to ascertain if there is value in adding these features:

1. If having an independent forum to communicate with platform users allows the generation of debate, the assessment of interest and the finding of new ideas;

2. If project forums encourage general discussing and the learning and sharing of ideas and information between project participants;

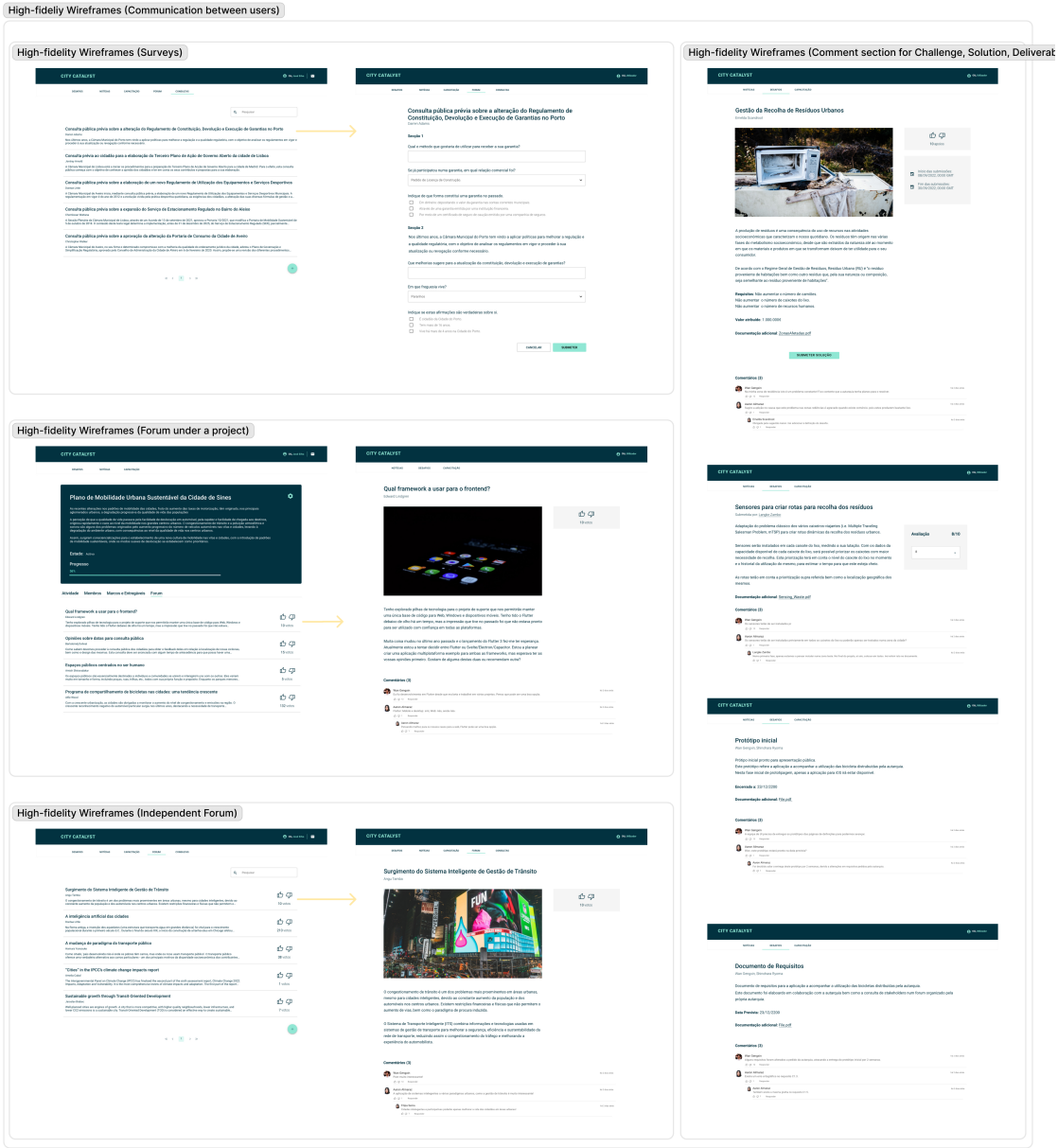
3. If non-textual communication through up and downvotes on forums incentivises users to easily share their support or disapproval about a topic;

4. If having open comment sections allows for asynchronous Co-Creation by receiving feedback from and having discussions with other users;

5. If challenges' support scores help entities and municipality representatives to understand which ones have more public support; and,

6. If surveys allow entities and municipalities to quickly gather insights from stakeholders (i.e. citizens).

Figure 6.5: High-Fidelity Wireframes for the suggested features under *Communication between users*.



Expand deliverables and milestones

In this section, the participant was asked about the concepts of milestones and deliverables. The questions aimed to recognize if the participant understands and wants to be aware of the connection between milestones and deliverables; if they utilize effort estimation to prioritize tasks and allocate adequate resources; if they want to associate individuals and state to milestones and deliverables; and, if milestones and deliverables should always be accessible even if they are abandoned (i.e. obsolete).

Participants were then presented with an animated image (Figure 6.6) of a list of deliverables

and milestones from a project. We then ask a series of questions regarding the animated image to ascertain if there is value in expanding these two concepts:

1. If adding state to deliverable or milestone allows participants to easily keep track of the project's development state;

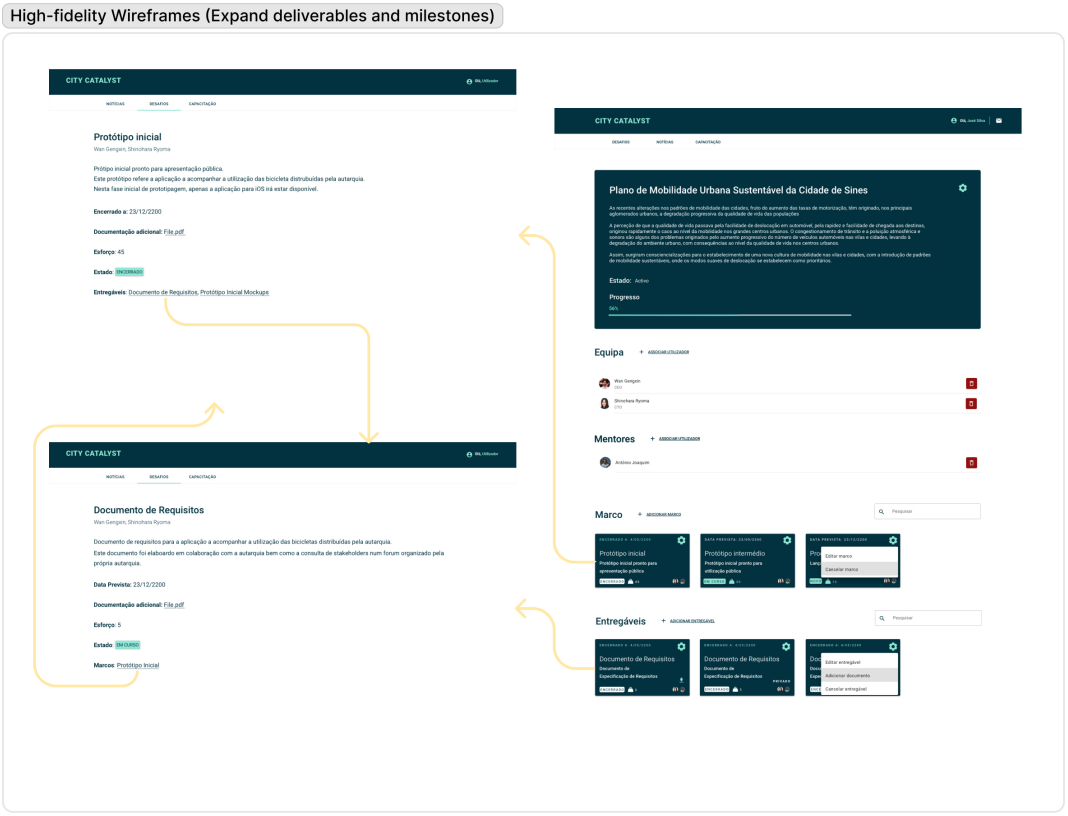
2. If having deliverable or milestone effort estimation helps to more easily prioritize tasks and allocate appropriate resources;

3. If seeing who is responsible for a deliverable or milestone allows for everyone within a project to be aware of their and others' responsibilities;

4. If associating deliverables to milestones and vice-versa is important to give context to each of these concepts; and,

5. If cancellation over deletion of deliverables and milestones so developers can keep track of changing requirements and can see the entire project's history.

Figure 6.6: High-Fidelity Wireframes for the suggested features under *Expand deliverables and milestones*.



Expand project

Participants were asked about their views on: the need for stakeholders to access project resources; the need to have a centralised document deposit; and, the difficulty to keep track of all project changes.

An animated image (Figure 6.7) showcasing a project with an activity mural, stakeholders as members and a documents tab was presented to the participants. They were then asked questions to ascertain if there is value in adding these new features to a project:

1. If adding stakeholders to a project allows stakeholders to more easily provide feedback to stakeholders;

2. If being able to see the most recent project changes gives project participants an easy way to keep track of all project changes; and,

3. If having a centralised document deposit makes life easier for participants.

Final remarks

The survey's final section focus on getting a general picture of the participant's opinion on the presented features and how all of them together can have an impact on the platform.

We enquire participants about their overall opinion on all the features, how they may aid the platform to support a more open, Agile and Co-Creative teams and which features left a better impression on them and which ones could be improved on.

6.2.5 Threats to validity

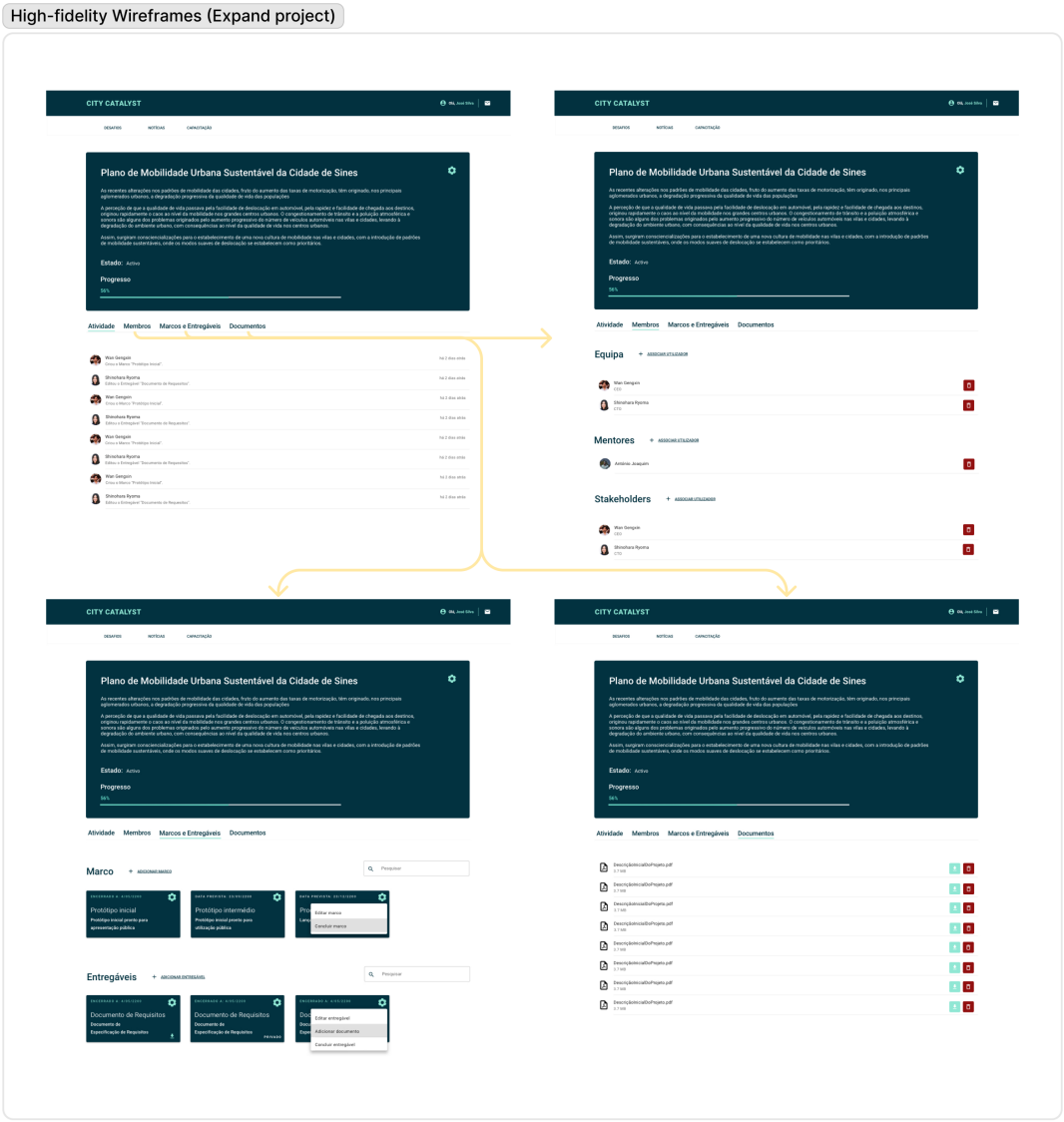
The validity of a survey is the extent to which it measures what it intends to and so it closely relates to how confidently can we trust the conclusions drawn from a survey [9]. To that extent, we analysed the threats to the validity of this survey in order to understand its trustworthiness.

Internal Validity

We have to take into account the following aspects to confirm that the casual relationship being tested is trustworthy:

Not having access to potential platform users. Ideally, we would have interviewed not only PPS4[1] participants but also future users of the platform such as citizens, academia, companies and municipalities representatives involved in an ongoing project that could be hosted on the City Catalyst platform. Not having any sample project with real stakeholders or a prototype of the platform condition us to only ask PPS4 participants for input, since they were the only ones we had access to and with enough knowledge of the platform to offer constructive feedback.

Figure 6.7: High-Fidelity Wireframes for the suggested features under *Expand project*.



Co-Creation, Open Innovation and Agility knowledge. This survey aims to assess if our proposed features will enhance the City Catalyst Platform to better support Co-Creation and Agility in Open Innovation for Cities. As such, it is relevant that participants correctly understand these concepts. We did not screen the participants with low knowledge of these concepts, since the survey itself doesn't require a profound knowledge about them but rather intends to understand the participant's experiences and opinions about specific problems, activities and features regarding these concepts.

Environment. All participants performed the survey completely online, so they were not in a controlled setting. Participants were in their chosen physical environments, therefore they could have been surrounded by distractions, or had someone influence their responses, for example. It

also means that participants could be doing the survey in one sitting or alternatively gradually. We believe that these factors are not significant given the content and objective of the survey.

External Validity

The results from this survey can be applied to other situations, groups or events taking into account:

Sample Size. Sample size is an important metric to analyse if we can have enough confidence that our findings can make inferences about the larger population, in this case, the future users of the platform.

The survey had only five participants, which is an extremely small sample size. Our target sample size was between 30 to 40 participants. Unfortunately, only five City Catalyst partners responded to the questionnaire. Hence, our findings must be interpreted taking into account the small sample size.

Sampling bias. We have to check if the participants are homogeneously distributed across the population, in order to ascertain that some members are not overly represented. To check if there is a sampling bias within the survey, we asked participants about their role and their timeframe in the project.

6.3 Results

In this section, we describe the feedback gathered from the five participants of the survey. We start by characterising the participants in terms of their longevity and role in the City Catalyst Platform (Section 6.3.1), followed by the description of the feedback given by them on the necessity of each group of features and the features themselves (Section 6.3.2).

6.3.1 Participants' Profiles

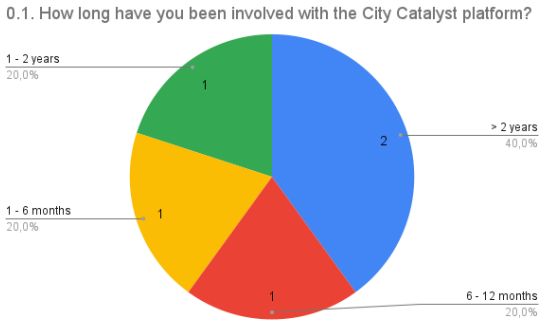
The participants in this survey were all City Catalyst PPS4 partners with varying degrees of seniority within the project: from one month to over two years (Figure 6.8). The participants had two types of roles: management – project manager, product owner, team lead – and developers.

6.3.2 Features evaluation

Framing the challenge

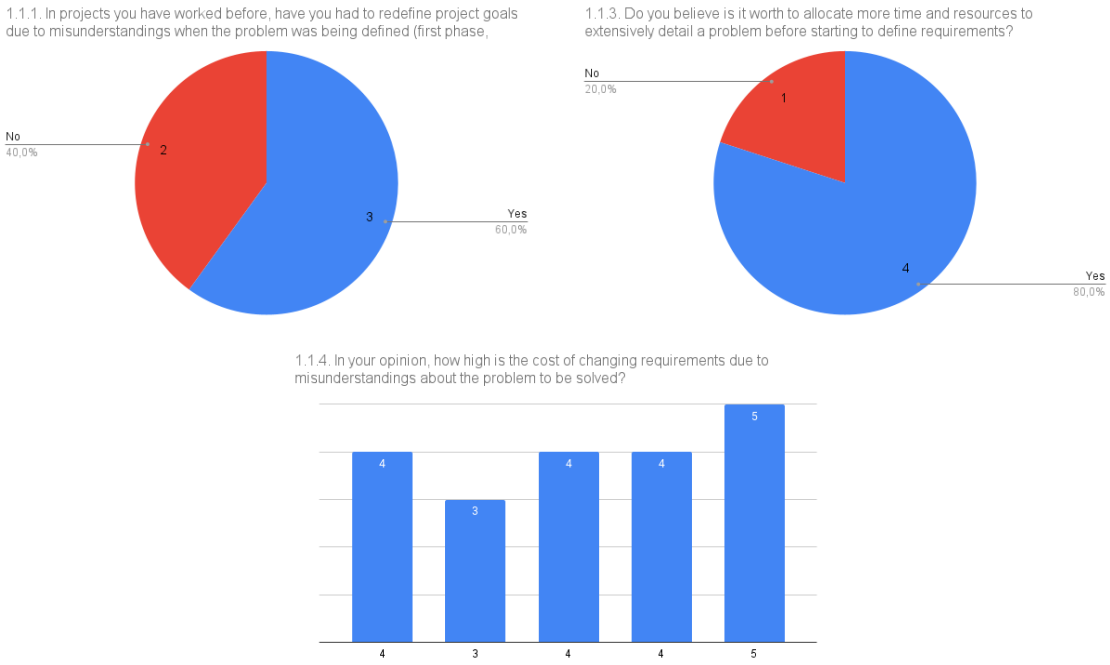
Necessity of a well-defined problem. Several participants recognized that, in previous projects, they had the need to redefine project goals due to misunderstandings when the problem to be solved was being defined (Figure 6.9). In general, the reasons identified by the participants for requirements changes due to misunderstandings in the problem definition phase could be traced to not including all or the correct stakeholders in the problem definition phase. This eventually

Figure 6.8: Participants' longevity in the City Catalyst Platform.



leads to an ill-defined problem that didn't take into account all stakeholders' needs or technical hurdles. Moreover, the majority of participants believe that allocating more time and resources to extensively detail a problem would contribute to a better outcome in requirements elicitation, and so greatly avoid the high costs of requirements changes in later phases of the value creation process (Figure 6.9).

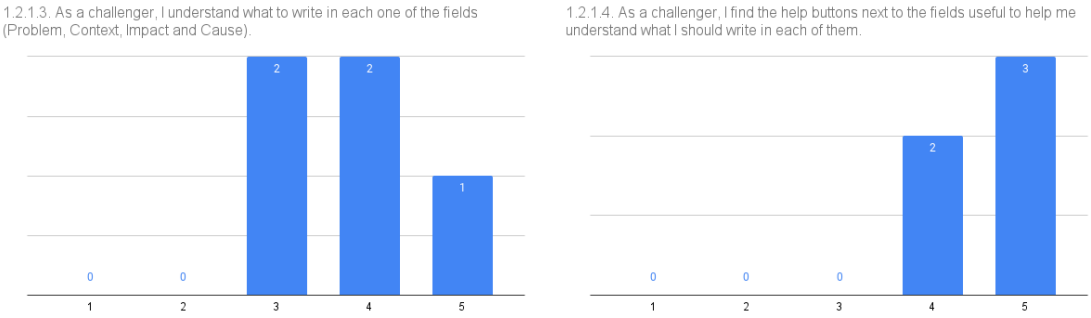
Figure 6.9: Participants opinions regarding the necessity of a well-defined problem.



Creating a challenge with four extra fields: Problem, Context, Impact and Cause. The majority of participants found the extra four fields – Problem, Context, Impact and Cause – useful to describe a challenge (Figure 6.11). They also found that the extra four fields could motivate challengers to pause and reflect on their challenge definition (Figure 6.11). The participants also

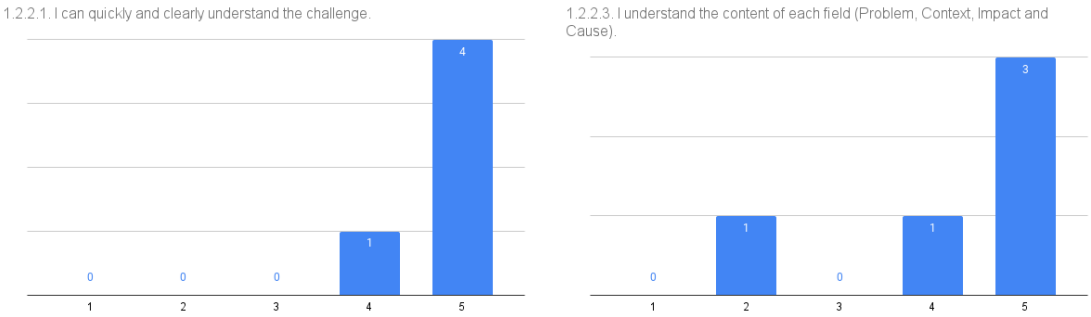
found that each of the four fields was self-explanatory, but having the helper buttons would greatly increase the chances of challengers understanding each of the fields correctly.

Figure 6.10: Participants opinions about creating a challenge with four extra fields: Problem, Context, Impact and Cause.



Viewing a challenge with four extra fields: Problem, Context, Impact and Cause. From the point of view of a general user of the platform, participants felt that the extra fields brought clarity to a challenge definition (Figure 6.11). However, one participant found that the fields – Problem, Context, Impact and Cause – were not self-explanatory and require further means for users to fully understand them (Figure 6.11).

Figure 6.11: Participants opinions about viewing a challenge with four extra fields: Problem, Context, Impact and Cause.



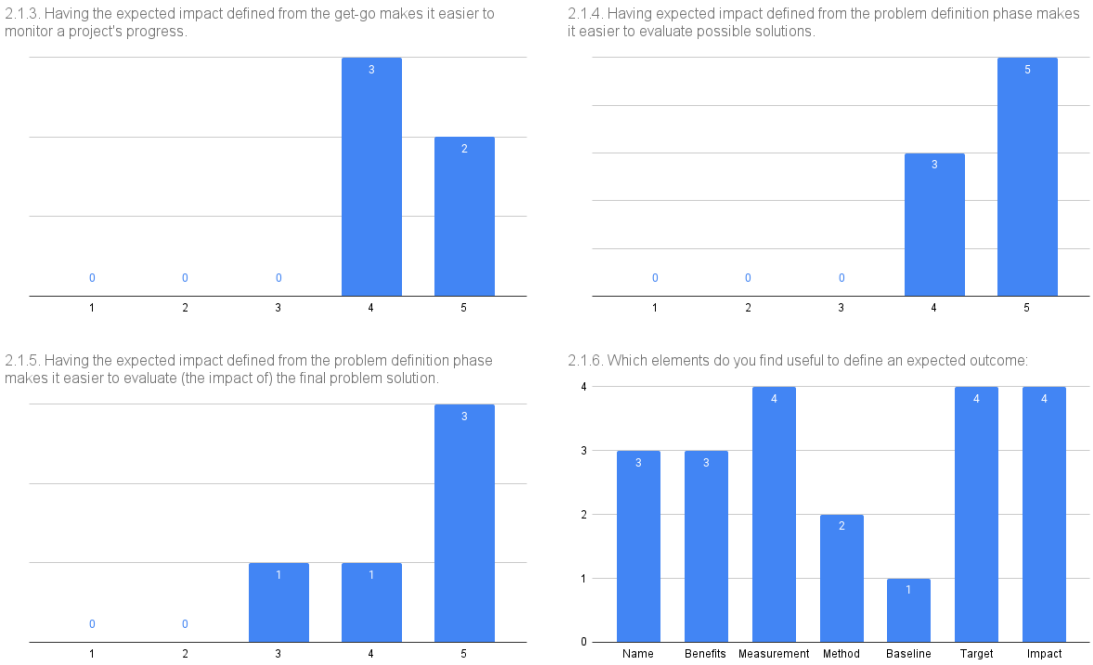
Defining the expected impact

Necessity of defining the expected impact. The majority of participants have never monitored the impact of a project during the entire value creation process, i.e. from requirements elicitation to the end result. Nonetheless, participants either felt neutral or positively toward the perspective that impact monitoring is important for a successful final outcome. More interestingly, participants strongly felt that having the expected impact defined from the problem definition phase makes it easier to evaluate possible solutions, monitor projects' progress and evaluate the real impact of the final finished project (Figure 6.12).

Regarding how should outcomes be defined, participants found that our definition was adequate: Name, Benefits, Unit of measurement, Method, Baseline, Target and Real results at the current development point (Figure 6.12).

The participants also found that all phases of the value creation process could benefit from having previously defined expected outcomes (i.e. impact), especially requirements elicitation and the leverage of the collaboration results.

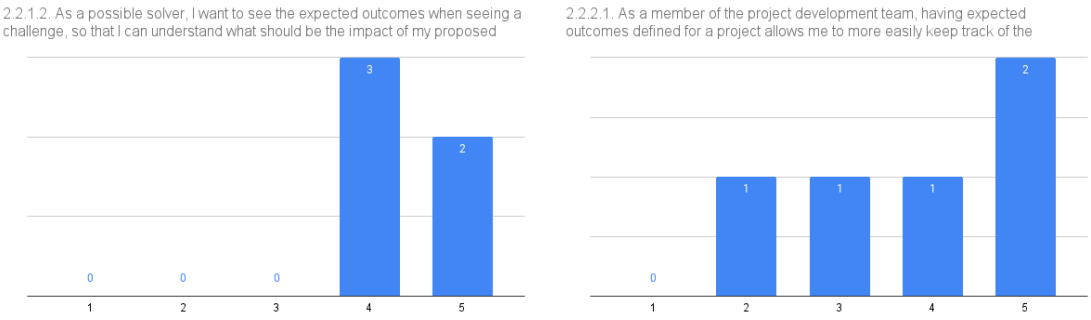
Figure 6.12: Participants opinions about the necessity of defining the expected impact.



Challenge with expected outcomes defined. Participants felt neutral or positively about adding expected outcomes to a challenge definition. They also found that having the expected outcomes available for possible solvers to see would help them to provide better solutions that take into account the defined expected outcomes (Figure 6.13). Participants also felt that users understand that the set of all expected outcomes is the expected impact of a solution to a challenge.

Project with expected outcomes defined. Participants didn't feel as confident about the role of having the expected impact defined during a project to monitor its progress and direction when compared to a challenge (Figure 6.13). These feelings are contrary to the findings of previous questions, where participants found that having previously defined the expected impact would greatly benefit phases of the value creation process that are carried out within a project on the platform.

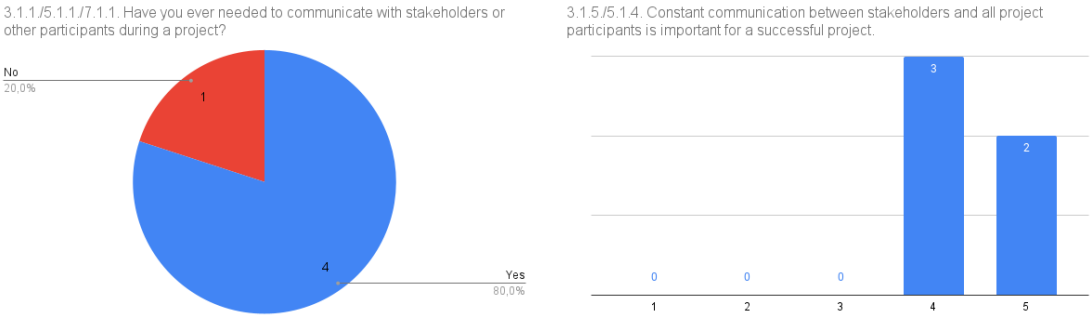
Figure 6.13: Participants opinions about a challenge and project with expected outcomes defined.



Association events to challenges and projects

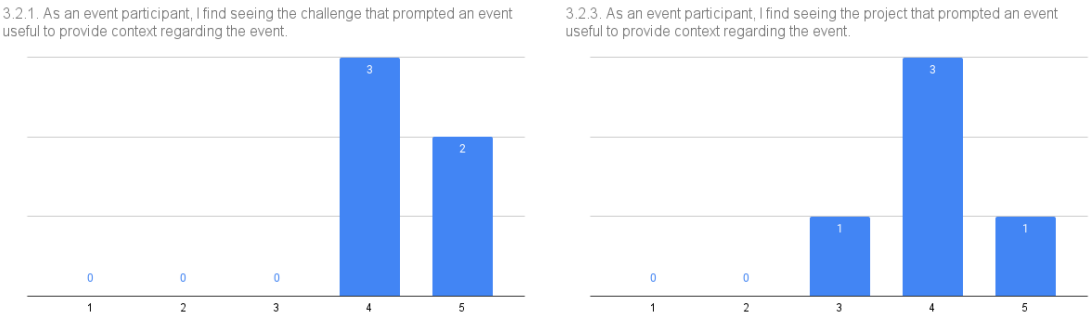
Necessity of communicating with stakeholders and platform users. All participants found that communication between stakeholders and all project participants is important for a successful project (Figure 6.14). Participants have also identified that they have had the need (Figure 6.14), in previous projects, to communicate with stakeholders and have it done so through several means such as email, phone, instant messaging and face-to-face. Regarding stakeholders they didn't have direct contact with, they have approached them through social media posts, email lists, events, and project coordinators. Unsurprisingly, they also found that promoting events within a platform is useful to find stakeholders and partners for a project.

Figure 6.14: Participants opinions the necessity of communicating with stakeholders and platform users.



Giving context to an event and promoting events within projects and challenges. Participants found that seeing either the challenges or projects that prompted an event is useful to provide context regarding the event (Figure 6.15). Participants were either neutral or positive about seeing the events being promoted within the challenges or projects that prompted them, so fellow participants could participate in them.

Figure 6.15: Participants opinions on giving context to an event and promoting events within projects and challenges.

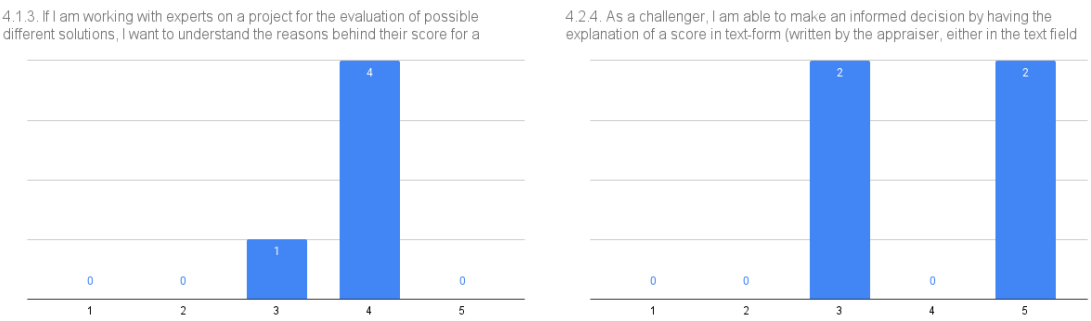


Expansion proposed solutions' score

Necessity of understanding a solution's score and evaluating a solution in an Agile manner. All participants haven't yet used a ranking system to prioritise options, but they also felt that they didn't have great difficulties on prioritizing options quickly and in an Agile manner when working on a project. However, participants found that when working with experts to evaluate possible solutions for a challenge, it is important to understand the reasons behind a solution's score (Figure 6.16).

Expansion of solutions' score to support the ICE scoring model, free text-field and annexes. Participants were neutral or positive towards the effect of Impact, Confidence and Ease as evaluation components of a proposed solution evaluation score. They were positive towards the addition of an explanation of the evaluation from the appraiser in text form (either in the text field or in a document annexed) to allow a challenger to make informed decisions regathering which solutions to choose for further development (Figure 6.16). Furthermore, participants felt that either challengers or appraisers would be able to understand the evaluation components – Impact, Confidence and Ease – with the assistance of the helpers.

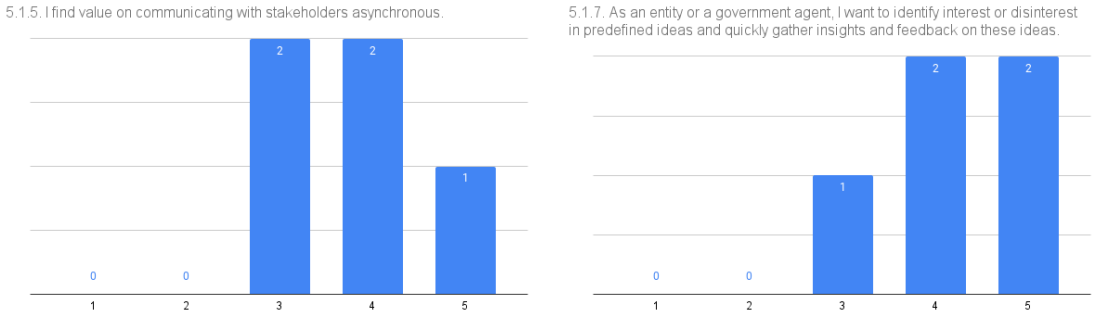
Figure 6.16: Participants opinions about the expansion of the proposed solutions' score.



Communication between users

Necessity of communicating with users asynchronously. We have already analysed the opinion of participants on the necessity and importance of communication between stakeholders and project participants in a previous section of the survey (Figure 6.14). In this section of the questionnaire, we went further and also asked participants specifically about asynchronously communication with stakeholders and other platform users (Figure 6.17). Participants found that there is value in communication with stakeholders and fellow project participants asynchronously. Participants also showed interest in identifying projects stakeholders are most interested in, in identifying interest or disinterest in predefined ideas (Figure 6.17) and in quickly gathering insights and feedback on these ideas.

Figure 6.17: Participants opinions on the necessity of communicating with users asynchronously.



Independent forum. Participants showed neutral or positive positions in relation to having an independent forum on the platform so entities or government agents can communicate with platform users and so generate debate, assess interest and find new ideas. They were mostly neutral on the point of view of general users regarding independent forums and how users could express their ideas or learn from others in them. In relation to non-textual communication in the independent forums, one participant showed disapproval of this idea, while the others felt neutral or positive about it.

Projects' forums. Similarly to the independent forums, overall participants were positive about having a discussion space for project participants to share ideas and learn from others. Contrary to independent forums, up and downvotes were viewed in a more positive light when applied to forums within projects.

Comment Sections. Comment sections for Challenges, Solutions, Deliverables or Milestones to allow greater collaboration between platform users were seen as neutral or positive by participants.

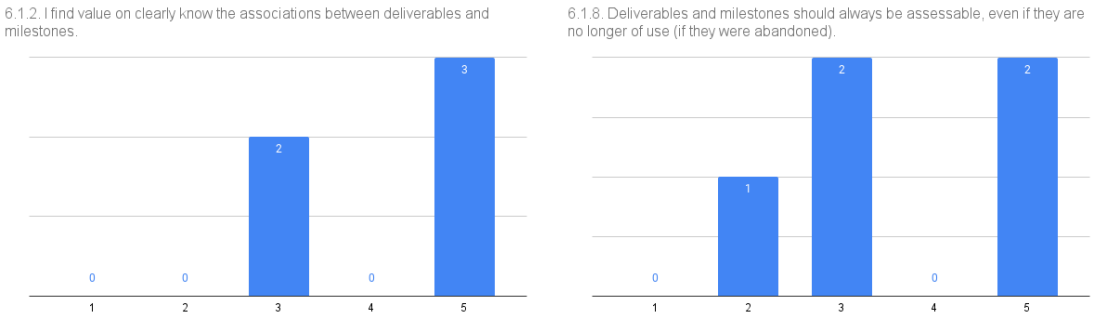
Surveys. Similarly to the comment sections, surveys were also seen neutrally or positively by participants in order to allow project developers, challengers and government agents to quickly gather insights from stakeholders (i.e. city citizens).

Challenges approval score. Participants found that having a challenge approval score could help entities and government agents perceive which challenges gathered greater public support.

Expansion of deliverables and milestones

Necessity to support activities related to deliverables and milestones. All participants reported that they understood the connection between deliverables and milestones, i.e. milestones can be viewed as a cluster of several deliverables. They felt that there is value in knowing the association between deliverables and milestones (Figure 6.18). Moreover, most participants utilize effort estimation to prioritize tasks and allocate adequate resources. They also felt value in knowing the state of a deliverable or milestone. Participants were neutral or positive about the relation of effort or state between a milestone and its deliverables. Furthermore, they also found value in allocating specific individuals to be responsible for deliverables and milestones. The most polarizing question was regarding the availability of deliverables and milestones after being cancelled (if they were abandoned): two strongly agreed with the statement, two were neutral and one slightly disagreed (Figure 6.18).

Figure 6.18: Participants opinions on the necessity to support activities related to deliverables and milestones.



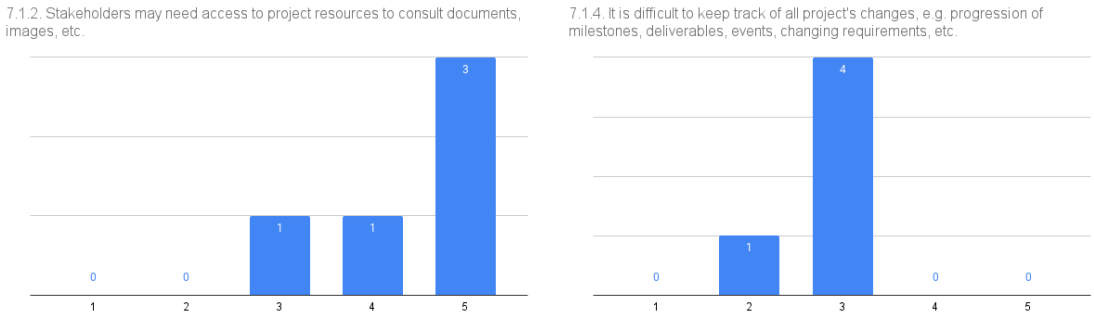
Deliverables and milestones with state, effort, cancellation, association to deliverables or milestones and association of individuals. Overall, participants found that expanding the deliverables and milestones with these features was neutral or positive.

Expansion of project

Necessity of having easy access to project documents, of keeping track of all project changes and for stakeholders to have access to project resources. Participants felt that stakeholders may need to access project resources to, for example, consult documents or images.

Participants find value in having easy access to project documents by having a centralised document deposit in the platform. However, most participants reported that they didn't have significant difficulty in keeping track of all project changes.

Figure 6.19: Participants opinions on the necessity of having easy access to project documents, of keeping track of all project changes and for stakeholders to have access to project resources.



Expansion of projects by adding a stakeholder role, mural and centralised document deposit. Participants found it easy to see and add new stakeholders to a project. They also found that it was easy to see the most recent project changes in the mural and to find project documents.

Final remarks

In general, participants found the proposed features simple and fast to understand. They also found that the proposed features would impact positively the City Catalyst Platform and its support for more Open, Agile and Co-Creative teams.

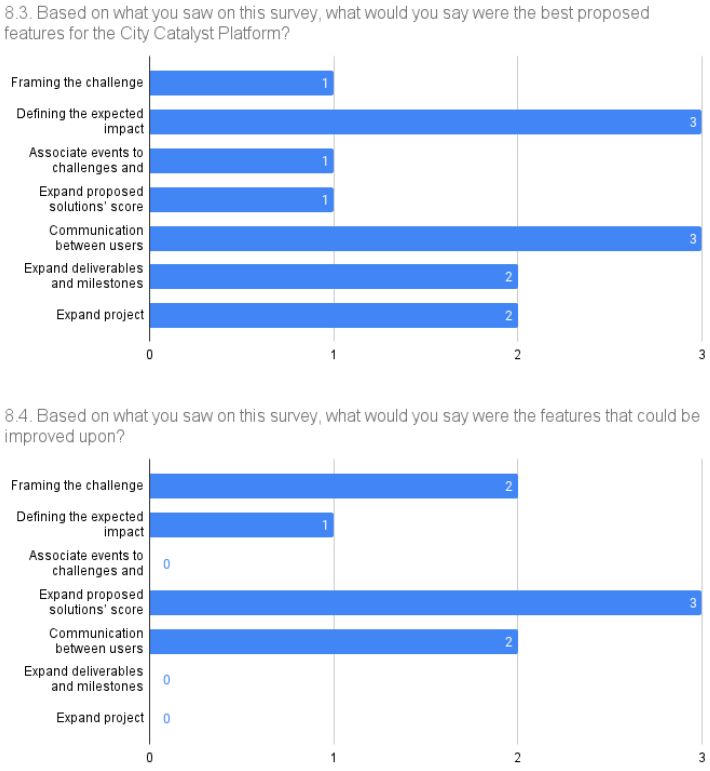
Participants highly rated the groups of features under *Defining the expected impact* and *Communication between users*, closely followed by *Expanding deliverables, milestones* and *Expanding projects*.

Participants identified the *Expansion of the proposed solutions' score* as the group of features that most need improvements, closely followed by *Framing the challenge* and *the communication between users*. This last group of features, which include the forums, comment sections, surveys and challenge approval score, was also highly rated in the previous question regarding the best-proposed features.

6.4 Summary and Discussion

The goal of this survey is to validate the proposed features in Chapter 5 to enhance the City Catalyst Platform to better support Co-Creation, Agility and Open Innovation. We asked City Catalyst partners working on PPS4 to be respondents to this survey. Unfortunately, only five participants responded to our questionnaire. This means that our sample size is extremely small, and as a

Figure 6.20: Participants opinions on the proposed features as a whole.



consequence, we are unable to make generalizations about our proposed features. Nonetheless, we were still able to analyse the collected data and gather feedback on the proposed features. Another restrain of this survey was the non-existence of pilot projects and the associated difficulty of accessing possible future users of the platform. In future, this survey should be repeated adapting the questionnaire (Annex C) to contextualize our proposed features with real pilot projects being developed on the platform and with real platform stakeholders as respondents.

Regarding the necessity of our proposed features, participants, in general, recognized the need for all groups of features, such as the 1) Benefits of allocating more time and resources to extensively detailing a problem; and the 2) Positive impact of monitoring the expected impact during the entire value creation process (Figure 6.12). Howbeit, some participants didn't agree on the necessity of the platform's support in the resolution of some problems or of the support of some activities: 1) Difficulty in prioritizing options quickly and in an Agile manner; 2) Necessity on looking back at obsolete deliverables or milestones (Figure 6.18); and, 3) Difficulty in keeping track of all project changes (Figure 6.19).

Regarding the proposed features to solve the identified problems or support activities related to OI, Co-Creation and Agility, they were also well received, particularly the ones related to *Defining the expected impact*. Although the features related to allowing a freer and more diverse asynchronous communication between all types of users in the platform, i.e. *Communication between users*, were well received by some, they also identified one of the groups that should be improved

upon (Figure 6.20). We can hypothesise that although participants recognize the advantages of having ways to freely communicate with other users, they also recognize that these features bring complexity to the platform such as in terms of moderation. We also received feedback that the content of the extra fields – Problem, Context, Impact and Cause – may not be self-explanatory to users when seeing a challenge (Figure 6.11). We can, for example, ratify it, by adding the same helpers presented in these fields when creating a challenge.

In summary, we believe that the feedback received supports the hypothesis that the proposed features can improve Co-Creation, Agile and Open Innovation activities in the City Catalyst Platform. Our findings show that participants found value in the proposed features, particularly in being able to define the expected impact of a challenge or a project and in having diverse means to communicate asynchronously with other platform users (Figure 6.20).

Chapter 7

Conclusions and Future Work

In this chapter, we summarize and reflect on the research done during this dissertation and our main contributions (Section 7.1). We then describe our recommendations for future work on the research topic (Section 7.2).

7.1 Summary and Main Contributions

The City Catalyst Project intends to facilitate the problem-solving of urban challenges by Municipalities. The project will output a platform to assist the collaboration between Municipalities and their citizens, academia and companies in order to identify and resolve challenges faced by city stakeholders (Section 3). This dissertation aims to enhance the City Catalyst Platform by proposing sets of features and tools to better support Open Innovation, Co-Creation and Agile activities.

In order to propose a set of features to enhance the City Catalyst platform to better support Agility and Co-Creation in Open Innovation, we studied four core concepts, Open Innovation, Co-Creation, Agile and Open Innovation Digital Platforms. We expanded our study beyond only the theoretical concepts to encompass their application by institutions, namely municipalities.

All three concepts, Open Innovation (Section 2.1), Co-Creation (Section 2.2) and Agile (Section 2.3), defend a better and more efficient way to create value by sharing resources (Open Innovation), focusing on their strengths (Co-Creation), and dealing with change as quickly and as naturally as possible (Agile). Moreover, all three give immense importance to constant communication between all parties – developers, partners and stakeholders –, especially giving stakeholders a central place during the entire value creation process, so results closely resemble the optimal solution.

We explored how several OIDPs platforms facilitated Open Innovation and Co-Creation activities within each phase of the collaboration process (Section 2.7), such as forum-like discussion areas to find new ideas and generate debate, document deposits, surveys, custom state for tasks, and tracking of impact (Section 2.8).

By analysing the currently planned features of the City Catalyst Platform, we were able to identify key Open Innovation, Co-Creation and Agile activities that the platform lacked support for (Section 4.2.1): 1) Transparency for superior collaboration; 2) Communication in all phases with stakeholders, developers and challengers; 3) Value outcomes (i.e. impact) over features; 4) Making choices quickly and easily; and, 5) Responding to change over following a plan.

Taking inspiration both from the analysed OIDPs and the Mobius Loop Framework and its trigger cards, we suggested seven groups of features (Chapter 5) in order to enhance the City Catalyst Platform to support (at least) part of the five identified activities:

Framing the challenge. Guide challengers to provide extra clarity on their challenges by adding clearly identifying the Problem, Context, Impact, and Cause (Section 5.1).

Defining the Expected Impact. Incentivize challengers, developers and solvers to value outcomes over features by allowing them to set the expected impact of a challenge and project (Section 5.2).

Associate events to challenges and projects. Promote synchronous communication between all platform users (Section 5.3).

Expanding Proposed Solutions' Score. Allow challengers to quickly and easily make an informed decision on which solution is the most adequate for their project (Section 5.4).

Communication between users. Allow for asynchronous communication between all platform users, including citizens (Section 5.5).

Expand deliverables and milestones. Expand deliverables and milestones so development teams can better adapt to change (Section 5.6).

Expand project. Allow for better collaboration and transparency of stakeholders and between project members (Section 5.7).

We validated the proposed groups of features next to City Catalyst partners working on the PPS4 module, responsible for the development of the Open Innovation Digital Platform (Chapter 6). We aimed to validate not only the proposed features but also their necessity. Although we are unable to make generalizations about the proposed features to all future platform users due to the small sample size (Section 6.2.5), we could still gather their feedback and opinions to make a qualitative analysis (Section 6.3.2). In general, we found that participants appreciated our proposed features and felt that they brought value to the City Catalyst platform and were useful for Open Innovation, Co-Creation and Agile workflows. The features under *Framing the Challenge* and *Defining the Expected Impact* were particularly well received in terms of their necessity and the proposed implementation.

In summary, the main objective of this dissertation was successfully met. We were able to design seven groups of features and tools to enhance the City Catalyst Platform to better support Agile, Co-Creation and Open Innovation workflows. In the wider picture, we believe that the designed features facilitate the management of innovation in cities by easing the sharing of knowledge between cities' several actors – academia, citizens, business and city councils – to construct better and more intelligent solutions.

7.2 Future Work

We have accomplished our overall goal to suggest features to enhance the City Catalyst platform to Support Agility and Co-Creation in Open Innovation for Cities. Nevertheless, we have identified three areas that this dissertation can be improved upon.

Firstly, as already mentioned in Section 7.1, the developed work necessitates further validation. Although we were able to collect feedback from an extremely small sample of City Catalyst PPS4 partners, we believe that more extended validation of the proposed features next to possible future users of the platform working in City Catalyst's pilot projects is necessary. Having access to pilot projects would also enable us to not only request their opinions on the proposed features of this work but also analyse how the teams work, and adapt the suggested features to their workflows.

After executing a more extensive validation, we propose the implementation of Minimum Viable Products for the suggested features, prioritizing the ones that can bring more value with the least effort. This prioritization can be done by collecting the opinion of both stakeholders, on what features they value most, and developers, and what features require more resources to be developed.

In later stages, after the Minimum Valuable Products are implemented, it is paramount that we analyse the features' impact during challenges and projects' lifespan. We need to analyse how the features impact the outcomes of challenges and projects and teams' workflows; and, if they resolve the problems or assist the activities that originated them (Section 4.2.1).

We want to emphasise that the proposed features in this dissertation are one of many possibilities to better support digitally Open Innovation, Co-Creation and Agility in Cities. They were elaborated in the specific context of the City Catalyst Platform and the Agile process defined by Dias [11] and will need to be revised as user feedback is received and teams' workflows evolve with time.

Finally, it should also be noted that the proposed features of this work can possibly be adapted to be incorporated into other platforms targeting innovation beyond urban management.

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Appendix A

City Catalyst Platform Low-level Requirements

The following is a copy of the Low-level Requirements for the City Catalyst platform elaborated by the participants of the PPS4 module [38] (Chapter 3).

A.1 User Management

Responsible: Inova+

ID	GU1
Priority	High
Description	Register in the platform.
Entries	Internet connection. Access credentials.
Processing	The user accesses the functionality of registering on the platform. The user creates their profile by inserting: Name; Location; Entity (if applicable); Email; and, Password.
Outputs	A register for the user is created. A confirmation email of the registration in the platform is sent to the user. A request for the association of the user to the entity email is sent to the Admin of the selected entity (if applicable).
Error treatment	If the new user is already registered in the system, then an error message is shown. If the data is invalid then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	GU2
Priority	High
Description	Identification in the platform.
Entries	Internet connection. Access credentials.
Processing	The user accesses the functionality of identification on the platform. The user identifies them-self in the platform by their profile by inserting their access credentials: Email; and, Password. The system validates the access credentials.
Outputs	The user is now identified in the platform and they have access to the correct functionalists in accordance with their user type.
Error treatment	If the access credentials are invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	GU3
Priority	High
Description	See a user profile.
Entries	Internet connection.
Processing	The user accesses the user list (GU9) or searches for a user (GU10). The user selects the profile they desire to see.
Outputs	The system shows the details of the selected profile.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Admin.

ID	GU4
Priority	High
Description	Edit user profile.
Entries	Internet connection. Access credentials. User data.
Processing	The user identifies themselves by inserting their access credentials (GU2). The system validates the access credentials. The user accesses their profile. The user accesses the functionally to edit their profile. The user edits the data in their profile.
Outputs	The user's data are updated.
Error treatment	If the access credentials are invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	GU5
Priority	Medium
Description	Apply to Lead User.
Entries	Internet connection. Access credentials. Sufficient activity of the user in the platform.
Processing	The user already identified in the system accesses their profile and, in accordance with the defined business model, requests for Lead User permissions.
Outputs	A request for the user to enter the Lead Users group is created.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	GU6
Priority	Medium
Description	Respond to Lead User Request.
Entries	Internet connection. Access credentials. Request to enter the Lead User's group.
Processing	The Admin for the group receives a notification of a request from another user to enter the Lead Users group and the Admin Accepts or Denies the request.
Outputs	If the Lead User Request is accepted, then the user who performed the request has permission to create challenges. An email with the request outcome (if it has been accepted or denied) is sent to the user who prompted it.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	GU7
Priority	High
Description	Invite user to become a Lead User.
Entries	Internet connection. Access credentials. User to be invited.
Processing	The user accesses the user's profile (GU3) that they intend to invite to become a Lead User. The user selects the functionality of inviting the user to become a Lead User.
Outputs	The invited user receives an email with the invitation to become a Lead User.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	GU8
Priority	High
Description	Respond to Lead User invite.
Entries	Internet connection. Access credentials. Invite to become a Lead User.
Processing	The user receives a notification of the invite to become a Lead User. The user accesses the functionality to accept or refuse the invite.
Outputs	The user that created the invite receives an email with the decision about the invite (if it has been accepted or refused). If the invite is accepted, then the user has permission to create challenges.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	GU9
Priority	Medium
Description	Access users' list.
Entries	Internet connection. Access credentials.
Processing	The user already identified in the system accesses the User area in the platform.
Outputs	The system shows the list of users registered on the platform.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Admin.

ID	GU10
Priority	Medium
Description	Search user.
Entries	Internet connection. Access credentials. Search input.
Processing	The user already identified in the system inserts the search input into the platform's search box.
Outputs	The system shows the list of users registered in the platform that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Admin.

ID	GU11
Priority	High
Description	Create entity profile
Entries	Internet connection. Access credentials. Entity data.
Processing	The user already identified in the system accesses the functionality of Registering an Entity. The user inserts the entity data: Name; Type; Description; Fiscal ID; Address; and, Field.
Outputs	The entity is created in the system. The user who created the entity is registered as the Admin of the entity profile. A confirmation email regarding the creation of the entity is sent to the user.
Error treatment	If the access credentials are invalid, then an error message is shown. If the entity is already registered on the platform, an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead Users.

ID	GU12
Priority	High
Description	Confirm user to entity.
Entries	Internet connection. Access credentials. Notification of new user to be associated with the entity.
Processing	The entity's Admin user receives a notification with the request for a user to be associated with the entity. The entity's Admin user accepts or rejects the association.
Outputs	The user who requested the association receives an email with the decision of the entity's Admin user (if they have been accepted into the entity or not). If the user is accepted into the entity, the user becomes associated with the entity.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entity's Admin.

ID	GU13
Priority	High
Description	Associate user with an entity.
Entries	Internet connection. Access credentials. User to associate with the entity.
Processing	The entity's Admin user inserts the email of the user they want to associate with the entity. The user accepts or rejects the association with the entity.
Outputs	The Admin user who requested the association receives an email with the decision of the user (if they have accepted the association or not). If the association is accepted, then the user who received the request becomes associated with the entity.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entity's Admin.

ID	GU14
Priority	Medium
Description	Manage users' permission that belongs to an entity.
Entries	Internet connection. Access credentials.
Processing	The entity's Admin user access to the entity profile and the list of associated users. The user changes the permissions for each associated user: Entity's Admin; Creation and edition of challenges/solutions; and, Association of other users to the entity.
Outputs	The entity's user permissions are updated.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entity's Admin.

ID	GU15
Priority	Medium
Description	See entity profile.
Entries	Internet connection. Entity.
Processing	The user accesses the Entities list (GU17) or searches for an entity (GU18). The user selects the entity.
Outputs	The entity's details are shown.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	GU16
Priority	Medium
Description	Edit entity profile.
Entries	Internet connection. Access credentials. Entity data.
Processing	The user accesses an entity profile (GU15). The user selects the edit option. The user changes the entity data: Name; Type; Description; Fiscal ID; Address; and, Field.
Outputs	The entity profile is updated.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entity's Admin.

ID	GU17
Priority	Medium
Description	Access Entities' list.
Entries	Internet connection.
Processing	The user accesses the Entity's area in the platform.
Outputs	The system shows a list of Entities registered in the platform
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	GU18
Priority	Medium
Description	Search for entity.
Entries	Internet connection. Search input.
Processing	The user inserts the search input into the platform's search box.
Outputs	The system shows the list of Entities registered in the system that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

A.2 Challenges and solutions

Responsible: Inova+

ID	DS1
Priority	High
Description	Publish a new challenge.
Entries	Internet connection. Access credentials. Challenge data.
Processing	The user already identified in the system and with Lead User permissions accesses the functionality of creating a challenge. The user fills in the data related to the challenge: Title; Description; Start and End date; Theme; Keywords; Promoting entity; Solution Requisites; Prize; Participation Rules; Contact for clarifications; and, Upload of supporting documents. The user publishes the challenge.
Outputs	The challenge is published in the platform and it is listed in the challenges' list. A new challenge notification is sent to users.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	DS2
Priority	Medium
Description	Access challenges' list.
Entries	Internet connection.
Processing	The user accesses the Challenge's area in the platform.
Outputs	The system shows a list of challenges registered in the platform.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	DS3
Priority	High
Description	See challenge.
Entries	Internet connection. Challenge.
Processing	The user accesses the challenges' list (DS2) or searches for an entity (DS12). The user selects the challenge.
Outputs	The challenge's details are shown.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	DS4
Priority	High
Description	Close challenge.
Entries	Internet connection. Access credentials. Challenge.
Processing	The user, already identified in the platform, accesses their profile and the functionality of created challenges. The user selects the option of Closing a Challenge. The user closes the challenge.
Outputs	The challenge is closed and it is no longer possible to associate solutions to the challenge.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	DS5
Priority	High
Description	Submit a solution.
Entries	Internet connection. Access credentials. Solution data.
Processing	The user already identified in the system accesses the functionality of creating a solution. The user fills in the data related to the solution: Name; Description; Technical details; etc. The user publishes the solution.
Outputs	The solution is published in the platform and it is listed in the solutions' list.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities.

ID	DS6
Priority	Medium
Description	Access solutions' list.
Entries	Internet connection.
Processing	The user accesses the Solution's area in the platform.
Outputs	The system shows a list of solutions submitted in the platform.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	DS7
Priority	High
Description	See solution.
Entries	Internet connection. Challenge (optional). Solution.
Processing	The user accesses the solutions' list (DS6) or the list of the challenge's solutions (DS9). The user selects the solution.
Outputs	The solution's details are shown.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	DS8
Priority	High
Description	Propose a challenge for a solution.
Entries	Internet connection. Access credentials. Challenge. Solution or Solution data.
Processing	The user already identified in the system accesses the challenge's list. The user selects the challenge. The user selects the option of Creating a Solution. The user selects the solution from the solutions' list (DS6) or creates a new solution (DS5).
Outputs	The solution is associated with the challenge.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities.

ID	DS9
Priority	High
Description	Access the solutions' list for a challenge.
Entries	Internet connection. Challenge.
Processing	The user with Lead User permissions accesses the challenges' list. The user selects the challenge. The user opens the list of solutions associated with the challenge.
Outputs	The system shows a list of solutions associated with the challenge.
Error treatment	If the access credentials are invalid, then an error message is shown. If the challenge has no solutions associated with it, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	DS10
Priority	Low
Description	Accept a solution for a challenge.
Entries	Internet connection. Challenge. Solution to be accepted.
Processing	The user with Lead User permissions accesses their profile and the functionality of Challenges created. The user selects the challenge. The user opens the list of solutions associated with the challenge (DS9). The user selects the solution they intend to accept for the challenge. The user accepts the solution.
Outputs	The accepted solution is associated with the challenge as the final solution. The solution's author is notified by email that their solution has been chosen as the final solution to the challenge.
Error treatment	If the access credentials are invalid, then an error message is shown. If the challenge has no solutions associated with it, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	DS11
Priority	Low
Description	Search for challenge.
Entries	Internet connection. Search input.
Processing	The user with Lead User permissions accesses their profile and the functionality of Challenges created. The user inserts the search input into the search box.
Outputs	The system shows the list of challenges created by the user that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	DS12
Priority	Low
Description	Search for a solution.
Entries	Internet connection. Search input.
Processing	The user with Lead User permissions accesses their profile and the functionality of Solutions submitted. The user inserts the search input into the search box.
Outputs	The system shows the list of solutions submitted by the user that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	DS13
Priority	Medium
Description	Submit an evaluation for a solution.
Entries	Internet connection. Access credentials. Challenge. Solution to be evaluated. Evaluation data.
Processing	The user with Lead User permissions accesses their profile and the functionality of the Challenges they Administrate. The user accesses the solution's list for a challenge. The user selects the solution. The user fills in the data related to the evaluation of the solution. The user submits an evaluation of the solution.
Outputs	The solution is published in the platform and it is listed in the solutions' list.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users and Appraisers.

A.3 Project Management

Responsible: Inova+

ID	EP1
Priority	High
Description	Create milestone.
Entries	Internet connection. Access credentials. Project to add a milestone to. Milestone data.
Processing	The user already identified in the system accesses the functionality of creating a milestone for a project they belong to. The user inserts the milestone data: Title; Description; and, Estimated end date. The user creates the milestone.
Outputs	The milestone is published on the platform and it is listed within the project's milestones.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities.

ID	EP2
Priority	Low
Description	Search for milestone.
Entries	Internet connection. Access credentials. Project. Search input.
Processing	The user accesses the list of projects they belong to. The user selects the project. The user inserts the search input into the project's milestone search box.
Outputs	The system shows the list of milestones in the project that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead Users.

ID	EP3
Priority	High
Description	Create deliverable.
Entries	Internet connection. Access credentials. Project to add deliverable to. Deliverable data.
Processing	The user already identified in the system accesses the functionality of creating a deliverable for a project they belong to. The user inserts the deliverable data: Title; Description; Estimated end date; and Access level (public or private). The user creates the deliverable.
Outputs	The deliverable is published in the platform and it is listed within the project's deliverables.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities.

ID	EP4
Priority	Medium
Description	See deliverable.
Entries	Internet connection. Access credentials. Project. Deliverable.
Processing	The user accesses the list of deliverables from a project they belong to. The user selects the deliverable.
Outputs	The system shows the details of the selected deliverable.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP5
Priority	Low
Description	Search for deliverable.
Entries	Internet connection. Access credentials. Project. Search input.
Processing	The user accesses the list of projects they belong to. The user selects the project. The user inserts the search input into the project's deliverables search box.
Outputs	The system shows the list of deliverables in the project that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP6
Priority	Medium
Description	See progress bar.
Entries	Internet connection. Access credentials. Project.
Processing	The user accesses the list of projects they belong to. The user selects the project.
Outputs	The system shows the degree of implementation based on the milestones and deliverables scheduled and delivered.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP7
Priority	Medium
Description	See project's state.
Entries	Internet connection. Access credentials. Project.
Processing	The user accesses the list of projects they belong to. The user selects the project.
Outputs	The system shows a list of milestones and deliverables of the project.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities, Lead Users and Mentors.

ID	EP8
Priority	Medium
Description	Invite mentor.
Entries	Internet connection. Access credentials. Project. Mentor to be invited.
Processing	The Lead User accesses the list of challenges they Administrate. The user selects the project (i.e. the approved solution). The user inserts the email of the user they intend to invite to be a mentor of the approved solution (the approved solutions are now called projects).
Outputs	The user invited to become a mentor for the project is notified by email of the invitation. If the user accepts the invitation, then they have permission to see the project.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	EP9
Priority	Medium
Description	Close project.
Entries	Internet connection. Access credentials. Project.
Processing	The user, already identified in the platform, accesses the list of challenges they Administrate. The user selects the project. The user closes the project.
Outputs	The system shows the project details.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users and Mentors.

A.4 Communication

Responsible: Fraunhofer Portugal

ID	C1
Priority	High
Description	Create message.
Entries	Internet connection. Access credentials. Message data.
Processing	The user already identified in the system accesses the Messages' area. The user selects the option to create a message. The user fills in the data related to the message: Image (optional); Title; and, Content. The user creates the message.
Outputs	The message is created in the system.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	C2
Priority	Medium
Description	Save message.
Entries	Internet connection. Access credentials. Created message (C1).
Processing	The user already identified in the system accesses the Messages' area, after having created the message (C1), selects the save option.
Outputs	The message is saved in the system.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	C3
Priority	Medium
Description	Access to saved messages.
Entries	Internet connection. Access credentials.
Processing	The user already identified accesses their profile. The user accesses the option of Saved Messages.
Outputs	The list of saved messages of the user is shown.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	C4
Priority	High
Description	Publish message.
Entries	Internet connection. Access credentials. Saved message (C2) or access to saved messages (C3).
Processing	The user already identified accesses their profile and the saved messages option. Alternatively, the user has just saved a message. The user selects the option to Publish a message.
Outputs	The message is published and it is visible in the published messages list (C5).
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	C5
Priority	High
Description	Access to published messages.
Entries	Internet connection.
Processing	The user accesses the section of published communications of the platform.
Outputs	The list of published messages are shown.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	C6
Priority	High
Description	See message.
Entries	Internet connection. Message.
Processing	The user accesses the list of published messages (C5). The user selects the message.
Outputs	The details of the selected message are shown.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	C7
Priority	High
Description	Edit message.
Entries	Internet connection. Access credentials. Saved Message (C2) or Published message (C4). Message data.
Processing	The user already identified in the system accesses their profile. The user selects their saved messages or their published messages. The user selects the message to edit. The user selects the edit option. The user edits the fields with the new data. The user saves or published the message with the altered details.
Outputs	The message is saved or published with the new data.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users with saved or published messages.

ID	C8
Priority	High
Description	Delete message.
Entries	Internet connection. Access credentials. Saved message (C2) or published message (C4).
Processing	The user already identified in the system accesses their profile. The user accesses their saved or published messages. The user selects the message. The user selects the delete option.
Outputs	The message is erased from the system.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users with saved or published messages.

ID	C9
Priority	Medium
Description	Comment message.
Entries	Internet connection. Access credentials. Published message.
Processing	The user selects the message (C6). The user fills out the text field for commenting on a message. The user selects the option to add a comment.
Outputs	The comment is published in the system and it is associated with the message.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	C10
Priority	Medium
Description	Search for message.
Entries	Internet connection. Search input.
Processing	The user accesses the messages' area. The user inserts the search input into the search box and clicks Enter.
Outputs	The system shows the list of published messages in the system that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	C11
Priority	Medium
Description	Create messages for each created challenge.
Entries	Created challenged.
Processing	For each new published challenge, the system generates and publishes a message automatically.
Outputs	The message related to the new challenge is published on the platform.
Error treatment	N/A-
Permissions	N/A.

A.5 Empowerment

Responsible: Fraunhofer Portugal

ID	CA1
Priority	High
Description	Access events' list.
Entries	Internet connection.
Processing	The user accesses the Empowerment's area in the platform. The user chooses the Events option.
Outputs	The system shows a list of events available in the platform.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	CA2
Priority	High
Description	See event.
Entries	Internet connection. Event.
Processing	The user accesses the Empowerment's area in the platform. The user chooses the Events option. The user selects the event.
Outputs	The event's details are shown.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	CA3
Priority	High
Description	Create a new event.
Entries	Internet connection. Access credentials. Event data.
Processing	The user already identified in the system accesses the Events area (E1). The user chooses the option to add an event. The user fills in the data related to the event: Image (optional); Title; Description; Start and End date; Start and End time (optional); and, Site. The user publishes the event.
Outputs	The event is published on the platform and it is listed in the events' list. A new challenge notification is sent to users.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	CA4
Priority	High
Description	Edit event.
Entries	Internet connection. Access credentials. Created event (CA3). Message data.
Processing	The user already identified accesses an event (CA2) they created. The user selects the edit option. The user edits the fields with the new data. The user saves or published the event with the altered details.
Outputs	The event is saved with the new data.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users with created events.

ID	CA5
Priority	High
Description	Delete event.
Entries	Internet connection. Access credentials. Created event (CA3).
Processing	The user already identified accesses an event (CA2) they created. The user selects the delete option.
Outputs	The event is erased from the system.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users with created events.

ID	CA6
Priority	Medium
Description	Search for event.
Entries	Internet connection. Search input.
Processing	The user accesses the events' list (CA1). The user inserts the search input into the search box and clicks Enter.
Outputs	The system shows the list of events in the system that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	General user.

ID	CA7
Priority	High
Description	Access providers' list.
Entries	Internet connection.
Processing	The user accesses the Empowerment's area in the platform. The user chooses the Providers option.
Outputs	The system shows a list of providers available in the platform.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead Users.

ID	CA8
Priority	High
Description	See provider.
Entries	Internet connection. Provider.
Processing	The user accesses the Empowerment's area in the platform. The user chooses the Providers option. The user selects the provider.
Outputs	The provider's details are shown.
Error treatment	If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead Users.

ID	CA9
Priority	High
Description	Create provider.
Entries	Internet connection. Access credentials. Provider data.
Processing	The user already identified in the system accesses the provider area (P1). The user chooses the option to add a provider. The user fills in the data related to the provider: Image (optional); Type (accelerator, incubator, living lab); Name; Description; and, Contacts. The user creates the provider.
Outputs	The provider is created in the platform and it is listed in the providers' list.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users.

ID	CA10
Priority	High
Description	Edit provider.
Entries	Internet connection. Access credentials. Created provider (CA9). Provider data.
Processing	The user already identified accesses to a provider (CA8) they created. The user selects the edit option. The user edits the fields with the new data. The user saves the provider with the altered details.
Outputs	The provider is saved with the new data.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users with created providers.

ID	CA11
Priority	High
Description	Delete provider.
Entries	Internet connection. Access credentials. Created provider (CA9).
Processing	The user already identified accesses a provider (CA9) they created. The user selects the delete option.
Outputs	The provider is erased from the system.
Error treatment	If the access credentials are invalid, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Lead Users with created events.

ID	CA12
Priority	Medium
Description	Search for provider.
Entries	Internet connection. Search input.
Processing	The user accesses the providers' list (CA7). The user inserts the search input into the search box and clicks Enter.
Outputs	The system shows the list of providers in the system that match the search input.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead Users.

ID	CA13
Priority	Medium
Description	Filter providers.
Entries	Internet connection. Provider's type.
Processing	The user accesses the providers' list (CA7). The user utilizes the filter field to choose the provider's type.
Outputs	The system shows the list of providers in the system of the selected type.
Error treatment	If the access credentials are invalid, then an error message is shown. If the data is invalid, then an error message is shown. If mandatory data is missing, then an error message is shown. If there is no internet connection, a warning message is shown advising the user to check their Internet connection and try again later.
Permissions	Entities and Lead Users.

Appendix B

City Catalyst Platform User Stories

The following are User Stories elaborated by us from the City Catalyst's Low-level Requirements (Annex A).

B.1 User management

US-GU1 As a city stakeholder, I want to register in the platform, so that I am able to explore and contribute to the platform.

US-GU2 As a registered user, I want to authenticate against my credentials, so that I am able to explore the platform.

US-GU3 As a user, I want to see another user's profile, so that I can get to know them better.

US-GU4 As a user, I want to edit my information, so that my profile holds updated and truthful information.

US-GU5 As a user, I want to apply to become a Lead User, so that I am able to publish challenges/opportunities.

US-GU6 As a Lead User, I want to respond to Lead Users' requests, so that more challenges are available on the platform.

US-GU7 As a Lead User, I want to respond to Lead Users' requests, so that more challenges are available on the platform.

US-GU8 As a user, I want to respond to a request to become a Lead User, so that I am able to accept the new role to publish challenges on the platform or refuse if I don't require those permissions.

US-GU9 As an Admin, I want to access a list of all of the users, so that I can make sure that all roles for all the users are correct.

US-GU10 As an Admin, I want to search for a user by a search term on a search box, so that I can quickly find other users.

US-GU11 As an Entity or Lead User, I want to create an Entity profile, so that I can register an Entity with its correct information.

US-GU12 As an Entity's Admin, I want to accept or deny users to the Entity, so I can moderate who can I have access to the Entity.

US-GU13 As an Entity's Admin, I want to associate a user with the Entity I am responsible for, so that I can add relevant users to the Entity.

US-GU14 As an Entity's Admin, I want to manage the permissions users have inside the Entity, so that users have the correct permissions according to their role in the Entity.

US-GU15 As a user, I want to see an Entity's profile, so that I can get to know the Entity better.

US-GU16 As an Entity Admin, I want to edit the Entity's information, so that its profile holds updated and truthful information.

US-GU17 As a user, I want to access a list of all entities, so that I am able to access an Entity's profiles.

US-GU18 As a user, I want to search for an Entity by a search term on a search box, so that I can quickly find entities.

B.2 Challenges and Solutions

US-DS1 As a Lead User, I want to publish a new challenge, so that other users can help co-create a solution for it.

US-DS2 As a user, I want to access a list of all challenges, so that I can check all new challenges.

US-DS3 As a user, I want to be able to see a challenge, so that I can check out new ideas.

US-DS4 As a Lead User, I want to be able to close a challenge, when it has become inactive and a solution is not probable to be obtained.

US-DS5 As an Entity, I want to submit a solution, so I can find partners to fulfil it.

US-DS6 As a Lead User, I want to be able to access a list of all solutions, so that I can view all proposed solutions.

US-DS7 As a Lead User, I want to see solutions, so that I can check the details of a proposed solution.

US-DS8 As an Entity, I want to submit a solution to a challenge, so I can help solve a challenge.

US-DS9 As a Lead User, I want to be able to access a list of all solutions to a challenge, so that I can quickly view all proposed solutions to a specific challenge.

US-DS10 As a Lead User, I want to accept a solution to a challenge, so that a final solution to a challenge has been identified.

US-DS11 As a Lead User, I want to be able to search for a challenge by a search term on a search box, so that I can quickly find a challenge.

US-DS12 As a Lead User, I want to be able to search for a solution by a search term on a search box, so that I can quickly find a solution.

US-DS13 As a Lead User or an appraiser, I want to evaluate a solution, so I can share my thoughts about the solution with the rest of the community.

B.3 Project Management

US-EP1 As an Entity, I want to create a milestone, so that users are able to keep track of what has to be completed by a certain date.

US-EP2 As an Entity or Lead User, I want to search for milestones, so I am aware of a project's timeframe.

US-EP3 As an Entity, I want to create a deliverable, so that there is a register of what has been delivered, and when it has been delivered.

US-EP4 As an Entity, Lead User or mentor, I want to see a deliverable, so that I can see the details of want has been delivered.

US-EP5 As an Entity, Lead User or mentor, I want to search for deliverables by a search term on a search box, so that I can quickly find deliverables.

US-EP6 As an Entity, Lead User or mentor, I want to see a project's progress bar, so that I can check our far along a project is in relation to its milestones and delivered or not deliverables.

US-EP7 As an Entity, Lead User or mentor, I want to check a project's state, so that I can see its list of milestones and deliverables.

US-EP8 As a Lead User, I want to invite mentors, so that I can invite mentors for approved solutions (which is then called a project).

US-EP9 As a Lead User or mentor, I want to close a project when it has reached all of its goals and/or is no longer active.

B.4 Communication

US-C1 As a Lead User, I want to create a message, so that I can promote a challenge or solution.

US-C2 As a Lead User, I want to save a message, so I can later publish it.

US-C3 As a Lead User, I want to see my messages, so that I can see my messages' history and publish any of them.

US-C4 As a Lead User, I want to publish a message, so others on the platform can see my promoted challenge or solution.

US-C5 As a user, I want to see publish messages, so I can find interesting challenges or solutions.

US-C6 As a user, I want to see a message, so I can see more details about the challenge or solution it's promoting.

US-C7 As a Lead User with saved or published messages, I want to edit a message, so that the message holds updated an truthful information.

US-C8 As a Lead User with saved or published messages, I want to delete a message, so that there aren't any useless messages on the platform.

US-C9 As a user, I want to comment on a message, so I can share my thoughts on it.

US-C10 As a user, I want to search for a message by a search term on a search box, so that I can quickly find messages.

US-C11 As a user, I want to receive a message when a new challenge is published, so that I can keep up to date with new challenges.

B.5 Empowerment

US-CA1 As a user, I want to access a list of all events, so I know which events have or will occur.

US-CA2 As a user, I want to see an event, so that I am aware of its details.

US-CA3 As an Admin, I want to create an event, so that I can provide an opportunity for like-minded individuals to network.

US-CA4 As a user, I want to edit my events, so that the information regarding an event is updated and truthful.

US-CA5 As a user, I want to delete an event created by me, so that there aren't any useless events on the platform.

US-CA6 As a user, I want to search for an event by keywords in a search box, so that I can quickly find an event.

US-CA7 As an Entity, I want to access a list of all providers, so that I am able to access providers' profiles.

US-CA8 As an Entity, I want to see a caretaker, so that I can check out and get to know a caretaker better.

US-CA9 As a Lead User, I want to create a caretaker, so that entities are able to identify and make use of living labs, incubators or a accelerators

US-CA10 As a Lead User with created providers, I want to edit my providers so that their information is updated and truthful.

US-CA11 As a Lead User with created providers, I want to delete my providers, so that they aren't any useless providers on the platform.

US-CA12 As an Entity or Lead User, I want to search for providers by keywords in a search box, so that I can quickly find a provider.

US-CA13 As an Entity or Lead User, I want to filter providers by some predefined field, so that I can quickly find a provider.

Appendix C

Questionnaire: Enhancing the City Catalyst Platform to Support Agility and Co-Creation in Open Innovation for Cities

The following is a copy of the questionnaire handed to City Catalyst PPS4 partners (Chapter 6). We did not include the animated pictures of the developed click-through prototypes in the following copy.

C.1 Complete questionnaire

This questionnaire aims to evaluate possible features to better support Co-creation, Agility and Open Innovation in the City Catalyst Platform.

The City Catalyst project aims to develop an Open Innovation platform that promotes collective intelligence, transparency and an efficient resolution of problems affecting citizens and industries.

City Catalyst is an R&D project funded by Portugal 2020 and the European Commission involving the cities of Porto, Aveiro, Guimarães, Famalicão and Cascais, in a consortium with other 18 organisations from academia and industry.

To answer this questionnaire, there is NO need for extensive knowledge about the platform itself. However, it is recommended that participants have a basic grasp on the concepts of Co-creation, Agility and Open Innovation.

All answers are anonymous and will be used exclusively for academic purposes. If you're interested and consent, your participation will be acknowledged in our work.

Thank you for your collaboration!

Filipa Senra.

Estimated completion time: 15 mins.

C.1.0 Participant's Profile (Optional)

This section will only be used to better understand the distribution among the participants. If you don't want to share your personal information, there is no need to fill these section.

ID	Question	Response options
0.1	How long have you been involved with the City Catalyst platform?	1 - 6 months (1) 6 - 12 months (2) 1 - 2 years (3) > 2 years (4)
0.2	What is your role within the development City Catalyst platform?	Developer. (1) Manager. (2) Team Lead. (3) UI Designer. (4) UX Designer. (5) Tester. (6) Other. (7)

C.1.1 Framing the challenge

The first part of this questionnaire will evaluate the *Framing the challenge* group of features.

C.1.1.1 Necessity of a well-defined problem

ID	Question	Response options
1.1.1	In projects you have worked before, have you had to redefine project goals due to misunderstandings when the problem was being defined (first phase, before requirements elicitation)? ?	Yes (1) No (1)
1.1.2	Why do you believe that you had to redefine requirements due to misunderstandings in the problem definition phase?	I haven't had the need to redefine requirements due to misunderstandings in the problem definition phase. (1) The problem was not properly defined by the client, leading to misunderstandings. (2) The team didn't have enough resources to allocate to the requirements elicitation phase. (3) Other. (7)
1.1.3	Do you believe is it worth to allocate more time and resources to extensively detail a problem before starting to define requirements?	Yes (1) No (1)
1.1.4	In your opinion, how high is the cost of changing requirements due to misunderstandings about the problem to be solved?	Likert scale (1 - 5)

C.1.1.2 Features in the City Catalyst Platform

In this section, we will analyse a set of proposed features for the City Catalyst Platform to help users better defined their challenge. The UI is just a suggestion and it is showed to help you better understand the proposed features.

The animated image below shows a challenge being created in the Platform with 4 extra fields: Problem, Context, Impact and Cause.

Creating a challenge with four extra fields: Problem, Context, Impact and Cause

ID	Question	Response options
1.2.1.1	As a challenger, I find that the four fields (Problem, Context, Impact and Cause) motivate me to pause and reflect on my challenge	Likert scale (1 - 5)
1.2.1.2	As a challenger, I find the four fields (Problem, Context, Impact and Cause) useful to describe my challenge	Likert scale (1 - 5)
1.2.1.3	As a challenger, I understand what to write in each one of the fields (Problem, Context, Impact and Cause)	Likert scale (1 - 5)
1.2.1.4	As a challenger, I find the help buttons next to the fields useful to help me understand what I should write in each of them	Likert scale (1 - 5)

Viewing a challenge with four extra fields: Problem, Context, Impact and Cause

ID	Question	Response options
1.2.2.1	I can quickly and clearly understand the challenge	Likert scale (1 - 5)
1.2.2.2	I find the extra fields (Problem, Context, Impact and Cause) bring helpful clarity to understanding a challenge	Likert scale (1 - 5)
1.2.2.3	I understand the content of each field (Problem, Context, Impact and Cause)	Likert scale (1 - 5)

C.1.1.3 Defining the Expected Impact

The first part of this questionnaire will evaluate the *Defining the expected impact* group of features.

NOTE: Expected impact is defined by the set of all expected outcomes for a challenge/project.

C.1.1.4 Necessity of defining the expected impact

ID	Question	Response options
2.1.1	Have you ever monitored the impact of a project during the entire value creation process (from requirements elicitation to the end result)?	Yes (1) No (1)
2.1.2	Monitoring impact during all of the development is important for a successful final outcome	Likert scale (1 - 5)
2.1.3	Having the expected impact defined from the get-go makes it easier to monitor a project's progress	Likert scale (1 - 5)
2.1.4	Having expected impact defined from the problem definition phase makes it easier to evaluate possible solutions	Likert scale (1 - 5)
2.1.5	Having the expected impact defined from the problem definition phase makes it easier to evaluate (the impact of) the final problem solution	Likert scale (1 - 5)
2.1.6	Which elements do you find useful to define an expected outcome:	Name: Short description of the expected outcome. (1) Benefits: What value will it deliver. (2) Measurement: Unit of measurement. (3) Method: Process to gather data. (4) Baseline: Start point. (5) Target: Desired improvement; End point. (6) Impact: The real results at the current point of development of the project. (7)
2.1.7	What phases do you think will benefit from having previously defined expected outcomes:	Requirements elicitation / Problem solution. (1) Analysis and Design. (2) Development. (3) Testing in the Large. (4) Deployed/Deliver/Production/Levering the collaboration results. (5) Measuring the collaboration results/Retrospective. (6)

C.1.1.5 Features in the City Catalyst Platform

In this section, we will analyse a set of proposed features for the City Catalyst Platform regarding the definition of expected impact in challenges and projects. The UI is just a suggestion and it is showed to help you better understand the proposed features.

NOTE: For our use case, the set of all expected outcomes is viewed as the expected impact of a challenge/project.

Challenge with expected outcomes defined

ID	Question	Response options
2.2.1.1	As a challenger, I want to add the expected outcomes to a challenge, so that I can inform challenge solvers about the expected value their solution should have	Likert scale (1 - 5)
2.2.1.2	As a possible solver, I want to see the expected outcomes when seeing a challenge, so that I can understand what should be the impact of my proposed solution	Likert scale (1 - 5)
2.2.1.3	As a user, I understand that the set of all of the outcomes is the expected impact of a solution to the challenge	Likert scale (1 - 5)

Project with expected outcomes defined

ID	Question	Response options
2.2.2.1	As a member of the project development team, having expected outcomes defined for a project allows me to more easily keep track of the progress and direction of the development effort	Likert scale (1 - 5)
2.2.2.2	As any project participant (developer, mentor, stakeholder), I can monitor the progress and direction of the project by looking at the expected outcomes and their current state	Likert scale (1 - 5)
2.2.2.3	As any project participant (developer, mentor, stakeholder), I can assess if the project has reached its goals or not by analysing the state of the expected outcomes defined for the project	Likert scale (1 - 5)

C.1.2 Associate events to challenges and projects

This part of this questionnaire will evaluate the *Associate events to challenges and projects* group of features.

C.1.2.1 Necessity of communicating with stakeholders and platform users

ID	Question	Response options
3.1.1 5.1.1 7.1.1	Have you ever needed to communicate with stakeholders or other participants during a project?	Yes (1) No (1)
3.1.2 5.1.2	What tools have you used to communicate with stakeholders or other participants during a project?	Email (1) Phone (2) Instant messaging (3) Face-to-face (4) Other. (7)
3.1.3 5.1.3	How have you approached stakeholders or other participants that you don't have direct contact with?	Social media posts (1) Email lists (2) Event organisation (3) One-to-one contact (4) Forums (5) Other. (6)
3.1.4	Would you find it useful to promote events within a platform to find stakeholders and partners?	Yes (1) No (1)
3.1.5 5.1.4	Constant communication between stakeholders and all project participants is important for a successful project.	Likert scale (1 - 5)

C.1.2.2 Features in the City Catalyst Platform

In this section, we will analyse a set of proposed features for the City Catalyst Platform to connect events to challenges and projects. The UI is just a suggestion and it is showed to help you better understand the proposed features.

The animated image below shows an event being promoted within a project and/or a challenge and vice-versa in the City Catalyst Platform.

Giving context to an event and promoting events within projects and challenges

ID	Question	Response options
3.2.1	As an event participant, I find seeing the challenge that prompted an event useful to provide context regarding the event.	Likert scale (1 - 5)
3.2.2	As a user, I want to see events related to a challenge, so I can participate in them.	Likert scale (1 - 5)
3.2.2	As a user, I want to see events related to a challenge, so I can participate in them.	Likert scale (1 - 5)
3.2.3	As an event participant, I find seeing the project that prompted an event useful to provide context regarding the event.	Likert scale (1 - 5)
3.2.4	As a project participant, I want to see events related to the project, so I can participate in them.	Likert scale (1 - 5)

C.1.3 Expanding Proposed Solutions' Score

This part of this questionnaire will evaluate the *Expand proposed solutions' score* group of features.

C.1.3.1 Necessity of understanding a solution's score and evaluating a solution in an agile manner

ID	Question	Response options
4.1.1	I have difficulty prioritizing options quickly and in an agile manner in a project.	Likert scale (1 - 5)
4.1.2	What ranking systems have you used to prioritise options?	None (1) TODO
4.1.3	If I am working with experts on a project for the evaluation of possible different solutions, I want to understand the reasons behind their score for a solution.	Likert scale (1 - 5)

C.1.3.2 Features in the City Catalyst Platform

In this section, we will analyse a set of proposed features for the City Catalyst Platform regarding the evaluation of a proposed solution. The UI is just a suggestion and it is showed to help you better understand the proposed features.

The City Catalyst platform is already planned to support the scoring of proposed solutions by designed appraisers. In this section, we present an expansion of this feature by adding three components to the overall score (Impact, Confidence and Ease), an open text field and the possibility to add an annex.

NOTE: The overall score (i.e. ICE score) is automatically calculated in the top right corner (average of the Impact, Confidence and Ease components).

Expansion of solutions' score to support the ICE scoring model, free text-field and annexes

ID	Question	Response options
4.2.1	As a challenger or an appraiser, I am able to understand the meaning of each evaluation components (Impact, Confidence, Ease).	Likert scale (1 - 5)
4.2.2	As a challenger, I understand why an appraiser evaluated a solution a certain way.	Likert scale (1 - 5)
4.2.3	As a challenger, I am able to make an informed decision by having a score deconstructed in three parameters (Impact, Confidence and Ease).	Likert scale (1 - 5)
4.2.4	As a challenger, I am able to make an informed decision by having the explanation of a score in text-form (written by the appraiser, either in the text field or in a document annexed).	Likert scale (1 - 5)

C.1.4 Communication between users

The part of this questionnaire will evaluate the *Communication between users* group of features.

C.1.4.1 Necessity of communicating with users asynchronously

NOTE: Entity is either an individual from a company or from academia.

ID	Question	Response options
5.1.5	I find value on communicating with stakeholders asynchronous.	Likert scale (1 - 5)
5.1.6	As a project participant, I find value on communicating with fellow project participants asynchronous.	Likert scale (1 - 5)
5.1.7	As a challenger or solver, I find value in identifying which projects stakeholders are most interested in.	Likert scale (1 - 5)
5.1.8	As an entity or a government agent, I want to identify interest or disinterest in predefined ideas and quickly gather insights and feedback on these ideas.	Likert scale (1 - 5)

C.1.4.2 Features in the City Catalyst Platform

In this section, we will analyse a set of proposed features for the City Catalyst Platform to help users better with each other. The UI is just a suggestion and it is showed to help you better understand the proposed features.

The images below show forums, comment sections and support buttons for challenges in the City Catalyst Platform.

NOTE: 1. There are two types of forums: 1) independent, open to everyone on the platform; and, 2) inside projects, open to project participants. 2. Entity is either an individual from a company or from academia.

Independent forum

ID	Question	Response options
5.2.1.1	As an Entity or Government agent, I want to generate debate, assess interest and find new ideas by communicating with platform users through the forum.	Likert scale (1 - 5)
5.2.1.2	As a user, I want to participate in posts on the forum, so that I can share my ideas about a topic and learn from ideas of other users.	Likert scale (1 - 5)
5.2.1.3	As a user, I want to up or downvote posts on the independent forum, so that I can quickly share my approval or disapproval about a topic.	Likert scale (1 - 5)

Projects' forums

ID	Question	Response options
5.2.2.1	As an Entity or Government agent, I can encourage general discussion within the project's team through project's posts.	Likert scale (1 - 5)
5.2.2.2	As an Entity or Government agent, I want to participate in project posts, so that I can share my ideas about a topic and learn from ideas of other project participants.	Likert scale (1 - 5)
5.2.2.3	As an Entity or Government agent, I want to up or downvote project posts, so that I can quickly share my approval or disapproval about a topic.	Likert scale (1 - 5)

Challenge Approval Score and Comment Section

ID	Question	Response options
5.2.3.1	I can quickly see which challenges gather more public support than others.	Likert scale (1 - 5)
5.2.3.2	As a challenger, I can receive feedback on my challenge definition by having an open challenge comment section.	Likert scale (1 - 5)

Solution Comment Section

ID	Question	Response options
5.2.4.1	As an author of a proposed solution, I can receive feedback by having an open solution comment section to entities and the challenger.	Likert scale (1 - 5)

Milestone and Deliverable Comment Section

ID	Question	Response options
5.2.5.1	As a project participant, I can have an asynchronous discussion with other developers through the comment section on milestones and deliverables.	Likert scale (1 - 5)
5.2.5.2	As a project participant, I am able to gather or give context to a milestone or deliverable through the comment section.	Likert scale (1 - 5)

questionnaires

ID	Question	Response options
5.2.6.1	As a project developer or a challenger, I can quickly gather insights from stakeholders (i.e. city citizens) through questionnaires.	Likert scale (1 - 5)

C.1.5 Expand deliverables and milestones

The part of this questionnaire will evaluate the *Expand deliverables and milestones* group of features.

C.1.5.1 Necessity to support activities related to deliverables and milestones

NOTE: 1. Deliverables are tiny, digestible chunks of work. 2. A Milestone can be viewed as a cluster of several deliverables. 3. Milestones are used to mark memorable events during project development and are usually viewed by clients/challengers. 4. They are used as a way to keep track of a project's development and to gather feedback from stakeholders at key points.

ID	Question	Response options
6.1.1	I understand the connection between deliverables and milestones.	Yes (1) No (1)
6.1.2	I find value on clearly know the associations between deliverables and milestones.	Likert scale (1 - 5)
6.1.3	I often utilize effort estimation for deliverables and milestones to prioritise tasks and allocate adequate resources.	Likert scale (1 - 5)
6.1.4	The effort estimation of milestones should be intimate related to the effort of related deliverables (i.e. the sum of the effort of the deliverables).	Likert scale (1 - 5)
6.1.5	I find value on knowing the state of a deliverable and milestone.	Yes (1) No (1)
6.1.6	The state of a milestones should be intimate related to the state of related deliverables (i.e. : if all of a milestone's deliverables are completed, then the milestone is also completed).	Likert scale (1 - 5)
6.1.7	I find value on allocating specific individuals to be responsible for deliverables and milestones.	Likert scale (1 - 5)
6.1.8	Deliverables and milestones should always be assessable, even if they are no longer of use (if they were abandoned).	Likert scale (1 - 5)

C.1.5.2 Features in the City Catalyst Platform

In this section, we will analyse a set of proposed features for the City Catalyst Platform to expand the concepts of deliverables and milestones. The UI is just a suggestion and it is showed to help

you better understand the proposed features.

The images below show new features regarding deliverables and milestones in a project within the City Catalyst Platform.

NOTE: 1. Deliverables are tiny, digestible chunks of work. 2. A Milestone can be viewed as a cluster of several deliverables. 3. Milestones are used to mark memorable events during project development and are usually viewed by clients/challengers. 4. They are used as a way to keep track of a project's development and to gather feedback from stakeholders at key points.

Deliverables and milestones with state, effort, cancellation, association to deliverables or milestones and association of individuals

ID	Question	Response options
6.2.1	I want to know a deliverable or milestone state (new, in progress, completed, canceled).	Likert scale (1 - 5)
6.2.2	I want to quickly see a deliverable or milestone effort estimation.	Likert scale (1 - 5)
6.2.3	I want to quickly see who is responsible for a deliverable or milestone.	Likert scale (1 - 5)
6.2.4	I want to see the deliverables associated with milestone and the milestone associated with a deliverable.	Likert scale (1 - 5)

C.1.6 Expand project

The part of this questionnaire will evaluate the *Expand project* group of features.

C.1.6.1 Necessity of having easy access to project documents, of keeping track of all project changes and for stakeholders to have access to project resources

ID	Question	Response options
7.1.2	Stakeholders may need access to project resources to consult documents, images, etc.	Likert scale (1 - 5)
7.1.3	I find value in having a centralised document deposit for a project.	Likert scale (1 - 5)
7.1.4	It is difficult to keep track of all project's changes, e.g. progression of milestones, deliverables, events, changing requirements, etc.	Likert scale (1 - 5)

C.1.6.2 Features in the City Catalyst Platform

In this section, we will analyse a set of proposed features for the City Catalyst Platform to help all project participants be better informed . The UI is just a suggestion and it is showed to help you better understand the proposed features.

The images below show a new UI for a project within the City Catalyst Platform that adds the support for stakeholders access, a mural and a centralize document deposit.

Expansion of projects by adding a stakeholder role, mural and centralised document deposit

ID	Question	Response options
7.2.1	I can quickly see and add new stakeholders to the project.	Yes (1) No (1)
7.2.2	I can see the most recent project changes.	Likert scale (1 - 5)
7.2.3	I can quickly find project documents.	Likert scale (1 - 5)

C.1.7 Final Remarks

The final section of the questionnaire aims to understand your opinion on all of the proposed features and which changes should be made to make them better.

ID	Question	Response options
8.1	The proposed features are simple and fast to understand.	Likert scale (1 - 5)
8.2	The proposed features can positively impact the City Catalyst Platform and its support for more open, agile and co-creative teams.	Likert scale (1 - 5)
8.3	Based on what you saw on this questionnaire, what would you say were the best proposed features for the City Catalyst Platform?	Framing the challenge. (1) Defining the expected impact. (2) Associate events to challenges and projects. (3) Expanding Proposed Solutions' Score. (4) Communication between users. (5) Expand deliverables and milestones. (6) Expand project. (7)
8.4	Based on what you saw on this questionnaire, what would you say were the features that could be improved upon?	Framing the challenge. (1) Defining the expected impact. (2) Associate events to challenges and projects. (3) Expanding Proposed Solutions' Score. (4) Communication between users. (5) Expand deliverables and milestones. (6) Expand project. (7)

C.2 Results of the questionnaire

Questions marked *.0, are free-fields for additional remarks from participants.

Item	Resp. 1	Resp. 2	Resp. 3	Resp. 4	Resp. 5
0.1	4	2	1	3	4
0.2	7: Project manager	1	1, 7: Product Owner	2	3
1.1.1	1	2	1	1	2
1.1.2	7: The problem defined was not accurate to the real needs.	1	7: County selected for POC had no interest in part of the goals	7: R&D heavy projects often run into technical issues that need redefinition of requirements	1
1.1.3	1	1	1	1	2
1.1.4	4	3	4	4	5
1.2.1.1	4	4	3	3	5
1.2.1.2	4	4	–	4	5
1.2.1.3	4	4	3	3	5
1.2.1.4	4	5	5	4	5
1.2.2.1	5	5	5	4	5
1.2.2.2	5	5	4	3	5
1.2.2.3	5	5	2	4	5
1.0	–	–	To evaluate the form we should have access to the text of all the help buttons.	–	–
2.1.1	2	2	2	1	2
2.1.2	3	3	3	5	4
2.1.3	4	4	5	4	5
2.1.4	4	4	5	4	5
2.1.5	4	5	5	3	5
2.1.6.	1, 3, 4, 6, 7	3, 6	1, 2, 3, 4, 5, 6, 7	1, 2, 6, 7	2, 3, 7.
2.1.7	1, 2, 3, 4, 5, 6	1, 4, 5	1, 2, 6	1, 2, 5	1, 3, 5

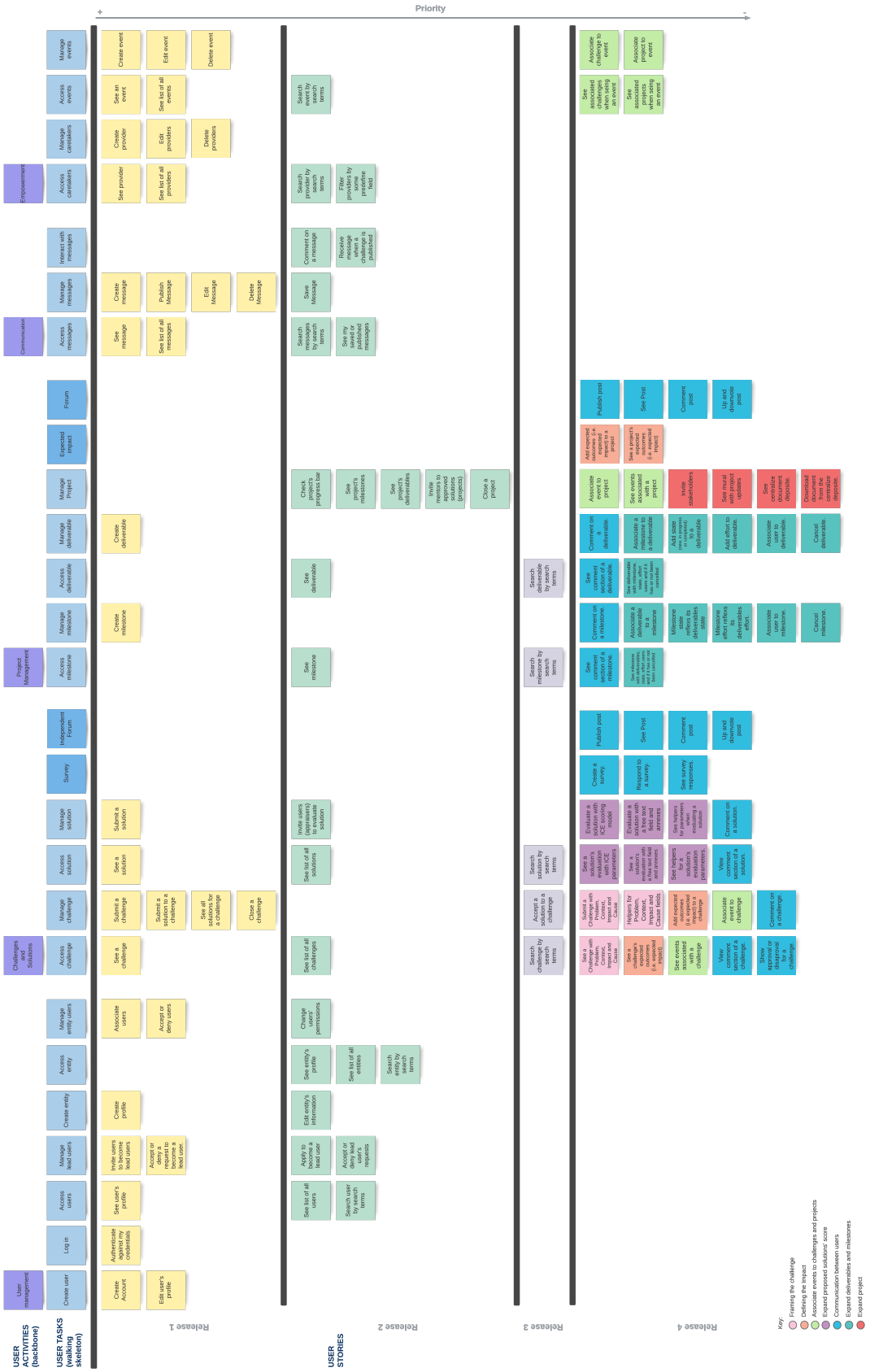
Item	**Resp. 1**	**Resp. 2**	**Resp. 3**	**Resp. 4**	**Resp. 5**
2.2.1.1	5	4	4	3	5
2.2.1.2	5	4	4	4	5
2.2.1.3	3	4	4	4	5
2.2.2.1	5	4	2	3	5
2.2.2.2	5	4	2	4	5
2.2.2.3	5	4	4	3	5
2.0	–	–	–	–	–
3.1.1 5.1.1 7.1.1	1	2	1	1	1
3.1.2 5.1.2	1, 2, 3, 4	1	1, 2, 3	1, 2, 4	1, 2, 3, 4
3.1.3 5.1.3	1	2	6: through project coordinator	2	3
3.1.4	1	1	1	1	1
3.1.5 5.1.4	4	5	4	4	5
3.2.1	4	5	4	4	5
3.2.2	4	4	3	3	5
3.2.3	4	4	3	4	5
3.2.4	4	4	5	4	5
3.0	–	–	–	–	–
4.1.1	3	1	2	4	1
4.1.2	1	1	1	1	1
4.1.3	4	4	4	4	3
4.2.1	3	3	3	4	5
4.2.2	3	3	3	3	5
4.2.3	3	3	5	4	5
4.2.4	3	–	5	3	5
4.0	–	–	–	–	–
5.1.5	5	3	4	4	3
5.1.6	5	3	4	4	3
5.1.7	5	4	5	3	5
5.1.8	5	4	5	3	5
5.2.1.1	5	4	3	4	5
5.2.1.2	5	3	3	3	5
5.2.1.3	1	3	3	4	5

Item	**Resp. 1**	**Resp. 2**	**Resp. 3**	**Resp. 4**	**Resp. 5**
5.2.2.1	5	3	3	3	5
5.2.2.2	5	3	3	4	5
5.2.2.3	5	3	3	3	5
5.2.3.1	5	3	3	4	5
5.2.3.2	5	3	3	4	5
5.2.4.1	3	4	3	4	5
5.2.5.1	4	3	3	3	5
5.2.5.2	4	3	3	4	5
5.2.6.1	4	4	3	3	5
5.0	–	–	–	–	–
6.1.1	1	1	1	1	1
6.1.2	5	5	3	3	5
6.1.3	4	5	3	5	5
6.1.4	3	4	3	4	5
6.1.5	5	5	3	5	5
6.1.6	3	4	3	4	5
6.1.7	4	5	3	4	5
6.1.8	2	5	3	3	5
6.2.1	3	4	3	3	5
6.2.2	3	4	3	4	5
6.2.3	3	4	3	3	5
6.2.4	3	4	3	4	5
6.0	–	–	–	–	–
7.1.2	5	5	3	4	5
7.1.3	5	3	3	4	5
7.1.4	2	3	3	3	3
7.2.1	5	4	3	3	5
7.2.2	3	4	3	4	5
7.2.3	3	4	3	4	5
7.0	–	–	–	–	–
8.1	4	5	3	4	5
8.2	4	5	3	3	4
8.3	2, 5, 6, 7	1, 2, 7	–	3, 4, 5	2, 5, 6
8.4	1,4	5	–	1, 2, 4, 5	4
8.0	–	–	Too long form.	–	–

Appendix D

Full Suggested User Story Map

Map of all users stories for the City Catalyst Platform: both the already planned (Annex B) and the suggested user stories (Chapter 5).


Priority
+
-
USER ACTIVITIES (backbone)
USER TASKS (walking skeleton)
USER STORIES
Release 1
Release 2
Release 3
Release 4
User management
Create user
Create Account
Edit user's profile
Log in
Authenticate against my credentials
Access users
See user's profile
Manage lead users
Invite users to become lead users
Accept or deny request to become a lead user
Create entity
Create profile
Access entity
Manage entity users
Associate users
Accept or deny users
Challenges and Solutions
Access challenge
See a challenge
Manage challenge
Submit a challenge
Submit a solution to a challenge
See all solutions for a challenge
Close a challenge
Access solution
See a solution
Manage solution
Submit a solution
Survey
Create a survey
Respond to a survey
See survey responses
Independent Forum
Publish post
See Post
Comment post
Up and downvote post
Project Management
Access milestone
Manage milestone
Create milestone
Access deliverable
Manage deliverable
Create deliverable
Manage Project
Expected impact
Forum
Empowerment
Access caretakers
See provider
See list of all providers
Manage caretakers
Create provider
Edit provider
Delete provider
Access events
See an event
See list of all events
Manage events
Create event
Edit event
Delete event
Communication
Access messages
See message
See list of all messages
Manage messages
Create message
Publish Message
Edit Message
Delete Message
Interact with messages
Comment on a message
Receive messages when a change is published
Search messages by search terms
See my saved or published messages
Search provider by search terms
Filter providers by some provided field
Search event by search terms
See list of all users
Search user by search terms
Apply to become a lead user
Accept or deny lead user's requests
See entity's profile
Edit entity's information
See list of all entities
Search entities by search terms
Change users' permissions
See list of all challenges
See list of all solutions
Invite users (appraisers) to evaluate solution
See milestone
See deliverable
Check projects progress bar
See projects milestones
See projects deliverables
Invite mentors to approved solutions (projects)
Close a project
Search challenge by search terms
Search solution by search terms
Accept a solution to a challenge
Search milestone by search terms
Search deliverable by search terms
See a challenge with Problem, Impact and Cause
See a solution's expected impact (i.e. expected impact)
See events associated with a challenge
View comment section of a challenge.
Show approval or disapproval for a challenge.
See a solution's evaluation with ICE criteria
See a solution's evaluation with a free text field and comments
See helpers for a solution's evaluation parameters
Add expected impact (i.e. expected impact) to a solution
Associate event to challenge
Comment on a solution
Comment on a challenge
Evaluate a solution with ICE scoring model
Evaluate a solution with a free text field and comments
See helpers for solutions when evaluating a solution
Submit a Challenge with Problem, Impact and Cause
Helpers for Impact, Context, Impact and Cause fields
See a solution's expected impact (i.e. expected impact)
See a project's outcome (i.e. expected impact)
Add expected outcomes (i.e. expected impact) to a project
See associated challenges when seing an event
See associated projects when seing an event
Associate challenge to event
Associate project to event
See comment associated with a milestone
See milestone was edited, deleted, or has not been edited
Associate a deliverable to a milestone
Milestone edited reflects its deliverables edits
Milestone edited reflects its deliverables edits
Associate user to milestone
Cancel milestone.
See comment associated to a deliverable
See deliverable was edited, deleted, or has not been edited
Comment on a deliverable.
Add state: Not started, in progress, completed to a deliverable
Add effort to deliverable
Associate user to deliverable
Cancel deliverable.
Associate to deliverable
See mural with project updates
See comment document deposite.
Download document from the comment deposite.
Associate project to milestone
Associate to milestone
Invite stakeholders
Associate project to deliverable
Key:
Framing the challenge
Defining the Impact
Associate events to challenges and projects
Expand proposed solutions' score
Communication between users
Expand deliverables and milestones
Expand project