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Abstract

This deliverable presents the work carried out in WP6 Economic and Business Opportunity Analysis and in the context of Task 6.3 Business Models and Opportunities Analysis. In particular, it adopts a “holistic” approach facilitating the integration of two key strategic components of the IoT Lab project as follows:

- **The IoT Lab Incentive Model:** The Incentive Model will be utilised in order to motivate users’ participation and engagement within the system.
- **The IoT Lab Business Model:** The Business Model will be employed in order to satisfy stakeholders’ needs by delivering value via the envisioned IoT Lab services.

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Abbreviations and acronyms

CaaS	Crowdsourcing & Crowdsensing as a Service
CCC	Cash Conversion Cycle
DoW	Description of Work
Eaas	EaaS – Experiment-as-a-Service
EU	European Union
Fed4FIRE	Federation for FIRE
FIRE	Future Internet Research and Experimentation
IC	Invested Capital
IaaS	Innovation as a Service
IoT	Internet of Things
IPv6	Internet Protocol version 6
NWC	Net Working Capital
ROIC	Return on Invested Capital
SWOT	Strengths, weaknesses, opportunities and threats
TaaS	Testbed as a Service
VNA	Value Network Analysis
WP	Work package

1 Executive Summary

The purpose of this deliverable is to contribute to the goals of Work Package 6 Economic and Business Opportunity Analysis by providing an in-depth analysis of Task 6.3 Business Model and Opportunities Analysis.

More specifically, this document provides an overview of the methodological approach that was employed for the identification of the:

a) **IoT Lab Incentive Model** that will be utilised in order to motivate users' participation and engagement within the system.
b) **IoT Lab Business Model** that will be employed in order to satisfy stakeholders' needs by delivering value via the envisioned IoT Lab services.

In the context of the IoT Lab Incentive Model, a contextual analysis has been conducted which includes in addition to the analysis of the IoT Lab experimentation process, the theoretical foundations for motives and incentives. This is followed by the Incentive Model analysis, which facilitates the design of the IoT Lab Incentive Model, which is a "*Hybrid Gamified Incentive Model*". This model combines two key types of incentives, namely intrinsic and extrinsic incentives while it also includes innovative approaches that aim to enhance both the extrinsic, intrinsic and social motives such as the *"gamification approach".*

The IoT Lab Incentive Model is anchored in the "*Social Good Business Approach*" that has been adopted by the IoT Lab partners and which enhances further the intrinsic motives of the crowd participants, as they will be contributing to a greater cause that goes beyond contributing to emerging research. In particular, IoT Lab will allow its community members to allocate the points/credits collected by participating in the experiment to a charity of their choice, out of a list that will be provided by the platform. This approach is based on the working assumption that a research sponsor provides a budget for an experiment, out of which a small amount (social revenue distribution) will be used for the platform maintenance. The rest will be allocated to the users so that they can in turn re-allocate the amount to the charities proportionally based on their point/credit distribution.

The IoT Lab partners have considered the possibility to donate the majority of the revenues to charities. Anchored in this decision and based on our analysis, the optimal social revenue distribution percentage was identified which is: ***40% IoT Lab* and *60% donations.*** As such, the total amount that could be donated to charities during the first five years of the IoT Lab operations, can reach the amount of ***2.4 million Euros***, which constitutes a high social impact for the IoT Lab ecosystem.

Similarly, in the context of the IoT Lab business model, a contextual analysis has been conducted providing the theoretical foundations of our analytical process from a theoretical and an empirical level. This is followed by the Business Model analysis, which provides an overview of the potential Business Models that could be adopted by IoT Lab, as well as a comparative analysis and evaluation of the different models. This process facilitates the definition of the most appropriate Business Model for the IoT Lab, and the analytical framework that will be utilised for its examination as well as its key components.

The IoT Lab Business Model is a "*Social Business Model*" that focuses on the impact that IoT Lab creates for the crowd participants, its stakeholders, the charities that participate (direct beneficiaries) as well as the wider community rather than the profits that it creates. The analysis of this model is conducted via a newly proposed Business Model framework for crowd-driven ecosystems, which extends existing research in the area.

Our analysis concludes with the IoT Lab Penetration Strategy at a geographical level, which adopts a layered approach, focusing initially upon the IoT Lab consortium countries (micro level – level 1) and expands to the European region (meso level-level 2) in order to finally reach international regions (macro level- level 3). This way a steady penetration is achieved, enabling IoT Lab to progressively create a stable crowd and stakeholder community that aligns with the IoT Lab Association cost structure.

2 Introduction

2.1 The IoT Lab project in brief

IoT Lab is a European research project exploring the potential of crowdsourcing to extend European IoT testbed infrastructure for multidisciplinary experiments with more end-user interactions. It researches and develops:

1. Crowdsourcing mechanisms and tools enabling testbeds to use third parties resources (such as mobile phones), and to interact with distributed users (the crowd). The crowdsourcing enablers will address issues such as privacy by design, identity management, security, reputation mechanisms, and data ownership.
2. Virtualization of crowdsourcing and testbed components by using a meta-layer with an open interface, facilitating the integration and interaction with heterogeneous components. It should ease data integration and reduce the cost of deployment in real environment.
3. Ubiquitous Interconnection and Cloudification of the testbeds resources. It will research the potential of IPv6 and network virtualization to interconnect heterogeneous and distributed resources through a Virtual IoT Network and will integrate them into the Cloud to provide an on-line platform of crowdsourcing Testbed as a Service (TBaaS) available to the research community.
4. End-user and societal value creation by analyzing the potential end-users and crowdsourcing participants to propose an optimized model for end-user adoption and societal value creation.
5. "Crowdsourcing-driven research" as a new model in which the research can be initiated, guided and assessed by the crowd. It will compare it to other models.
6. Economic dimension of crowdsourcing testbed, by analyzing the potential markets and Business Models able to monetize the provided resources with adequate incentives, in order to optimize the exploitation, costs, profitability and economic sustainability of such testbeds. It will also develop tools for future experiments.

7. Performing multidisciplinary experiments, including end-user driven experiments through crowdsourcing, to assess the added value of such approach.
8. The project will adopt a multidisciplinary approach and address issues such as privacy and personal data protection. To achieve these ambitious goals, the consortium consists of seven international academic or research partners and a SME that bring in expertise from complementary research areas, including Information and Communication Technologies, End-user interaction, and Economics.

2.2 Purpose and scope of the WP 6

WP 6 Economic and Business Opportunity Analysis aims to research and provide an IoT and Testbed Market Analysis (Task 6.1), as well as Cost and Efficiency Monitoring Tools (Task 6.2). It will compare the various models and explore innovative Business Models and an opportunities analysis, while proposing an economic incentive mechanism for crowdsourcing participants (Task 6.3 Business Model and Opportunities Analysis). In addition, this WP will take a broader perspective leading to an economic impact analysis, which will link the firm-level (Task 6.3) to the industry and country level (Task 6.4 Economic Impact Analysis).

WP6 establishes an analytical framework to estimate both the economic impact and the potential of the IoT crowdsourcing platform for companies regardless of their size. This WP will conduct a critical analysis of the economic aspects of the IoT Lab platform. In particular, we will identify and compare Business Models, which will lead to an optimal Business Model for such a crowdsourcing platform. More specifically, the following four tasks will be addressed:

- **Task T6.1 IoT and Testbed Market Analysis:** In this Task, a stakeholder analysis (together with WP5 End-user and Societal Added Value Analysis) is provided which will help us identify market segments as well as the market size, growth and volume. This analysis will lead to an evaluation of arising business opportunities related to the IoT Lab's core concepts.
- **Task T6.2 Cost and Efficiency Monitoring Tools:** As part of this Task, a value chain analysis is performed to establish how services are provided to various

stakeholders. Establishing the value chain will translate into a value driver analysis from which the cost and efficiency measures are derived. A generic economic evaluation form will be integrated into the IoT Lab application to collect inputs from the participants on the economic potential of the performed experiments.

- **Task T6.3 Business Model and Opportunities Analysis***:* A set of Business Models for IoT Lab and their future sustainability are identified.

- **Task T6.4 Economic Impact Analysis:** The stakeholder analysis performed in Task T6.1 is taken further by exploring the wider economic impact of IoT Lab, starting from a micro-level perspective to an industry and finally a country-level assessment.

2.3 Purpose and scope of the Task T6.3

Task T6.3 aims to identify a set of business models that can be used to deliver IoT Lab services. An initial exploration of potential business models will be conducted and it will highlight whether they can be used in this context following the Value Chain analysis (T6.2). This task will also consider the role of end-users and the potential for the co-creation of value as this constitutes a critical component of IoT Lab. Part of our analysis will determine whether different options (e.g. crowdsourcing) require different or modified business models.

After establishing a set of possible business models, we will assess the sustainability of business models anchored in our preceding analyses in the context of WP6 (T6.2 and T6.1). The cost and efficiency of different business models will be assessed and their sensitivity to environmental changes (e.g. flexibility, change in market demand). This will be based on Sensitivity analysis**.** The analysis will lead to a selection of optimal business models, and their respective market opportunities.

Given the inherent asymmetry in terms of motivation between researchers (highly motivated) and crowdsourcing participants (who could be less motivated), this task will also analyze the possible economic incentives that could be used to encourage effective crowdsourcing participation. Based on the business model analysis, we will research and propose an Economic Incentive Model, which could help optimize the crowdsourcing participation through economic incentives. Such a monetization scheme should be optional and cost efficient. Different models will be considered, where the monetization of the resource provided by the crowd could be real, or could take the form of credits, which could be capitalized by crowdsourcing participants in order to be later used for their own experiments.

2.4 Purpose and scope of the current document

This document reports on the work carried out in WP6 in the context of Task 6.3. It contains an overview of the methodological approach that was employed for the identification of the IoT Lab Incentive Model and the Business Model that will be used to deliver the IoT Lab services.

Our approach integrates an in-depth analysis of two key parameters:

- **IoT Lab Incentive Model**
- **IoT Lab Business Model**

A contextual analysis of the IoT Lab Incentive Model is which facilitates the design of the IoT Lab Incentive Model is presented including the analysis of the IoT Lab experimentation (Phase A) and the theoretical foundations for motives and incentives (Phase B).

Regarding the IoT Lab Business Model, a contextual analysis sets the theoretical foundations of our analytical process (at a theoretical and an empirical level). This is followed by the “Business Model Analysis” which includes an overview, comparative analysis and evaluation of the potential business models that could be adopted by IoT Lab. This process concludes with the definition of the most appropriate business model for the IoT Lab and the analytical framework that will be utilised for its examination as well as its key components.

The main aims of Task T6.3 is to:

(a) Identify and analyse the potential Incentive Models that can be utilised for IoT Lab experimentation processes;

(b) Provide an effective Incentive Model for IoT Lab that will foster crowd-participation and thus “crowdsourcing-driven research”;

(c) Identify and analyse potential business models that can be utilised for IoT

Lab;

(d) Identify an Innovative Business Model for the IoT Lab ecosystem.

2.5 Structure of the current document

The structure of the current document is as follows:

Section 3 presents the methodological approach that has been followed in the course of D6.3.

Section 4 provides the Incentive Model Analysis which includes:

- Incentive Model methodology (Section 4.1)
- IoT Lab experimentation process background (Section 4.2.1)
- Theoretical foundations underpinning Incentive Models (Section 4.2.2)
- Definition of the IoT Lab Incentive Model (Section 4.2.3)

Section 5 presents the Business Model Analysis which includes:

- Business model methodology (Section 5.1)
- Business model foundations (Section 5.2)
- Definition of the IoT Lab Business Model (Section 5.3)
- IoT Lab market penetration (Section 5.4)

Section 6 concludes this deliverable.

3 Overall Methodology

3.1 Methodology Overview

This section presents an overview of the methodology that has been employed for the identification of the IoT Lab Incentive Model that will be utilised in order to motivate users' participation and engagement within the system as well as the IoT Lab Business Model that will be employed in order to satisfy stakeholders' needs by delivering value via the IoT Lab services. The approach is a "holistic" one, facilitating the integration of the IoT Lab Incentive Model in the Business Model components of the IoT Lab.

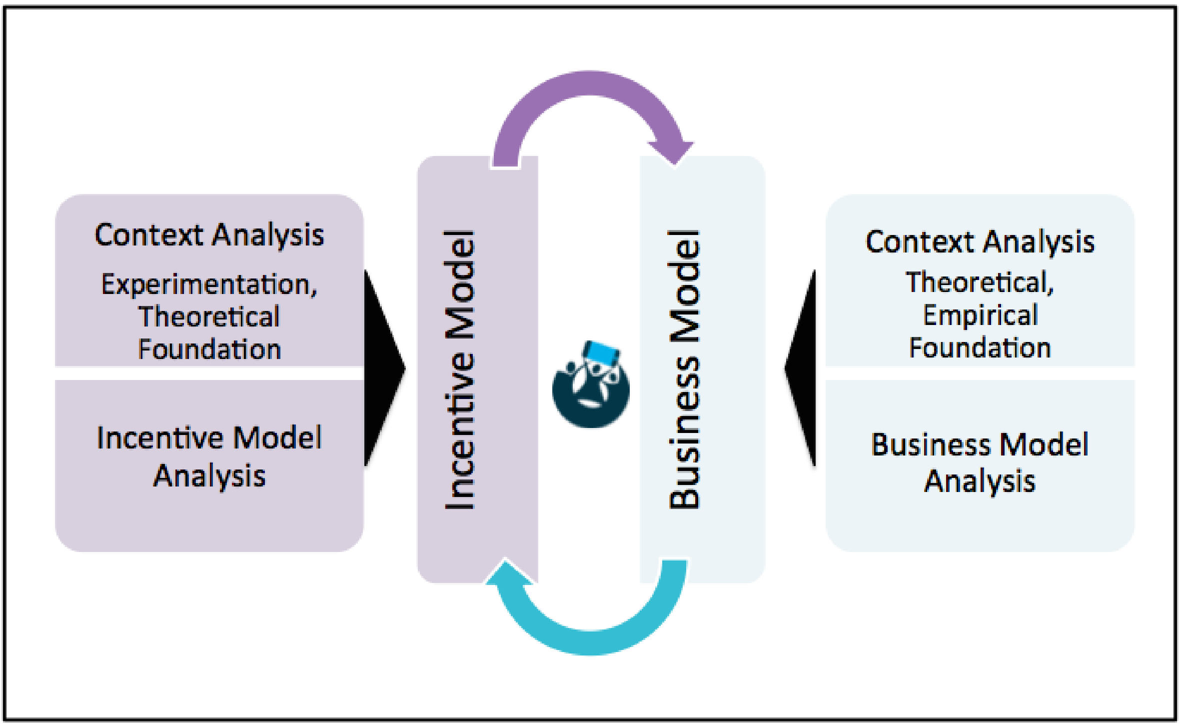

Figure 1: Overall Methodology – IoT Lab Incentive and Business Modeling

In Figure 1, the overall methodology entails two distinct analytical steps across both models. These steps include:

- A "contextual analysis" via the examination of the theoretical and empirical foundations of each that will essentially set the basis of our analysis;
- The actual analysis for the identification of the most appropriate Incentive and Business Model for IoT Lab.

4 Part I: Incentive Model Analysis

4.1 Incentive Model Methodology

A three-fold methodology is utilized (Figure 2) as follows:

- *Two phases that set the foundations of our analysis (context analysis)* which include: (a) analysis of the IoT Lab experimentation context (Phase A) as well as (b) theoretical foundations for motives and incentives (Phase B), drawing upon the analysis of WP5 (End-user and societal added value analysis).
- *The Incentive Model Analysis* which facilitates the design of the IoT Lab Incentive Model.

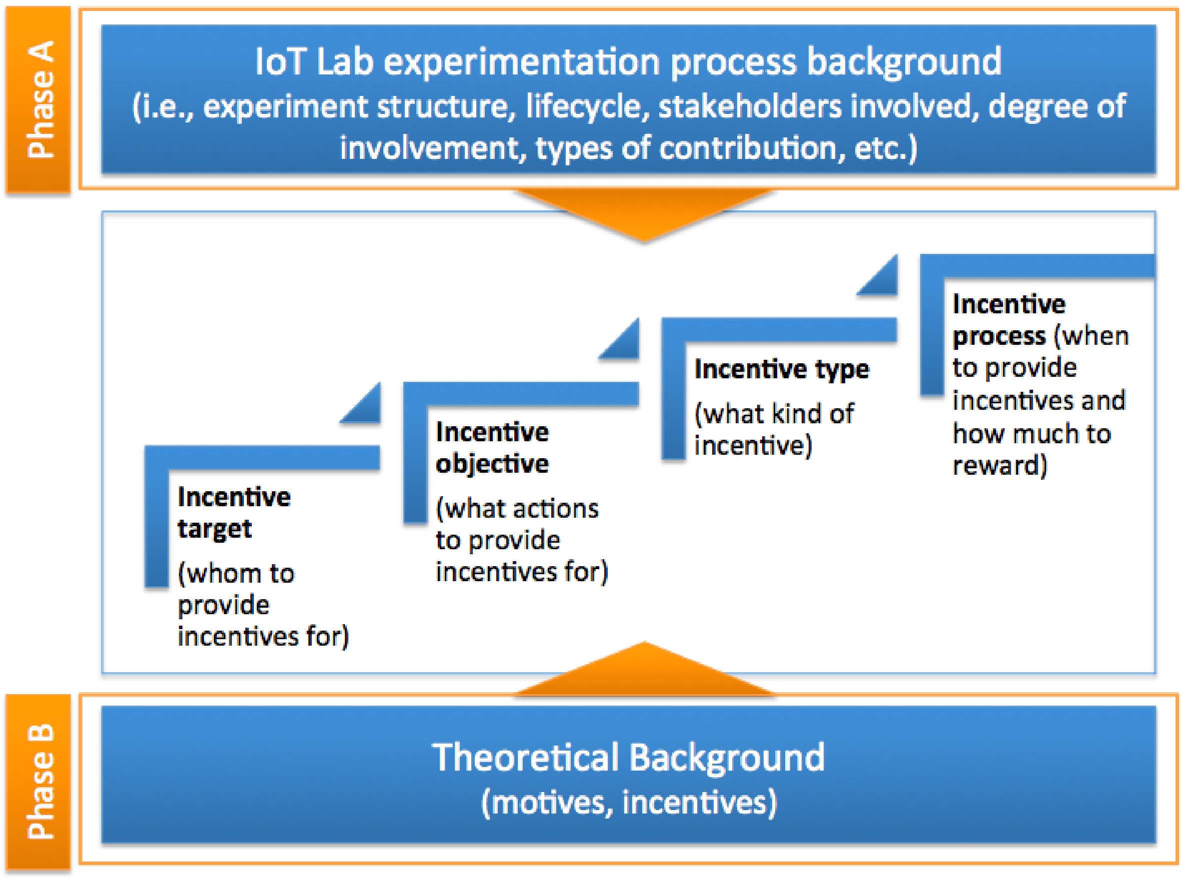

Figure 2: Incentive Model Methodology

4.2 Incentive Model Analysis

4.2.1 Phase A: Experimentation Process Background

In order to design the IoT Lab Incentive Model, it is critical to consider the IoT Lab experimentation process (i.e., generic experimentation process, types of experiments, experiment lifecycle, etc.) and the experiment data sources (i.e., types of data sources (data velocity and variety) and stakeholder specifications.

4.2.1.1 IoT Lab Life-Cycle Model of the Experimentation Process

Drawing upon the analysis conducted in the course of Task T6.2, the IoT Lab experimentation life-cycle model is a composition of *six distinct experimentation phases*, as seen in Figure 3. Across these phases, two critical parameters are identified: (a) the crowd-driven focus of the different phases and (b) the type of evaluation that IoT will facilitate.

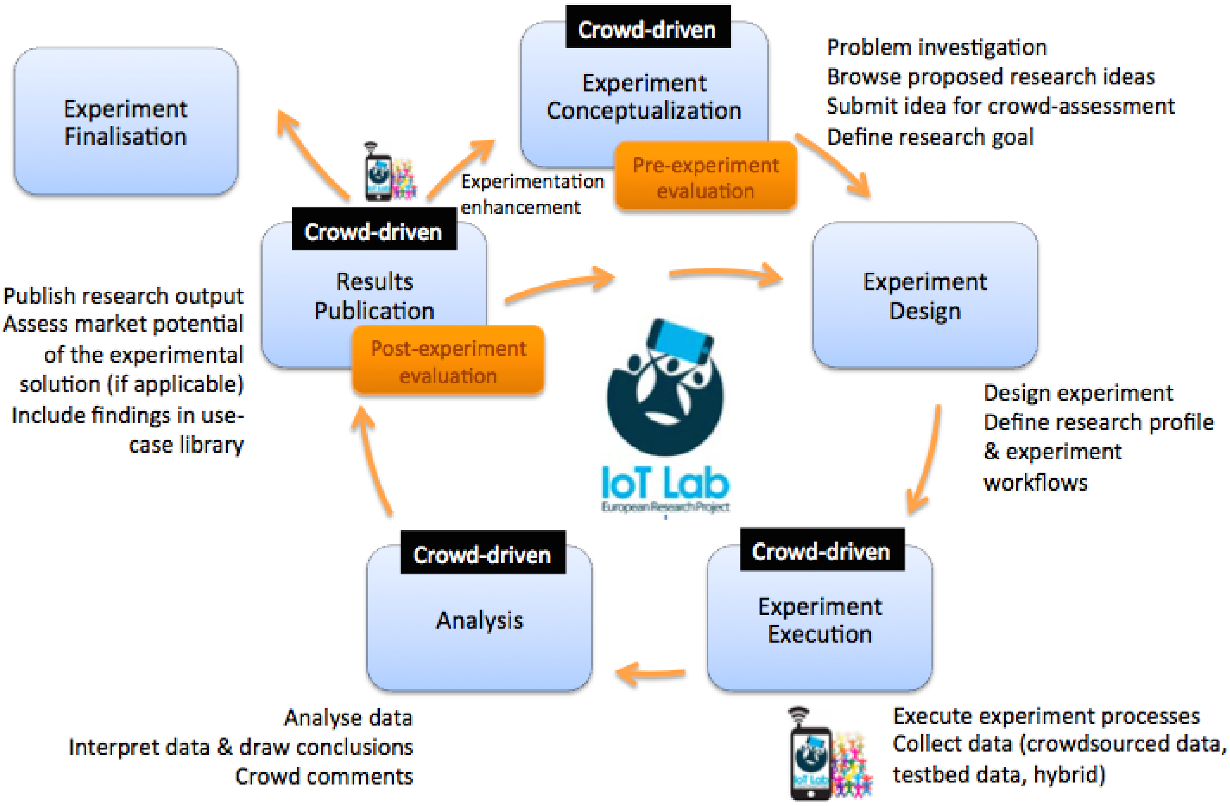

Figure 3: IoT Lab Experiment Life-Cycle Model

Based on this analysis, a taxonomy of the different evaluation processes was created by considering two criteria: (1) evaluation focus and (2) aim of the evaluation (see Table 1 below).

Table 1: Taxonomy of the different Evaluation Processes in the IoT Lab Experimentation Life-Cycle

Evaluation Focus	Evaluation Aim
IoT Lab	*Idea screening:* Assessing the perceived value of the IoT Lab service prior to its usage.
	Service screening: Assessing the perceived value of the IoT Lab service after using the service.
Experiments via IoT Lab	*Idea screening:* Assessing the perceived value of a proposed idea for an experiment via the IoT Lab.
	Market insight (Part 1): (a) Specifying the market insight for the experimented solutions (researcher-focused).
	Market potential screening (Part 2): (b) Assessing the perceived value and market potential of proposed experimented solutions (crowd-focused).

4.2.1.2 Types of IoT Lab Experiments

IoT Lab can facilitate two types of experiments:

a) **Investigator-driven experiments**

Experiments that are initiated by the investigator (i.e., individual researcher, student, company, research organisation, university, etc.).

b) **Crowd-driven experiments**

Experiments that are initiated/proposed by the crowd (i.e., crowd-proposed experiment ideas, etc.).

a. Investigator-driven Experiments

These type of experiments (Figure 4) are instigated by the investigator who provides the experiment task request to IoT Lab (step 1, Figure 4), which acts as a trigger for this type of experimentation process.

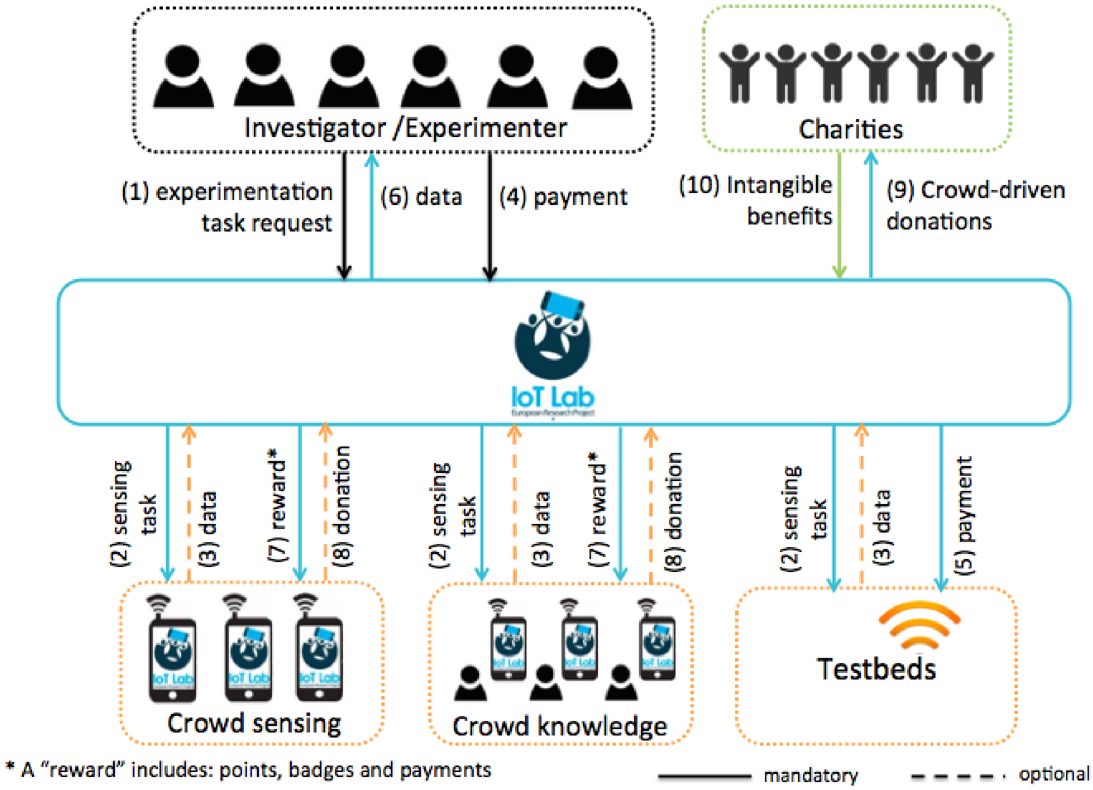

Figure 4: Investigator-driven Experiments

b. Crowd-driven Experiments

The second type of experiments involves experiments that are instigated by the crowd participants of the IoT Lab community (Figure 5).

In particular, the crowd participants present an experiment idea to the broader community via the IoT Lab app (step 1, Figure 5). The community then rates this as well as other ideas (step 2) triggering the experimentation process.

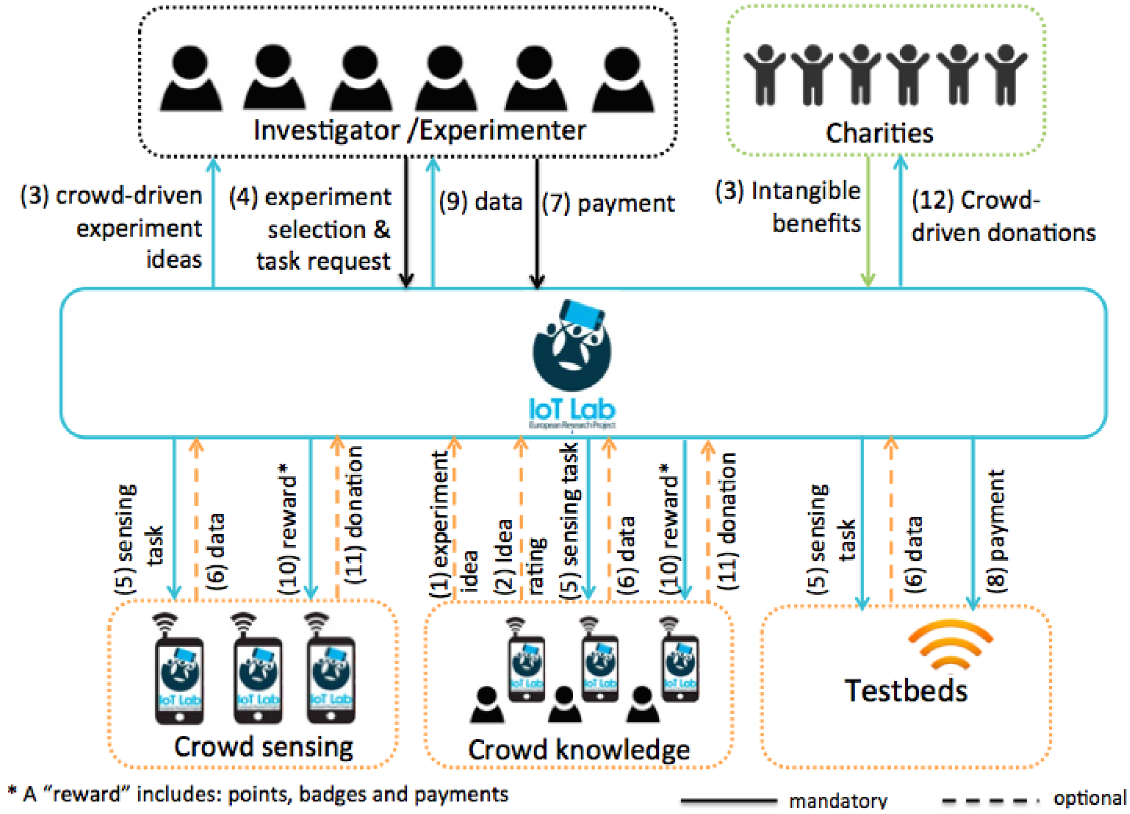

Figure 5: Crowd-driven Experiments

4.2.1.3 Usage Process

In order to analyse the formal activities of the end-user in IoT Lab we examine the different steps/activities that they have to perform in order to successfully use the IoT Lab app.

Our analysis, examines two types of users: crowd-participants and researchers, and their activities (generic activities, optional and mandatory) can be divided into the following processes:

(a) ***Part A - Installation process of the IoT Lab app***: The process of formally installing the IoT Lab application (see Table 2), which involves three generic steps that entail both optional and mandatory activities.

(b) ***Part B - Usage process of the IoT Lab app***: This process entails the usage process of the IoT Lab app, such as the crowd-sensing activities and crowd-wisdom activities (see Table 3).

Table 2: Part A - Installation process of the IoT Lab app

Category	Activities	Crowd	Researcher	Type of Activity
1. Smartphone app	Download the app	✔	✔	Optional
2. Installation	Register/sign-in	✔	✔	Mandatory
	Welcome intro (IoT Lab introduction, language switch)	✔	✔	Optional
	Profile fill-in (i.e., socio-economic profile)	✔	✔	Optional
3. IoT Lab participation model	1 Select participation mode (Minimum participation vs. all by default)	✔	✔	Optional
	2. Invited and accept	✔	✔	Optional
	3. Search and select	✔	✔	Optional

Table 3: Part B- Usage process of the IoT Lab app

Category	Activities	Crowd	Researcher	Type of Activity
4. Crowd sensing (smart-phone sensor data)	1. Wi-Fi restrictions	✔	✔	Optional
	2. Sensors shared	✔	✔	Optional
	3. GPS shared	✔	✔	Optional
5. Crowd wisdom	1. Vote for ideas	✔	-	Optional
	2. Suggest potential improvements, research extensions (to be developed in the future)	✔	-	Optional
	3. Participate in an experiment a. Provide feedback/answer b. Provide sensor measurements c. Hybrid	✔	-	Optional
	4. Propose an idea for an experiment	✔	✔	Optional
	5. Assess market potential of a proposed research innovation	✔	-	Optional

4.2.1.4 Types of Data Source

IoT Lab data constitute a critical parameter as they facilitate our understanding of the stakeholder involvement which demonstrates the importance of each data source and these findings will impact the design of the IoT Lab Incentive Model. IoT Lab data sources can be classified based as Data Variety and Data Velocity.

Data Variety

The variety of data sources has been classified into three key categories:

1. Crowd-driven data

a) End-user profile: User socio-economic profile;
b) End-user “crowd sense” data: Smartphone sensor data preferences (i.e., Wi-Fi restrictions, shared sensors, share GPS, etc.);
c) End-user “crowd knowledge” data: (i.e., ratings, reporting, annotations, questionnaires, etc.).

2. Testbed infrastructures (sensors, actuators.).

3. Mixed data (Hybrid data): A combination of data sources.

Data Velocity

In order to analyse data value, we classify it in order to examine their data velocity. We consider the degree of data acquisition difficulty and the data owners.

In Figure 6, these variables have enabled the classification of:

(i) Real-time data (high velocity) such as testbed data, end-user crowd-sensed data that have a low degree of acquisition difficulty and uncertainty.
(ii) Near-real time (medium velocity) data such as end-user crowd-knowledge data that have a medium/high degree of acquisition difficulty and uncertainty.
(iii) Static data (low velocity) such as end-user profile data that have a high degree of acquisition difficulty and uncertainty.
(iv) Hybrid data that combine the different data sources (real time, near real time and static data – mixed velocity) and have the highest degree of

acquisition difficulty and uncertainty but also the highest degree of data value (innovation potential of data).

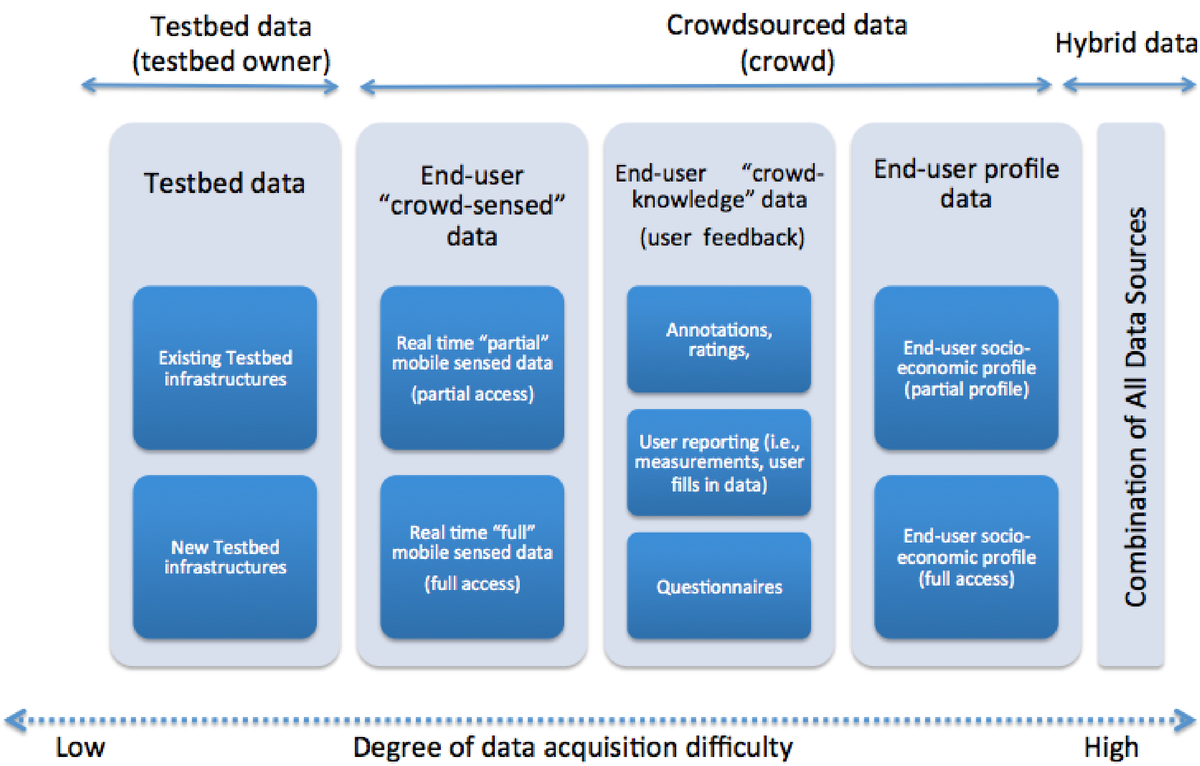

Figure 6: IoT Lab Data Velocity

4.2.1.5 Stakeholders Perspective of IoT Lab Data

As the two key data owners in IoT Lab are testbed owners and the crowd, we adopt these two perspectives in order to examine the specifications of the data that each stakeholder segment provides, based on frequency of data usage, user involvement in the data provision process and finally associated cost.

Testbed Owner Perspective

From the testbed owner perspective, real-time data have medium/high usage frequency and no testbed owner involvement.

In relation to the cost, real-time data have mainly medium/high monetary costs mostly related to maintenance costs for testbed owners. In Table 4, static data sources are not associated with testbed data sources.

Table 4: Testbed Owner Perspective of IoT Lab data

Testbed Owner Specifications		IoT Lab “Testbed” Data Sources	
		“Real-time” (dynamic) Data sources	Static Data sources
		Sensor data	Sensor data
Frequency	Frequency of data usage	**Medium/High**	None
Involvement	Degree of Testbed-owner involvement	None (indirect)	None
Cost	Monetary costs (i.e., maintenance costs, etc.)	**Medium/High (Testbed maintenance)**	None
	Non-figurative costs (i.e., costs in terms of time, consumption of own resources)	None	None

Crowd Perspective

From the crowd perspective, real-time data and near real-time data are associated with (1) crowdsensing and (2) crowd-knowledge whereas static crowd data are related with End-user profile data (Table 5).

Table 5: Crowd Perspective of IoT Lab data

Crowd Specifications		IoT Lab "Crowd-driven" Data Sources				
		"Real-Time" & "Near Real Time" Crowd Data sources		Static Crowd Data sources		
		Crowd sensing (1)	Crowd knowledge (2)	Crowd sensing	Crowd knowledge	End-user profile Data
Frequency	Frequency of data usage	Medium/ High	Medium	-	-	Medium
Involvement	Degree of crowd involvement	Medium (indirect)	High (direct)	-	-	Low
Cost	Monetary costs (i.e., Wi-Fi connection, electricity costs, etc.)	Medium	Medium	-	-	Low
	Non-figurative costs (i.e., costs in terms of time, consumption of own resources (battery, bandwidth, etc.), etc.)	Medium (varies by the type of experiment)	High	-	-	Low

Notes: (1) Smartphone sensor data, (2) end-user wisdom/data

In relation to the former, we can see that crowdsensing has a medium/high usage frequency and indirect user involvement. In relation to the cost, real-time/near real-time data have medium monetary costs and medium non-figurative costs that vary by the time of experiment for the crowd-participant. Although the involvement of the crowd is relatively low for crowdsensing, the associated costs are medium. Crowd knowledge on the other hand, necessitates a medium frequency of data usage and a high degree of crowd involvement. The associated costs are medium monetary costs but high non-figurative ones.

Regarding static data, mainly end-user profile data are associated with medium data usage frequency and low user involvement as users provide their profile data only once and then if needed they can update this information. This type of data has low cost impact for the end-user both with low monetary and low non-figurative costs.

Conclusions

Our preceding analysis provides a number of conclusions that facilitate the design of the IoT Lab Incentive Model. In particular we can assert the following:

IoT Lab Data Sources

- Diverse data sources are needed across the IoT Lab experimentation lifecycle from diverse data providers (testbed owners and crowd participants).
- Higher degree of value adding potential of data sources is associated with higher degree of data acquisition difficulty.

IoT Lab Data Providers (Impact of data provision)

- ***Testbed owners***

High data usage frequency is associated with medium/high testbed monetary costs (maintenance costs).

- ***Crowd participants***

Higher value adding data (real-time, crowdsourced knowledge data), are associated with medium monetary costs and high non-figurative costs for the crowd participants.

- ***Need for an engaging IoT Lab Incentive Model***

A generic conclusion of our analysis is that it validates the critical need for an Incentive Model that will engage diverse stakeholders not only into downloading but also into maintaining their engagement with the IoT Lab app across time. A community of data-owner stakeholders (testbed owners and crowd participants) among other stakeholders that will be created and increasing over time.

4.2.2 Phase B: Theoretical Background

The second part of our Incentive Model Analysis entails a high-level examination of the theoretical background of motivation. This analysis is directly linked with WP5 and Task T5.2 (D5.2). Our analysis will initially examine the major motivation factors and will subsequently identify the IoT Lab Incentive Model via a detailed scenario analysis.

4.2.3 Motivation Factors

Motivation constitutes a critical aspect that explains behavior as it explains the reasons for an individual’s behavior. We aim to provide a synopsis of the key motivation factors from a generic (section 4.2.3.1) and specific perspective (i.e., in the context of crowd-driven ecosystems refer to section 4.2.3.2, section 4.2.3.3, section 4.2.3.4) while examine some key emerging motivation factors such as gamification (see section 4.2.3.5).

4.2.3.1 Generic Motivation Factors

Existing research in the area indicates that motivation can be divided into two different theories of motivation, namely intrinsic motivation (internal motivation) and extrinsic motivation (external motivation). A synopsis of these two theories of motivation is provided in the sections that follows.

Intrinsic motives

- *Intrinsic motives* are internal motives that are directly connected to the act of performing a task (i.e., peer recognition, satisfaction in learning, enjoyment in performing a task, etc., [1] rather than external factors or rewards. Driven by the self-desire to engage in curiosity-driven, enjoyment-driven and/or personal-development driven behaviours, intrinsic motivation represents a natural motivational tendency that is long-lasting and self-sustaining.
- *Common intrinsic (internal) motivations*: curiosity, learning, mastery, meaning, belonging, autonomy, enjoyment, etc. [2], [3], [4].
- *Advantages:* intrinsic motivation is long-lasting and self-sustaining.
- *Disadvantages:* it requires a lengthy and well-planned process that has a slow behavioural effect as opposed to external motivation.

Extrinsic motives

- *Extrinsic motivation* originates from influences outside the individual as opposed to intrinsic motivation. In extrinsic motivation, the performance of an activity is unrelated to the nature of the task (i.e., economic motives, direct compensation, anticipated return, etc. [5].
- *Common extrinsic (external) motivations*: rewards such as money and points for demonstrating the desired behaviour as well as competition and the fear of failure and punishment [6], [7].
- *Advantages:* extrinsic motivation is easy to foster and relatively fast to implement.

- *Disadvantages*: it is has a relatively short-lasting effect that needs continuous efforts to maintain having significant cost-implications.

4.2.3.2 Motivation in the context of Crowdsourcing

Existing research in the area of crowdsourcing indicates that the two key theories of motivational behavior (intrinsic and extrinsic motivation) explain the reasons for an individual's behavior in emerging crowd-driven ecosystems ([8], [9]). These theories are described in detailed in the sections that follow.

Intrinsic motivation

- *Intrinsic motivation* in the context of crowdsourcing is essentially "the motivation to engage in work for its own sake because the work itself is interesting or satisfying" [10].
- *Common intrinsic motives in the context of crowdsourcing*: Exchange of information [11], social identity and influence [12], a sense of membership and attachment to a group [13] and also fun, enjoyment or entertainment [14] and altruism [15].
- *Intrinsic motivation-crowdsourcing* examples: Wikipedia, open source projects, etc.

Extrinsic motivation

- *Extrinsic motivation* in the context of crowdsourcing is essentially "the motivation to work for something apart from and external to the work itself" [11].
- *Common extrinsic motive in the context of crowdsourcing:* financial rewards respectively free products [16], competitions, etc.
- *Extrinsic motivation-crowdsourcing examples:* Crowdspirit, FellowForce, Innocentive, Threadless, etc.

4.2.3.3 Motivation in the context of Crowdsensing

In crowdsensing the two motivational theories also explain individual behavior. Research indicates that the success of participatory sensing relies upon "sustained, high quality participation" [17]. Such participation can be explained by intrinsic and extrinsic motives. The sections that follow provide a number of key crowdsensing projects that are driven by these motives.

Intrinsic motivations

- **Citizen science projects:** voluntary participation of citizens for crowd interaction and self-interest among others.
- **Galaxy Zoo:** classification of galaxies by citizens.
- **eBirding:** focusing on "birders" target group (i.e., sporadic bird observers to those whom observing birds becomes a life style headed by Cornell Lab of Ornithology).

Extrinsic motivations

- **"Medusa project"** uses monetary incentives to encourage user participation [18].
- **"McSense"** Android-based urbansensing platform (smart cities) uses monetary incentives [19].
- Financial incentive (platform-centric or user-centric model) [20].

4.2.3.4 Implications

The previous sections provide some useful insight in explaining one's behavior in crowdsourcing and crowdsensing ecosystems. In particular, it can be seen that intrinsic (internal) and extrinsic (external) motives describe the reasons for people's actions in such crowd-driven environments. Some of the key findings of our analysis are:

Intrinsic motives are highly critical in crowdsourcing and crowdsensing as they provide long-lasting and self-sustaining behavior, however they require a lengthy and well-planned process that has a slow behavioral effect as opposed to external motivation.

Extrinsic motives are a key incentive mechanism of successful crowd-driven ecosystems. However, although this type of motivation is easy to foster and relatively fast to implement, it is usually associated with a relatively short-lasting effect that needs continuous efforts to maintain having significant cost-implications. For example monetary rewards create significant cost-related implications given that in order "…to make users participate in “heavy” sensing tasks (either physically or mentally), stronger incentive is required. Thus, the total amount of rewards paid by the client will quickly rise…” [21]

Hence, a critical question during the design of an Incentive Model for a crowd-driven platform, such as IoT Lab, is not only how to foster but also how to sustain user engagement?

Based on emerging research in the area, both intrinsic and extrinsic motivational factors are critical in the initial and continued use of a crowdsourcing system [15]. According to the recent analysis of Soliman and Tuunainen [15] when a temporal dimension is introduced, there is an interplay between intrinsic and extrinsic motives. In particular, *initial use* of such systems is dominated by selfish motivational factors (such as financial reward and curiosity, see Figure 7), while *continued use* is driven by both selfish and social motivational factors.

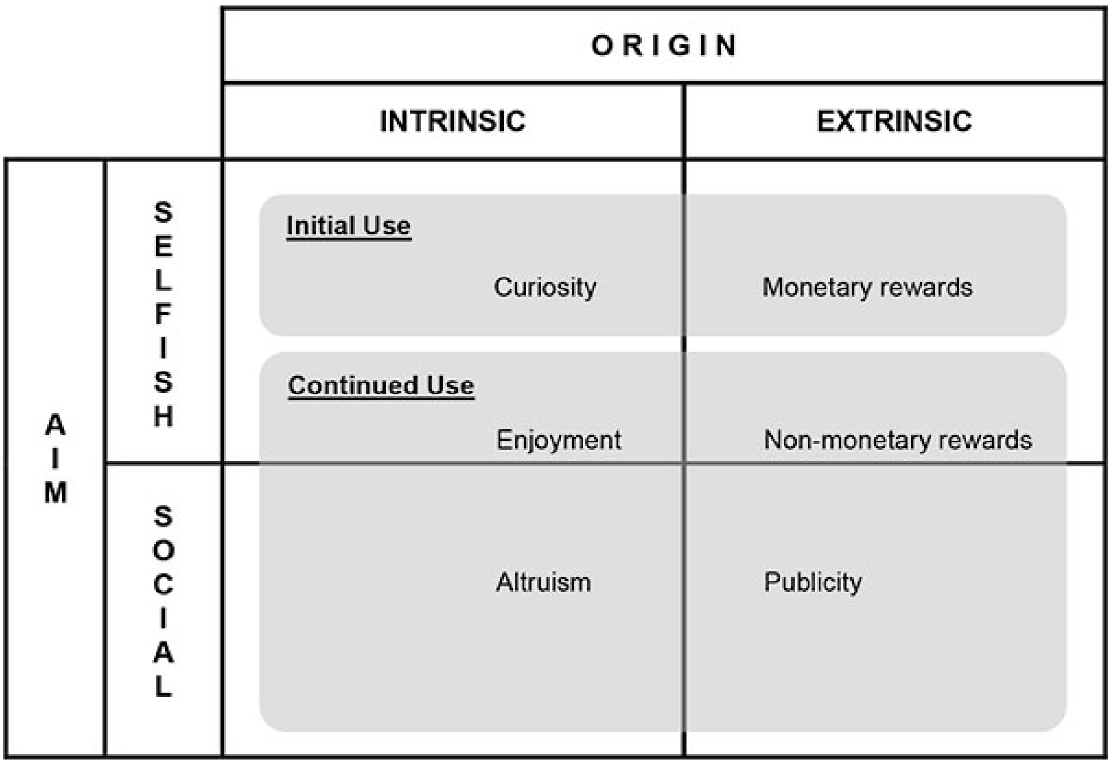

Figure 7: Motivational factors and the temporal dimension

(Source: [15])

Based on this analysis while selfish motivational factors (especially monetary rewards) play a dominant role in attracting users in making their initial usage decision, social motivational factors (e.g., altruism) are the ones that play a critical role during the subsequent user decisions.

Combining the dimensions of motivation will enable us to capture the changing nature of the motivational factors driving users' behavior not only during the initial but also during the continued use for crowdsourcing systems such as IoT Lab.

4.2.3.5 Gamification: An emerging motivation factor

Gamification has been recently utilised as a viable and effective technique to incentivize users' participation, increase quality of information [22] while at the same time sustain users' engagement through time.

Formally, gamification is the use of game design elements in a non-game context [23], so as to engage and motivate people to achieve specific goals. Gamification aims to *digitally engage,* rather than personally engage, meaning that users interact with computers, smartphones, wearable monitors or other digital devices, rather than engaging with a person [24]. As such, gamification techniques (such as points, badges, levels, leaderboards and challenges – the five most commonly used) aim to *leverage people's natural desires* for: competition, achievement, status, altruism, community collaboration and many more desires (Badgeville).

Gamification has emerged as a growing trend to motivate users and enhance user experience [25] in numerous crowdsourcing systems. Existing research in the area of gamification and crowdsourcing has been rapidly growing, as illustrated by [26] (Figure 8), denoting that these systems integrate gamification aiming to enhance their services with "(motivational) affordances in order to invoke gameful experiences and further behavioral outcomes" [27].

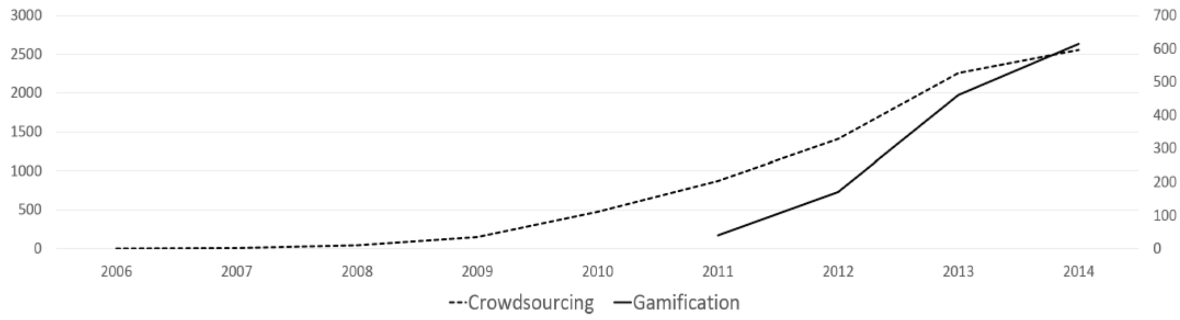

Figure 8: Search hits for Gamification (G) and Crowdsourcing (CS) (Scopus, all fields, CS left axis, G right axis)

(Source: [26])

Some examples of this trend are presented in the section that follows.

Gamification & Crowdsourcing Examples [9]

- **Idea Street** (Department for Work and Pensions, UK) an online ideas-management platform that encourages employees to share their innovative ideas for change with a community of likeminded colleagues, and work with those colleagues to help make their ideas a reality.
- **The Great Brain Experiment** (Trust Centre for Neuroimaging London) Players indirectly contribute to scientific research as they engage in fun mobile games with scores based on the community achievements. They hardly realize that they contribute to research and scientists are able to form reliable conclusions, by collecting information from large and unique and/or varied populations.
- **Tomnod** - A digital initiative that uses high-definition images from Digital Globe satellites to pinpoint objects and places in the aftermath of natural disasters and man-made catastrophes. Crowd-participants tag areas of a map so as to identify possible clues such as rafts, slicks, and wreckages (e.g., a popular search focused on finding the missing Malaysia Airlines Flight MH370 in the Indian Ocean). This way the crowd is engaged in an actual real-life mission of critical importance.

Recently we observe that the gamification trend (as an incentive mechanism) is starting to spread in crowdsensing systems as well ([28]; [22]; [29]). In particular, "sensing systems, inspired by models like Foursquare, by incorporating serious games in their systems in order to attract and motivate participants" [30]. Exploiting gamification is proving to be an effective technique that motivates people to participate and contribute to sensing data.

Gamification and Crowdsensing Examples

- **Apisense** – a mobile sensing platform that uses a multi-cloud architecture with a trusted central node, which enables scientists to conduct sensing tasks. Apisense uses a combination of gamification and monetary rewards [30].
- **WiFiScout** - a crowdsensing WiFi advisory system that helps smartphone users to find good quality WiFi hotspots [31]. WiFiScout integrates a gamification-based incentive scheme with badges (users can "conquer WiFi territories" and become the top contributor for WiFi hotspots at different locations), points, etc.
- **Waze** – a GPS app that uses crowdsourcing real-time traffic and road information. It is a popular gamified crowdsourcing/crowdsensing system with various game mechanics such as avatars, points, levels, leaderboards, etc.

Overall we see the gamification acts as an important incentivisation scheme for both crowdsourcing and crowdsensing systems that not only motivates user participation but it also enhances user experience and facilitates user on-going engagement in such systems while accounting for the user evolution within the system (i.e., novice user, regular user etc.). The latter parameter is a critical one for all crowd-driven ecosystems and thus for IoT Lab as well.

4.3 Defining the IoT Lab Incentive Model

Based on our preceding contextual analysis (see Section 4.2.1, Section 4.2.2) it becomes evident that:

(a) There is a need for an engaging Incentive Model for IoT Lab. This model should engage diverse stakeholders not only into downloading but also into maintaining their engagement with IoT Lab app across time. Creating a community of data-owner stakeholders (testbed owners and crowd participants) among other stakeholders that will increase over time.

(b) It is critical that a combination of the two key theories of motivation is implemented. In particular we should jointly provide both intrinsic and extrinsic motives that will enable us to capture the changing nature of the motivational factors driving users' behavior in a crowd-driven ecosystem such as IoT Lab. Such an amalgamation will not only motivate the users' participation during their initial usage decision phase but also play a critical role in the users' decision to continue to use the IoT Lab system.

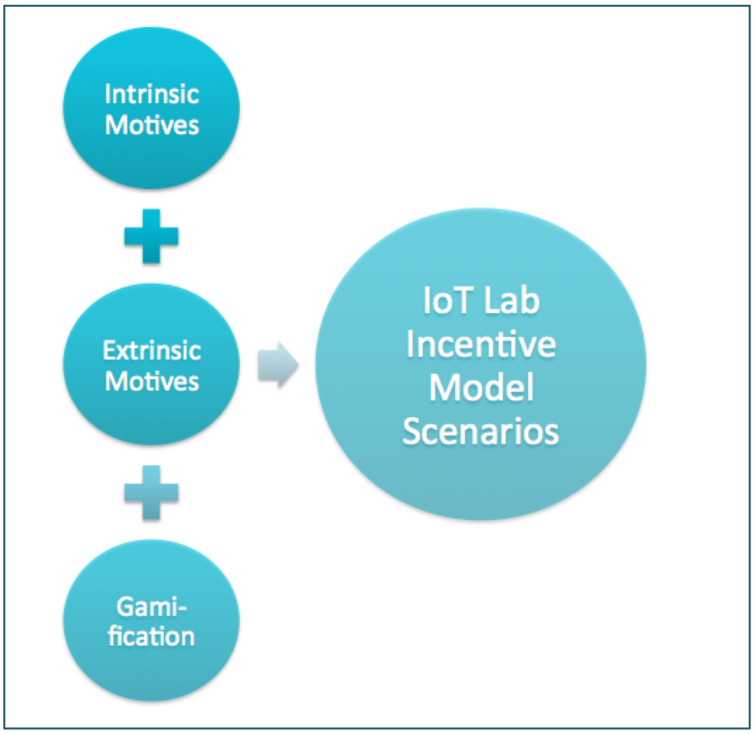

Figure 9: The IoT Lab Incentive Model

(c) Another critical parameter of our Incentive Model, based on our analysis, should also be the enhancement of the user experience within the system and their on-going engagement and user evolution within the IoT Lab system. As such the integration of a gamification practices within IoT Lab can effectively act as an important incentivisation scheme that will not only trigger user participation, but will also sustain their engagement while increasing the quality of information.

Consequently, the IoT Lab Incentive Model should be a combination of these three motivational mechanics, as seen in Figure 9. The sections that follow aim to facilitate the identification of the most appropriate Incentive Model for IoT Lab community[1]. This will be achieved via the analysis and assessment of a set of different incentive scenarios.

4.3.1 Potential Incentive Models for IoT Lab

The first step of our Incentive Model scenario analysis is to identify the different scenarios for incentivising of the IoT Lab crowd participants acknowledging that they have an inherent asymmetry in terms of motivation compared to researchers (who are highly motivated). Crowdsourcing participants are relatively less motivated than researchers and based on our analysis (see Section 4.2.1.5) they also have quite high monetary and non-figurative costs that vary by the time of experiment.

In particular, our analysis indicated that although the involvement of the crowd is relatively low for crowdsensing tasks the associated costs are medium. Crowd-knowledge on the other hand, necessitates a medium frequency of data usage and a high degree of crowd involvement. The associated costs are medium monetary costs but high non-figurative ones.

Our scenario analysis will facilitate the identification of the most appropriate Incentive Model for this stakeholder segment that will account for the inherent motivation asymmetry and associated costs. This analysis will start by considering the alternative possible Incentive Models that range between two extremes: No

[1] Please note that we focus on crowd participants only, given that they have fewer motives to participate as opposed to any other stakeholder. The other important data owner/provider segment (Testbed owners, Testbed infrastructure providers) will be incentivised via the IoT Lab Business Model.

Incentives (Case 1) and Hybrid Incentives (a combination of all motivation theories, extrinsic intrinsic and gamification) (Case 4b):

Incentive Model Scenarios

Case 1: No incentives

– No/very low sustainability of the IoT Lab community

Case 2: Non-monetary incentives (Intrinsic)

– Contribution acknowledgement (participation levels, etc.), collaboration, networking, sense of purpose, altruism, enjoyment of participation, etc.

Case 3: Monetary incentives (Extrinsic)

– ***3a. Direct monetary incentives*** (i.e., financial rewards);

– ***3b. Indirect monetary incentives*** (i.e., "good-cause" model: monetary contribution will be donated to a charity);

Case 4: Hybrid model (Combination of all motivation mechanisms)

– ***4a. Simple – Hybrid model:*** monetary (direct & indirect) and non-monetary incentives (extrinsic and intrinsic);

– ***4b. Gamified – Hybrid model:*** gamification as well as monetary (direct and indirect) and non-monetary incentives (extrinsic intrinsic and gamification).

Table 6 below provides a taxonomy of these Incentive Model scenarios depicting the motive category to which they belong. The four selected scenarios (accounting for six distinct incentive cases) represent all the different options for an Incentive Model for IoT Lab.

Table 6: Incentive model scenarios taxonomy

Case	Incentives Scenarios	Intrinsic motives	Extrinsic motives		Gamification approach
			Monetary	Non-monetary	
Case 1:	No incentives	-	-	-	-

Case 2:	Intrinsic incentives	X	-	-	-
Case 3: Monetary incentives	Case 3a: Direct monetary incentives	-	X	-	-
	Case 3b: Direct & indirect (good-cause) incentives	-	X	X	-
Case 4: Hybrid incentives	Case 4a: Hybrid- simple (monetary (direct & indirect) and non-monetary)	X	X	X	-
	Case 4b: Gamified hybrid (gamification, (monetary (direct & indirect) & non-monetary)	X	X	X	X

4.3.2 Incentive Models Scenario Assessment

The different potential Incentive Model scenarios for IoT Lab have been identified and we now analyse them based on a set of criteria/factors. The selected criteria are the ones that are critical for the success of the IoT Lab community such as: (a) the community building potential of the Incentive Model, (b) the economic cost implications of each model (for the IoT Lab Partners) as well as the associated (c) social implications. These three areas will significantly impact the success of IoT Lab (community building success, social success, economic success).

Incentive Model Scenario Analysis

Based on these impact factors we assess each scenario on a five-point Likert-scale (very low, low, medium, high, very high) as seen in Table 7 below.

Table 7: Incentive model scenarios and Impact factors

Case	Incentives Scenarios	Social Impact	Economic/ Cost Impact	Community building potential Impact
Case 1:	No incentives	Very Low	-	Very low
Case 2:	Non-monetary incentives	Low	-	Low
Case 3: Monetary incentives	Case 3a: Direct monetary incentives	Low	High	Medium/High
	Case 3b: Direct & indirect (good-cause) incentives	Medium/High	High	High
Case 4: Hybrid incentives	Case 4a: Hybrid- simple (monetary (direct & indirect) and non-monetary)	High	High	High
	Case 4b: Gamified hybrid (gamification, (monetary (direct & indirect) & non-monetary)	High	Medium	Very High

From our analysis it becomes obvious that Case 4-Hybrid Incentive Models (Case 4a, Case 4b) have the highest scores both in the social impact category as well as in the community building one (Case 4b has the highest score in the community building category). However, we see that case 4a has a high cost impact, indicating that the impact of this Incentive Model upon the economic analysis of the IoT Lab Association for the project partners will be the highest. In contrast Case 4b has a medium cost impact, which is favorable for the IoT Lab. Consequently, Case 4b – Hybrid gamified

Incentive Model appears to be the most appropriate based on our analysis (Figure 10).

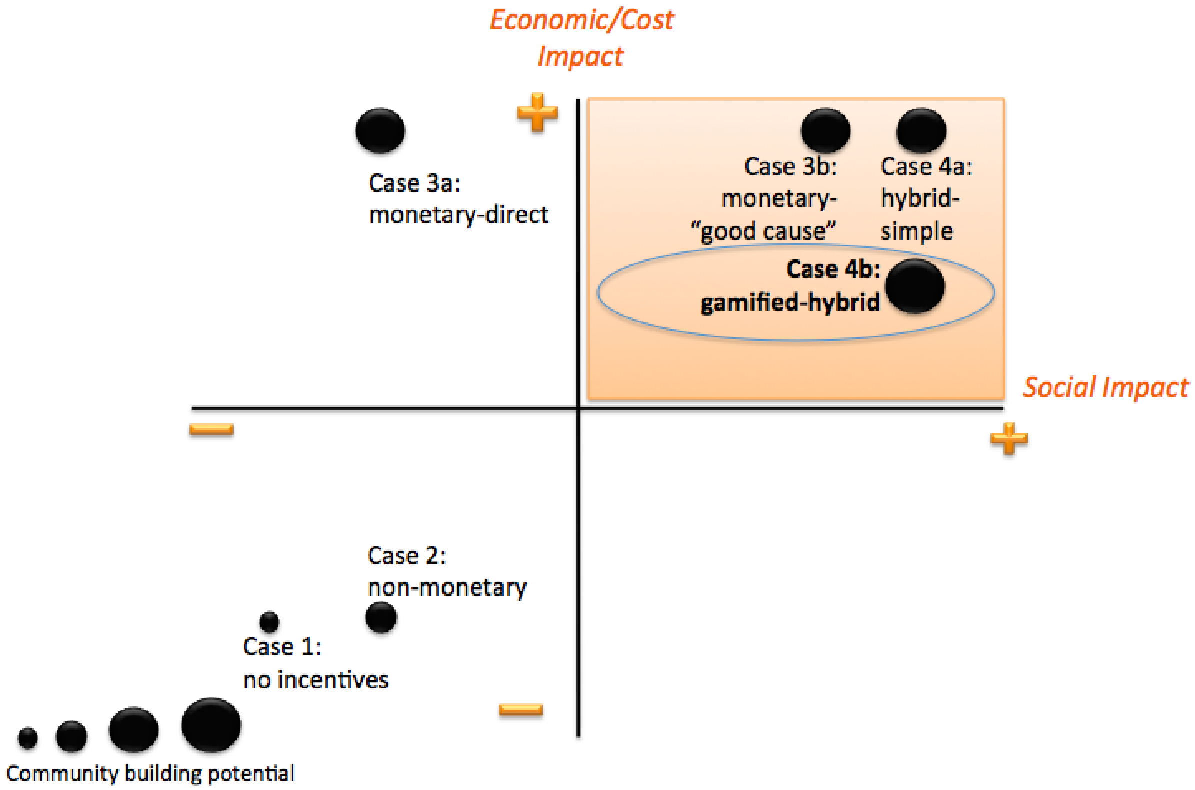

Figure 10: Classification of the Incentive Model scenarios based on their impact

4.3.3 The IoT Lab Incentive Model

In accordance with our preceding analysis, the IoT Lab Incentive Model is a “*Hybrid Gamified Incentive Model*” that combines two key types of incentives, namely: (i) intrinsic and (ii) extrinsic incentives (in accordance with the analysis of WP5), while it also includes innovative approaches that aim to enhance both the extrinsic, intrinsic and social motives such as the “***gamification approach***”.

Having adopted a "*Social Good Business Approach*" IoT Lab will allow its community members to allocate the points/credits collected by participating in the experiment to a charity of their choice, out of a list that will be provided by the platform. This approach is based on the working assumption that a research sponsor provides a budget for an experiment, out of which a small amount of the budget (“social revenue distribution”) will be used for the platform maintenance and the rest will be allocated to the users so that they can in turn re-allocate the amount to the charities proportionally based on their point/credit distribution. This will enhance further the intrinsic motives of the crowd participants, as they will be contributing to a greater cause that goes beyond contributing to an emerging research. An overview of this model, the IoT Lab Hybrid-Gamified Model is presented in the following sections.

Intrinsic motives

The Intrinsic motivates in IoT Lab are:

- *Initial use:* curiosity
- *Continued use:* exchange of information, influence that the crowd participants can/will have upon emerging research, peer recognition, a sense of membership and attachment to a community such as IoT Lab that contributes to the innovative and crowd-driven research, fun, enjoyment in performing a crowdsensing and crowdsourcing tasks, and finally altruism for contributing to a greater cause (i.e., research as well as actual contribution to charities), etc.

Extrinsic Motives

The extrinsic motivates are:

- *Initial use:* monetary rewards, direct compensation, anticipated returns
- *Continued use:* non-monetary rewards, competitions, credits/points, etc.

Gamification Mechanics (Gamification by design)

The IoT Lab Incentive Model is “gamified” which will integrate gamification[2] elements aiming to enhance the user experience and engagement within the system (Figure 11). The three most commonly used gamification techniques [26] are:

- ***Points***: awarded for the different actions of a user inside the IoT Lab platform. A *point-based reward system* has been designed taking into account the specificities of the IoT Lab experimentation process for the crowd participants and the researchers.
- ***Badges***: earned for different activities (different levels) and will be essentially

[2] Gamification is defined as the use of game elements in non-gaming systems so as to improve the user experience and user engagement, loyalty and fun [23].

providing a sense of accomplishment for distinct types of user-effort (simple/complex tasks), while they will demonstrate user status and progress within the IoT Lab ecosystem. Badges will be visual appealing (i.e., icons) and users will be able to share them (if they want) via social media.

- ***Leaderboards***: allow users to track their performance over time and anonymously to other users of the IoT Lab ecosystem. Leaderboards will be visually displaying the overall user status in regards to the points gained and the badges received as well as the ones that could be received (unlock) with a small additional effort.

These gamification mechanics will be utilized in IoT Lab in addition to another novel incentivisation scheme designed for the purposes of the project, namely the “Reputation Scoring” (R-Score) (see Table 8).

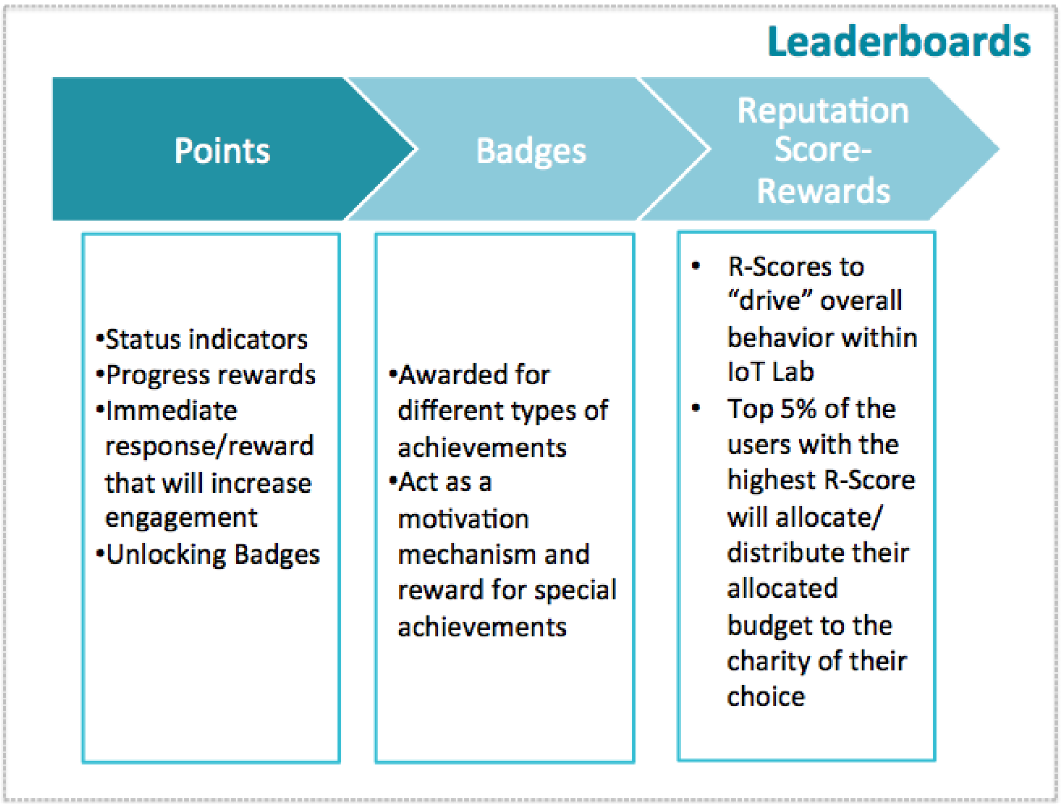

Figure 11: IoT Lab Leaderboards Overview

Reputation scoring (R-Score): Aiming to enhance further the user engagement within the platform while also considering the user behaviour in a qualitative and quantitative manner, an innovative scoring mechanism has been designed. The proposed *Reputation scoring (R-Score)* accounts for the users' overall activity (crowd-driven research value-added) from different perspectives and associated KPIs namely:

- (a) *Incentive-based KPI* (i.e., points, badges gathered);
- (b) *Crowd-driven research KPI* (i.e., proportion of proposed ideas, rate of proposed ideas, evolution of ideas into experiment)
- (c) *Behaviour KPI* (i.e., usage history, experiment contribution score, market assessment contribution score) (see Table 8).

Table 8: IoT Lab Reputation Scoring (R-Score)

Reputation Scoring (R-Score)	
Incentives-based KPI	No. of points that the user has gathered
	No. of badges that the user has gathered
Crowd-driven Research KPI	No. of ideas that the user has proposed/all proposed ideas
	The rate of ideas that he has proposed for experiments
	The No. of ideas that the user proposed and which were utilised by experimenters (resulted in crowd-driven research)
Behavior KPI	Since when he is using the platform
	No. of experiments that the user participated/all experiment-participation requests he received
	No. of market assessments he participated/ all market assessment requests he received

Keeping the R-score of users' facilitates a different rewarding that encourages the users on-going contribution. The R-score based rewards will be provided to the top 5% users with the highest R-Score:

- *Social rewards:* Top Contributor Reward (Badge)
- *"Good-cause" reward:* Distinct badge and ability to select the charity of their choice and receive part of the IoT Lab donations that will be allocated to the user.

An overview of the gamification mechanics that have been utilised in the context of

IoT Lab is provided in Table 9, which details the purpose, intended behavior and motivation of each gamification technique.

Table 9: Overview of the IoT Lab gamification mechanics

	POINTS	BADGES	REPUTATION-SCORING REWARDS (R-Score)
Summary	Points will be used to keep track of the user's activities: (a) generic users activities (i.e., accessing the app, profile fill-in, etc.) and (b) various crowdsourcing (crowd sensing and crowd knowledge) tasks that take place in the IoT Lab.	Badges will be rewarded for: (a) reaching a level of usage and for (b) special achievements. Users will be able to see each other's badges which will provide a way to "show off" both within the IoT Lab community as well as via social media, increasing this way both willingness to perform badge-awarding tasks.	Rewards based on the user R-Score. These rewards will be provided to the top 5% of the users with the highest R-Score : • Social rewards – Top Contributor Reward • "good-cause" reward: ability to do select the charity of their choice to receive part of the IoT Lab donations
Purpose	A point system provides a structured way to track the user's activities and engagement with the system and provide immediate reward for their activities.	Promote certain behavior (i.e., perform activities that will enhance their level and badge acquisition, badge-awarding tasks etc.) while account for the user evolution within the system and provide "special" achievement badges.	Promote user active engagement, behavior, & progress as well as "crowd-driven research" impact
Intended behavior	To encourage interaction and engagement with the system through awarding points that are associated with user's activities.	To enhance progress (intra-activity progress) and reward special achievements (inter-activity progress/ evolution) within the system. Incentive to look at other player profiles to see which badges other users have collected.	To enhance the overall user engagement with the platform by rewarding: their behavior, the impact of their aggregate activities in addition to their accomplishments.
Motivation	Points act as a motivation mechanism to increase engagement with the IoT Lab, as they will reward various user activities and tasks.	Badges act as a (a) motivation mechanism and (b) direct feedback process. Badges will act as intrinsic motivators to increase the engagement connected to certain activities (different types of badges will exist and 3 classes for each: Good, Top and Master)	Rewards based on the R-Score act as (a) an additional motivation mechanism and (b) direct feedback process for the overall user activity. They will act as extrinsic motivators.

4.3.3.1 Gamification mechanics across the crowd-journey in the IoT Lab app

The IoT Lab Incentive Model and its mechanics having been identified, we now turn our attention to the customisation of these incentivisation schemes for the crowd-journey in the IoT Lab app (i.e., the different steps/activities that they have to perform in order to successful use the IoT Lab app) as those were identified in our preceding analysis (see Section 4.2.1.3).

In particular, we define the following short-term (during the IoT Lab project life-time) and long-term (post IoT Lab project) schemes, for each of the crowd activiies within the app as well as the engagement process.

Short-term schemes:

- Points: Points associated with each of the user activities focusing both on partial and full coverage of the activities.
- Badges: Badges that users gain and their association with the activities within the app.

Long-term schemes:

- Challenges: Challenges that can be designed at a later stage so as to trigger user engagement further.

These schemes are defined in detail in the Tables that follow (refer to Table 10, and Table 11).

Table 10: Incentivisation/gamification mechanics during the Installation process of the IoT Lab app (Part A)

Smart phone app	Engagement mechanism/ trigger	POINTS	BADGES	CHALLENGE (CH)	Engagement process
1. Smartphone app	External trigger	-	-	-	Awareness creation via marketing activities (external engagement process)
2. Installation	Internal trigger	Partial: POINTS=100	-	-	Register/sign-in Welcome intro (IoT Lab introduction, language switch) Profile fill-in (i.e., socio-economic profile)
	Welcome to our community note !	Full coverage: POINTS=200 (if 2 rounds: 100 each)	BADGE 1	-	
3. Participation Mode	Internal trigger	POINTS X= 50 or 200 (full participation)	BADGE 2	-	Select participation mode (Minimum vs. all by default)
		POINTS = 100 for every invitation acceptance	BADGE 3 + (for every 5 acceptance s)	CH 1	(Invite and) Accept invitation to participate (activity level/ engagement)
		POINTS = 100 (for 10 search activities) & for every 50 searches	BADGE 4	CH 2	Search and select (high degree of usage/activity level/engagement)

Table 11: Incentivisation/gamification mechanics during the Usage process of the IoT Lab app (Part B)

Smart phone app	Engagement mechanism	POINTS	BADGES	CHALLENGE (CH)	Engagement process
4. Crowd sensing (sensor data)	Internal trigger	Partial: POINTS=100	-	-	Wi-Fi restrictions Sensors shared by default GPS shared by default
		Full coverage: POINTS=200 (if 2 rounds: 100 each)	BADGE 5	-	
5. Crowd wisdom	Internal trigger	POINTS = 10 points (for 10 votes)	BADGE 6+ (for every 100 votes)	CH 4	1. Vote for ideas (activity level/ engagement)
		POINTS =100 (for every 5 suggestions/ improvements)	BADGE 7+ (for every 10 suggestions)	CH 5	2. Suggest potential/future improvements, research extensions (activity level/ engagement)
		POINTS = 100 (for each exp. Participation)	BADGE 8 + (for every 5 experiments)	CH 6	3a. Participate in an experiment by providing feedback
		POINTS = 1 per sensor measurement	BADGE 8 +	CH 6	3b. Participate in an experiment via mobile sensors only
		POINTS = 100 (for every 5 ideas)	BADGES 9 + (for every 5 ideas)	CH 7	4. Propose an idea for an experiment
		POINTS = 100 (for each assessment)	BADGES 10 + (for every 5 assessments)	CH 8	5. Assess market potential of a proposed research innovation (i.e., fill in questionnaire)

4.3.4 Social revenue distribution: scenario analysis

The "*triangular model*" that IoT Lab has adopted allows crowd-participants to allocate points/credits collected by participating in the experiment to a charity of their choice, based on a list that will be provided by the platform.

IoT Lab partners have considered the possibility to donate the majority of the revenues to charity. Anchored in this decision and in order to identify the optimal social revenue distribution percentage, we conducted a scenario analysis based on two social revenue distribution scenarios, as seen below:

- ***Scenario 1:*** *20% IoT Lab & 80% donations*
- ***Scenario 2:*** *40% IoT Lab & 60% donations*

In addition the following assumptions were made:

Following the analysis of T6.2, Case 2 is adopted from the "Internal Cost Analysis" (D6.2): Extended, in-house service.

Free-service is integrated within the other 3 types of services.

The adopted market segment distribution is:

- Basic service: 50% of sales
- Extended service: 40% of sales
- Premium service: 10% of sales

Scenario 1: *20% IoT Lab & 80% donations*

The findings of our analysis indicate that in order for IoT Lab to donate 80% while also sustaining its internal cost structure (presented in D6.2), it should price highly its services as show in Table 12 below. Indicatively during the first year under Scenario 1, and in order for IoT Lab to cover its expenses (20%), the following pricing model for its services should be adopted:

- Basic service - Targets Universities and research institutes: 530 Euro
- Extended service – Targets small companies: 1,848 Euro
- Premium service – Targets medium companies: 66,756 Euro

Please note that the detailed overview of the IoT Lab services is part of the Business Model Analysis.

Table 12: Scenario 1 (20% IoT Lab-80% donations) Social Revenue Distribution

IoT Lab Pricing – Scenario 1			
Basic	Extended	Premium	
€530	€22,252	€66,756	Year 1
€751	€31,531	€94,593	Year 2
€468	€19,670	€59,009	Year 3
€383	€16,087	€48,262	Year 4
€305	€12,827	€38,482	Year 5

Sales			
Basic	Extended	Premium	
€448,750	€359,00	€89,750	Year 1
€635,875	€508,700	€127,175	Year 2
€793,346	€634,677	€158,669	Year 3
€973,274	€778,619	€194,655	Year 4
€1,164,095	€931,276	€232,819	Year 5

The key issues of Scenario 1:

- Very high prices for the IoT Lab Service (Basic, Extended, Premium) compared with existing similar services in the market.
- Competitive disadvantage compared to existing services (combination of different services).
- Ddifficulties with market penetration and thus low sales creation potential.
- Consequently, the high donation percentage (80%) may result at lower overall revenue generation for charities (due to lower overall sales for IoT Lab).

Scenario 2: *40% IoT Lab and 60% donations*

The analysis findings indicate that in order for IoT Lab to donate 60% and sustain its internal cost structure, it should price highly its services as seen in Table 13 below. Indicatively during the first year under Scenario 1 and in order for IoT Lab to cover its expenses (40%), the following pricing model for its services should be adopted:

- Basic service (targets Universities and research institutes): 265 Euro
- Extended service (targets small companies): 11,126 Euro

- Premium service (targets medium companies): 33,378 Euro

Table 13: Scenario 2 (40% IoT Lab-60% donations)

IoT Lab Pricing – Scenario 1			
Basic	Extended	Premium	
€265	€11,126	€33,378	Year 1
€375	€15,765	€47,296	Year 2
€234	€9,835	€29,505	Year 3
€192	€8,044	€24,131	Year 4
€153	€6,414	€19,241	Year 5

Sales			
Basic	Extended	Premium	
€224,375	€179,500	€44,875	Year 1
€317,938	€254,350	€63,588	Year 2
€396,673	€317,339	€79,335	Year 3
€486,637	€389,310	€97,327	Year 4
€582,047	€465,638	€116,409	Year 5

The key issues of Scenario 2:

- Lower prices (almost 50% reduction) for the IoT Lab Service (Basic, Extended, Premium) compared with Scenario 1.
- IoT Lab will have a competitive advantage, under Scenario 2, compared to existing services (combination of different services) in the area (as those were presented in D6.2).
- Easier market penetration and thus higher sales creation potential as opposed to Scenario 1.
- The relatively high social donation percentage (60%) is one that can be realised due to penetrating the market easier and due to the competitive advantage that IoT Lab will maintain.

Our scenario analysis clearly indicates that Scenario 2 is a realistic social donation scenario for IoT Lab. Under this scenario, the total amount donated to charities during the first five years of the IoT Lab operations, will reach the amount of 2.4

million Euro (see Table 14), which constitutes a high social impact for IoT Lab.

Table 14: Scenario 2 (40% IoT Lab-60% donations) Social Revenue Distribution

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Revenues	**€ 448,750**	**€635,875**	**€793,346**	**€973,274**	**€1,164,095**
Total IoT Lab Costs	€179,500	€254,350	€317,339	€389,310	€465,638
Donations (60%)	*€269,250*	*€381,525*	*€476,008*	*€583,964*	*€698,457*

Total Amount Donated to charities (5 year period): **€ 2,409,204**

5 Part II: Business Model Analysis

5.1 Business Model Methodology

The methodological approach for the IoT Lab Business Model Analysis is aligned with the overall methodology for this deliverable and entails three distinct analytical steps, as it can be seen in Figure 12.

Our analysis begins with “context analysis” which sets the theoretical foundations of our analysis (***Phase 1***), including: (a) the theoretical context for the business models and (b) the analogous empirical context. This is followed by the “Business Model Analysis”, which includes two distinct phases, namely: (a) ***Phase 2***: provides an overview of the potential business models that could be adopted by IoT Lab, which essentially define a set of scenarios for it and (b) ***Phase 3***: presents a comparative analysis of the different business models which includes an evaluation process based on a set of predefined criteria that are critical for the success of the IoT Lab. Having assessed the different business models, our analysis concludes with the definition of the most appropriate business model for the IoT Lab (***Phase 4***), the analytical framework that will be utilised for its examination as well as its key components.

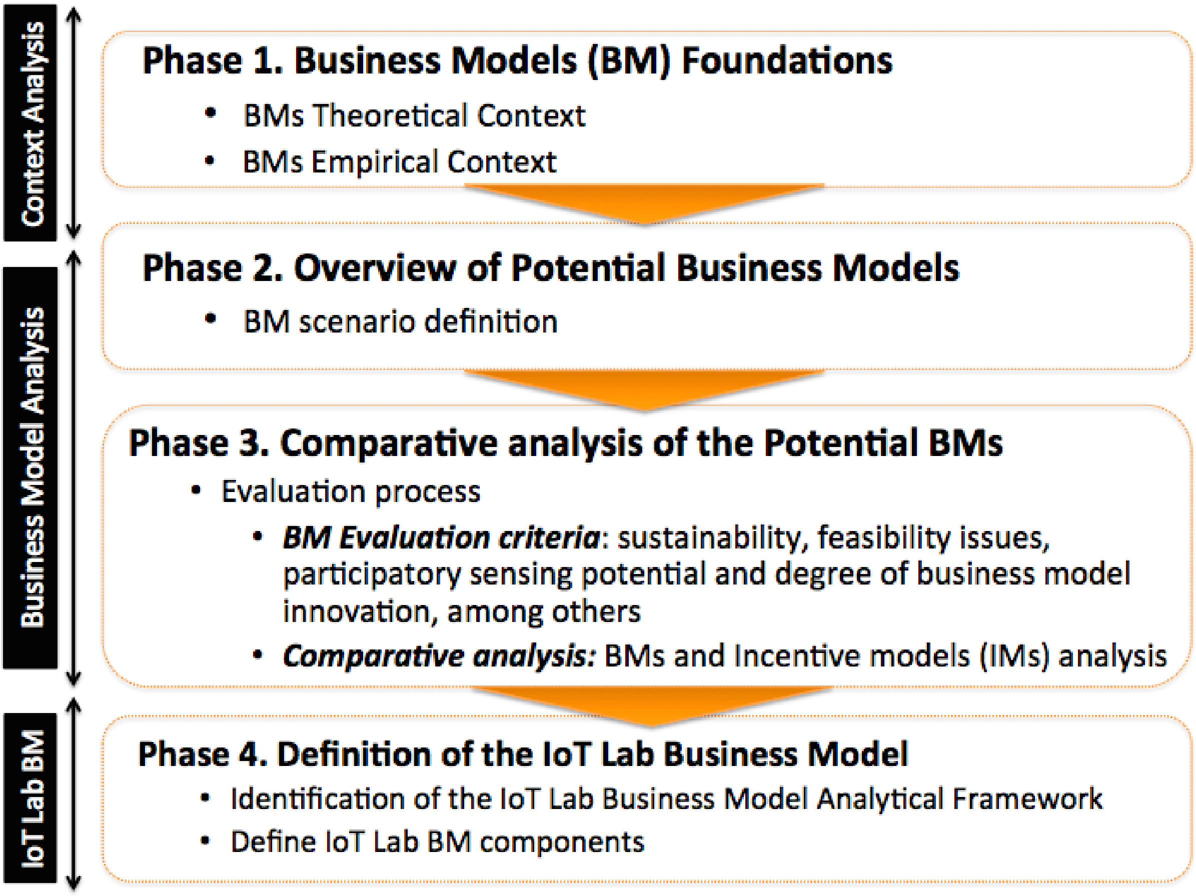

Figure 12: Business Model Methodology

5.2 Business Model Foundations

5.2.1 Business Models Theoretical Frameworks

The "Business Model" concept is a relatively recent. Although it first appeared in an academic article in 1957 [32] and it was used in the title of an academic paper in 1960 [33], it was during the 1990's that it started to gain widespread popularity. The advent of the Internet and the changing firm boundaries enhanced further the interest in the notion of business models and played a critical role for its enhancement ([34], [35]).

Since then the Business Model construct has received a lot of research attention providing numerous definitions, taxonomies, typologies and business model components among others. However, this research stream reflects numerous fundamental differences rather than similarities, which to some extent may be attributed to the different perspectives and research areas (i.e., technology, e-business, m-business, etc.) [36]. To date there is lack of consensus over the Business Model concept and components. For the purposes of this study we adopt the definition of Magretta that defines a Business Model as “a story that explains how an enterprise works” [37], essentially a story that explains “how a firm organizes it to create and distribute value in a profitable manner” [38, p. 157).

Over the years, the Business Model concept has evolved from a general construct that explains how a firm interacts with suppliers, customers and partners [39] and how it creates and distributes value in a profitable manner [38, p. 157) to an innovative business logic that disrupts entire industries, creating substantial value for the customers and corporate stakeholders and competitive advantages for the company itself. This aligns perfectly with the realisation that product and process innovation alone are no longer sufficient for companies to stay competitive in today's fast-moving economy [40]. Innovative Business Models are a critical component of business success as they innovate upon the core corporate logic of value creation and value distribution.

Business Model Frameworks

Some of the key Business Model frameworks are presented in the sections that follow.

- ***STOF Business Model Framework***

The STOF framework ([41], [42]) describes a Business Model in terms of four interrelated dimensions that describe how value is delivered to the customer and how value can be retrieved from the service offered (by the service provider). These four domains are: the service domain (service offering, value proposition, and target group), the technology domain (technical functionality required for the service offering, service delivery system), the organisation domain (division roles, network strategy) and finally the finance domain (revenue model, pricing model).

- ***Business Model Canvas***

The Business Model canvas [43] is the most well-known and widely used framework for describing the Business Model components (see Figure 13). This framework has nine distinct components namely, the key partners, the key resources and the key activities of the value chain, as well as the value proposition, the customer relationships, the channels, the customer segments, as well as the cost structure, and revenue streams.

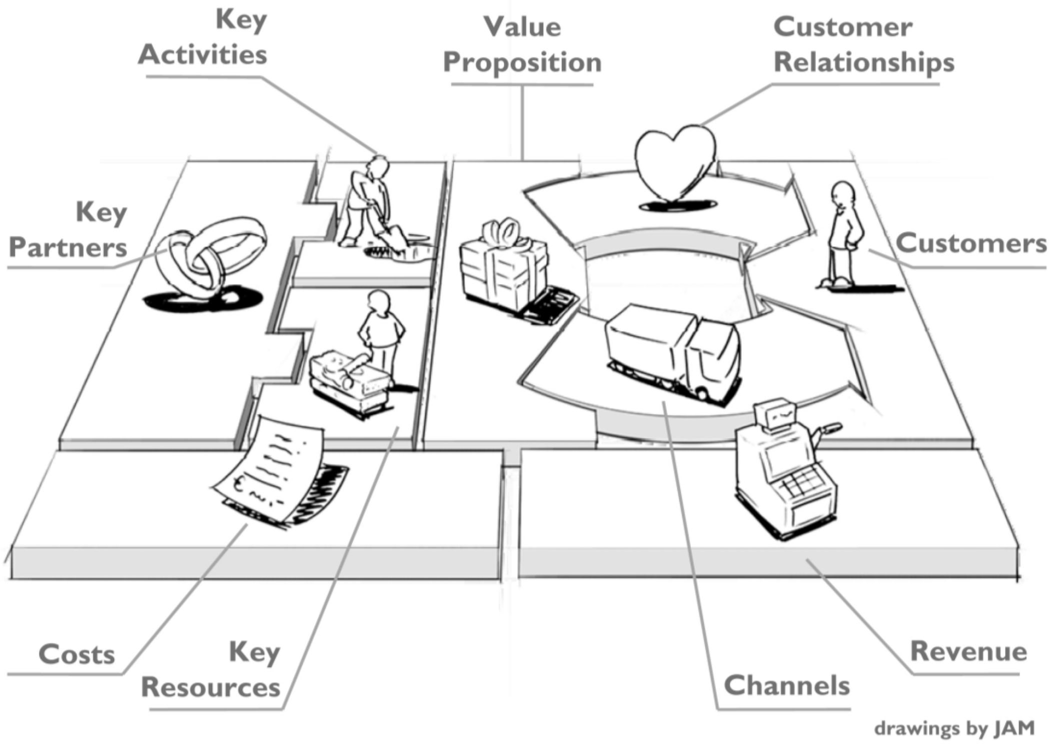

Figure 13: The Business Model Canvas

(Source: [43])

- ***Four-Box Business Model***

The Four-Box Business Model ([44], [45]) describes Business Models via four distinct boxes that include: (1) Customer value proposition (i.e. jobs to be done, offering), (2) Profit formula (i.e., revenue model, cost structure, target unit margin), (3) Key resources and (4) Key processes (i.e., processes, business rules and success metrics, behavioral norms).

The Four-Box Business Model has many similarities with the Business Model Canvas, while one of the key differences is that the Canvas considers customers, and key partnerships as distinct Business Model components whereas the Four-Box

Model covers the customer aspects via the value proposition box and the partnerships under the Key resources box.

5.2.2 Business Models in the context of IoT

During the past few years, one can observe a gradual growth of the Internet of Things Business Model research, which is relatively unexplored. The focus varies between descriptive research ([46], [47], [48], among others), new IoT Business Models ([46]; [49] among others) as well as new IoT Business Model analytical frameworks ([50], [51], among others).

Starting from the influence of IoT on Business Model, existing research indicates that the emergence of IoT has emphasized and enhanced many classic Business Models and realized new components and patterns that are now possible with the IoT ([52] [47]) (see Table below).

Table 15: Business Model Patterns according to Gassmann that are facilitated by the Internet of Things

Business model patterns according to Gassmann et al. [52]	**Facilitating components and patterns of the Internet of Things**
Add- on	“Digital Add- on” – Remote sale and installation of additional options for products during the post- sale/usage period.
Affiliation	“Product as Point of Sales" – Sales commissions for Internet transactions are connected to the real world, e.g. the location of the user or an object.
Crowdsourcing	"Sensor as a Service" – A "crowd" of sensors generates data.
Customer Loyalty	"Product as Point of Sales" – Customer loyalty can be rewarded not only for the purchase of a certain product but can be measured according to use of the product, or presence at a certain location, for instance.
Direct Selling	"Object Self- Service" – Objects make purchases autonomously,

Business model patterns according to Gassmann et al. [52]	**Facilitating components and patterns of the Internet of Things**
	directly, without an intermediary.
Flat rate	"Remote Usage and Condition Monitoring" – Use and consumption of physical goods are measured in order to reduce the risks associated with a flat- rate business model.
Fractionalized Ownership	"Remote Usage and Condition monitoring" – Use and consumption of goods of lower value can be measured too, making this business model applicable to those goods as well.
Freemium	"Digital Add- on" – This business model can be applied in the physical world as well by combining free digital services with a physical product for sale. Premium services are available for a fee.
From Push to Pull	"Object Self- Service" – Kanban systems with Internet of Things Technology.
Guaranteed Availability	"Remote Usage and Condition Monitoring" – Monitoring the status of production plants or equipment via the Internet simplifies the application of the business model pattern.
Hidden Revenue	"Product as Point of Sales" – For example, flexible location- specific advertising becomes possible using the Internet of Things technology.
Leverage Customer Data	"Sensor as a Service" – Objects such as cars or razors transmit data to the manufacturer over their lifetime. The manufacturer can then use the data to improve the product.
Lock- in	"Digital Lock- in" – Compatibility with competitors' systems is prevented by use of a digital handshake and authentication mechanism.
Pay per Use	"Remote Usage and Condition Monitoring" – Use and consumption of lower- value products can be measured too. The business model

Business model patterns according to Gassmann et al. [52]	**Facilitating components and patterns of the Internet of Things**
	pattern is applicable to these goods as well.
Performance- based Contracting	"Remote Usage and Condition Monitoring" – Use and consumption of lower- value goods can be measured too. Technology for monitoring the status of production plants and equipment further promotes the application of this business model pattern.
Razor and Blade	"Digital Lock- in" – "Razor blades" can be authenticated online using digital mechanisms. Eliminates elaborate safeguarding of the Business Model, such as through patents, for instance.
Self- Service	"Object Self- Service" – Objects order consumables or services autonomously.
Solution Provider	"Object Self- Service" and "Remote Usage and Condition Monitoring" – These components increase the attractiveness of the Business Model pattern.
Subscription	"Digital Add- on" – The usability of a product or sub- functions can be restricted to the time span of a subscription.
Two- Sided Market	"Sensor as a Service" – Platforms combine data suppliers with data users.

(Source: [47])

In addition, existing research findings indicate that the emergence of the Internet of Things (IoT) has significant implications for Business Model innovation [48]. According to Hui [48], it is critical to rethink value creation[3] and value capture in IoT

[3] While value creation, involves "performing activities that increase the value of a company's offering and encourage customer willingness to pay, is the heart of any business model", value capture involves the monetization of customer value [48].

as in this new environment, as adopting established Business Models and frameworks will not be enough (see Figure 14). This mindset shift is critical for the success of IoT ventures that will not only create value by identifying customer needs and creating value-adding IoT solutions but also co-create value with users facilitated by technology while at the same time identify ways for monetizing customer value.

Furthermore, IoT has also brought about new business model patterns that initially emphasized the role of technology such as testbed infrastructures (Testbed-as-a-Service, TaaS Business Model, [49]), IoT platforms (Platform-as-a-Service, PaaS Business Model), networks (Network-as-a-Service, NaaS Business Model) as well as software (Software-as-a-Service, SaaS Business Model). However, they are gradually expanding towards more strategically holistic Business Model schemes such as IoT experimentation which combines technological and non-technological elements emphasing the key role of innovation facilitated by the technology (Experimentation as a Service, EaaS Business Model).

		TRADITIONAL PRODUCT MINDSET	INTERNET OF THINGS MINDSET
VALUE CREATION	Customer needs	Solve for existing needs and lifestyle in a reactive manner	Address real-time and emergent needs in a predictive manner
	Offering	Stand alone product that becomes obsolete over time	Product refreshes through over-the-air updates and has synergy value
	Role of data	Single point data is used for future product requirements	Information convergence creates the experience for current products and enables services
VALUE CAPTURE	Path to profit	Sell the next product or device	Enable recurring revenue
	Control points	Potentially includes commodity advantages, IP ownership, & brand	Adds personalization and context; network effects between products
	Capability development	Leverage core competencies, existing resources & processes	Understand how other ecosystem partners make money

SOURCE SMART DESIGN HBR.ORG

Figure 14: IOT requires a mindset shift

(Source: [48])

IoT Business Model Frameworks

In relation to Business Model frameworks that vast majority of research studies, utilize the Business Model canvas in order to develop IoT Business Model whereas only a few studies present new business model frameworks for the context of IoT (see our comparative analysis below). The new frameworks are mainly focusing on the specification of IoT ecosystems and the Business Model components that cover the specifics of these IoT-driven environments. However, given that this research stream is at its infancy, all these models lack empirical validation.

Table 16: Taxonomy of IoT Business model research

Authors		Descriptive	New BM framework	BM Canvas
Dijkman, Sprenkels, Peeters and Janssen (2015) [46]	Focus upon the creation of a framework for developing business models for IoT applications.	X		X
Chan (2015) [50]	Propose a business model that builds on existing research (Holler *et al*., 2014) and consists of three dimensions: “Who, Where, and Why”. “Who” describes collaborating partners, which builds the “Value Network”? “Where” describes sources of value co-creation rooted in the layer model of digitized objects, and “Why” describes how partners benefit from collaborating within the value network.		X	
Rong, Hu, Lin, Shi, and Guo (2015) [51]	Developed an integrated 6C framework to facilitate the systematic understanding of the IoT based business system. This framework includes: Context, Cooperation, Constructive elements, Configuration, Capability, and Change.		X	
Fleisch, Weinberger & Wortmann (2015) [47]	Analyse the role that Internet and Internet of Things play in business models as well as new digital business model patterns that emerge.	X		
Turber, Brocke, Gassmann, and Flesich (2014) [53]	Propose a 3-dimensional business model framework for IoT-driven ecosystems, namely: (a) the value network of collaborating partners (who); (b) sources of value creation (where); (c) benefits from collaboration (why).		X	

Hui (2014) [48]	Examine the role of value creation and value capture in the context of IoT and emphasise upon the impact of IoT on business models.	X		
Westerlund, Leminen and Rajahonka (2014) [55]	Examine ecosystem business models in the IoT context and propose a new design tool for ecosystem business models and suggest that "value design" might be a more appropriate term when talking about Business Models in ecosystems. Provide four pillars for designing ecosystem Business Models in the IOT context: the drivers, value nodes, exchanges and extracts of value		X	
Silva and Maló (2014) [49]	Anchored upon the SmartSantander IoT testbed Business Model, the authors provide an overview of an IoT testbed generic Business Model utilising the Business Model canvas.	X		X
Li and Xu (2013) [54]	Examine the Business Model of Internet of Things as a multidimensional structure composed of technology dimension, industry dimension, policy dimension and strategy dimension and utilise a slightly modified Business Model canvas (they use the following components: key partners, key activities, customer relationships, customer segments, cost structure, revenue streams)	X		X
Sun, Yan, Lu, Bie, and Thomas (2012) [56]	Propose the Business DNA Model, a representation of a Business Model in terms of Design (D), Needs (N), and Aspirations (A), which greatly simplifies presentation, analysis, and design of business models.		X	
Leminen, Westerlund, Rajahonka and Siuruainen (2012) [57]	Focus upon the notion of Business Models in the IoT ecosystem context and they create a framework for analyzing different types of IOT Business Models by examining two dimensions: ecosystem and customers.	X	X	
Bucherer and Uckelmann (2011) [58]	Examine IoT Business Models and utilise the Business Model canvas by integrating physical entities, such as IoT devices and big data.	X		X
Fan and Zhou (2011) [59]	They examine the application of IoT technology in postal logistics and its impact on the construction of the Business Model of Internet of Things. The utilise four components of the Business Model canvas, namely : key partners, value proposition, customer segments, revenue streams	X		X

5.2.3 Empirical Business Models Analysis

Our empirical Business Model analysis will be anchored in the finding of our competitor analysis, presented in the course of D6.2 (Task 6.2). Based on this analysis we initially identify the Business Models and their revenue models.

We begin with the classification of the identified competitors based on their Business Model and their thematic focus, as seen in Table 17. Our findings indicate that (a) innovation-focused companies have innovation-oriented business (i.e., Innovation-as-a-Service (IaaS)) whereas (b) IoT-focused companies have technology-oriented Business Models (i.e., Testbed-as-a-Service (TaaS), Software-as-a-Service (SaaS) and a few Crowdsourcing-as-a-Service (CaaS)). IoT-focused EU projects tend to focus on TaaS and SaaS models. Overall we see that the Business Models are aligned with the thematic focus of the competitors creating a gap between their activities.

Table 17: Taxonomy of Competitors Business Models

Thematic Focus	Type of Project		Business model	Typology
Innovation-focus	Industrial Initiatives	InnoCentive	Open Innovation intermediary	IaaS
		OpenIDEO	Open Innovation intermediary for social good	IaaS - Social Good
		IdeaConnection	Open Innovation intermediary	IaaS
		Yet2.com	Innovation marketplace	IMaaS
		NineSigma	Open Innovation intermediary	IaaS
IoT-focus	Industrial proj./ initiatives	Ushahidi	Crowdsourcing as a service/Platform as a service	CaaS/PaaS
		FanTaaStic	Testbed-as-a-Service/Testing as a service	TaaS
		SciStarter	Crowdsourcing as a service (Science-focused)	CaaS
		APISENSE*	Software-as-as-Service	SaaS
	EU Projects	OneLab	Resource or Testbed-as-a-Service	TaaS
		OpenLab	Sensing-as-a-Service	SaaS
		Fed4FIRE	IoT Federation	SaaS

* Inactive project

The Business Models of the IoT Lab competitors having been identified, we now examine their revenue models in order to identify differences between the industrial initiatives and the funded initiatives. As it can be seen in Table 18, there is a clear differentiation between the funded initiatives that adopt a sponsor-based model and the industrial initiatives that adopt a multi-revenue model. While the former offers their services for free as the sponsorship sustains their activities, the latter adopts a variety of revenue models such as fee-based services, training/consulting, posting fee, and advertising. An interesting finding is that two industrial activities (that have a social-good character) adopt a Hybrid Model as they offer some services for free and some services for a fee (Ushahidi and SciStarter), this way they can successfully sustain their business activities.

Table 18: Taxonomy of Competitors Revenue Models

Thematic Focus	Type of Project	Competitors	***Sponsor-based model***			***Multi-revenue model***					
			Free	**Fee-based services**	**Other**	**Free**	**Posting/ Challenge Fees**	**Fee-based services**	**Advertising**	**Training/ Consulting**	**Other**
Innovation-focus	Industrial Initiatives	InnoCentive	-	-	-	-	√	√	√	√	√
		OpenIDEO	-	-	-	-	-	√	√	-	√
		IdeaConnection	-	-	-	-	√	√	-	-	√
		Yet2.com	-	-	-	-	-	√	√	-	√
		NineSigma	-	-	-	-	√	√	√	√	√
IoT-focus	Industrial proj./ initiatives	Ushahidi	-	-	-	√	-	√	-	√	-
		FanTaaStic	-	-	-	-	-	√	-	-	√
		SciStarter	-	-	-	√	-	√	√	√	-
		APISENSE	√	-	-	-	-	-	-	-	-
	EU Projects	OneLab	√	-	-	-	-	-	-	-	-
		OpenLab	√	-	-	-	-	-	-	-	-
		Fed4FIRE	√	-	-	-	-	-	-	-	-

5.3 Defining the IoT Lab Business Model

In order to define the IoT Lab Business Model we start by examining:

(a) IoT Lab value chain and the emergent strategic service option (as those were identified in T6.2 and D6.2) (Section 5.3.1);

(b) An examination of value creation in the context of IoT Lab, which is essentially the "heart" of the Business Model (Section 5.3.3;

(c) Define the IoT Lab Service and the augmented service offering (Section 5.3.2);

(d) Identification of the potential Business Models for the IoT Lab (Section 5.3.4);

(e) Assessment of these Business Models (Section 5.3.5);

(f) Identification of the IoT Lab Business Model (Section 5.3.6).

5.3.1 IoT Lab Value Chain and Strategic Service Options

Drawing upon the Value Chain Analysis conducted in the course of Task T6.2 (Cost and Efficiency Monitoring Tools and Comparative Analysis), one can identify two distinct value chains (see Appendix 1. IoT Lab Value Chain Analysis):

a) "*External Value Chain*": a high-level value chain of the IoT Lab broader market;

b) "*Internal Value Chain*": the IoT Lab value chain at an intra-organisational level.

External Value Chain

The IoT Lab External Value Chain Analysis presented the key layers of the industry-wide value chain including the list of stakeholders and different players in the market so as to show the diversity and the coverage of the domain.

Based on this analysis, the IoT Lab role (positioning) has been identified as a composition of two distinct roles across the platform layer and the service layer. As shown in Figure 15, IoT Lab can act both formally as a **platform provider** and also play the role of the **service provider** in order to create additional value and competitive advantage.

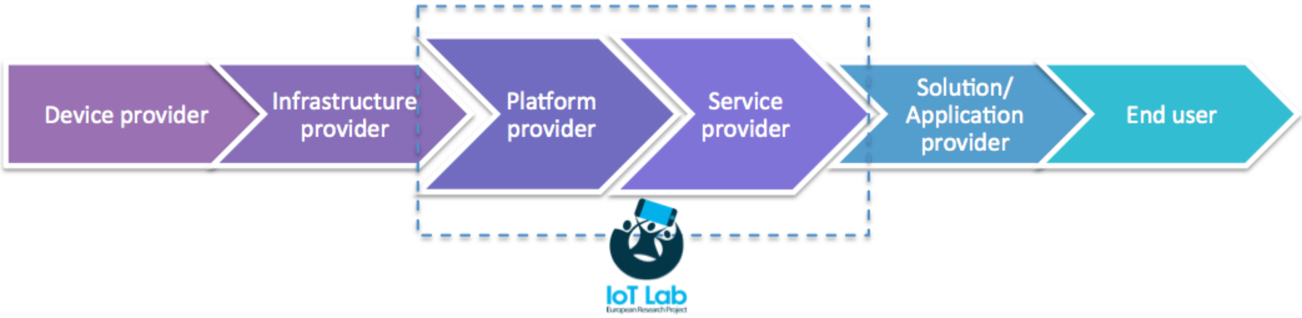

Figure 15: IoT Lab positioning in the IoT value chain

Strategic Service Options

The external value chain analysis facilitated the identification of different "*strategic service options*" for IoT Lab which provide direct input to the Business Model analysis and the value proposition of IoT Lab.

The three strategic service options based on two key service parameters are: *(1) Degree of service provision:* (a) *Basic customer support* (Basic Service covering technical support and experiment-related support) and (b) *Specialized customer support* (extended/premium service technical support and experiment-related support) and *(2) Type of service provision:* (a) *In-house service provision* and (b) *Service outsourcing* to an external third party, as an attempt to achieve cost-effectiveness. These strategic service options for IoT Lab can be seen as a step to achieve a higher degree of vertical integration by undertaking more activities in the industry value chain.

Assessing the Strategic Service Options

The Internal Cost Analysis (Task 6.2) provided a number of key findings both at a cost as well as at a strategic level. An overview of the cost implications for each of the three service options is presented in Table 19.

Table 19: IoT Lab Strategic Service Options Overview

Cases	***Service Options***	***Cost Implications***	***Limitations***	***Limitation Impact***
Case 1	*Basic, in-house*	• Lowest cost per experiment	Case 1 limitations are: The inability to address the	*High*

Cases	***Service Options***	***Cost Implications***	***Limitations***	***Limitation Impact***
	service provision	• Lowest monthly cost • Supports the highest number of "basic service" experiments	needs of companies, mainly SMEs and start-ups and other stakeholders (i.e., government bodies) that need high value-added-experimentation services (i.e., end-to-end experimentation /Experiment-as-a-Service) over the IoT Lab infrastructure. These stakeholders need to perform fewer experiments on a yearly basis but have a greater revenue-generating potential (compared with individual researchers) while their usage patterns indicate more experiments on a yearly basis. As such we may claim that by providing only the "basic service", IoT Lab fails to capture the "long tail" [Anderson, 2006] of its market.	
Case 2	*Extended, in-house service provision*	• Highest cost per experiment (which presents a high growth rate during Year 2- 5 as opposed to Case 3 which increases with a lower rate). • Highest monthly cost. • Supports 22 "extended service" experiments.	Case 2 limitations are: The cost of recruiting, the downtime cost associated with the EaaS (Experiment-as-a-Service) learning curve, the uncertainty regarding the impact on sales/revenues that such a service provision may have.	*Medium*
Case 3	*Extended,*	• Lower cost per	Case 3 limitations are:	*Medium/*

Cases	Service Options	Cost Implications	Limitations	Limitation Impact
	outsourced service provision	experiment. • Lower monthly cost for the same number of experiments (as Case 2 – 22 experiments).	The inability to perform quality controls over the service provisioning, the safety concerns associated with data protection as well as the inability of IoT Lab to create expertise in a critical area of its operations.	*High*

Our analysis indicated that the strategic service option with the lowest comparative risk is Case 2 Extended, in-house service (medium overall risk) (see Figure 16).

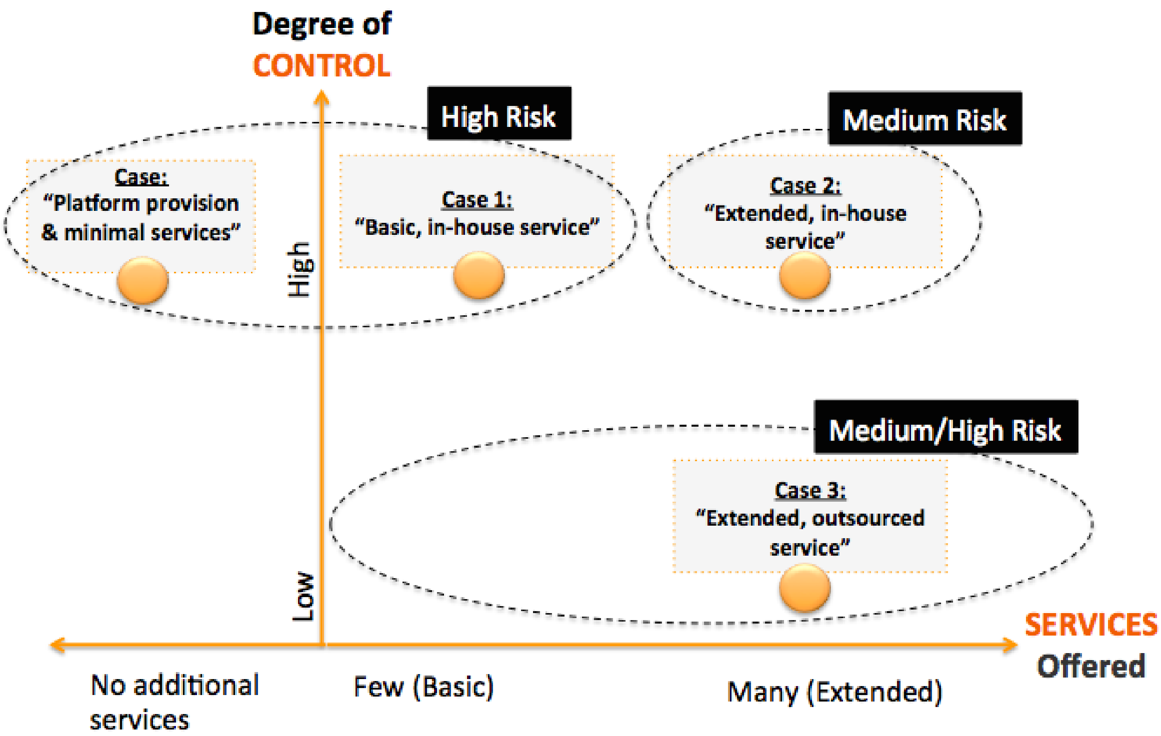

Figure 16: Assessing the IoT Lab Service Options

Internal Value Chain

The IoT Lab Internal Value Chain Analysis provided an overview of the intra-IoT Lab value-adding activities from service suppliers (i.e., data suppliers, testbed providers etc.) to servicing the final IoT Lab consumers. The findings of this analysis indicate that the IoT Lab margin/profit is highly dependent on its ability to effectively perform the internal value adding activities (primary activities and support activities), so that the amount that its customers will be willing to pay for the service will exceed the cost of these intra-organizational activities. The internal value chain model facilitated the definition of the IoT Lab's key value adding activities in which it can achieve a competitive advantage, either by providing lower cost (cost advantage) or superior service (differentiation advantage).

5.3.2 The IoT Lab Service Definition

The definition of the IoT Lab service is a key component of the Business Model definition. The value proposition of the IoT Lab will act as the core element of its Business Model (see Figure 17), as it will detail the value created for users by the offering based on the technology [60].

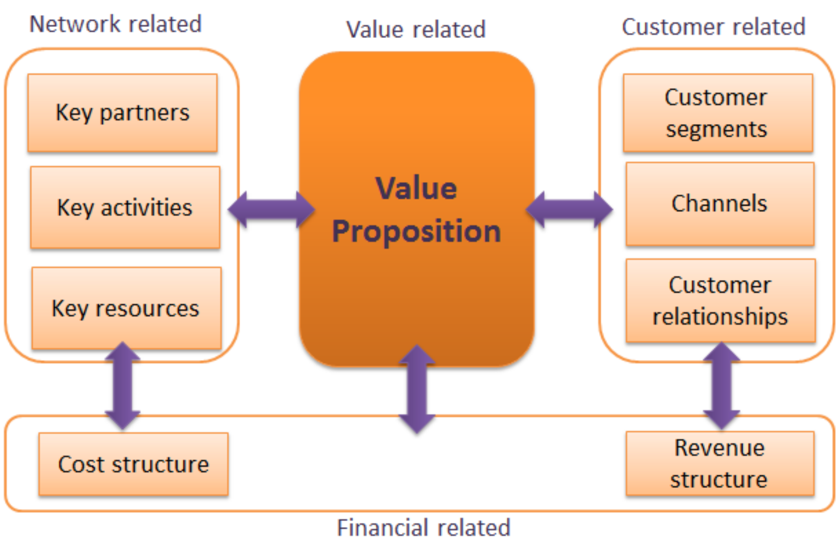

Figure 17: Value related components in the Business Model

(Adapted from [61])

The IoT Lab service definition will provide the sum of benefits that a customer will receive via the "augmented" IoT Lab service (see Figure 18). This will integrate the benefits of three distinct service levels:

Level 1: Core service

– The *core benefits* that IoT Lab will offer to its customers, the generic service (i.e., core functions).

Level 2: Actual service

– The *expected service benefits* (i.e., brand name, quality level, features, design) that users will receive via the IoT Lab service.

Level 3: Augmented service

– The additional *services* that IoT Lab can offer (i.e., training services, online support, certification services, reporting services, analytics, add-ons, etc.).

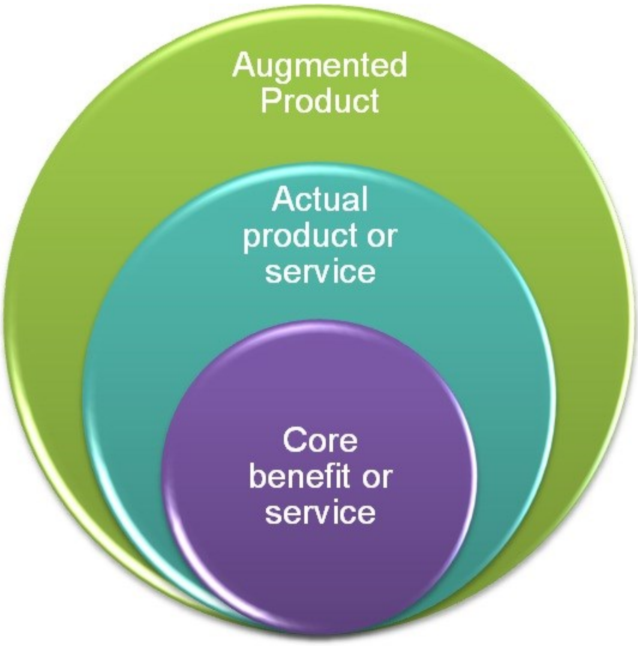

Figure 18: The Augmented Product/Service

5.3.2.1 Defining the IoT Lab Augmented Service

In the context of IoT Lab these distinct service levels are presented in the sections that follow.

Level 1: Core Service of IoT Lab

The core services of IoT Lab are: the technical infrastructure, the smart phone app, the content and the access to it. These privacy-aware services include:

Technical infrastructure

- **Cloud platform** - a reliable crowdsourcing augmented experimentation environment for multidisciplinary experimentation.
- **Crowdsourcing mechanisms and tools** enabling testbeds to use third parties resources (i.e., mobile devices) and to interact with distributed users (crowd).
- **Virtualisation** of crowdsourcing and testbed components by using a meta-layer with an open interface, facilitating the integration and interaction with heterogeneous components, including physical, mobile and virtual ones.
- **Ubiquitous interconnection and cloudification** of the testbed resources.
- **Crowdsourcing test-bed as a service (TBaaS).**

Smart phone app

- Crowdsourcing (crowd-driven innovation)
- Crowd sensing
- Customizable surveys
- Crowd-evaluated experimentation process
- Crowd-assessment tool for the market potential of experimented products/services
- Crowd-driven experiments
- Multilingual solution
- Privacy by design

Content & Access

- **Interconnection of testbeds** (several FIRE testbeds).
- **Crowdsourced infrastructure** (made of mobile resources owned by individuals and .possibly combined with the existing infrastructure and online services).
- **Crowdsourced intelligence** (distributed network of users that act as: initiators, research collaborators (provision of feedback, etc.), validators, etc.
- **Collection, storage, access** to crowd-based data (experimental content).
- **Access to new sources of data** from crowdsourcing.
- **Multidisciplinary experimentation.**
- **Crowd-driven research model.**

Level 2: Actual Service of IoT Lab

The actual service of IoT Lab is for its wider community. These privacy-aware services include:

Community

Online communities of: a) Crowd participants; b) Experimenters (1.Individual researchers; 2. Universities/Researchers labs; 3. Companies (SMEs, start-ups, etc.,), 4. Public Authorities, etc.); c) Testbed owners/providers; d) Public administrations, governmental bodies; e) Charities. This also includes Pan-European collaborative and crowd-driven lab community and Pan-European network of devices and sensors.

Level 3: Augmented Service of IoT Lab

The "augmented service offering" includes value-adding services that will be provided by the IoT Lab partners during the operational phase of the IoT Lab (post project expiration phase).

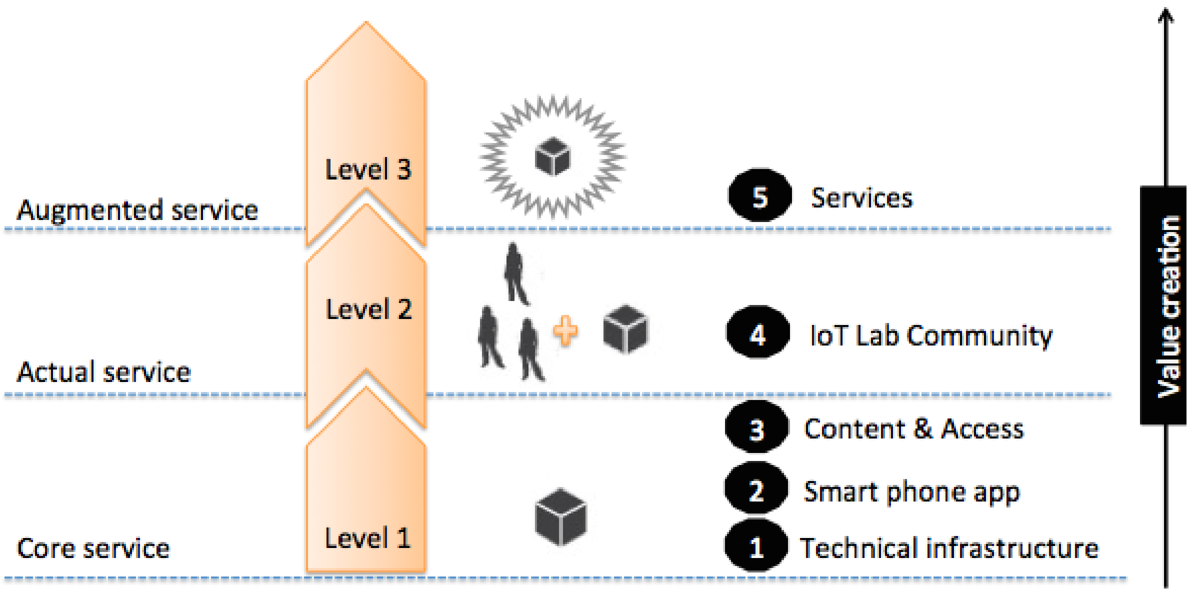

Figure 19: IoT Lab Augmented Service Levels

Aiming to maximize the value of IoT Lab and in accordance with the analysis in the context of T6.2 (D6.2), the consortium partners will provide an "*augmented service offering*" (see Level 3, Figure 19), which will integrate a number of value-adding services in addition to the core and actual services.

These services will be connected to the core IoT Lab service and will aim towards the fulfillment of the different user needs and requirements (in alignment with WP5 and WP6 findings). Considering that support services such as "Experimentation-As-A-Service (EaaS)" (end-to-end experimentation) constitute an important criterion for the majority of industrial users as well as public organisation users (non-academic users) when selecting to collaborate (i.e., outsource) with an third-party regarding their research activities/market assessment activities, IoT Lab will provide a wide array of services that will support highly diverse needs of its users during different experimentation phases (i.e., ideation/ innovation exploration, experimentation, market assessment).

In order to define the "augmented service", we examine the envisioned IoT Lab partners exploitation service provisioning. This analysis is presented in the sections that follow.

Individual Partners Service Provision Strategy (Augmented Service)

The IoT Lab consortium partners can be categorised into two categories:

(a) ***Academic and Research Institutions:*** CTI, UniGE, Alexandra, LTU, SOTON, UNIS

(b) ***Industrial Institutions:*** MI, DNET

Their highly distinct roles and core competencies dictate their individual exploitation strategy and service provision, which is presented in the sections that follow.

Academic and Research Institutions

CTI – Computer Technology Institute and Press "Diophantus" (Greece)

Service Types:

Experimenter training services

CTI will provide: Free training service at the CTI premises; Introduction to crowd-driven research; Technical usage support and training sessions organization.

Provision of online experimenter training material

CTI will provide: Free training material at the CTI premises; Leaflets, hardware and manuals.

General supporting services for experimenters

Free support, advising and consulting of experimenters.

Experiment as a Service

Modular experimental services development, on top of the current implementation.

Content Updates

Support to the website manager regarding platform technical information.

Provision of tools & Custom developments and tools

Several research oriented, technical tools can be developed: feature extraction tool, virtual testbeds, mobile testbeds, etc.

Support Services

CTI will provide: Technical support for the back end of the platform; IoT Lab usage support; Testbed managers coordination.

IoT Lab facility and infrastructure monitoring services

Server monitoring and coordination of the testbed owners.

IoT Lab Maintenance Services

Technical support to the overall back end and CTI testbed maintenance.

IoT Lab Platform upgrades and enhancements

Constant maintenance and upgrade of IoT Lab back end service and CTI testbed functionalities

IoT Lab mobile app upgrades and enhancements

Ad hoc enhancements in order to promote possible future research directions.

Consultancy services for different actors

Knowledge transfer to the academic community of University of Patras through student and researcher collaborations.

UniGE – University of Geneva (Switzerland)

Service Types:

Experimenter training services

To utilize the IoT Lab platform in the context of Academic courses for young researchers to be exposed to the concepts of IoT and Crowdsourcing/Crowdsensing.

Provision of online experimenter training material

To provide course material for young researchers on IoT and Crowdsourcing/Crowdsensing.

General supporting services for experimenters

Continuous support, amelioration and expansion of the functionalities provided by the platform.

Experiment as a Service

Continuous support on experiment scenario composition and virtual/modelled testbeds APIs.

Content Updates

Depending on the demand, new services could be developed for supporting new types of experiments.

Provision of tools

Continuous support on experiment scenario composition and virtual/modelled testbeds APIs.

Custom developments and tools

Such software modules could be developed and supported depending on demand.

Support Services

Continuous support and amelioration of the provided services.

IoT Lab facility and infrastructure monitoring services

Continuous monitoring and maintenance of the IoT Lab DBs and the UNIGE testbed facility.

IoT Lab Maintenance Services

Continuous monitoring and maintenance of the IoT Lab DBs and the UNIGE testbed facility.

IoT Lab Platform upgrades & enhancements

Continuous monitoring and maintenance.

SLA services

UNIGE would contribute towards defining and achieving SLA services regarding the IoT Lab platform.

Consultancy services for different actors

UNIGE will contribute via corresponding training material (see above.)

ALEXANDRA – Alexandra Institute of Technology (Danemark)

Service Types:

Experimenter training services

Experimenter training services on IoT and crowdsourcing through workshops/tutorials, etc. (free and paid).

Provision of online experimenter training material

Provisioning of different material (tutorials, videos, etc.) free and paid.

General supporting services for experimenters

Service co-creation and support (paid).

Experiment as a Service

Help develop customized applications (paid).

Content Updates

Paid content updates.

Provision of tools

Provision of examples and tools (free).

Custom developments and tools

Development of own crowdsourcing applications and services on market (paid/free).

Support Services

Stakeholder workshops and technical introduction to tools (free/paid).

IoT Lab mobile app upgrades and enhancements

Update of applications.

Consultancy services for different actors

Technical, business and knowledge services provisioning.

LTU – Lulea University of Technology – Centre for Distant Spanning Technology (CFT) (Sweden)

Service Types:

Experimenter training services

Botnia Living Lab services (paid).

Provision of online experimenter training material

Our research papers and handbooks are available online for free.

General supporting services for experimenters

Botnia Living Lab can support experiments and real world pilots via the IoT Lab facilities (paid).

Experiment as a Service

Botnia Living Lab can support experiments and real world pilots via the IoT Lab facilities (paid).

Support Services

We can assist in stakeholders' engagement in innovation processes via Botnia Living Lab (paid).

SOTON – University of Southampton (UK)

Service Types:

Experiment as a Service

SOTON will provide test and development services that aim at providing experimental design, implementation and analysis via IoT Lab facilities but only for business related experiments.

Content Updates

SOTON will provide content updates for the IoT Lab.

Provision of tools

SOTON will develop and provide tools related to IoT Lab platform and/or mobile app but only for business related experiments.

UNIS – University of Surrey (UK)

Service Types:

Experimenter training services

Hands on training through industry short courses can be provided.

General supporting services for experimenters

Handbooks and guidelines for the use of sensor suite (deskegg) resources.

Experiment as a Service

This can be offered on a case-by-case basis, either as a technology or as a social science research project.

Provision of tools

The IoT-Lab Mobile App will be provided for free, the software will be maintained for a period after the project ends, longer term maintenance arrangements will need to be made.

Custom developments and tools

UoS can offer the use of their deskegg sensor suite, which is used for workplace research as well as social research projects.

Support Services

Support related to the sensor suite and local IoT-Lab facilities can be provided.

IoT Lab facility and infrastructure monitoring services

The Surrey Smart Campus deployment connected to IoT-Lab will be maintained by UoS.

IoT Lab Platform upgrades & enhancements

Upgrades of the smart campus testbed as well as of versions of the deskegg will be undertaken following the development plans for both.

IoT Lab Mobile App upgrades & enhancements

Initial updates/maintenance are foreseen for the project duration, upgrades and extensions at a later stage will need to be agreed.

SLA services

UoS will follow the approach taken by the project.

Consultancy services for different actors

Technology consultancy can be offered on a per need basis.

MI – Mandat International (Switzerland)

Service Types:

General supporting services for experimenters

Research service and consulting.

Experiment as a Service

This can be offered on a case-by-case basis, either as a technology or as a social science research project.

Support Service

Technical support and research services.

IoT Lab facility and infrastructure monitoring services

MI smart office testbed.

IoT Lab Maintenance Services

MI will support the server through the IoT Lab association.

Consultancy services for different actors

Yes.

Other services

Market analysis and end-user acceptance analysis.

SME - Industrial partners

DNET – Dunavnet (Serbia)

Service Types:

Experiment as a Service

The outcomes of the IoT Lab project will be fully utilized to provide a basic setup of Experiment as a Service. DNET will plan these experiments within their existing range of smart city IoT services. The payment model will depend on the experimenter role and project aim; for example for society beneficial experiments the service resources can be donated.

Provision of tools and Custom development and tools

DNET will develop and provide additional tools requested by the users. The tools will be offered using SaaS model.

IoT Lab facility and infrastructure monitoring services

Firstly this service needs to be provisioned within the IoT Lab project, and thereafter it should be mutually agreed how to proceed within the IoT Lab association or possibly commercially for DNET based on commercial grounds

IoT Lab Maintenance Services

Upon the completion of the project it should be decided whether the IoT Lab association will be a sole owner of the platform and associated services, or the rights will be equally shared by all the partners. Each commercial partner will then have to provide all the necessary services.

IoT Lab Platform upgrades and enhancements

DNET will continue this in a commercial manner.

IoT Lab mobile app upgrades and enhancements

DNET will take this further if original IoT Lab Mobile App is available to all the partners.

SLA services

DNET will create individual SLAs depending on the role and type of the customer and the services provided.

Consultancy services for different actors

DNET will provide consultancy services as part of support package.

Other services

This will be in line with DNET business and product development plan:

- Transport service satisfaction
- Subjective assessment of the air quality

- Mood of the city
- Crowdsourcing/Crowdfunding for community projects

Aggregate Partner Service Matrix

The services that IoT Lab consortium partners' will be offering based on their individual competencies and area expertise have been identified, we now provide a synopsis of these service types as seen in Table 20.

Table 20: Aggregated Partner Service Matrix

Type of Organisation	SME	University					Research Institute	
Service Types	**DNET**	**LTU**	**CTI**	**UNIS**	**SOTON**	**UniGE**	**AI**	**MI**
Experimenter training services		■	■	■		■	■	
Provision of online experimenter training material		■	■			■	■	
General supporting services for experimenters		■	■	■		■	■	■
Experiment as a Service	■	■	■	■	■	■	■	
Content Updates			■		■	■	■	
Provision of tools	■		■	■	■	■	■	
Custom developments and tools	■		■	■		■	■	
Support Services		■	■	■		■	■	■
IoT Lab facility and infrastructure monitoring services	■		■	■		■		■
IoT Lab Maintenance Services	■		■			■		■
IoT Lab Platform upgrades & enhancements	■		■	■		■		
IoT Lab mobile app upgrades & enhancements	■		■	■			■	
SLA services	■			■		■		
Consultancy services for different actors	■		■	■		■	■	■
Certification services for experiments via IoT Lab								
Provision of training accreditation								
Other services	■							■

These high quality/specialised services (that detail IoT Lab partners' offering) can be grouped into generic and homogeneous service categories, which provide added value to distinct stakeholder segments, as seen in Table 21.

Table 21: Classification of Service Categories and Target Audience

Service Categories	Service Description	Target Audience: Individual Researcher	University	Company	Public Authority
1. Experimenter-related services	1a. Experimenter training services and training material	X	X	X	X
	1b. General supporting services for experimenters	X	X	X	X
	1c. Provision of training accreditation	X	X	-	-
2. Experiment-as-a-Service (EaaS)	2a. Experiment as a Service (end-to-end experimentation)	X	X	X	X
	2b. Certification services for experiments via IoT Lab	X	X	X	X
3. Specialized Content	3a. Content Updates	X	X	X	X
	3b. Online training material for experimentation	X	X	-	-
4. Supporting services	4a. General supporting services	X	X	X	X
	4b. IoT Lab facility and infrastructure monitoring services (*)	-	-	-	-
5. Consultancy, SLA & Other Services	5a. Consultancy services for different actors	X	X	X	X
	5b. SLA services				
	5c. Other services	X	X	X	X
6. Specialized Tools	6a. Provision of tools	X	X	X	X
	6b. Custom developments and tools	-	-	X	X
7. IoT Lab	7a. Maintenance services	-	-	-	-

Service Categories	Service Description	Individual Researcher	University	Company	Public Authority
Platform & Mobile App Maintenance, Upgrades & Enhancements (*)	7b. IoT Lab Platform upgrades & enhancements	-	-	-	-
	7c. IoT Lab Mobile App upgrades & enhancements	-	-	-	-
*Notes: * these services are indirectly critical for IoT Lab users*					

Based on this analysis the "augmented service offering" of the IoT Lab Association is presented in Figure 20.

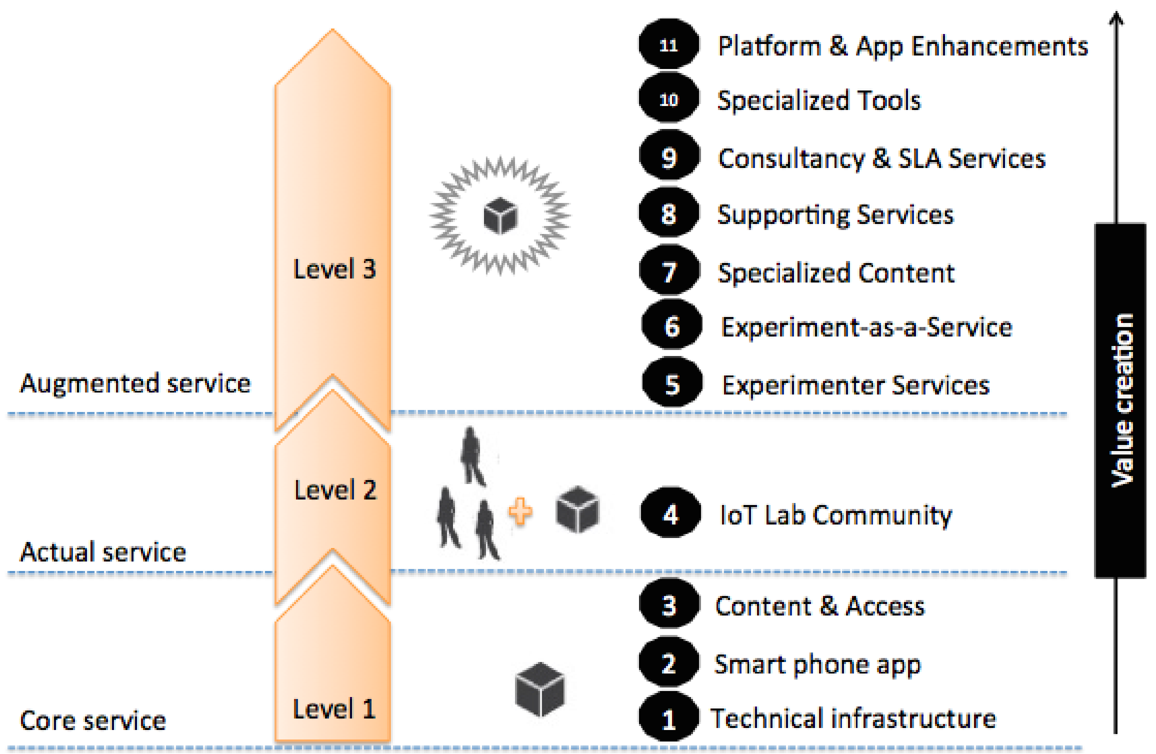

Figure 20: The IoT Lab Augmented Service Offering

5.3.3 Value Creation in the context of IoT Lab

IoT Lab Value Added

The IoT Lab Project encapsulates four distinct value-adding properties:

1. **IoT Lab technological innovation,** innovative IoT mechanisms and tools that can extend IoT testbed infrastructure with crowdsourced resources in a privacy aware manner so as to facilitate multidisciplinary experiments, with more end-user interactions, flexibility, scalability, cost efficiency and societal added value.
2. **IoT Lab crowd-driven innovation** that will emerge via "crowdsourcing-driven research", enhancing the capabilities of the IoT Lab technology and creating an open crowd-driven IoT ecosystem for research.
3. **IoT Lab value co-creation with the community**, that will involve crowd participants, individual researchers and universities from the research community along with the business and public sector community and via IoT Lab they will be able to interact, collaborate while at the same time co-creating research and value for the society as a whole.
4. **IoT Lab "social good" business approach that** will allow community members to donate to charities via IoT Lab. In particular, IoT Lab users will be able to allocate the points/credits collected by participating in the experiments to a charity of their choice, out of a list that will be provided by the platform.

We can summarise the IoT Lab value creation as ***"shared value innovation"*** and "***technology innovation***" (see Figure 21). *Shared value innovation* is a new term that merges two distinct value elements, namely: (a) "shared value" i.e. generating economic value in a way that also produces value for the society by addressing its challenges ([62] and (b) "*value innovation*" i.e. places equal emphasis on value and innovation as it anchors innovation with buyer value [63].

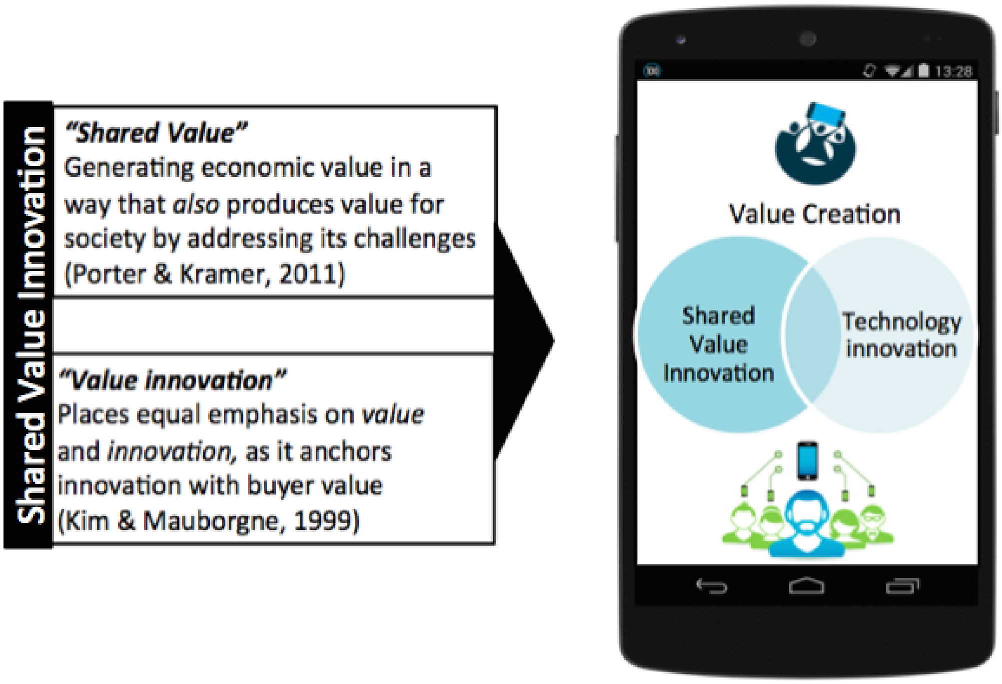

Figure 21: IoT Lab Shared Value Innovation

(Own elaboration based on [62] and [63])

5.3.4 Potential Business Models for IoT Lab

Our Business Model scenario analysis, starts with the identification of the different scenarios that can be adopted for the IoT Lab, acknowledging also the potential Incentive Model options (i.e., no incentives, monetary incentive). Although the latter aspect has been examined in detail in the first part of this deliverable, we have also integrated it in the Business Model analysis as it acts as a validation mechanism for the selected Incentive Model and its combination with the most appropriate IoT Lab Business Model is of critical importance for the success of the IoT Lab.

The Business Model scenario analysis will start by considering the possible Business Models for IoT Lab that range between two extremes: free service (Case 1) and Hybrid Social Business Model (a combination of all free and premium services and the Social Good Aspect that has been a core decision element of the IoT-Lab partners) (Case 3). The scenarios also integrate two subcases with two extreme Incentive Model scenarios: No Incentives and Hybrid-Gamified Incentives (the proposed Incentive Model based on our analysis).

Business Model Scenarios

Case 1: Free Model

- All services are free for all stakeholders (non-sustainable model).
- Means for sustainability: sponsorship, advertising.

Case 2: Fee-based Model

- Case 2a. Fee-based model with No incentives.
- Case 2b. Fee-based model with Hybrid-incentives (monetary, non-monetary and “good-cause”).

Case 3: Hybrid Social Model (free services & premium services)

- Case 3a. Hybrid Social Model with No incentives.
- Case 3b. Hybrid Social Model with Hybrid-incentives (monetary, non-monetary and “good-cause”).

5.3.4.1 Scenario Analysis

Based on the identified scenarios, we now proceed with a figurative examination of the different Business Model cases in order to identify their dynamics and value adding potential both for IoT Lab users and stakeholders as well as for the IoT Lab and for the society in general. This analysis will be based on the following generic model of the IoT Lab ecosystem (Figure 22).

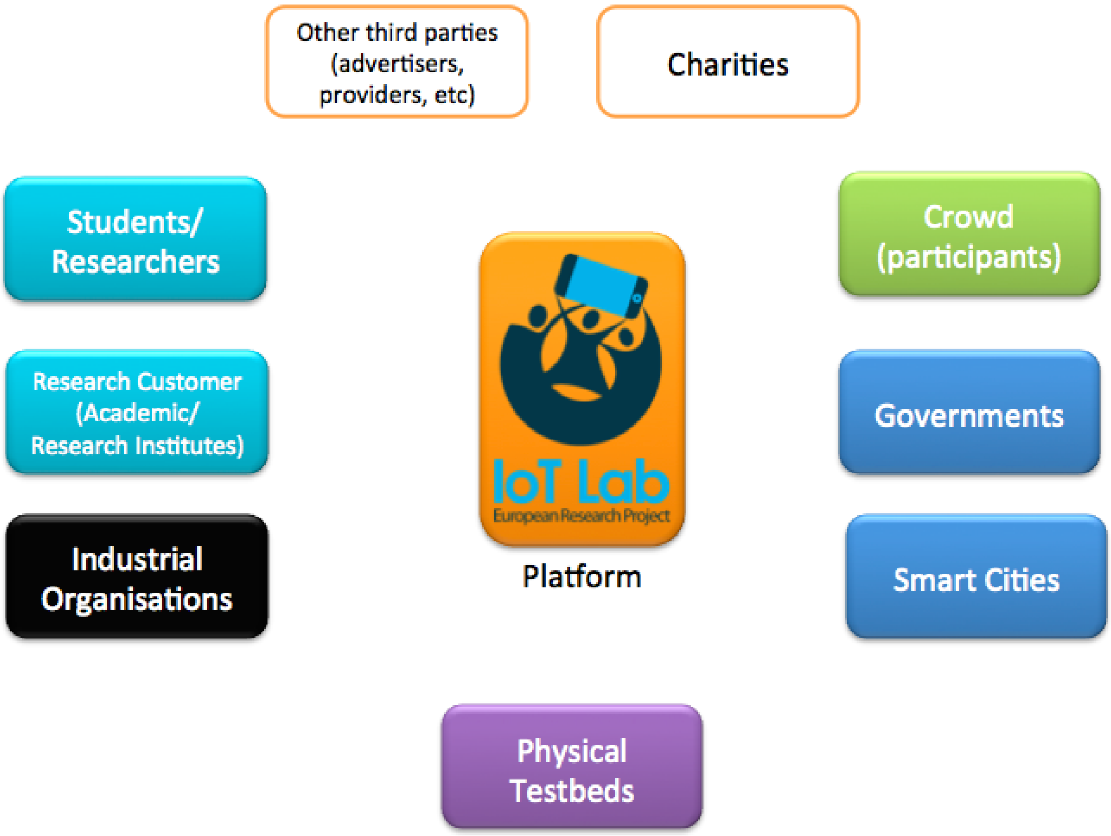

Figure 22: IoT Lab Generic Ecosystem Model

Case 1: Free Model

Case 1 model implies free services for all IoT Lab stakeholders (Figure 23). The means for sustaining the IoT Lab operations under this model could be either via governmental funding/external funding/sponsorship, that would be really difficult to establish, and/or via advertising that would be equally difficult acknowledging that this revenue model necessitates a mature initiative that has a big community and has achieved a high level of community engagement. Under this model the sustainability of IoT Lab would be limited as it would not be able to cover its operational expenses or provide fees to testbed owners.

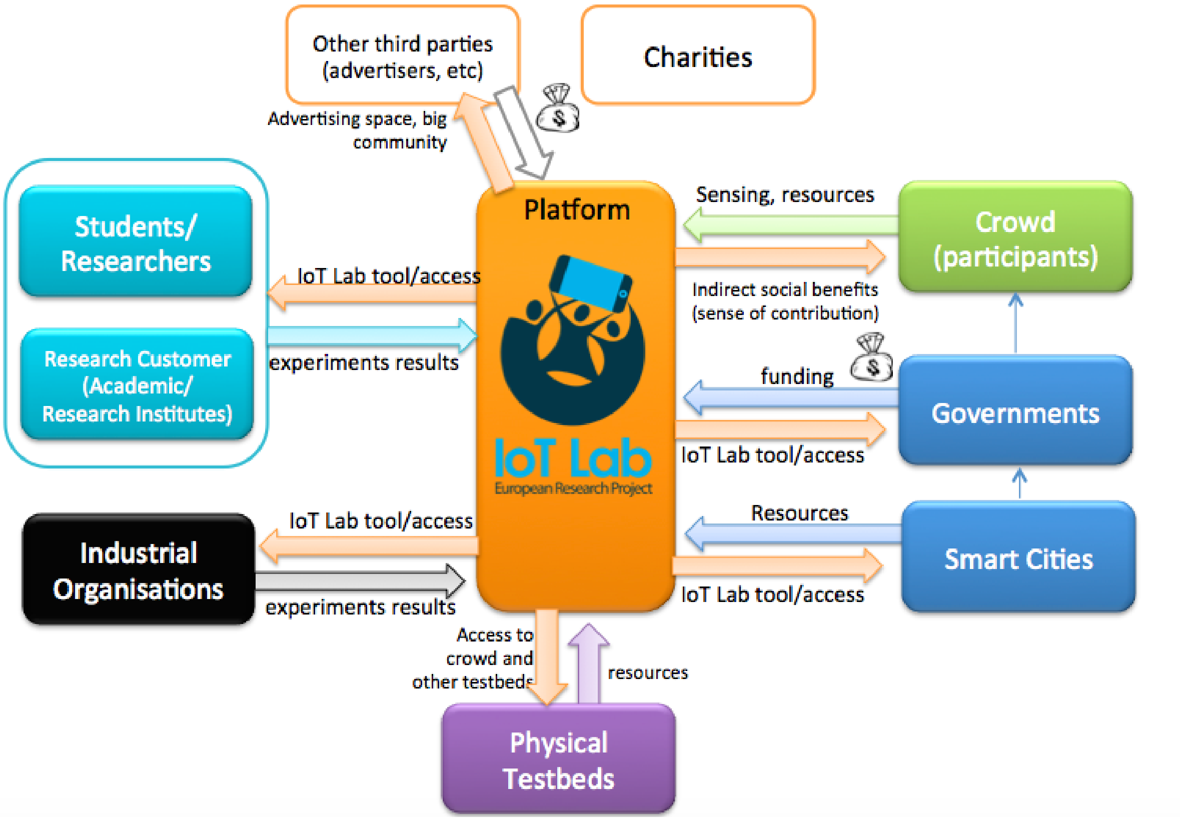

Figure 23: Case 1: Free Model

Case 2a: Fee-based Model with No incentives

The second Business Model category goes to the other extreme and proposes fee-based services for all IoT Lab stakeholders. Under this scenario, Case 2a implies a fee-based model with No incentives for the IoT Lab crowd participants. The means that access to the IoT Lab platform and services will be restricted to paying users only (high barriers to access) and no free services will be provided (Figure 24). Although this model has higher revenue potential (as opposed to Case 1 model) its sustainability will be low as it will not offer any incentives for crowd participants. As such the crowd community will have no reason to become part of such a for-profit community that will utilise their participation and will not distribute this value that they have created. Therefore, sustaining the IoT Lab operations under this model could be difficult.

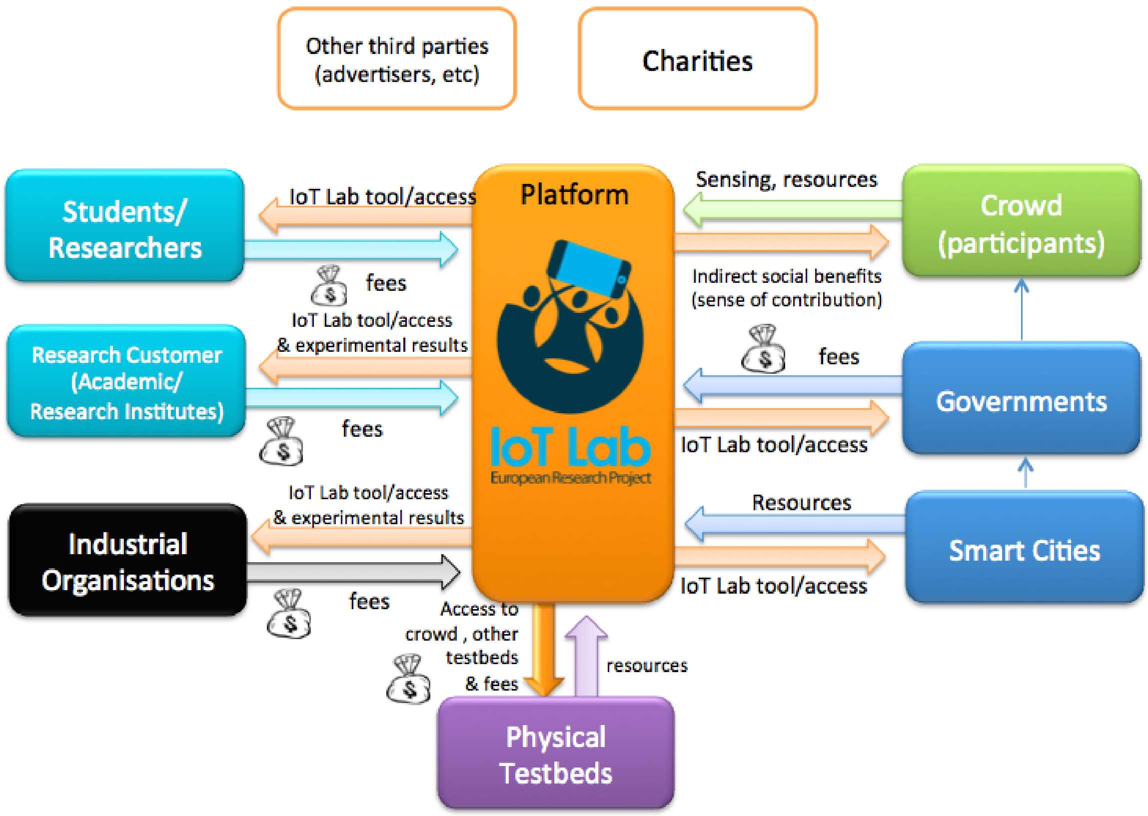

Figure 24: Case 2a: Fee-based Model and No Incentives

Case 2b: Fee-based Model with Hybrid-incentives (monetary, non-monetary and "good-cause")

Case 2b alleviates the incentivisation problems of Case 2a and adopts hybrid-incentivisation scheme (monetary, non-monetary and "good-cause"). Under this model although access to the IoT Lab platform and services will be restricted to paying users only, crowd participants will have adequate reasons to become part of such a for-profit community. However, as opposed to open, non-profit initiatives such a model could be maintained only by a for-profit organisational form that would attract only special segments of the crowd community and in order to incentivise them it would have to provide quite high monetary rewards. Such a model (Figure 25) would be closer to existing models of innovation-focused industrial initiatives that we examined in our competitors analysis (Task 6.2, D6.2) (i.e., InnoCentive, IdeaConnection, OpenIDEO, etc.). Therefore, although sustaining the IoT Lab operations under this model would be high, it would be the model feasibility that will be lower as IoT Lab would have to compete with existing initiatives in the area, which would be make it difficult and costly to establish a successful presence.

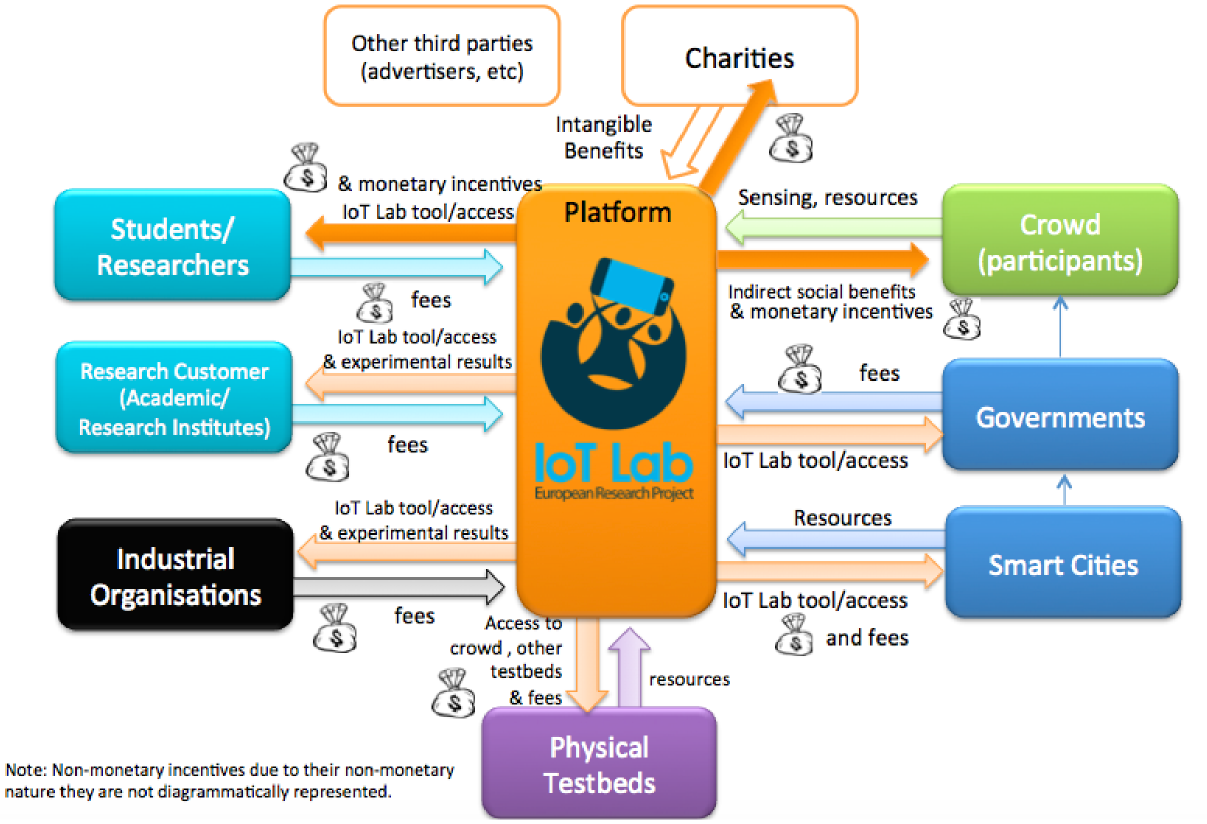

Figure 25: Case 2b: Fee-based Model and Hybrid Incentives

(monetary, non-monetary & good-cause)

Case 3a: Hybrid Social Model (free services & premium services) with No incentives

The third Business Model category balances the other two extreme cases and proposes hybrid social model with both free and fee-based services for IoT Lab stakeholders. Free services could target individual users and fee-based specialised services which could target universities, research institutes, companies and public authorities. Under this scenario, Case 3a implies such a model (Figure 26) with no incentives for the IoT Lab crowd participants. Although this model has higher revenue potential (as opposed to Case 1 model) and its feasibility will be higher (as opposed to Case 2 model), its sustainability will be moderate, as it will not offer any incentives for crowd participants. As such the crowd community will have no reasons to participate in such an IoT-driven ecosystem. Therefore, sustaining the IoT Lab operations under this model could be difficult.

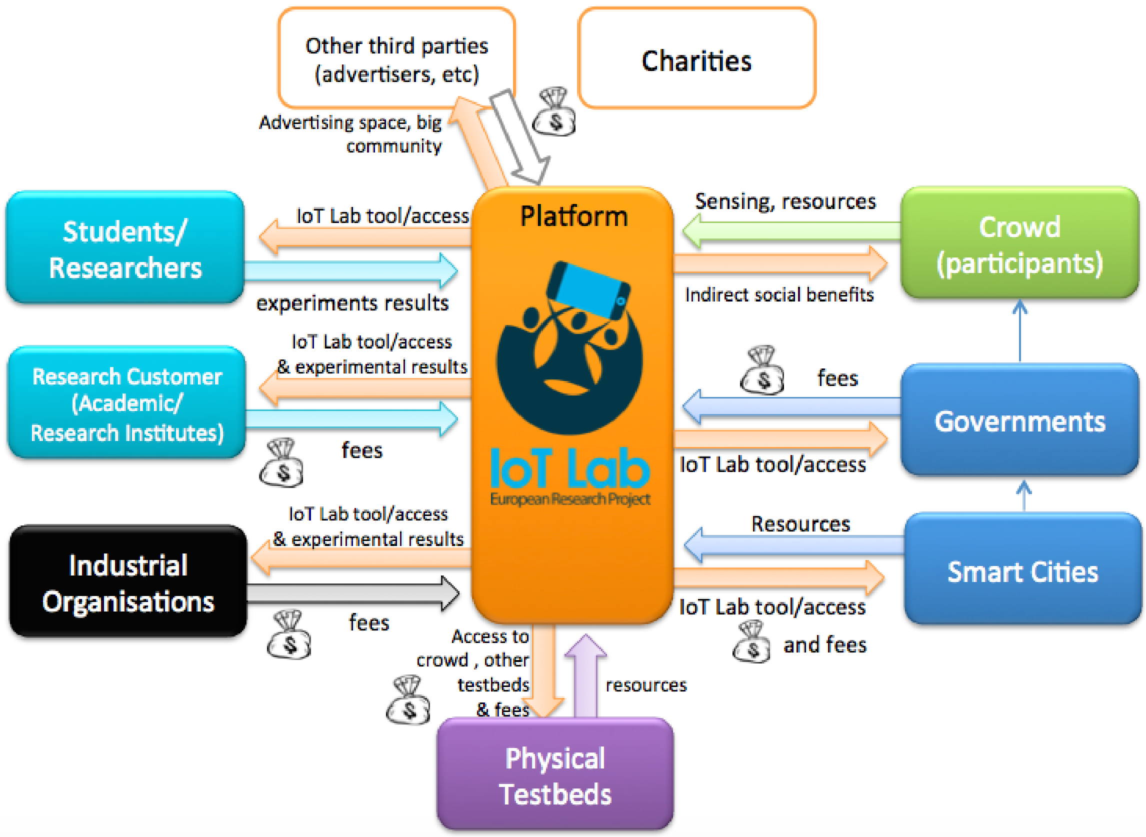

Figure 26: Case 3a: Hybrid Model and No Incentives

Case 3b: Hybrid Social Model (free services & premium services) with Hybrid-incentives (monetary, non-monetary and "good-cause")

Case 3b eliminates the incentivisation problems of Case 3a and adopts hybrid-incentivisation scheme with monetary, non-monetary and "good-cause" motives. Under this model (Figure 27) access to the IoT Lab platform and services will be free to individual users and fee-based to corporate, industrial and governmental users (such as universities, research institutes, companies, public organisations, public authorities) and crowd participants will have adequate reasons to become part of such a community that would be most probably governed by an open, non-profit initiative. Such a model would have a high degree of sustainability and feasibility as opposed to all other business model scenarios.

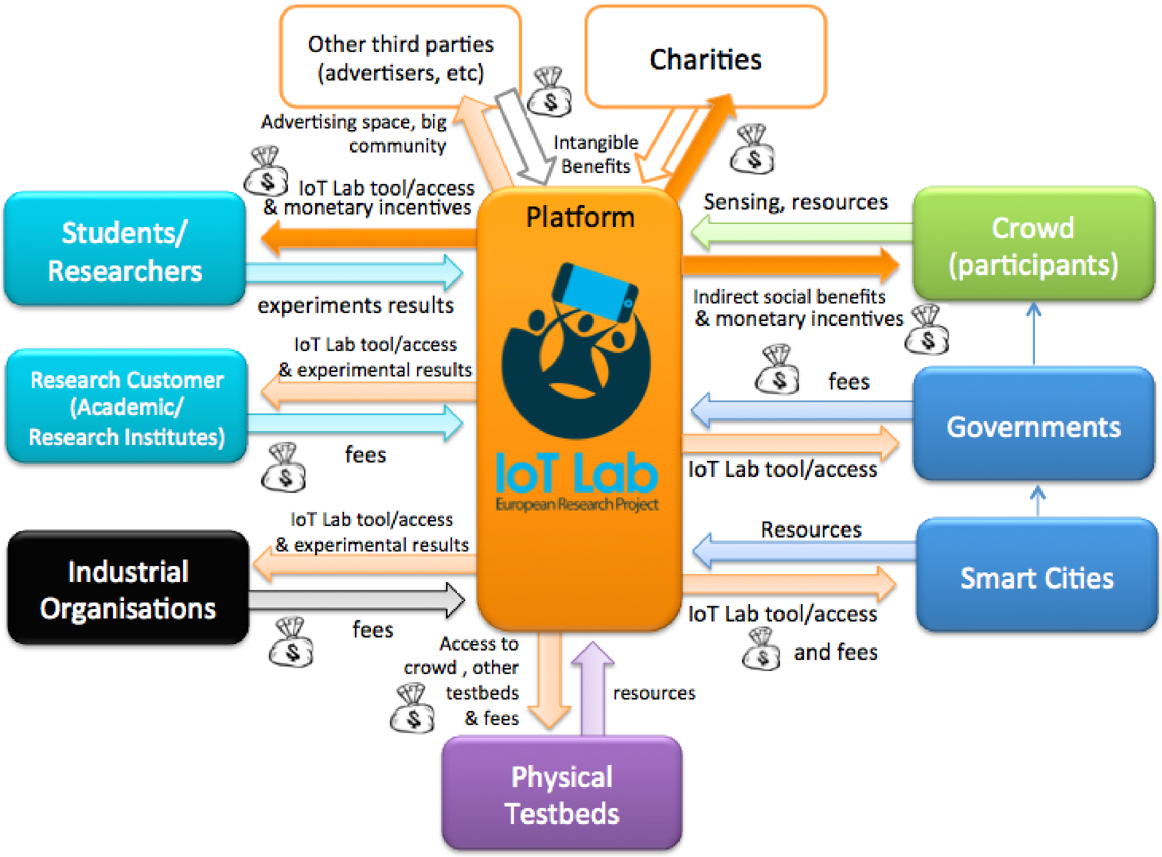

Figure 27: Case 3b: Hybrid-Social Model & Hybrid Incentives

5.3.5 Business Model Assessment

Based on this initial overview of the different Business Model scenarios for IoT Lab we now analyse them based on a set of distinct criteria. The selected criteria are critical for the success of the IoT Lab Association such as: (1) ecosystem innovation, (2) model sustainability, (3) model feasibility, (4) organisational model that could operate IoT Lab (5) participatory sensing potential and (6) community building potential.

These areas will significantly impact the success of IoT Lab across a number of different areas including community building success, social success, and economic success.

Table 22: IoT Lab Business Model Scenarios Overview

	Business Models Scenarios		
	Free BM (Case 1)	Fee-based BM (Case 2)	Hybrid BM (Case 3)
BM Overview	Free to all users	Fee-based for all users	Free for specific user segments (i.e., individuals) and fee-based (premium) for others (i.e., companies, etc.)
Offering	Stand alone infrastructure that will become obsolete over time	Crowdsourcing infrastructure that will evolve over time via updates and new services	Crowdsourcing infrastructure that will evolve over time via updates, synergetic value added and broad crowdsourcing community
User segmentation	None (free for all users)	None (fee-based for all users)	User segmentation applied (free and fee-based users)
Barriers to access	None (open access)	High barriers to access	Limited
Model Financed by	- Sponsor - Advertising revenues (at mature stage)	All users of the platform	Sub-segment of users (Premium service users finance the model - Long tail model)
Ecosystem Innovation	Slow & immature	Slow & costly	Rapid, dynamic & efficient
Model Sustainability	Low	High	High
Model Feasibility	Low	Medium/Low	Medium/High
Form of organisation that operates the infrastructure	- NGO - Non-profit	For-profit	- NGO, non-profit - For-profit
Participatory sensing potential	Low	Medium/Low	Medium/High
Community building potential	Low	Medium/Low	Medium/High
Degree of BM innovation	Low	Low	High

From our analysis it becomes obvious that Case 3-Hybrid Social Business Models (Case 3a, Case 3b) have the highest values across the areas under examination. However, we see that some values range between medium and high (e.g., feasibility, participatory sensing potential, community building potential) and this is due to the differences between Case 3a (No Incentives) and Case 3b (Hybrid Incentives).

Furthermore our examination of the crowdsourcing potential and consequently the social value creation of IoT Lab across the Business Model and the Incentive Model scenarios indicated that Case 3b: Hybrid Social Business Model with Hybrid Incentives has the highest success potential for the IoT Lab Association (see Figure 28); defining our Business Model while validating at the same time our selected Incentive Model (see Section 0).

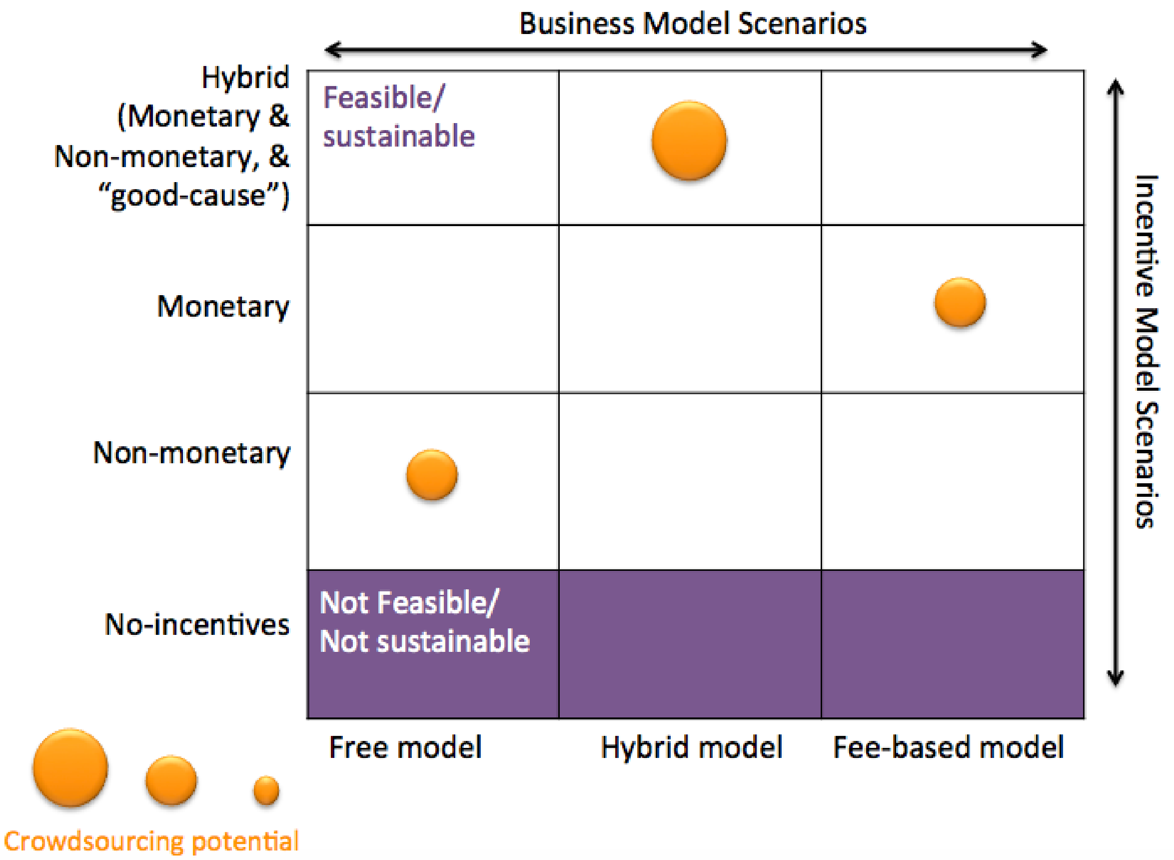

Figure 28: Classification of Business model scenarios & Incentive model scenarios

5.3.6 The IoT Lab Business Model

This section will provide an overview of the IoT Lab Business Model, starting with the specifications of the IoT service offering and then the Business Model framework analysis.

5.3.6.1 The IoT Lab Service Offering

Based on the augmented IoT Lab service offering and acknowledging the distinct stakeholder segments and their needs as well as our value chain analysis, we can identify four distinct service categories, as seen in Figure 29.

These services are:

(1) D-service (Default service): free IoT Lab usage for individual users, with quality control/validation processes.

(2) B-service (Basic service): quality control and basic supporting services for experienced research groups (i.e., Universities, research institutes) with a small fee.

(3) E-Service (Extended service): quality services in addition to extended (end-to-end) experimentation support (Experiment-as-a-Service) for start-ups and small companies as well as public authorities with a medium service fee and finally.

(4) P-Service (Premium service): which includes in addition to E-Service offering specialised experimenter services, specialised content and tools, supporting services for experimentation process, consultancy, SLA and other services, targeting the needs of large corporations interesting in utilising the IoT Lab platform. The platform maintenance, updates and enhancements will be horizontal services.

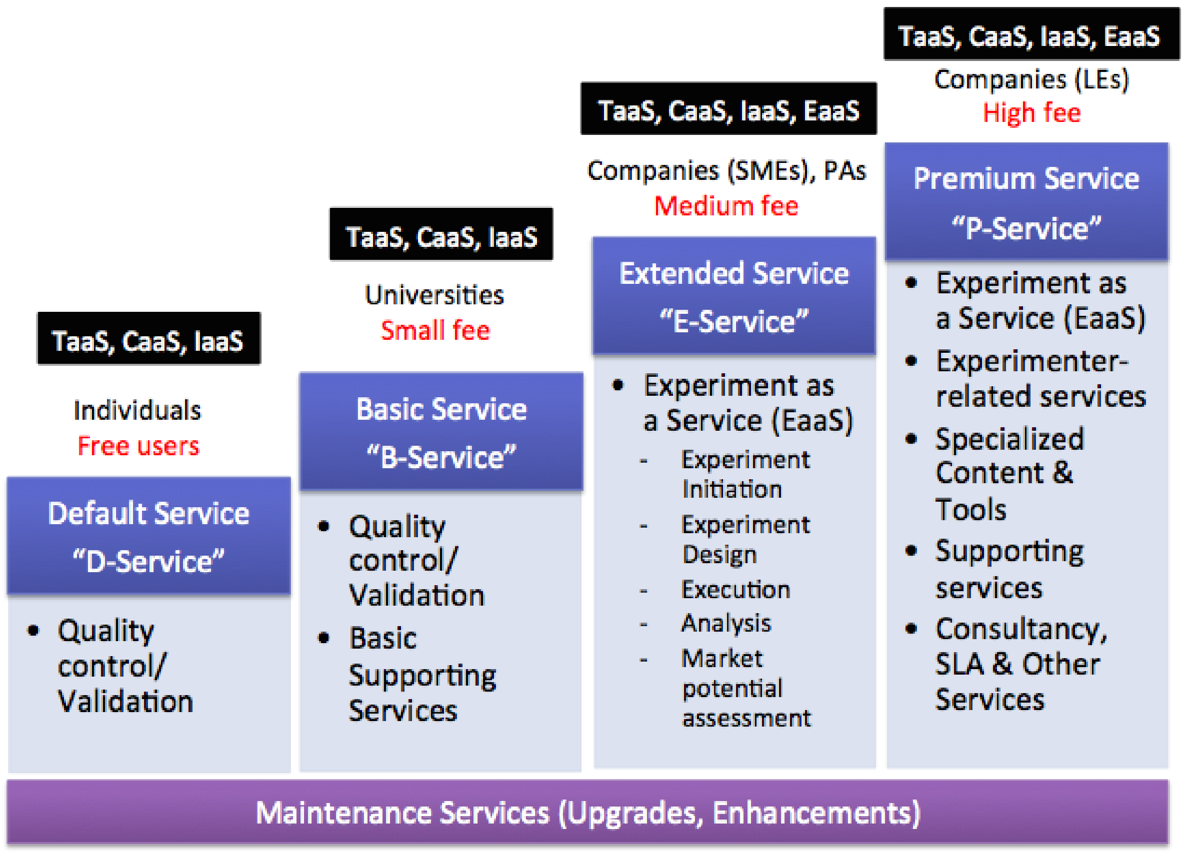

Figure 29: IoT Lab Service Categories

An overview of the IoT Lab Business Model elements (as depicted via the service offerings) is presented below:

- *IaaS – Innovation as a Service*
- *EaaS – Experimentation as a Service*
- *CaaS- Crowdsourcing & Crowdsensing as a Service*
- *TaaS - Testbed as a Service*

These elements will enhance the value of the IoT Lab platform as identified in our Value Chain Analysis and will facilitate the creation of value for IoT Lab and the society. Given that the largest segment of our stakeholders will utilise the free-service offering ("D-service": 60% of our users), we foresee that the revenue generating segments will account for 40% of our user group and will be distributed across the services offering that IoT Lab will provide (see Figure 30), given their specialised needs (this is based on our findings with the user segments, in the course of our analysis T6.1, D6.1).

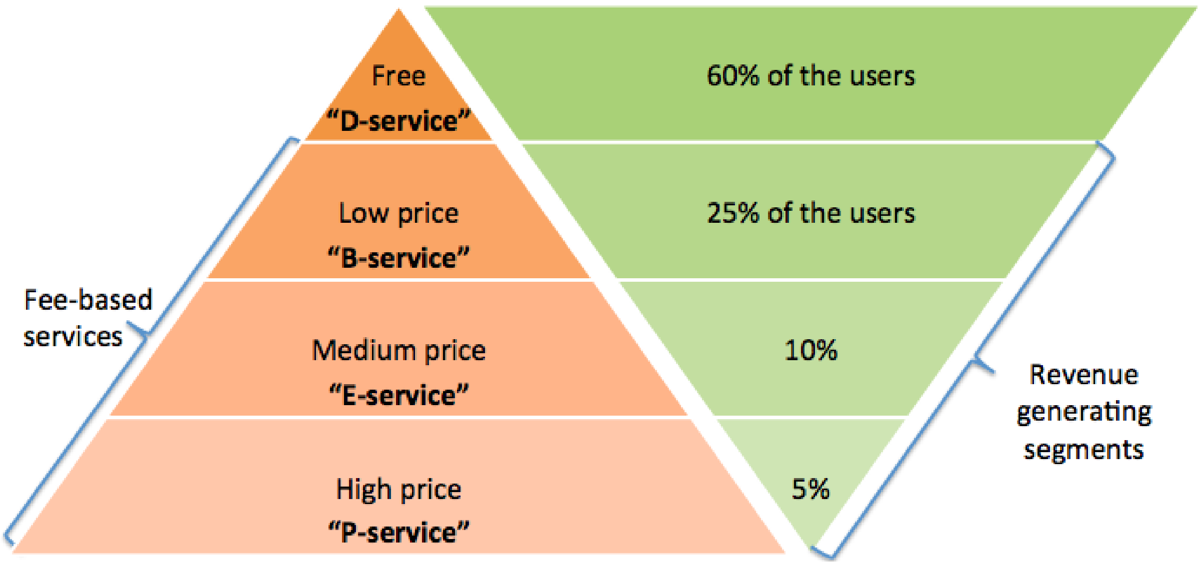

Figure 30: IoT Lab Service Categories and Stakeholder Segment Distribution

Furthermore for the IoT Lab Association the different service types will have distinct associated effort as seen in Table 23, and thus, cost implications for IoT Lab operational structure and cost.

Table 23: IoT Lab Service Types

1. Default Service			**1 hour per experiment**
Quality Control/Validation Process	A. User registration - validation	Once (per registration)	30min. per registration
	B. Experiment proposition/initiation - validation	Per experiment	30min. per experiment

2. Basic Service			**2 hours per experiment**
Quality Control/Validation Process	A. User registration - validation	Once (per registration)	30min. per registration
	B. Experiment proposition/initiation - validation	Per experiment	30min. per experiment
Basic supporting Services	C. Technical support	Per experiment	30min. per experiment
	D. Experiment support	Per experiment	30min. per experiment
3. Extended Service			**84 hours per experiment**
Experiment initiation	Technical & Experimental Support	per experiment	7 hours (1 day) per experiment
Experiment Design	Technical & Experimental Support	per experiment	21 hours (3 days)
Experiment Execution	Technical & Experimental Support	per experiment	14 hours (for all experimental duration)
Analysis	Technical & Experimental Support	per experiment	35 hours (5 days)
Market Potential Assessment	Technical & Experimental Support	per experiment	7 hours (1 day)
4. Premium Service			**252 hours per experiment**
Experimenter-related services	Technical & Experimental Support	per experiment	42 hours (6 days) per experiment
Experiment-as-a-Service (EaaS)	Technical & Experimental Support	per experiment	84 hours per experiment (12 days)
Specialized Content	Technical & Experimental Support	per experiment	42 hours (6 days) per experiment
Supporting services	Technical & Experimental Support	per experiment	42 hours (6 days) per experiment

Consultancy, SLA & Other Services	Technical & Experimental Support	per experiment	42 hours (6 days) per experiment
Note: Platform and app maintenance, updates and enhancements have been accounted as part of the IoT Lab extended service			

5.3.6.2 The IoT Lab Social Business Model

The IoT Lab Business Model is a "***Social IoT Business Model***" (Figure 31) that focuses on the impact that IoT Lab creates for the crowd participants, its stakeholders, the charities that participate in the IoT Lab (direct beneficiaries) as well as the wider community rather than the profits that it creates for IoT Lab.

This aligns with the "*Social Good Business Approach*" IoT Lab partners have adopted and which allows the IoT Lab community members to allocate the points/credits collected by participating in experiments to a charity of their choice, out of a list that will be provided by the platform. This approach is based on the working assumption that a research sponsor provides a budget for an experiment, out of which a small amount of the budget ("social revenue distribution") will be used for the platform maintenance and the rest will be allocated to the users so that they can in turn re-allocate the amount to the charities proportionally based on their point/credit distribution.

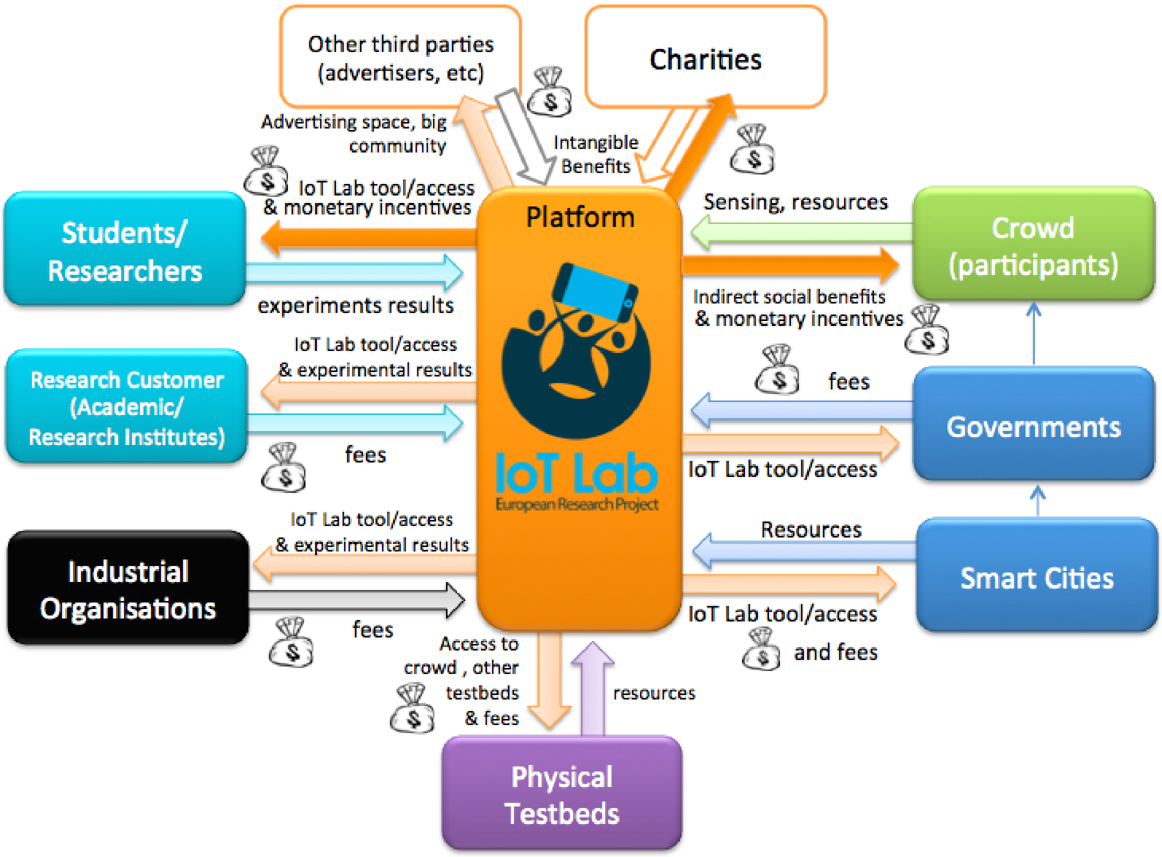

Figure 31: The IoT Lab Social Business Model

The IoT Lab partners have considered the possibility to donate the majority of their revenues to charities. Anchored in this decision and based on our analysis, the optimal social revenue distribution percentage was identified which is: *40% IoT Lab and 60% donations.*

As such, the total amount that could be donated to charities during the first five years of the IoT Lab operations, can reach the amount of ***2.4 million Euros,*** which constitutes a high social impact for the IoT Lab ecosystem.

The IoT Lab Crowd-driven and Social Business Model Canvas

In order to analyse the IoT Lab Business Model we present a new Business Model framework for crowd-driven ecosystems, which extends the Business Model canvas [43].

In particular, the updated Business Model canvas integrates two additional components that relate to the needs of crowd-driven platforms and ecosystems, namely: *(a) Governance structure*: which involves the governance model of the ecosystem (i.e., open, closed, for-profit, non-profit, etc.), *(b) Incentive Model*: that entails the incentivisation schemes for the crowd-community and the rest of the ecosystem stakeholders (Figure 32).

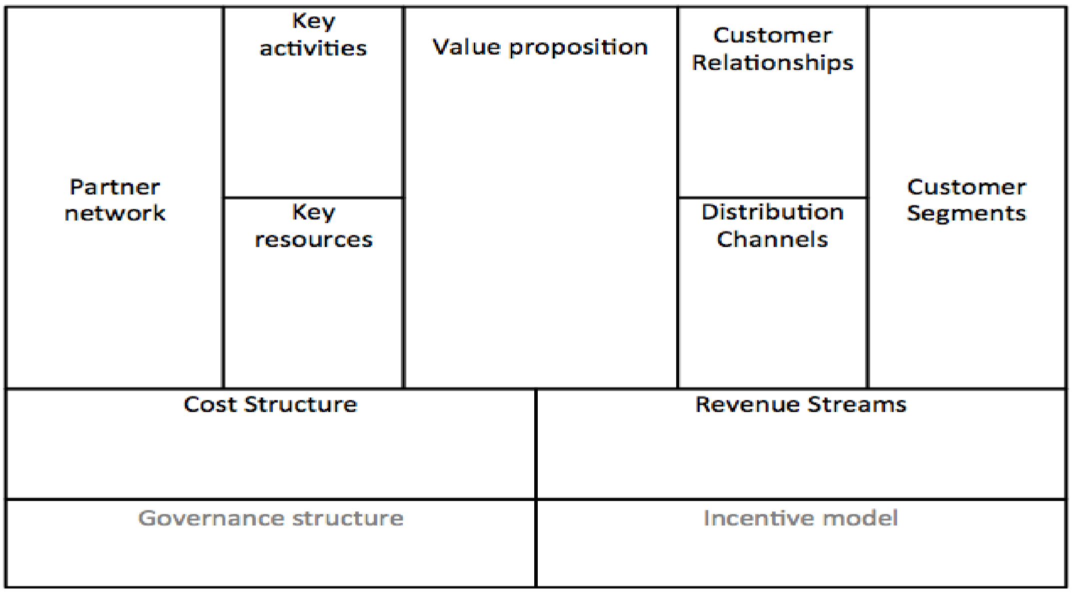

Figure 32: Updated Business Model Canvas for Crowd-driven Business Models

(Source: own elaboration extending [43])

Based on this analytical framework the IoT Lab social Business Model can be depicted as follows:

Table 24: The IoT Lab- Crowd-driven, Social Business Model Canvas

Key Partners	**Key Activities**	**Value Proposition**	**Customer Relationships**	**Customer Segments**
Crowd-participants, testbed owners, Individual researchers, universities, research institutes, Industrial community (start-ups, SMEs, large companies), public authorities, public organisations	Platform maintenance and enhancement, Customer support, Experimentation services, premium services and specialised developments, Marketing, Promotion (including community building activities)	Provide an innovative multidisciplinary, crowd-driven experimentation infrastructure that enables the execution of technological, social and economic experiments leveraging mobile (phones, tablets) and IoT devices owned by individuals while ensuring fair incentives for participation through	IoT Lab Community is a composition of: Crowd community, researcher community, industrial community and testbed owner community. Co-creation with the crowd community. Automated service for the free users (individual researchers). Dedicated assistance for the paying customers.	Niche market, Segmented Market, Multi-sided platform.
	Key Resources		**Channels**	

	Human resources, Crowd community, IoT Lab partnerships, testbeds, financial resources, intellectual resources (code, software, etc.)	monetization of contributed resources and providing a “social good” revenue distribution with charities.	IoT Lab website, IoT Lab App, Social media channels, Physical Channels (research events, conferences, workshops, etc.). Personal networks	

Cost Structure	**Revenue Streams**
The most important monetary consequences for IoT Lab are: - Payroll Expenses - Operating Expenses: • Third Party Fees: testbed fees, maintenance fees, rent etc. and • Sundry Expenses: Marketing & Advertising expenses, Hosting services, etc.	IoT Lab adopts different pricing models, associated with different service provision that target diverse types of user groups. 1. “D-Service” (Default Service) – free service for all individual users 2. “B-Service” (Basic Service) – low price service for Universities and Research centers. 3. “E-Service” (Extended Service) – medium price service for start-ups and SMEs and Public Administrations 4.“P-Service” (Premium Service) – higher price service for larger companies Addition revenue streams can also be: Sponsoring & Donations

Governance structure	**Incentive Model**
IoT Lab is an open, crowd-driven ecosystem that will be operated the IoT Lab Association (centralised model of governance). The IoT Lab Association is a nonprofit organization that has been established as a Swiss-based non-profit entity[4] by partners of the IoT Lab consortium (CTI, UniGE and MI) and it will ensure the sustainability and future evolution of the IoT Lab ecosystem.	IoT Lab has adopted a “Hybrid Gamified Incentive Model. ” This model combines intrinsic and extrinsic incentives, while it also includes innovative approaches that aim to enhance both the extrinsic, intrinsic and social motives such as the “gamification approach”.

[4] The non-profit association is the most common legal form for NGOs, whose non-profit character does not imply that the association must refrain from generating profit, but that any profits that are made may not be distributed to members and must be used by the association in order to achieve its aims. By law an association is considered to be a body in its own right. It can, therefore, employ personnel, make agreements, etc. Equally, it is liable for the actions carried out in its name. In Switzerland, the legal principles governing the establishment and functioning of these associations are found in Articles 60 to 79 of the Swiss Civil Code. (Source: MI).

5.4 IoT Lab Market Penetration

5.4.1 Generic Strategy

The IoT Lab penetration strategy at a geographical level adopts a layered approach. Initially it focuses upon the IoT Lab consortium countries (micro level – level 1) and expands to the European region (meso level- level 2) in order to finally reach international regions (macro level- level 3) (see Figure 33).

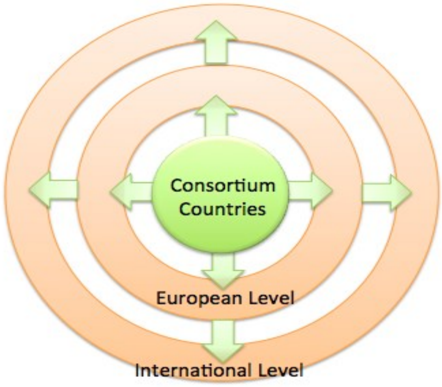

Figure 33: IoT Lab Generic Market Penetration Strategy

5.4.2 Strategic Penetration in the European Market

Level 1: Penetration in the IoT Lab Consortium Countries

The IoT Lab market penetration will start with the IoT Lab consortium countries (micro level – level 1), which are in total six EU region countries: four EU member countries, one EFTA country and one EU candidate country (Table 25).

Table 25: IoT Lab consortium countries

EU countries	UK Denmark Sweden Greece
EFTA countries (European Free Trade Association)	Switzerland
EU candidate	Serbia

Level 2: Penetration in the Rest of EU Countries

The second level of the IoT Lab penetration (level 2 - meso level) covers the European region. However, in order to penetrate the rest of EU countries, a strategic plan should be identified that will entail a gradual penetration. This will be achieved by segmenting the market.

<u>Segmentation process</u>

The first step towards the EU market division into homogeneous groups entails the identification of the classification variables. In the course of our study these variables evolve around three key areas (relevant to the IoT Lab aims and objectives):

- **Innovation Sector:** Innovation Union Score (per country).
- **Corporate Sector:** Number of Innovative Enterprises (NACE R2[5]) (innovation core activity per country).
- Higher Education Sector: Number of Universities (per country).

Cluster analytic techniques were employed in order to identify the natural groupings of countries, with high degree of similarity across the three key areas of interest. Specifically, both hierarchical clustering techniques (method: between-groups linkage, distance measure: square Euclidean distance) were utilised in order to derive the desired clusters. The results of this analysis are presented in the sections that follow.

Three distinct segments were identified, which exhibit a high degree of cohesion within cluster. As seen in Figure 34, the first cluster is composed by two countries, Germany and Italy which represent the highest values across all three strategic axis. The second cluster is a composition of Spain, Italy and Poland. Finally, the rest of the EU Member States participate in the third cluster, which reveals lower values across all classes of criteria.

[5] NACE is the statistical classification of economic activities in the EU; NACE is derived from the French Nomenclature statistique de activites economiques dans la Communaute europeene.

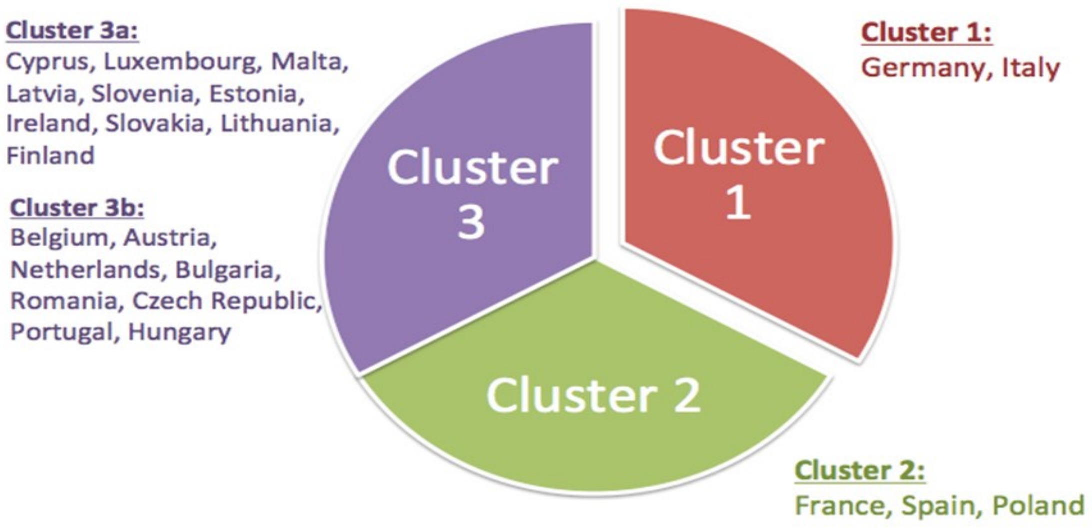

Figure 34: Overview of the IoT Lab EU Market Penetration per cluster

Acknowledging the fact that Cluster 3 has the majority of EU countries we have further conducted a cluster analysis in order to subdivide it. Based on our analysis, two sub-cluster emerge, Cluster 3a with ten EU countries (Cyprus, Luxembourg, Malta, Latvia, Slovenia, Estonia, Ireland, Slovakia, Lithuania, Finland) and Cluster 3b with nine countries (Belgium, Austria, Netherlands, Bulgaria, Romania, Czech Republic, Portugal and Hungary).

5.4.3 IoT Lab 5-Year EU Penetration Plan

Based on our preceding analysis, we can now define a five-year plan for the EU market penetration. Our penetration assumption is that we want to achieve steady penetration so as to progressively create a stable crowd-community and stakeholder community and align with the IoT Lab Association cost structure.

Our plan for the first five years of operations of the IoT Lab Association, entails a gradual penetration across the all EU countries. The first two years we will aim towards a growing the existing consortium countries in the EU region. Our expansion plan will start from Year 3 onwards enabling is to address key EU countries, with an established community while maintaining a relatively stable dissemination budget. During Year 3 we will penetrate Cluster 1 countries in addition to the enhanced penetration across the IoT Lab consortium countries (8 countries in total). This plan will continue into Years 4 (11 countries in total) and 5 (30 countries in total) where one new cluster will be penetrated each year (see Table 26).

Table 26: IoT Lab 5-Year Penetration Plan

	Year 1	Year 2	Year 3	Year 4	Year 5
No. of countries	6	6	8	11	30
Countries	Consortium countries	Consortium countries	Consortium countries & Cluster 1 countries	Consortium countries, & Cluster 1, Cluster 2 countries	Consortium countries, & Cluster 1, 2, Cluster 3 a, b countries

Based on this penetration plan the number of experiments via IoT Lab will increase gradually, enabling the IoT Lab Association to address user needs adequately. This will also be the case for the services that will be offered via the IoT Lab. In the first two years that enhanced dissemination activities will be required, the number of experiments are expected to be stable as IoT Lab will cross the “introductory phase” of its adoption life-cycle. The number of experiments will steadily grow from Year 3 onwards as market penetration will increase.

6 Conclusions and Recommendations

This deliverable presents the work carried out in the context of Task 6.3 Business Models and Opportunities Analysis, contributing to the goals of WP6 Economic and Business Opportunity Analysis.

As depicted in the course of our work a “holistic” approach has been adopted, facilitating the integration of the IoT Lab Incentive Model and Business Model; an integration, which creates a key strategic component for the success of the IoT Lab ecosystem (focusing on the post-project expiration phase) (see Figure 35). In particular, the “*IoT Lab Incentive Model*” will be utilised in order to motivate users’ participation and engagement within the system and the “*IoT Lab Business Model*” will satisfy stakeholders’ needs by delivering value via the envisioned IoT Lab services, triggering their active engagement with the IoT Lab ecosystem.

	IoT Lab User Groups					
Usage mode	Crowd/ End-users	Experiments-research/ Researchers	Universities	Testbed Infra structure providers	Companies	Public Authorities
Smart phone app	✔					
Web site		✔	✔	✔	✔	✔
Engagement mechanism	*Incentive model & Reputation Scoring*	*Engagement via Reputation Scoring & Business model*	*Engagement via the IoT Lab business model*	*Engagement via the IoT Lab business model*	*Engagement via the IoT Lab business model*	*Engagement via the IoT Lab business model*

Figure 35: IoT Lab Engagement Strategy

The IoT Lab Incentive Model

In accordance with our analysis the appropriate Incentive Model for IoT Lab, is a “*Hybrid Gamified Incentive Model*”, as it combines two key types of incentives, intrinsic and extrinsic incentives and includes innovative approaches that aim to enhance both the extrinsic, intrinsic and social motives such as *“gamification”.*

Furthermore, the IoT Lab Incentive Model is fully aligned with the "*Social Good Business Approach*" that has been adopted by the IoT Lab partners and which enhances further the intrinsic motives of the crowd participants, as they will be contributing to a greater cause that goes beyond contributing to emerging research. In particular, IoT Lab will allow its community members to allocate the points/credits collected by participating in the experiment to a charity of their choice, out of a list that will be provided by the platform. This approach is based on the working assumption that a research sponsor provides a budget for an experiment, out of which a small amount of the budget (social revenue distribution) will be used for the platform maintenance and the rest will be allocated to the users so that they can in turn re-allocate the amount to the charities proportionally based on their point/credit distribution.

The IoT Lab partners have considered the possibility to donate the majority of their revenues to charities. Anchored in this decision and based on our analysis, the optimal social revenue distribution percentage was identified which is: ***40% IoT Lab and 60% donations.*** As such, the total amount that could be donated to charities during the first five years of the IoT Lab operations, can reach the amount of ***2.4 million Euros,*** which constitutes a high social impact for the IoT Lab ecosystem.

The IoT Lab Business model

Based on our analytical findings, the appropriate Business Model for IoT Lab is a "***Social IoT Business Model***" (see Figure 36) that focuses not only upon sustaining the ecosystem (from a profit-oriented perspective) but also upon the impact (social impact) that IoT Lab creates for the crowd participants, its stakeholders, the charities that participate in the IoT Lab (direct beneficiaries) as well as the wider community.

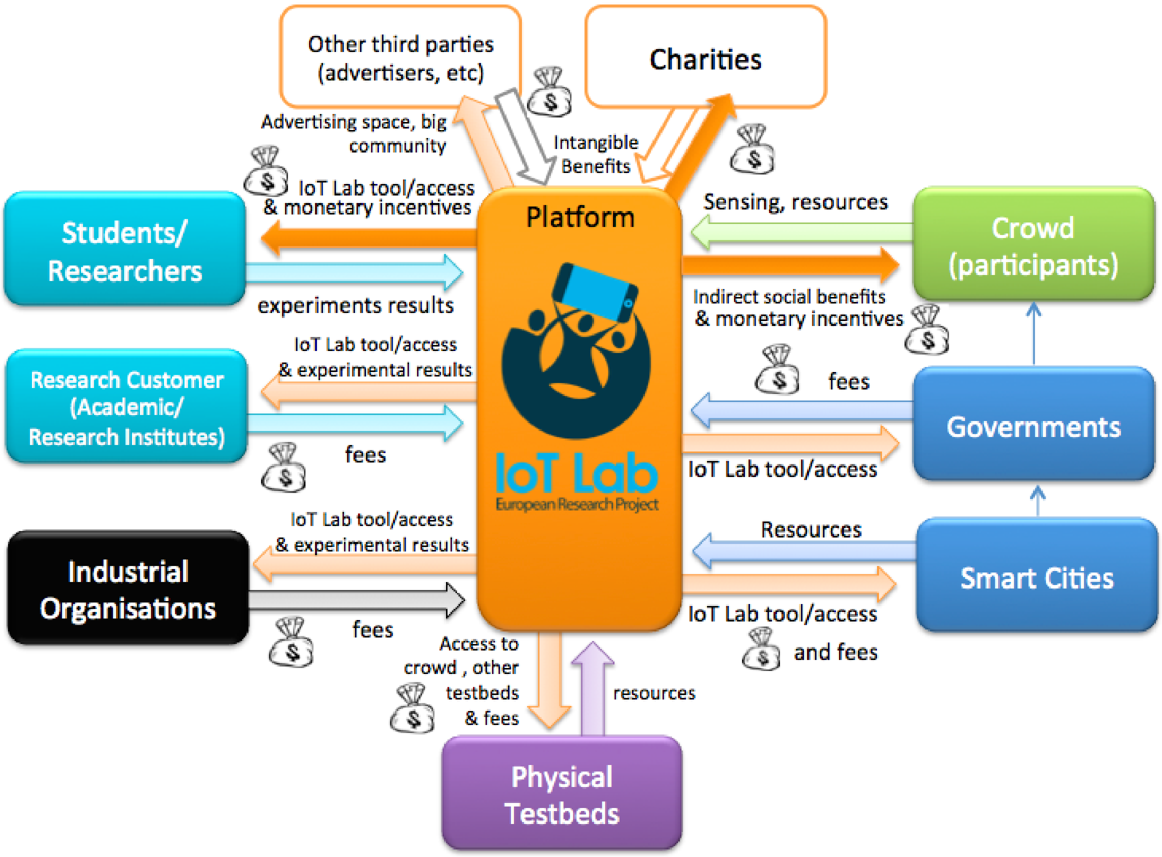

Figure 36: The IoT Lab Social Business Model

Our analysis of this model was facilitated via the introduction of a newly proposed Business Model framework for crowd-driven ecosystems, such as IoT Lab. In particular, this framework extends the "classic" Business Model canvas by integrating two additional components that relate to the needs of crowd-driven platforms and ecosystems, such as: *(a) Governance structure* (the governance model of the ecosystem), *(b) Incentive model* (the incentivisation schemes for the crowd-community and the rest of the ecosystem stakeholders).

The Incentive and Business Model components of the IoT Lab strategy has been identified with the last part of our analysis detailing the IoT Lab Penetration Strategy at a geographical level. The selected strategy adopts a layered approach, focusing initially upon the IoT Lab consortium countries (micro level – level 1) and expanded to the European region (meso level- level 2) in order to finally reach the international regions (macro level- level 3). This way a steady penetration is achieved, enabling IoT Lab to progressively create a stable crowd-community and stakeholder community that aligns with the IoT Lab Association cost structure.

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8 Appendix

8.1 Appendix 1. IoT Lab Value Chain Analysis Conclusions

Please note that this section provides an overview/summary of the analysis conducted in the course of Task 6.2: Cost and Efficiency Monitoring Tools and Comparative Analysis so as to facilitate the Business Model Analysis performed in this deliverable.

External Value Chain Analysis

In order to create the External Value Chain of the IoT Lab, we examined the Internet of Things (IoT) ecosystem-wide value-adding activities, from raw material (devices, sensors) to the end-user, describing the value-chain processes that represent an industry.

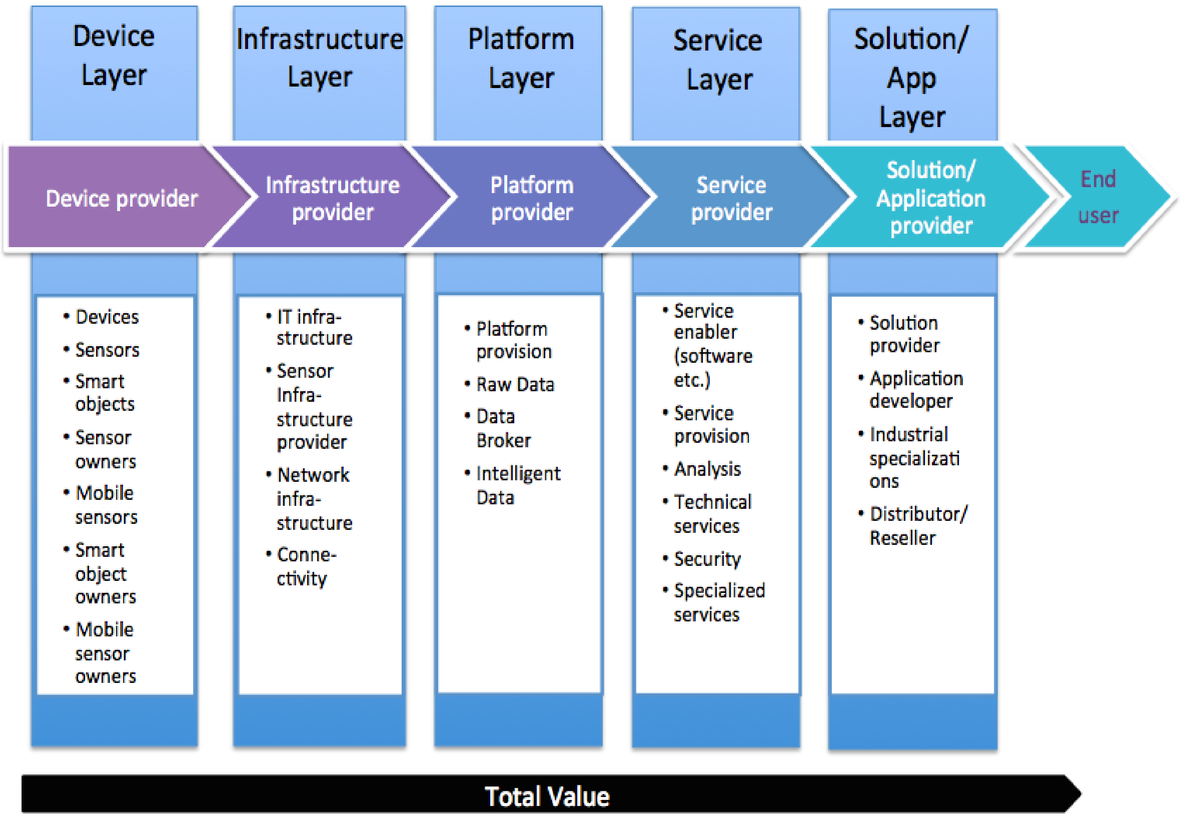

Figure 37: IoT Lab "External Value Chain" Analysis

Our analysis in Figure 37 presents five distinct layers of value adding activities and presents the associated stakeholders in each layer:

- ***Device Layer***: Data acquisition and capture devices and their associated device providers;
- ***Infrastructure Layer***: Different types of infrastructures, namely the IT, Sensor (IoT) and network infrastructure as well as the connectivity of smart devices and the network management (connectivity provisioning);
- ***Platform Layer***: The platform provision with the underlying management capabilities, different data types such as raw data (from sensors and data producers) and intelligent data (aggregated and analysed data) and data brokerage provision for organizing the value flow of data;
- ***Service Layer:*** Service enablers (i.e., software provision, etc.) as well as service provisioning platforms that provide a number of services (i.e., technical services, data analysis, specialized services, etc.);
- ***Solution/App Layer***: The provision of IoT solutions and application services to the end users.

IoT Lab's positioning in the External Value Chain

The position of IoT Lab in the external IoT value chain is a composition of two distinct roles across the platform layer and the service layer. As shown in the Figure 38 below, IoT Lab can act both formally as a ***platform provider*** and also play the role of the ***service provider*** in order to create additional value and competitive advantage.

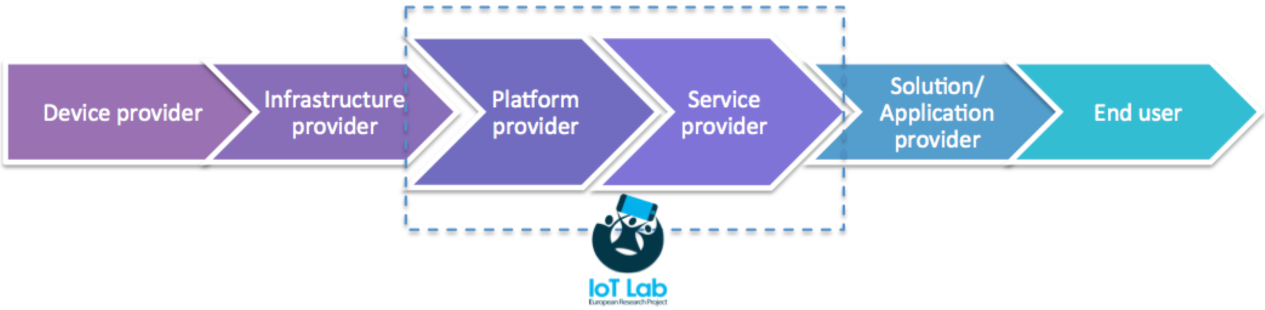

Figure 38: IoT Lab positioning in the IoT value chain

Based on this analysis a number of strategic service options were identified and comparatively assessed based on their internal cost implications in the course of D6.2 (Task T6.2).

IoT Lab Strategic Service Options Analysis Overview

The IoT Lab Strategic Service Options Analysis identified three service options based on two key service parameters: *(a) Degree of service provision:* (a1) Basic customer support (Basic Service covering technical support and experiment-related support) and (a2) Specialized customer support (extended/premium service technical support and experiment-related support) and *(b) Type of service provision:* (b1) In-house service provision and (b2) Service outsourcing to an external third party, as an attempt to achieve cost-effectiveness. These strategic service options for IoT Lab can be seen as a step to achieve a higher degree of vertical integration by undertaking more activities in the industry value chain. Our internal cost analysis (Figure 39) provided a number of key finding both at a cost as well as at a strategic level.

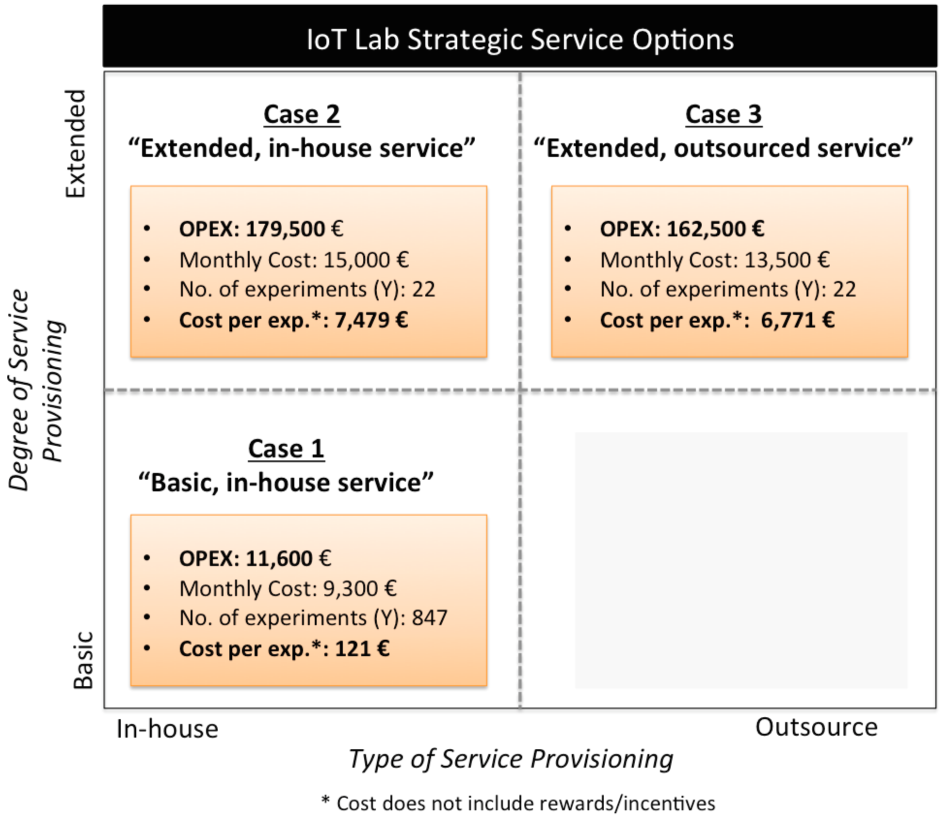

Figure 39: Comparative cost analysis for the IoT Lab Strategic Service Options

Internal Value Chain Analysis

In view of the strategic service options, for IoT Lab (i.e., capturing two distinct roles across the Platform and the Service layer) we conducted an Internal Value Chain Analysis. Our analysis provides an overview of the intra-IoT Lab value adding activities that essentially connects the supply and the demand side (Figure 9).

Following Porter's analysis [7] the IoT Lab activities that add value are primary and support activities.

The IoT Lab ***primary activities*** add value directly and include the following:

- ***Inbound logistics***: Receiving and managing data and services from service contractors and service suppliers (such as sensor providers, testbed owners/providers, crowdsourcing participants, etc.) as well as managing internal processes that relate to ensuring quality of service via quality controls/validation processes of the users (i.e., service suppliers such as crowd participants) or proposed experiments and it involves).
- ***Network infrastructure, development, operation and maintenance***: Process of transforming inputs into outputs, which in the context of IoT Lab include the network infrastructure, the core technologies as well as the diverse data sources that add value to the IoT Lab output.
- ***Service development and operation:*** Activities related to developing and delivering the IoT Lab service to its customers, as well as activities related to building brand awareness regarding the IoT Lab service.
- ***Service delivery***: Activities that are related to maintaining the value of the service even after it has been provided to the IoT Lab customers (i.e., follow up value with added services such as notification for experiments in the same research area, etc.).

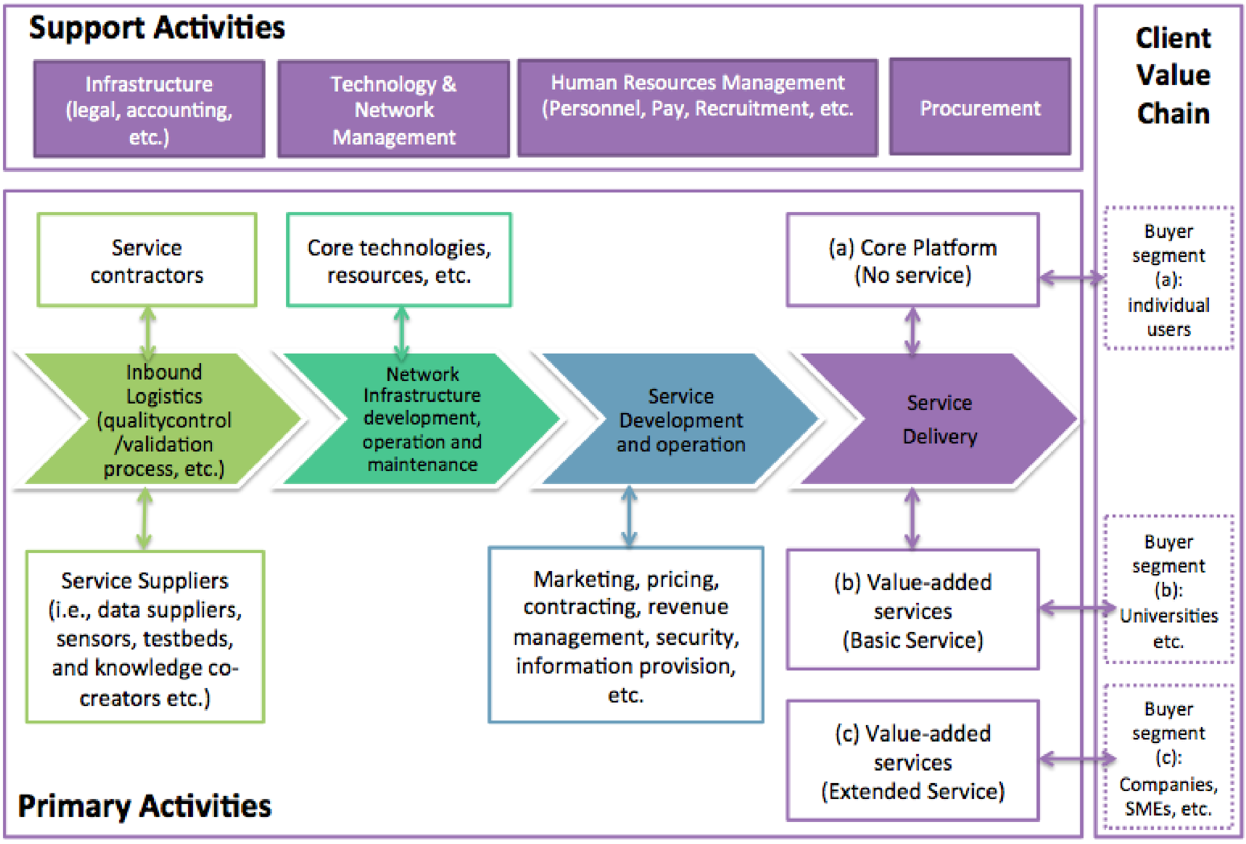

Figure 40: IoT Lab Internal Value Chain Model

The IoT Lab ***support activities*** add value indirectly by supporting the primary activities in their execution as presented below:

- ***IoT Lab Infrastructure:*** Activities related to the legal, financial, accounting and management processes within the organisation.
- ***Technology and Network Management:*** Activities related to the development of technologies (software and technical knowledge) to support value-creating activities of IoT Lab as well as network management activities.
- ***Human-resource Management*****:** Processes related to employee recruitment, training and compensation.
- **P*rocurement:*** Sourcing of services from external third parties (i.e., specialised service provisioning, etc.).

IoT Lab's margin/profit is highly dependent on its ability to effectively perform these internal value-adding activities so that the amount that its customers will be willing to pay for the service will exceed the cost of these intra-organizational activities. The

Internal Value Chain Model facilitated the definition of the IoT Lab's key value adding activities in which a competitive advantage can be achieved, either by providing lower cost (cost advantage) or superior service (differentiation advantage).

8.2 *Appendix 2. IoT Lab Partner-Service Form*

Mandat International

Partner Name	**Mandat International (MI)**
Country	**Switzerland**
Type of Organization (i.e., Academic, Commercial, etc.)	**Research**

Service Types	Description
Experimenter training services For individual experimenters and for corporate experimenters (Free and/or paid services)	-
Provision of online experimenter training material (free and/or paid material)	-
General supporting services for experimenters (free and/or paid material)	Research service and consulting
Experiment as a Service Test and development services that aim at providing specialised experimental design, implementation and analysis via IoT Lab facilities (Free and/or paid services)	This will be provided through the IoT Lab platform anyway
Content Updates (free and/or paid)	-
Provision of tools Development and provision of tools related to IoT Lab platform and/or mobile app (free and/or paid)	-
Custom developments and tools - Premium software and tools for experiments, via the IoT Lab	-
Support Services Technical, support for the platform and mobile app, assistance in using IoT Lab, support to testbed owners, other stakeholders, etc.	Technical support and research services
IoT Lab facility and infrastructure monitoring services Monitoring and operational status of IoT Lab, resource usage monitoring, etc.	MI smart office testbed
IoT Lab Maintenance Services	MI will support the server through the IoT Lab association
IoT Lab Platform upgrades & enhancements	-
IoT Lab Mobile App upgrades & enhancements	-
SLA services SLA establishment, discovery and negotiation, evaluation and related actions, between different actors such as: (a) testbed owners, (b) companies, (c) universities, (d) charities, and other stakeholders)	-

Service Types	Description
Consultancy services for different actors Technical, business consultancy, knowledge transfer services, etc.	Yes
Certification services for experiments via IoT Lab	-
Provision of training accreditation	-
Other services Please specify and detail your proposition for additional services that your organization can provide via the IoT Lab	Market analysis and end-user acceptance analysis

DunavNET

Partner Name	**DunavNET (DNET)**
Country	**Serbia**
Type of Organization (i.e., Academic, Commercial, etc.)	**SME**

Service Types	Description
Experimenter training services For individual experimenters and for corporate experimenters (Free and/or paid services).	This is not of interest for DNET.
Provision of online experimenter training material (free and/or paid material).	This is not of interest for DNET.
General supporting services for experimenters (free and/or paid services).	This is not of interest for DNET.
Experiment as a Service - Test and development services that aim at providing specialised experimental design, implementation and analysis via IoT Lab facilities (Free and/or paid services).	The outcomes of the IoT Lab project will be fully utilized to provide a basic setup of Experiment as a Service. DNET will plan these experiments within their existing range of smart city IoT services. The payment model will depend on the experimenter role and project aim; for example for society beneficial experiments the service resources can be donated.
Content Updates (free and/or paid)	This is not of interest for DNET.
Provision of tools - Development and provision of tools related to IoT Lab platform and/or mobile app (free and/or paid).	DNET will develop and provide additional tools requested by the users. The tools will be offered using SaaS model.
Custom developments and tools - Premium software and tools for experiments, via the IoT Lab.	Same as previous one
Support Services Technical, support for the platform and mobile app, assistance in using IoT Lab, support to testbed owners, other stakeholders, etc.	Not planned at the moment. However, it will be considered again towards the end of the project.
IoT Lab facility and infrastructure monitoring services Monitoring and operational status of IoT Lab, resource usage monitoring, etc.	Firstly this service needs to be provisioned within the IoT Lab project, and thereafter it should be mutually agreed how to proceed within the IoT Lab association or possibly commercially for DNET based on commercial grounds
IoT Lab Maintenance Services	Upon the completion of the project it should be decided whether the IoT Lab association will be a sole owner of the platform and associated services, or the rights will be equally shared by all the partners. Each commercial partner will then have to provide all the necessary services.

Service Types	Description
IoT Lab Platform upgrades & enhancements	DNET will continue this in a commercial manner.
IoT Lab Mobile App upgrades & enhancements	DNET will take this further if original IoT Lab mobile app is available to all the partners.
SLA services SLA establishment, discovery and negotiation, evaluation and related actions, between different actors such as: (a) testbed owners, (b) companies, (c) universities, (d) charities, and other stakeholders).	DNET will create individual SLAs depending on the role and type of the customer and the services provided.
Consultancy services for different actors Technical, business consultancy, knowledge transfer services, etc.	DNET will provide consultancy services as part of support package.
Certification services for experiments via IoT Lab	Not of interest to DNET
Provision of training accreditation	Not of interest to DNET
Other services Please specify and detail your proposition for additional services that your organization can provide via the IoT Lab.	This will be in line with DNET business and product development plan Transport service satisfaction Subjective assessment of the air quality Mood of the city Crowdsourcing/Crowdfunding for community projects

Computer Technology Institute and Press "Diophantus"

Partner Name	**CTI**
Country	**GREECE**
Type of Organization (i.e., Academic, Commercial, etc.)	**RESEARCH**

Service Types	Description
Experimenter training services For individual experimenters and for corporate experimenters (Free and/or paid services).	Free training service at the CTI premises. Introduction to crowd-driven research Technical usage support Training sessions organization
Provision of online experimenter training material (free and/or paid material).	Free training material at the CTI premises Leaflets, hardware and manuals
General supporting services for experimenters (free and/or paid material).	Free support, advising and consulting of experimenters
Experiment as a Service - Test and development services that aim at providing specialised experimental design, implementation and analysis via IoT Lab facilities (Free and/or paid services).	Modular experimental services development, on top of the current implementation
Content Updates (free and/or paid)	Support to the website manager regarding platform technical information
Provision of tools Development and provision of tools related to IoT Lab platform and/or mobile app (free and/or paid.) **Custom developments and tools** Premium software and tools for experiments, via the IoT Lab.	Several research oriented, technical tools can be developed: feature extraction tool, virtual testbeds, mobile testbeds, etc.
Support Services Technical support for the platform and Mobile App, assistance in using IoT Lab, support to testbed owners, other stakeholders, etc.	Technical support for the back end of the platform IoT Lab usage support Testbed managers coordination
IoT Lab facility and infrastructure monitoring services Monitoring and operational status of IoT Lab, resource usage monitoring, etc.	Server monitoring and coordination of the testbed owners
IoT Lab Maintenance Services	Technical support to the overall back end and CTI testbed maintenance
IoT Lab Platform upgrades & enhancements	Constant maintenance and upgrade of IoT Lab back end service and CTI testbed functionalities
IoT Lab Mobile App upgrades & enhancements	Ad hoc enhancements in order to promote possible future research directions
SLA services SLA establishment, discovery and negotiation, evaluation and related actions, between different actors such as: (a) testbed owners, (b) companies, (c) universities, (d)	-

Service Types	Description
charities, and other stakeholders	
Consultancy services for different actors Technical, business consultancy, knowledge transfer services, etc.	Knowledge transfer to the academic community of University of Patras through student and researcher collaborations
Certification services for experiments via IoT Lab	-
Provision of training accreditation	-
Other services Please specify and detail your proposition for additional services that your organization can provide via the IoT Lab	-

University of Geneva

Partner Name	**UNIGE**
Country	**Switzerland**
Type of Organization (i.e., Academic, Commercial, etc.)	**University**

Service Types	Description
Experimenter training services For individual experimenters and for corporate experimenters (Free and/or paid services)	To utilize the IoT Lab platform in the context of Academic courses for young researchers to be exposed to the concepts of IoT and Crowdsourcing/Crowdsensing
Provision of online experimenter training material (free and/or paid material)	To provide course material for young researchers on IoT and Crowdsourcing/Crowdsensing
General supporting services for experimenters (free and/or paid material)	Continuous support, amelioration and expansion of the functionalities provided by the platform
Experiment as a Service Test and development services that aim at providing specialized experimental design, implementation and analysis via IoT Lab facilities (Free and/or paid services.)	Continuous support on experiment scenario composition and virtual/modelled testbeds APIs
Content Updates (free and/or paid)	Depending on the demand, new services could be developed for supporting new types of experiments
Provision of tools- Development and provision of tools related to IoT Lab platform and/or mobile app (free and/or paid).	Continuous support on experiment scenario composition and virtual/modelled testbeds APIs
Custom developments and tools - i.e., premium software and tools for experiments, via the IoT Lab	Such software modules could be developed and supported depending on demand
Support Services Technical, support for the platform and mobile app, assistance in using IoT Lab, support to testbed owners, other stakeholders, etc.	Continuous support and amelioration of the provided services
IoT Lab facility and infrastructure monitoring services Monitoring and operational status of IoT Lab, resource usage monitoring, etc.	Continuous monitoring and maintenance of the IoT Lab DBs and the UNIGE testbed facility
IoT Lab Maintenance Services	Continuous monitoring and maintenance of the IoT Lab DBs and the UNIGE testbed facility
IoT Lab Platform upgrades & enhancements	Continuous monitoring and maintenance
IoT Lab Mobile App upgrades & enhancements	-
SLA services SLA establishment, discovery and negotiation, evaluation and related actions, between different actors such as: (a) testbed owners, (b) companies, (c) universities, (d) charities, and other stakeholders).	UNIGE would contribute towards defining and achieving SLA services regarding the IoT Lab platform

Service Types	Description
Consultancy services for different actors Technical, business consultancy, knowledge transfer services, etc.	UNIGE will contribute via corresponding training material (see above)
Certification services for experiments via IoT Lab	-
Provision of training accreditation	-
Other services Please specify and detail your proposition for additional services that your organization can provide via the IoT Lab	-

Alexandra Institute of Technology

Partner Name	**Alexandra Institute**
Country	**Denmark**
Type of Organization (i.e., Academic, Commercial, etc.)	**Research Institution**

Service Types	Description
Experimenter training services For individual experimenters and for corporate experimenters (Free and/or paid services).	Experimenter training services on IoT and crowdsourcing through workshops/tutorials, etc. (free and paid)
Provision of online experimenter training material (free and/or paid material)	Provisioning of different material (tutorials, videos, etc.) free and paid
General supporting services for experimenters (free and/or paid material)	Service co-creation and support (paid)
Experiment as a Service - Test and development services that aim at providing specialised experimental design, implementation and analysis via IoT Lab facilities (Free and/or paid services).	Help develop customized applications (paid)
Content Updates (free and/or paid)	Paid
Provision of tools Development and provision of tools related to IoT Lab platform and/or mobile app (free and/or paid).	Provision of examples and tools (free)
Custom developments and tools - Premium software and tools for experiments, via the IoT Lab.	Development of own crowdsourcing applications and services on market (paid/free)
Support Services Technical, support for the platform and Mobile App, assistance in using IoT Lab, support to testbed owners, other stakeholders, etc.	Stakeholder workshops and technical introduction to tools (free/paid)
IoT Lab facility and infrastructure monitoring services Monitoring and operational status of IoT Lab, resource usage monitoring, etc.	-
IoT Lab Maintenance Services	-
IoT Lab Platform upgrades & enhancements	-
IoT Lab Mobile App upgrades & enhancements	Update of applications
SLA services SLA establishment, discovery and negotiation, evaluation and related actions, between different actors such as: (a) testbed owners, (b) companies, (c) universities, (d) charities, and other stakeholders)	-
Consultancy services for different actors Technical, business consultancy, knowledge transfer services, etc.	Technical, business and knowledge services provisioning

Service Types	Description
Certification services for experiments via IoT Lab	-
Provision of training accreditation	-
Other services Please specify and detail your proposition for additional services that your organization can provide via the IoT Lab.	-

Lulea University of Technology – Centre for Distant Spanning Technology

Partner Name	**Luleå University of Technology**
Country	**Sweden**
Type of Organization (i.e., Academic, Commercial, etc.)	**Academic**

Service Types	Description
Experimenter training services For individual experimenters and for corporate experimenters (Free and/or paid services).	Botnia Living Lab services (paid)
Provision of online experimenter training material (free and/or paid material)	Our research papers and handbooks are available online for free
General supporting services for experimenters (free and/or paid material)	Botnia Living Lab can support experiments and real world pilots via the IoT Lab facilities (paid)
Experiment as a Service Test and development services that aim at providing specialised experimental design, implementation and analysis via IoT Lab facilities (Free and/or paid services).	Botnia Living Lab can support experiments and real world pilots via the IoT Lab facilities (paid)
Content Updates (free and/or paid)	No
Provision of tools Development and provision of tools related to IoT Lab platform and/or mobile app (free and/or paid).	No
Custom developments and tools Premium software and tools for experiments, via the IoT Lab.	No
Support Services Technical, support for the platform and mobile app, assistance in using IoT Lab, support to testbed owners, other stakeholders, etc.	We can assist in stakeholders' engagement in innovation processes via Botnia Living Lab (paid).
IoT Lab facility and infrastructure monitoring services Monitoring and operational status of IoT Lab, resource usage monitoring, etc.	No
IoT Lab Maintenance Services	No
IoT Lab Platform upgrades & enhancements	No
IoT Lab Mobile App upgrades & enhancements	No
SLA services SLA establishment, discovery and negotiation, evaluation and related actions, between different actors such as: (a) testbed owners, (b) companies, (c) universities, (d) charities, and other stakeholders)	No

Service Types	Description
Consultancy services for different actors Technical, business consultancy, knowledge transfer services, etc.	No
Certification services for experiments via IoT Lab	No
Provision of training accreditation	No
Other services Please specify and detail your proposition for additional services that your organization can provide via the IoT Lab.	No

University of Southampton

Partner Name	**University of Southampton (SOTON)**
Country	**UK**
Type of Organization (i.e., Academic, Commercial, etc.)	**Academic**

Service Types	Description
Experimenter training services For individual experimenters and for corporate experimenters (Free and/or paid services)	No
Provision of online experimenter training material (free and/or paid material)	No
General supporting services for experimenters (free and/or paid material)	No
Experiment as a Service Test and development services that aim at providing experimental design, implementation and analysis via IoT Lab facilities (Free and/or paid services).	SOTON will provide test and development services that aim at providing experimental design, implementation and analysis via IoT Lab facilities but only for business related experiments.
Content Updates (free and/or paid)	SOTON will provide content updates for the IoT Lab.
Provision of tools development and provision of tools related to IoT Lab platform and/or mobile app (free and/or paid)	SOTON will develop and provide tools related to IoT Lab platform and/or mobile app but only for business related experiments.
Custom developments and tools Premium software and tools for experiments, via the IoT Lab.	No
Support Services Technical, support for the platform and mobile app, support to testbed owners, other stakeholders, etc.	No
IoT Lab facility and infrastructure monitoring services Monitoring and operational status of IoT Lab, resource usage monitoring, etc.	No
IoT Lab Maintenance Services	No
IoT Lab Platform upgrades & enhancements	No
IoT Lab Mobile App upgrades & enhancements	No
SLA services SLA establishment, discovery and negotiation, evaluation and related actions, between different actors such as: (a) testbed owners, (b) companies, (c) universities, (d) charities, and other stakeholders).	No

Service Types	Description
Consultancy services for different actors Technical, business consultancy, knowledge transfer services, etc.	No
Certification services for experiments via IoT Lab	No
Provision of training accreditation	No
Other services Please specify and detail your proposition for additional services that your organization can provide via the IoT Lab	No

University of Surrey

Partner Name	University of Surrey
Country	UK
Type of Organization (i.e., Academic, Commercial, etc.)	**Academic**

Service Types	Description
Experimenter training services – For individual experimenters and for corporate experimenters (Free and/or paid services)	Hands on training through industry short courses can be provided.
Provision of online experimenter training material (free and/or paid material)	Not foreseen at this stage.
General supporting services for experimenters (free and/or paid material)	Handbooks and guidelines for the use of sensor suite (deskegg) resources.
Experiment as a Service - Test and development services that aim at providing specialised experimental design, implementation and analysis via IoT Lab facilities (Free and/or paid services).	This can be offered on a case by case basis, either as a technology or as a social science research project.
Content Updates (free and/or paid)	Not applicable.
Provision of tools Development and provision of tools related to IoT Lab platform and/or mobile app (free and/or paid).	The IoT-Lab mobile App will be provided for free, the software will be maintained for a period after project end, longer tem maintenance arrangements will need to be made.
Custom developments and tools Premium software and tools for experiments, via the IoT Lab	UoS can offer the use of their deskegg sensor suite which is used for workplace research as well as social research projects.
Support Services Technical, support for the platform and mobile app, assistance in using IoT Lab, support to testbed owners, other stakeholders, etc.	Support related to the sensor suite and local IoT-Lab facilities can be provided.
IoT Lab facility and infrastructure monitoring services Monitoring and operational status of IoT Lab, resource usage monitoring, etc.	The Surrey Smart Campus deployment connected to IoT-Lab will be maintained by UoS.
IoT Lab Maintenance Services	Not applicable.
IoT Lab Platform upgrades & enhancements	Upgrades of the smart campus testbed as well as of versions of the deskegg will be undertaken following the development plans for both.
IoT Lab Mobile App upgrades & enhancements	Initial updates/maintenance are foreseen for the project duration, upgrades and extensions at a later stage will need to be agreed.
SLA services SLA establishment, discovery and negotiation, evaluation and related actions, between different actors such as: (a) testbed owners, (b) companies, (c) universities, (d) charities, and other stakeholders)	UoS will follow the approach taken by the project.

Service Types	Description
Consultancy services for different actors Technical, business consultancy, knowledge transfer services, etc.	Technology consultancy can be offered on a per need basis.
Certification services for experiments via IoT Lab	-
Provision of training accreditation	-
Other services Please specify and detail your proposition for additional services that your organization can provide via the IoT Lab	-