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D4.15 GATEKEEPER Marketplace Services

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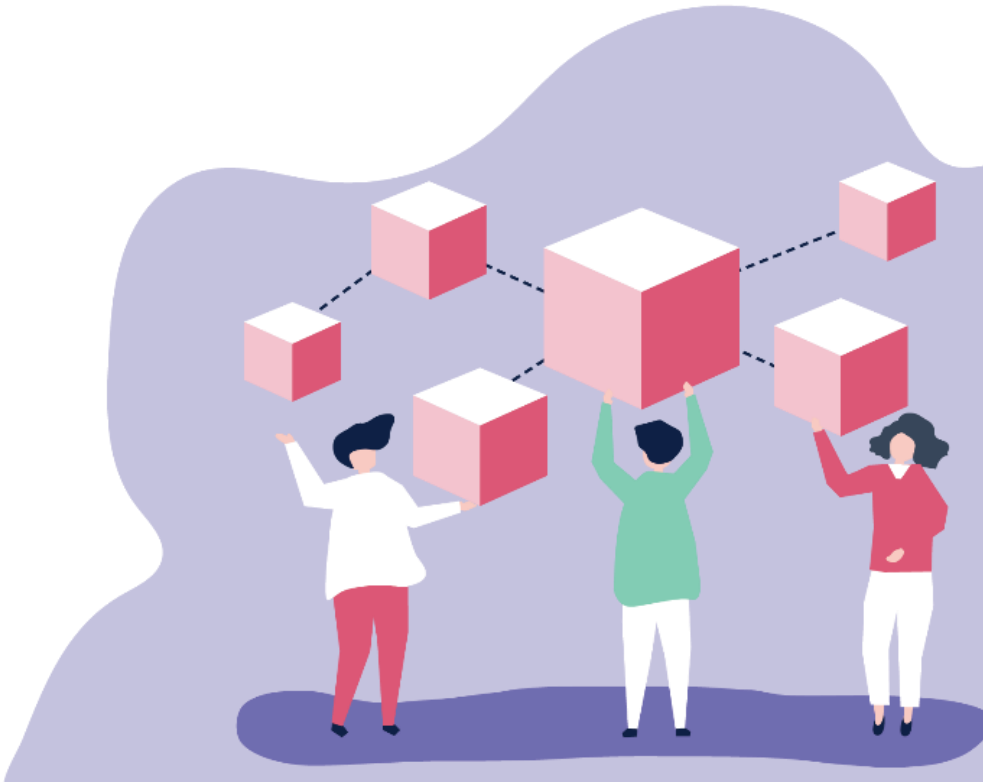

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Abstract

D4.15 "GATEKEEPER Marketplace Services" presents the outcome of T4.6 - GATEKEEPER Marketplace, which is part of Work Package 4 "GATEKEEPER Things Management Infrastructure & Development". The document initially presents the development of the GATEKEEPER Marketplace – a one-stop-shop for developers to provide and monetise their applications and for users to discover, obtain and deploy them. D4.6 first provides a state-of-the-art review of marketplaces within and beyond Web of Things (WoT), as well as the requirements and use case scenarios for the GATEKEEPER marketplace. Next, the stakeholder interaction flows envisioned are outlined, so as to clarify the business perspective. The implemented features are then presented, including both updates to the browsing, registering Things, and extracting analytics pages and an analysis of the newly added functionalities including data sharing through IDS Connectors, Things' testing capabilities before the final purchase, facilitated datathon organisation, and an interactive dialogue-based assistant. Discovery of available Things is possible through logic- and text-based search, while an administrator environment enables moderating and organising. The integration of the Marketplace is ongoing, therefore advances to it and further development to implement the business model will be described in the next version of this deliverable.

Statement of originality

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1 Introduction

The GATEKEEPER Marketplace is a single-entry point for all users to explore, conceptualize, test and consume the added value services they are interested in. As a high-level component, the Marketplace is a web application with a User Interface (UI) to allow users from all Spaces (Consumer, Healthcare and Business) to share and discover the Marketplace Things (certified solutions, services and devices provided). To do so, it interacts with multiple components in GATEKEEPER, such as the Things Management System (TMS) to allow discovery of Services/Things, the GATEKEEPER Trust Authority (GTA) to allow secure authentication and the Validator to allow publishing of only certified/validated content.

In an era where marketplaces are on the rise, the GATEKEEPER Marketplace offers unique capabilities. Item marketplaces (e.g. Amazon, eBay) were followed by smartphone app stores (Apple, Google, Samsung) and more recently by data marketplaces, especially in European project platforms. The GATEKEEPER Marketplace offers a unique variety of content including not only apps, most common in app stores, but also services/Things and datasets. Interconnected with the GATEKEEPER Platform it provides secure authentication, discovery and validated/certified content. Connecting the pilot sites in the project it will facilitate cross-border and cross-use case applications and ecosystem growth.

From a business and exploitation perspective, the GATEKEEPER Marketplace will be the infrastructure to enable transactions (trading) and technical platform services (as described in D9.5). Considering the spaces conceptualized by GATEKEEPER (Figure 1), specifically healthcare (business-to-government, B2G), consumer (business-to-consumer, B2C) and ecosystem transaction space (business-to-business, B2B), intra-space and inter-space transactions are envisioned to be supported.

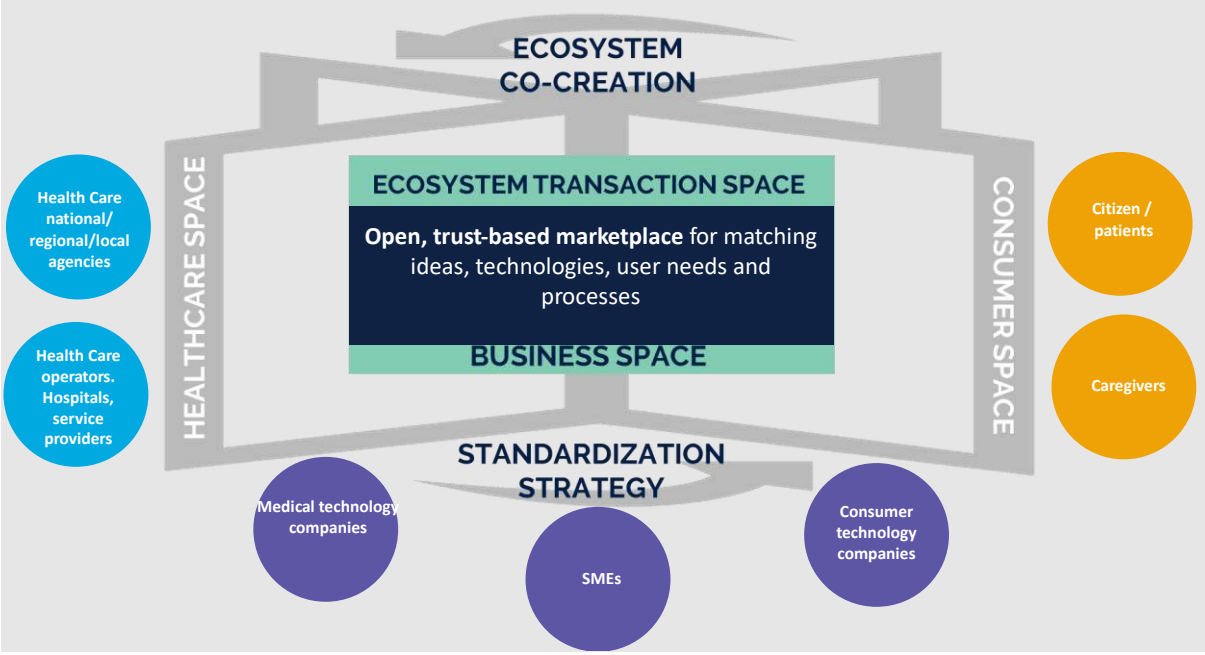

Figure 1 - The GATEKEEPER concept

This deliverable follows up on:

- D2.13 "User Requirements and Taxonomy", further analysing user requirements with respect to the Marketplace
- D3.1.2 "Functional and technical requirements of the GATEKEEPER Platform" to align with the Platform requirements and terminology
- D3.3.2 "Interoperability within GATEKEEPER, second edition" to follow the interoperability guidelines described
- D3.6 "Overall GATEKEEPER architecture" about the overall architecture of the GATEKEEPER ecosystem and the relation of the Marketplace with the main components
- D3.8 "Semantic Models, Vocabularies & Registry", using the Key Enabling Technologies (KETs) shared by the partners there, to serve as initial content for the Marketplace
- D4.14 "Gatekeeper Trust Authority" as Marketplace features, such as data sharing and Intelligent Discovery, are dependent on or enhanced by the integration with the Gatekeeper Trust Authority component
- D9.5 "Exploitation and sustainability" about an initial overview of the needs of the multi-sided platform model of the project that the Marketplace must satisfy.

The Marketplace within GATEKEEPER is presented in **Section 2** and a state-of-the-art review in **Section 3** shows a prevalence of marketplaces on the web. The GATEKEEPER Marketplace requirements and specifications are displayed in **Section 4**, while the business model and the progress towards its implementation are presented in **Section 5. Section 6** elaborates on the functionalities offered. Afterwards, **Section 7** outlines the integration with other components, then **Section 8** summarizes the conclusions and future steps from this deliverable.

2 The Marketplace within GATEKEEPER

The schemas in Figure 2 and Figure 3 respectively show the relation of the Marketplace with the GATEKEEPER components and the base behaviour for all interactions that take place in the GATEKEEPER Platform. As described in D3.6, the Marketplace is the commercial entry point of the whole Platform. It allows users to explore, provide or consume Things registered in the Platform while the GATEKEEPER components interconnect, performing validation, authorization and security checks for auditing purposes.

The Marketplace can be accessed publicly at https://gatekeeper-marketplace.iti.gr/.

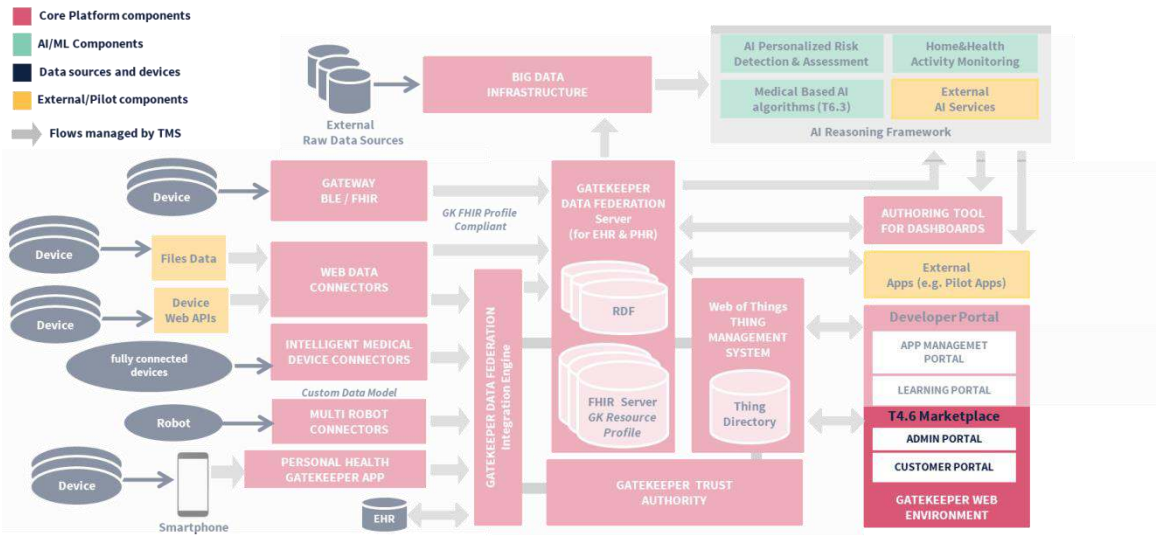

Figure 2 - Marketplace relation with the GATEKEEPER components

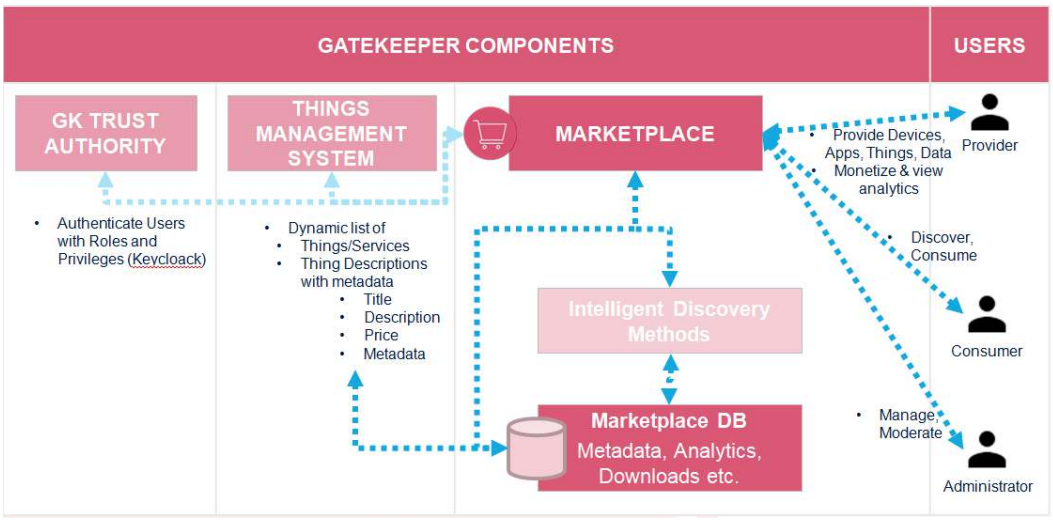

Figure 3 - GATEKEEPER Components

3 Existing State-of-the-Art Marketplaces

This section explores the state-of-the-art in online marketplaces, within the GATEKEEPER platforms, similar to R&D project efforts. It also explores discovery tools and open-source solutions related to the infrastructure of the proposed GATEKEEPER Marketplace to place it in context and shape its specification.

3.1 Marketplaces in European Large-Scale Pilots

The European Large-Scale Pilots Program [1] includes the innovation consortia that are collaborating to foster the deployment of Internet of Things (IoT) solutions in Europe. These are targeted, goal-driven initiatives that propose IoT approaches to specific real-life industrial/societal challenges. Through the integration of advanced technologies across the value chain, demonstration of multiple IoT applications at scale and in a usage context, are as close as possible to operational conditions. The consortia currently include:

- ACTIVAGE [2]
- AUTOPILOT [3]
- IOF2020 [4]
- MONICA [5]
- SYNCHRONICITY [6]
- CREATE-IOT [7]
- U4IOT [8]

Concurrently, the Web of Things (WoT) seeks to counter the fragmentation of the IoT by using and extending existing, standardized Web technologies [9]. There is a prevalence of marketplaces accompanying every WoT aspect of life: agriculture, smart city, healthcare and transportation (Figure 4). Therefore, all of the above consortia aim to progress in IoT and have, others more and others less, the intention to reshape or create markets in Europe. Central to this strategy is often a marketplace as the one envisioned in GATEKEEPER and the objective of this deliverable.

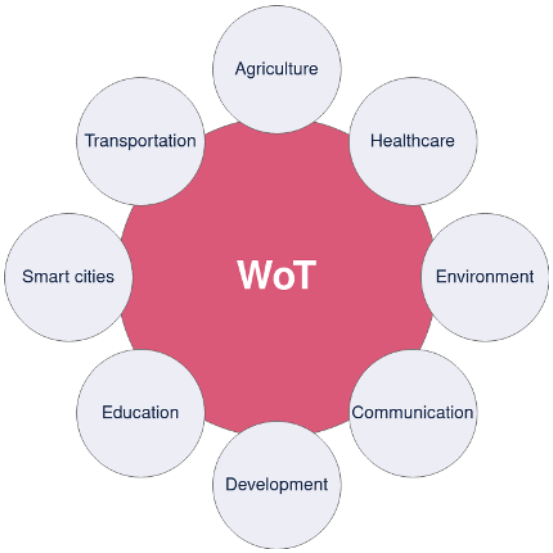

Figure 4 - Web of Things

As a prevalent example, the ACTIVAGE Marketplace [2] (Figure 5) follows the paradigm of IoT European platforms offering the ability to monetize and discover apps built on top of them in the domain of health and Active and Healthy Ageing (AHA), according to ACTIVAGE deliverable D4.3 [10].

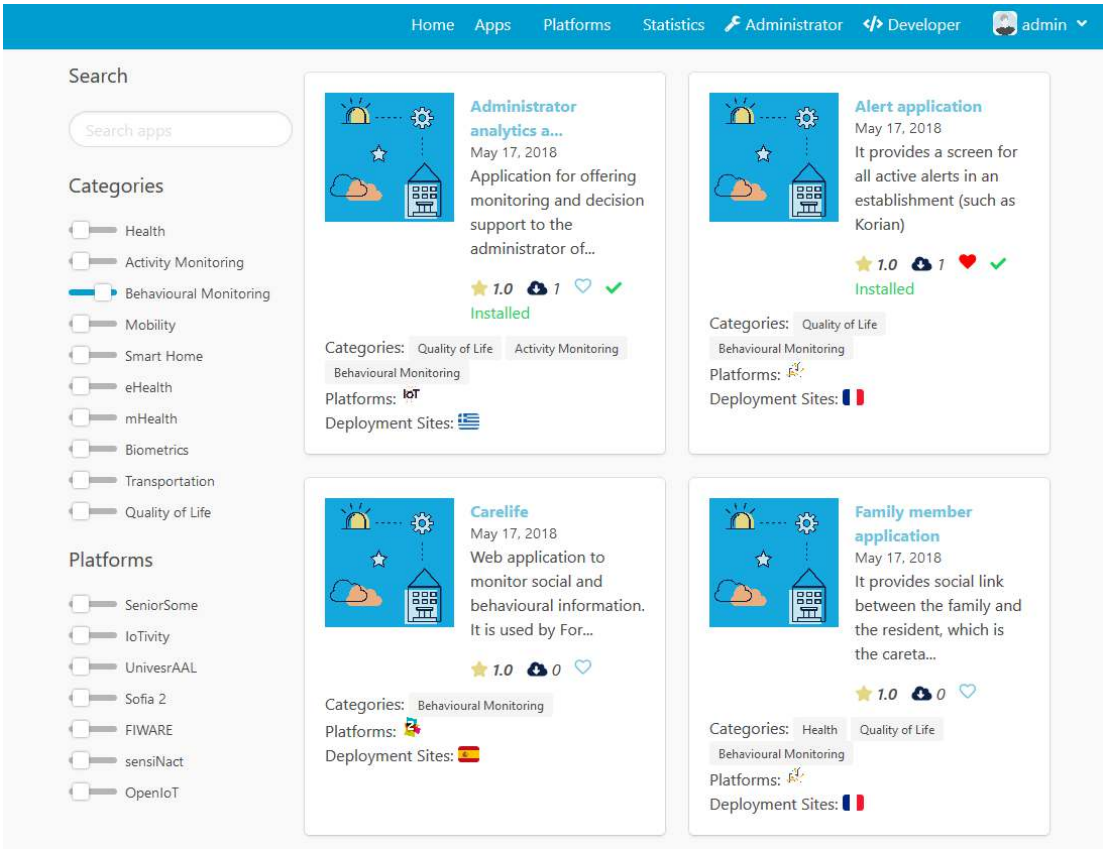

Figure 5 - The ACTIVAGE Marketplace

IOF2020 [4] also offers a data marketplace with datasets around IoT and farming (Figure 6).

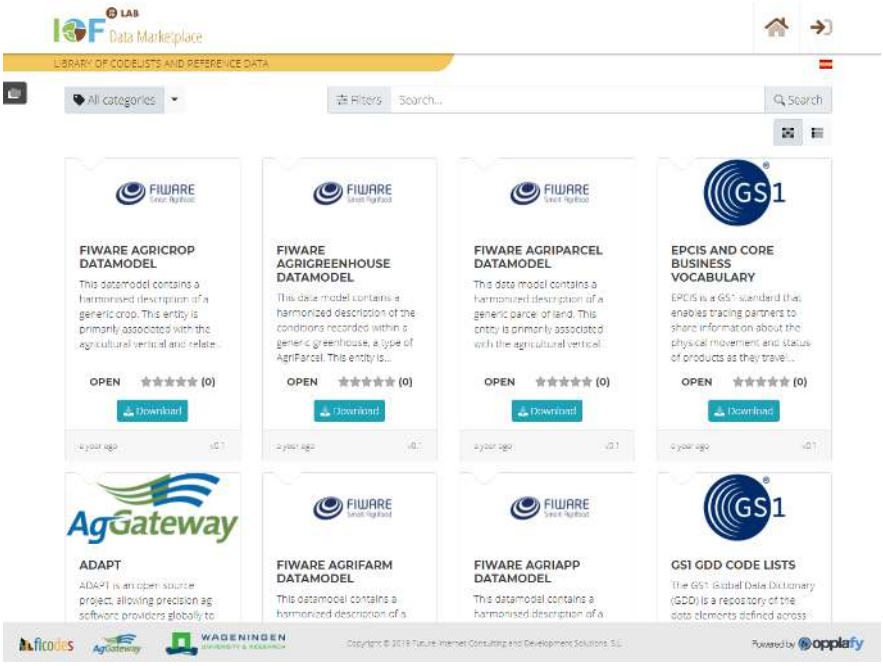

Figure 6 - The IOF2020 Data Marketplace for Farming

Beyond State of the Art: The GK Marketplace goes beyond standard IoT platform marketplaces as it offers:

- Services/Things in addition to Apps and Datasets
- Connection to a more sophisticated platform utilizing the Web of Things, validated/certified content, secure authentication and more

3.2 SIKKA

Sikka Software [11] is reimagining the retail healthcare market using a single API cloud platform with Artificial Intelligence (AI) and Predictive Analytics with the SIKKA Marketplace (Figure 7). They focus on non-physician practices, including dentistry, veterinary, optometry, chiropractic, orthodontics, oral surgery and more.

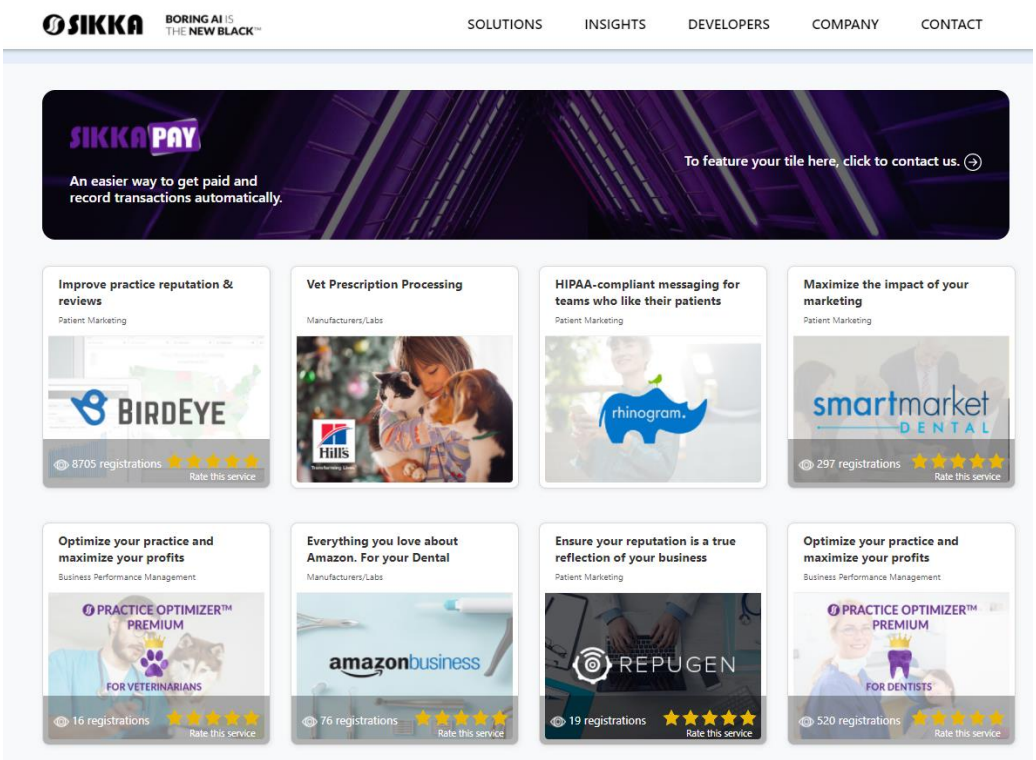

Figure 7 - The SIKKA Marketplace

Beyond State of the Art: The GK Marketplace includes a more organized solution in order to preview the Things offered allowing users to apply filters and sorting, also extending the discovery capabilities by a) offering devices, services, apps in addition to datasets or health condition (and separate fields to discover them), b) offering an intelligent search functionality by combining hierarchical (semantic) category search with text similarity when using keyword search.

3.3 Samsung Health

From patient engagement to clinical performance, Samsung Health [12], shown in Figure 8, deploys healthcare technology in hospitals in order to enhance the patient experience and improve clinical workflow with targeted healthcare technology solutions, incorporating the following elements:

Broad device portfolio to meet any purpose

Secure, yet open with a rich partner ecosystem and wide range of use cases, form factors and specifications.

Continuum of care in any setting

Empowering clinicians to do more with a single device, maximizing provider efficiency and improving the patient experience.

Personalized care, from hospital to home

Easy-to-use devices that are patient-ready right out of the box, with simplified user interfaces including special options for seniors.

HIPAA-ready device security

Knox defence-grade security from hardware to software, with data encryption and continuous threat monitoring to protect sensitive Patient Health Information (PHI).

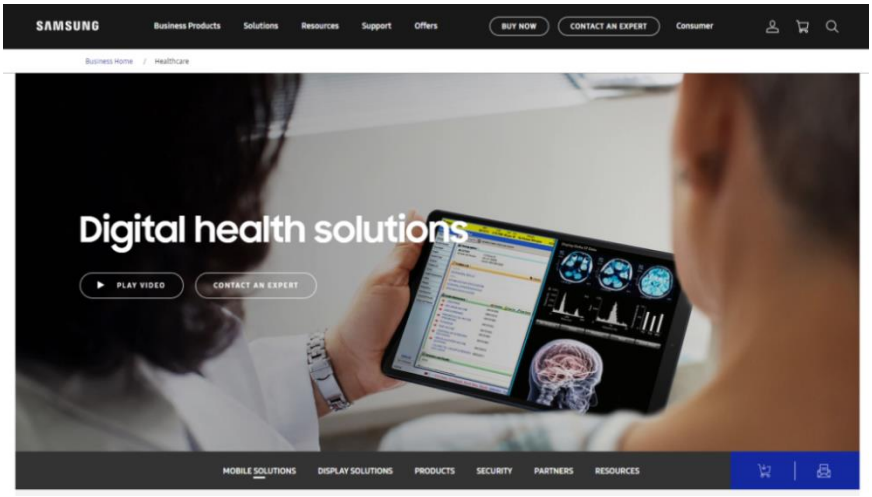

Figure 8 - Samsung health

Beyond State of the Art: The GK Marketplace includes the same functionality to categorize Things, allows users to apply filters and sort and extends the discovery capabilities by also offering devices, services and apps in addition to datasets (and separate fields to discover them).

3.4 Beyond State of the Art for the GK Marketplace

The GK Marketplace offers not only similar features to other marketplaces but also unique features and functionalities, beyond the state of the art. Similar features include user roles, which are typically the providers and consumers, and the Marketplace functioning as a broker between them. There are also administrators to manage and moderate the platform. Like other typical store catalogues, it offers a full offerings list that can be customized with filters, keyword search and sorted according to various criteria. More advanced features include a workbench to test data sets and facilitated datathon organization.

The unique features of the GK Marketplace include:

- **Diverse Offerings of Devices, Apps, Services and Datasets:** While most marketplaces offer one or two of these options, the GK Marketplace provides all four types of Things and the ability to discriminate them easily (each with unique filters and metadata), as well as functionality to test and obtain/deploy them. The whole feature is compliant with the FAIR principles [13].
- **Compliance with standards including W3C WoT, FHIR and ISO:** The GK Marketplace entails communications with the GK Validator to ensure that all Things comply with established standards pertaining to their type. Specifically, Things/Services are automatically validated for compliance with the W3C WoT standard for APIs and HL7/FHIR unique to healthcare data exchange. Additionally, there are semi-automatic validation capabilities for statements and legal

documents, such as CE-mark certification validation by experts in the case of medical-grade devices.

- **Intelligent Discovery:** While most marketplaces offer the typical store list view with filters and keyword search, the GK Marketplace employs a hybrid similarity method [14] to find the best matches and suggest alternatives. The method combines hierarchical relationships between filters chosen by the users and flexible text-similarity between keywords typed by the users and the actual available Things.
- **Workbench testing of Things/Services and Datasets:** While most marketplaces offer one or the other, the GK Marketplace offers the ability to test existing Things/Services with sample, configurable inputs for each of them as well as datasets in common format and customizable code.
- **Datathon support:** The GK Marketplace facilitates organization and participation in datathons, allowing users to create, market and conduct such competitions using datasets directly through it in order to generate insights and potential solutions for the global community.
- **Security and Trust:** The GK Marketplace goes beyond the typical security approach of most marketplaces by being part of the GK ecosystem, offering a GATEKEEPER Trust Authority component described in D4.14 to authenticate users with assigned roles/privileges and a blockchain approach to data security. Particularly for services, they are dynamically added and maintained by a universal Things Validator System accessible only from within the ecosystem.
- **Dynamic consent and International Data Spaces (IDS) compliance:** The GK Marketplace will also allow Thing providers to give dynamic consent to Thing Consumers on accessing their Things. This dynamic consent mechanism will be based on a set of attributes provided by the Thing Consumer and by employing an attribute-based access control mechanism to check their attributes. Data sharing in the GK Marketplace is compliant with the IDS reference Architecture Model 3.0 [15].

Table 1 shows the features and functionality of existing marketplaces and the GATEKEEPER Marketplace. Its purpose is to highlight its added value and to make sure that it achieves the highest standards relative to format, consistency, completeness and quality.

Table 1: Existing marketplaces vs. GK Marketplace

	universAAL - reAAL	OpenIoT	Sensi Nact	Sofia2	FIWARE	IoTivity	Senior Some	Activage	SIKKA	Samsung Health	GATE KEEPER
Marketplace is Online	✓	✓	✓	-	✓	✓	-	✓	✓	✓	✓
Marketplace is Open Source	✓	-	-	-	✓	-	-	✓	✓	✓	✓
Users can offer apps/services	✓	-	✓	-	✓	✓	-	✓	✓	✓	✓
Users can sell apps/services	✓	-	✓	-	-	-	-	✓	✓	-	✓
Providers can view Analytics	✓	-	✓	-	✓	✓	-	✓	✓	✓	✓
Multi-criteria search and filtering	✓	-	-	-	-	-	-	✓	✓	✓	✓
Featured and Top Rated Apps	✓	-	-	-	-	-	-	✓	✓	✓	✓
Users can register and maintain a wish list, installed apps list, write reviews and provide ratings	✓	-	-	-	-	✓	-	✓	✓	✓	✓
Users can download apps	✓	-	✓	-	-	✓	-	✓	✓	✓	✓
Applications can be updated	✓	-	✓	-	-	-	-	✓	✓	✓	✓
Users can download datasets	-	-	-	-	-	-	-	-	-	-	✓
Users can test datasets	-	-	-	-	-	-	-	-	-	-	✓
Users can organize datathons	-	-	-	-	-	-	-	-	-	-	✓
Users can access Services/Things	-	-	-	-	-	-	-	-	-	-	✓
Users can test Services/Things	-	-	-	-	-	-	-	-	-	-	✓

Content is validated according to standards (FHIR, W3C, ISO)	-	-	-	-	-	-	-	-	-	-	✓

4 Marketplace Requirements and Specification

This section defines the GATEKEEPER Marketplace specifications to extract the functionality to be implemented. Firstly, we have conducted a requirement analysis in the form of polls and with the help of WP2, among the project members. Then, we have defined the end-user roles and the functionality that the Marketplace should provide to each of them. Finally, we have provided use case scenarios to fully conceptualize the flows to be implemented and the end-result to realize from the end-user perspective.

4.1 Requirement Analysis

The polls below were created and distributed over email among project partners early on (even before the task started) with the help of WP2, using Google Forms. As described in D2.3 (and in its second version, D2.13), a total of 32 answers were collected, where 20 responders were related to Pilot Cluster, 8 to Platform Cluster, 2 to Business Cluster, 1 to both (Pilot and Business cluster) and a last one related to a multi-stakeholder's network. Most of the participants are related to the pilot organization and conduction of the pilot and the implementation of technological solutions to support them. The user requirements in D2.13 are focusing on:

- Functional
- Usability and Humanity Requirements
- Look and Feel Requirements
- Compliance Requirements

Questions
1. In which cluster is your main role in the project?
2. What is your main role in the project?
3. Are you a solutions provider or a consumer?
4. How would you characterize your solution?
5. Is your solution uploaded in any other marketplace or listing?
6. Is your solution packaged?
7. What do you expect the Marketplace to help you in regards with?
8. What do you expect to find in the Marketplace?
9. What do you expect to achieve through the Marketplace?

The outcomes of this survey are illustrated in the Figure 9 - Figure 18.

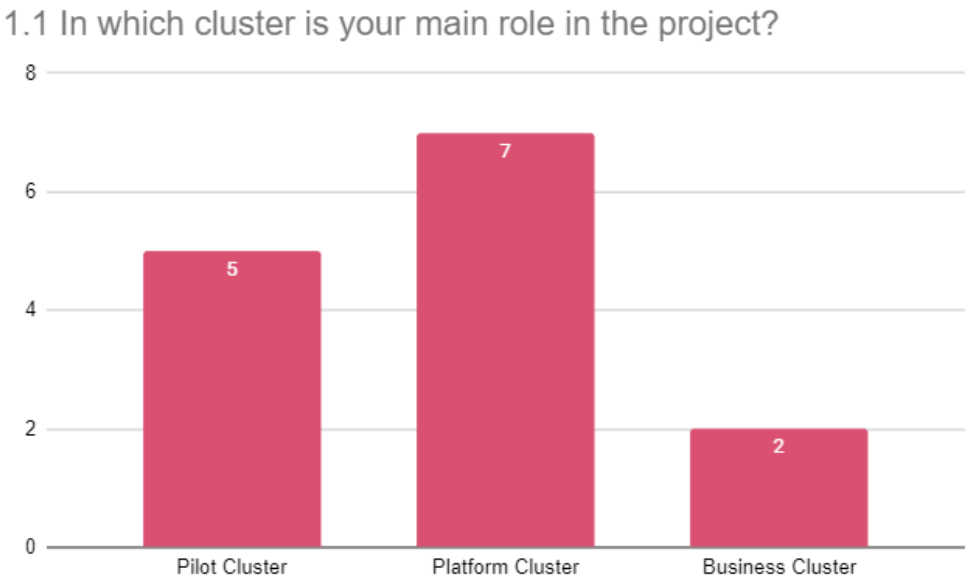

Figure 9 - Cluster main roles distribution

The vertical bars in Figure 9 show comparisons among the three categories about the cluster main roles.

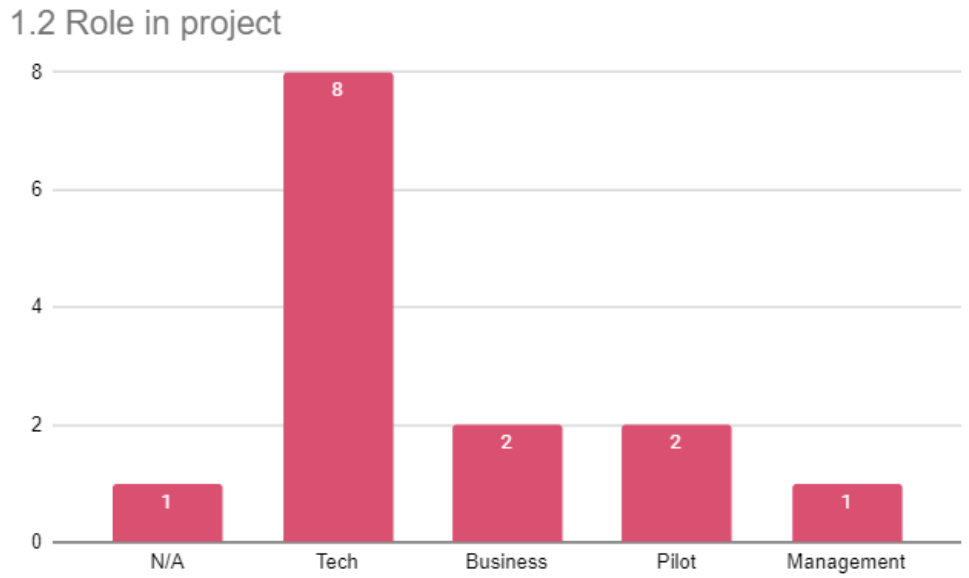

Figure 10 - Roles in project distribution

Similarly, the chart in Figure 10 displays the distribution between the project roles. It is quite clear that the majority of the project partners identify themselves in the Tech industry.

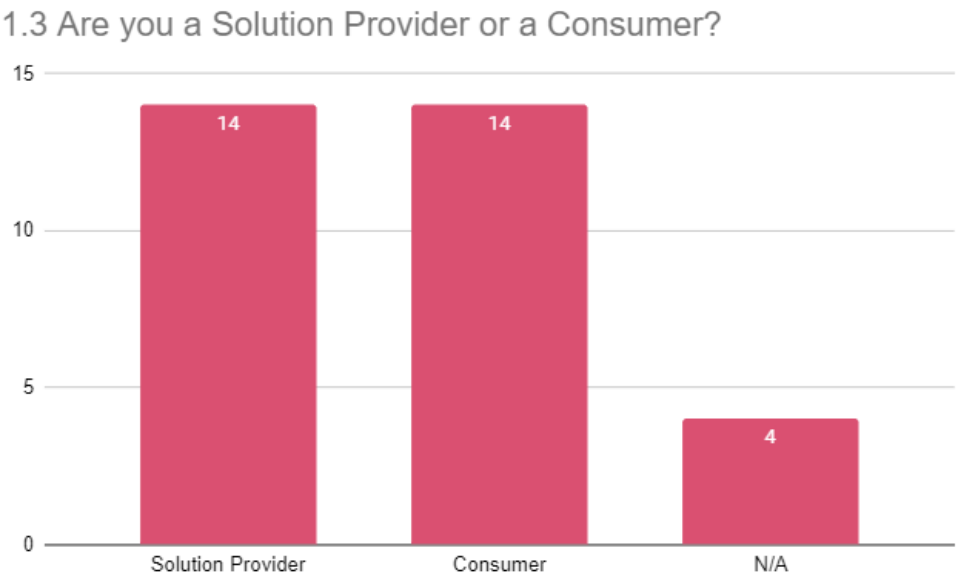

Figure 11 - Solution provider or Consumer statistics

The visualized outcome of the statistics between Solution providers, Consumers and Not Applicable roles is shown in Figure 11.

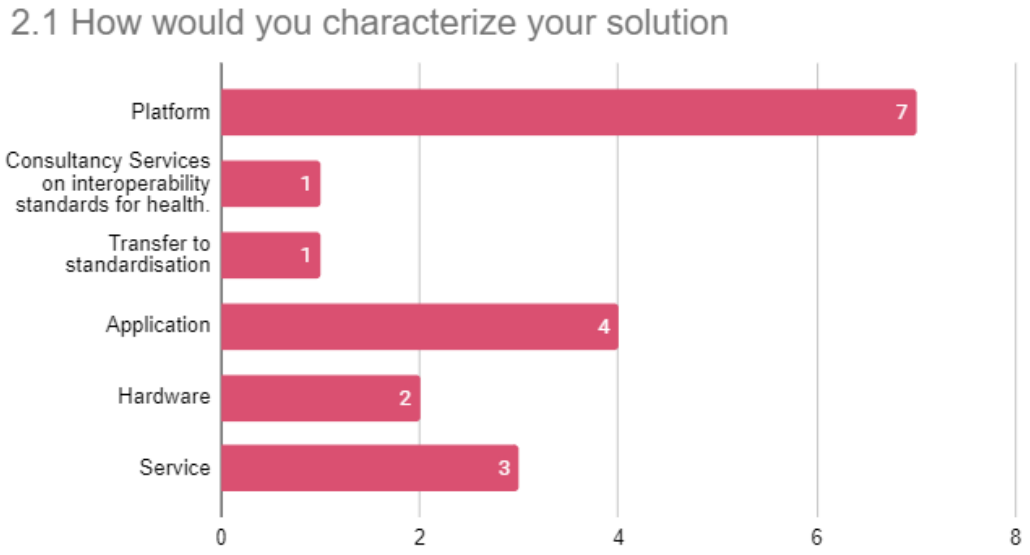

Figure 12 - Solution characterization statistics

At the horizontal bar chart in Figure 12 the solution characterization statistics are presented with the Platform, Application and Service categories to be the most selected.

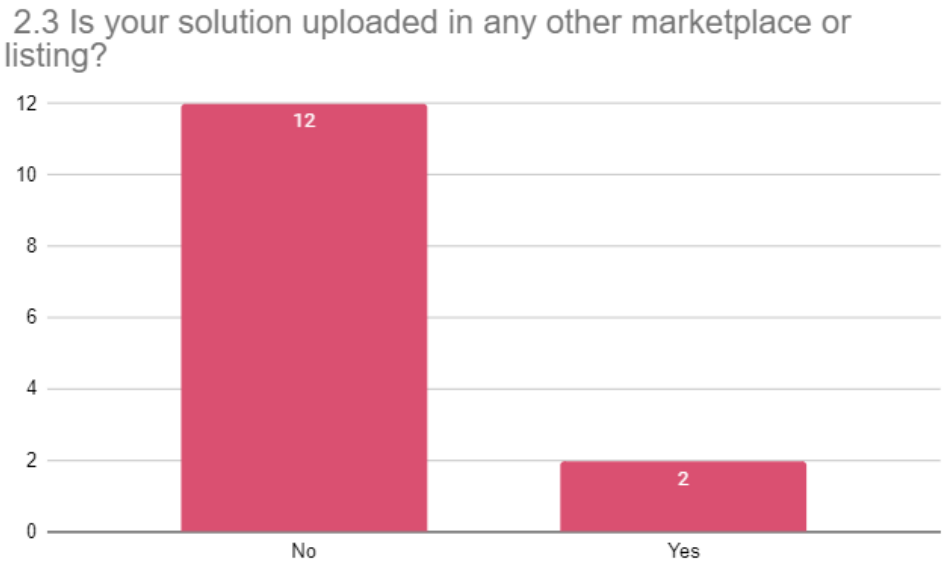

Figure 13 - Total number of uploaded Vs. not uploaded solutions

Figure 13 describes the total number of uploaded and the total number of not uploaded solutions.

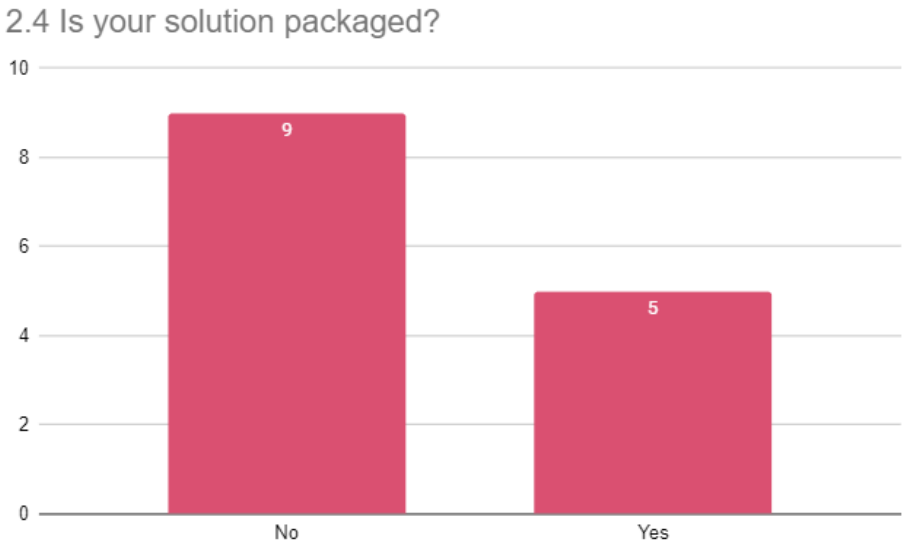

Figure 14 - Total number of packaged Vs. not packaged solutions

Meanwhile, the total number of packaged and the total number of not packaged solutions appears in Figure 14.

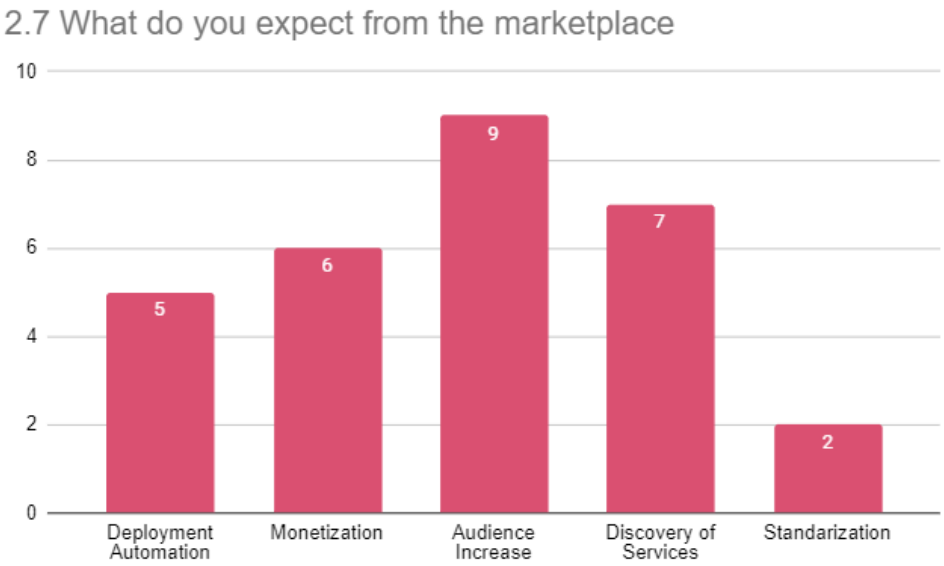

Figure 15 - Marketplace expectations

In Figure 15 there is a quantitative distribution of the answers about the Marketplace expectations between the key objectives of the project, highlighting the Audience Increase, the Discovery of Services and the Monetization as the most expected outcomes.

Figure 16 - Issues on goal achievement

The biggest barriers that are stopping the project partners from achieving their goals, as shown in Figure 16, are the Market Issues.

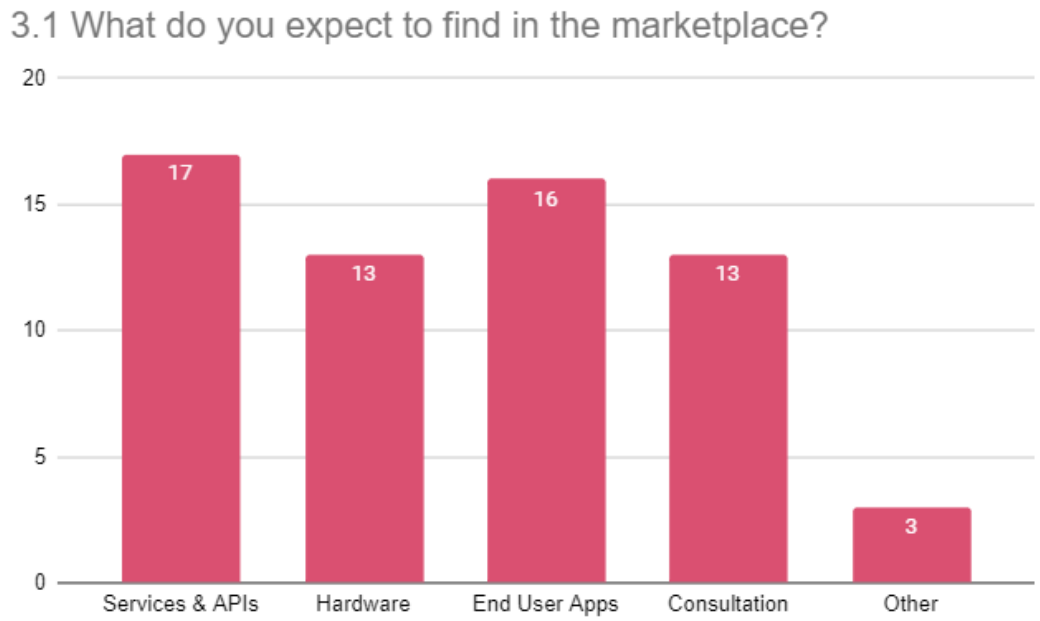

Figure 17 - Marketplace findings expectations

The most expected findings in the Marketplace as per the order of priority, according to Figure 17, are: the Services & APIs, the End User Apps, Hardware and Consultation.

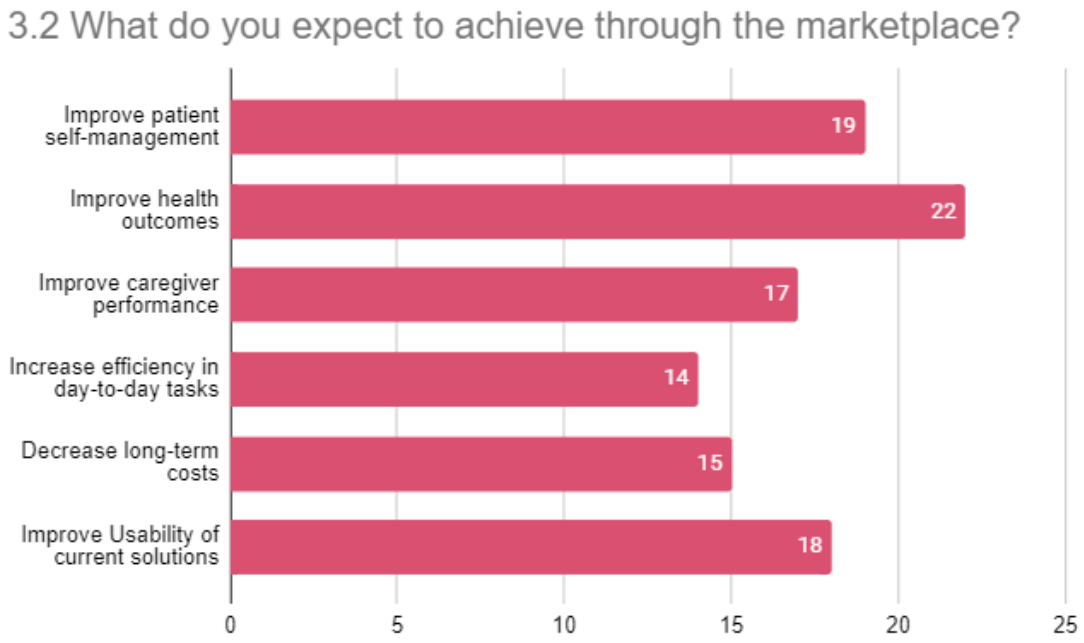

Figure 18 - Marketplace achievement expectations

As in the last bar chart displayed in Figure 17, the top three expected Marketplace achievements are about the improvement of: health outcomes, patient self-management and usability of current solutions.

The outcome of the D2.13 polls provided a valuable insight into potential user needs and expectations. This, combined with the resulting D2.13 and the D3.1.2 requirements and later discussions with the Business Cluster helped in extracting the Marketplace specification presented below.

4.2 End-user Roles

This section aims at aligning with the analysis of D3.1.2 and D3.6, focusing on GK stakeholders in order to identify them and the role they cover in the usage of the marketplace.

The GATEKEEPER Marketplace considers three distinct roles of end-users in relation to it:

- Providers
- Consumers
- Administrators

4.2.1 Providers

This category of end-users, comprised of both the Providers and the Vendors of D3.1.2, is the consortium partners and third-parties (Table 2) that have the **knowledge and intention to provide Things** compliant with GATEKEEPER. As the types of Things vary, it includes products such as:

- Hardware manufacturers and vendors of **Devices**
- Software developers and vendors of **Apps and Services**
- Researchers, organizations and hosts of **Datasets**

The Marketplace should enable all of them to provide the necessary metadata and upload, host or link the Things in the Marketplace, monetizing them and widening their reach while also growing the GK ecosystem. Also, they should be able to view analytics, track performance, receive ratings and reviews for their offerings.

Table 2: Providers

Identity	Relation to GK	Abilities
Software Developers	• GK Developers • Third-party Developers through Open Calls • External Adopters	• Access Developer Educational Material Resources (public) – GK Developer Portal • Upload and Provide Applications or Services • Receive Payments • Receive User Comments, Reviews and Rating • View Insights regarding • Downloads/Usage, Avg. Ratings etc.
Hardware Manufacturers	• GK Partners • Third-party manufacturers through	• Access Informative Material - GK • Developer Portal if needed • Upload hardware/Device descriptions

	• Open Calls External Adopters	• Receive Payments • Receive User Comments, Reviews and Ratings • View Insights regarding Purchases, Avg. Ratings etc.
Dataset Providers	• GK Researchers • Third-party organizations • through Open Calls External Adopters	• Access Informative Material - GK • Developer Portal if needed • Upload datasets and metadata descriptions • Receive Payments • Receive User Comments, Reviews and Rating • View Insights regarding • Downloads/Usage, Avg. Ratings etc.

4.2.2 Consumers

This category includes end-users (Table 3) that wish to consume various Things. It includes:

- Healthcare providers and individuals (doctors, patients) that seek **Devices.**
- Organizations and individual software developers that seek **Services** to integrate with their software.
- Any healthcare or technology organization or individual that seeks **Apps.**
- Researchers and organizations that seek **Datasets.**

All consumers should be able to **find, obtain, install and use** Marketplace Things according to their type. Also, they should be able to test and benchmark Things before acquiring them. Consumers can register, manage their profile, maintain a wish list and purchases list, review and rate Things. At any point, a consumer wishes to become a Provider, they should create a respective developer profile, kept separate from the consumer profile, as in most online marketplaces currently (e.g., Google Play store).

Table 3: Consumers

Identity	Relation to GK	Registration	Abilities
Consumers	• GK pilot members • Professionals, Potential Adopters • General web users browsing	Optional Unlocks abilities marked with an asterisk (*)	• View and Search Things • Test/Buy Things* • Maintain Wish list and Purchases list* • Comment, Review, Rate Things*

4.2.3 Administrators

This category of end-users (Table 4) has full access to the Marketplace setup, meaning the ability to add and remove applications or users at will. To gain these privileges, this role is attainable by consortium members, at least in the context of the project, in contact with WP4 leaders CERTH in charge of Marketplace development. While in the previous version the Administrators' main task was the validation of Things for compliance, in the current version validation of compliance with selected standards is performed by the GTA Things Validation module. The Administrators are now responsible for **moderating the content, as well as monitoring the transactions and activity** in the Marketplace.

Table 4: Administrators

Identity	Relation to GK	Registration	Abilities
Administrators	• Marketplace Developers,(CERTH) • Business Cluster, Dissemination and Exploitation, Open Call drivers • Any other interested party identified within GATEKEEPER	Only available through the consortium partners	• Access Administrator Insights, Registered Users • Moderate content (spam, malicious use) • Select top Marketplace picks or monetizing strategies (e.g. sponsored apps)

4.3 Use Case Scenarios

4.3.1 Use Cases for Providers

The Use Cases (UC) for providers are designed with GATEKEEPER partners in mind. The scenario (Figure 19) considers a seasoned GATEKEEPER developer with an application ready to be monetized and provided.

Provider Scenario: Register a new Thing
A Provider has a Service/Thing that they developed. Going to the Provider section and following the upload link they are allowed to register as Providers. Although they already own a Marketplace user account which they use to try out applications by others, they proceed to create a new Marketplace Provider account with elevated permissions for the separate developer section. *The Provider section is now open for user content so they immediately choose the Upload option. Filling the metadata information as accurately as possible, using text to describe the aims and functions and selecting the proper category, will serve to better index and make the Thing discoverable.* *Legal policy is also signed to claim liability for the application's usage. The Thing now appears under the developers' profile with a "Pending" status as it has to be validated for*

compliance and validity by the GATEKEEPER validation system. The Marketplace redirects them to the GTA Validator to execute the validation process and add the Thing to the TMS. When this happens, the user receives an automated verification email. The user starts receiving payments directly to their PayPal account.

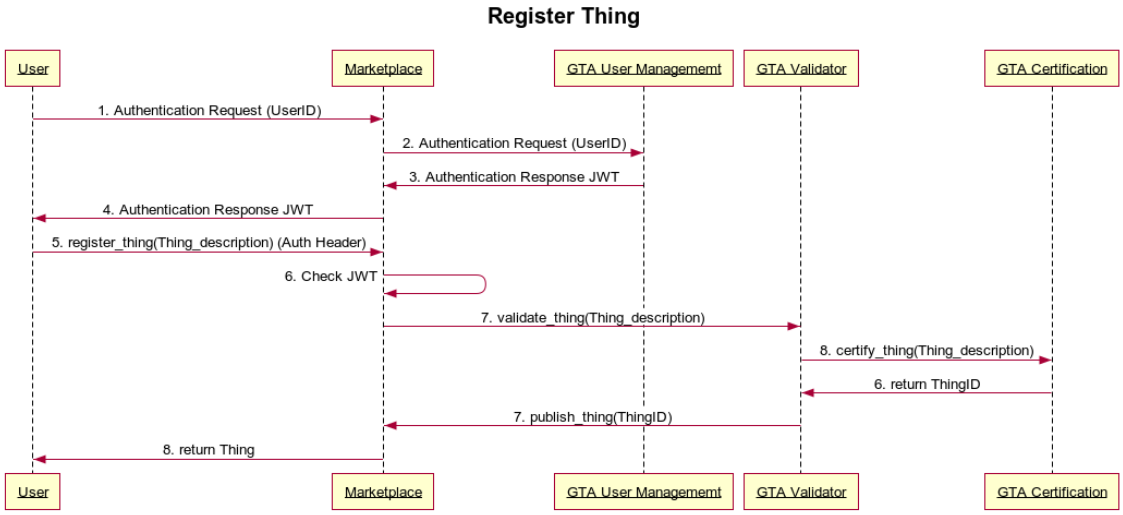

Figure 19 - UC: Register a new Thing

4.3.2 Use Case Scenarios for Consumers

This subsection considers end-user scenarios to be supported by the Marketplace.

User Scenario: Browsing & Consuming a Thing (Service)

A user accesses the GATEKEEPER Marketplace online. They can immediately view Things on the home page at an order suggested by the Marketplace, e.g., popular offerings. The user wants to browse some more, so they can visit all the categories' page, pick a few filters such as a category from the available ones, name search or price threshold. The page immediately displays a list of the respective content available to them for preview or testing.

The user finds a Thing they wish to consume.

Figure 20 shows an action diagram of the flow in the backend to realize this scenario information on how to consume a Thing is returned to the user after authentication via the GTA.

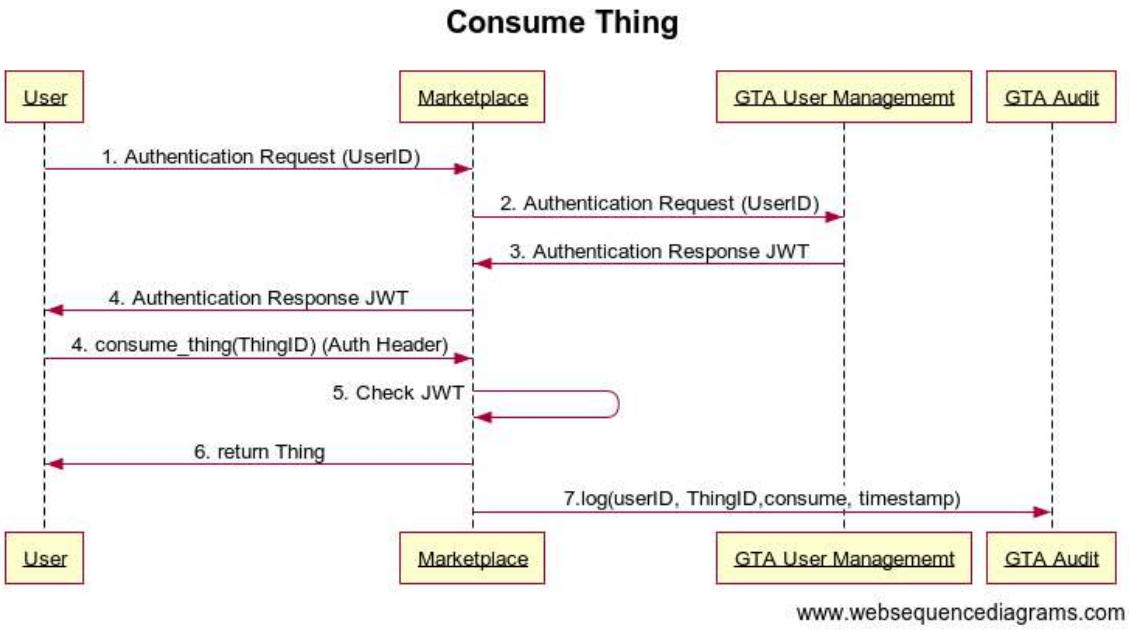

Figure 20 - UC: Consume a Thing

4.3.3 Use Cases for Administrators

This scenario considers an administrator that needs to moderate the content.

Administrator Scenario: Moderating Content
The administrator has received an email notification regarding an offensive content report. The link takes them directly to the comment in question, where they see that it is indeed offensive and they proceed to delete it. *Taking this opportunity, the administrator navigates back to the dashboard and the moderation section, where all reported content is shown. Many reports come from a single user. After deleting the comments, the administrator deletes and blocks the user, who receives an email notification for the action.*

4.4 System Requirements

The GATEKEEPER Marketplace functionalities include basic services for registering business entities, publishing and retrieving offerings and demands, searching and discovering Things according to specific user requirements, based on D2.13, as well as lateral functions like review, rating and recommendation.

4.4.1 User Requirements

The user requirements specification, based on D2.13, is targeting the groups of stakeholders listed below:

- **Patients and Citizens**, and **Professional Caregivers**, who are interested in using the GK solutions and applications.

- **Providers**, covering GK Platform developers, GK consultants, Research & Innovation and Standards Developing Organizations (SDO), who are interested in producing assets for the GK Platform and the Marketplace.

According to D2.13, a total of 39 user-centric requirements have been identified: 20 requirements from RUCs, and 19 requirements from developers. The decomposition of them according to the requirement type is 24 functional, 5 look & feel, 9 usability and humanity and 1 compliance requirements.

- **Functional requirements**: They describe what the GK solution has to do or what processing actions it is to take.
- **Non-functional requirements**: the properties that the GK solution must have, such as performance and usability. These requirements are as important as the functional requirements for the solution's success. Look and Feel Requirements, Usability and Humanity Requirements, Performance Requirements, Operational and Environmental Requirements, Maintainability and Support Requirements, Security Requirements, Cultural Requirements and Compliance Requirements.

4.4.2 Requirements for the Interaction with other Components

The following figure shows a mock-up drawn according to requirements from other components, including how to receive validated content from the Validator (developed in T4.5) via the GTA (developed in T4.5) and the TMS (developed in T4.2).

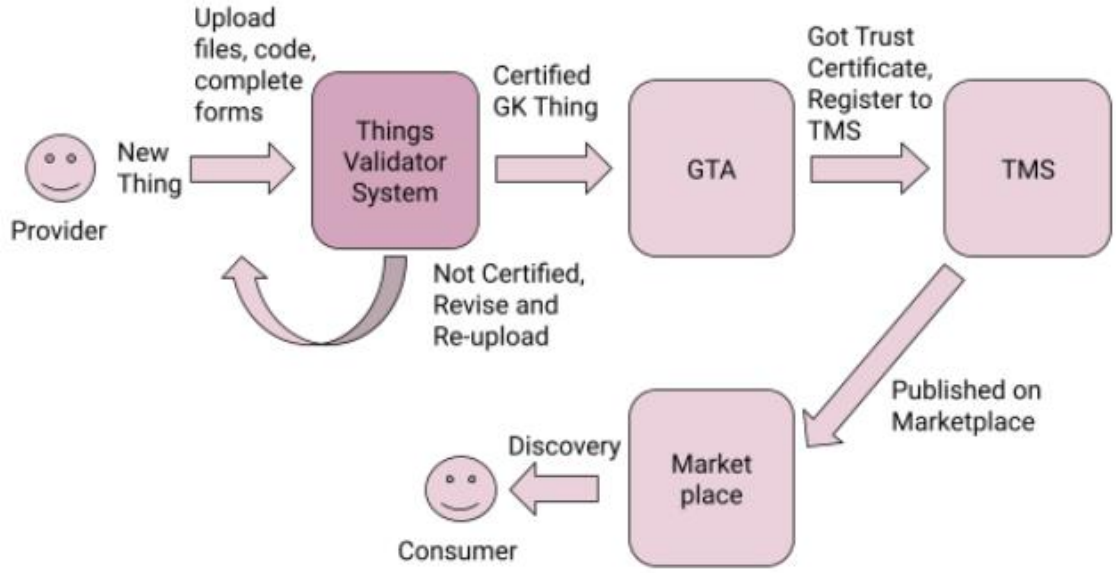

Figure 21 - Marketplace interaction with other components

4.5 Functional Requirements

Table 5 shows a list of functionalities available per each user role and the implementation plan to include it in the Marketplace in order to fulfil the related technical requirements presented in D3.1.2, their associated user requirements from D2.13 and also support the transaction flows described in D9.5.

Table 5: Functional requirements of the Marketplace

User	Function	Status/Plan
All	See KPIs (shared content metrics, downloads, analytics) on the landing page	Updated: KPIs available in the Provider dashboard for each Provider, and in the Admin dashboard for the whole Marketplace
All	Login via Keycloak	Done
All	Link Apps, Devices, Datasets to their APIs	Done (Providers must provide links in description)
All	Find Apps, Devices, APIs and Datasets	Done
All	Legal and ethical approach to manage data should be clearly described	Done
All	Users view respective offerings and related content depending on the GK Space they belong to (Consumers, Business, Healthcare)	Done
All	Interactive tools to ask users about any issues they may have	Done
All	Dialogue-based assistant to make accessible the Things belonging to the respective space	Done
Consumer	View all Offerings and search using keyword & filters	Done
Consumer	Discover easily with multiple filters. In each filter section include - find easily what you are looking for: Search sort by popularity	Done
Consumer	Discovery by selecting Categories	Done
Consumer	Consultation services that can install an offering tailored to consumer needs shall be available	V3
Consumer	Discovery by using filters pertinent to each category: e.g., Disease, Medical Use Case,	Done

	Pilot for Devices and Apps, Platform for Apps etc.	
Consumer	Discovery by map / origin country	Done
Consumer	Discover dataset: - according to FAIR principles - according to IDS/integration - read metadata before requesting access	Done
Consumer	Personalized - adaptive discovery based on user settings/profile/initial preferences, similar items/history/similar users etc.	Done
Consumer	Organize datathons and clinical trials - with description/aim page) by creating and sharing/inviting users, - associate collections of datasets/APIs/apps/users - with ability for Providers to contribute	Done for datathons, further refinement in V3 depending on business needs
Consumer	View Thing code, validation status (integration with Validator)	Done
Consumer	Testing/Workbench for Things: test with allowed parameters	Done for Datasets, further development in v3
Consumer	View Analytics, Purchases with Apps, Devices, APIs, Datasets	Done
Consumer	Web Accessibility Directive statements should become visible to the actors on the GK Marketplace who need to have this information to decide on which Thing to use	Done (Integration with GTA Things Validation)
Consumer, Provider	Links to the conventional marketplaces for Apps (e.g., Google Play, Apple Store etc.) if published	Done
Provider	View analytics (KPIs, visitor map, revenue, status of offering, reviews)	Done
Provider	The dashboard shall provide overview for companies clustering data by location (area) and user profile.	Done
Provider	Limited sharing of datasets after approval and consent exchange with Consumer contract	Done
Provider	Developers/Companies sign up & accept terms of usage of GK Platform for the Marketplace before publishing services.	Done
Provider	Providers can optimize customer engagement e.g. by replying to comments and reviews	Done

Provider (Maybe All)	All Marketplace users shall receive notification of updates in software offerings from the Marketplace	Done
Administrator	View analytics, moderation	Done

4.6 Attributes for Discovery

The following table shows a list of attributes used to filter and search for appropriate content.

Table 6: Attributes for discovery

Attribute	Allowed Values	Applies to
Category	• App • Device • API • Dataset	All
Domain	• Health • Energy • Transport • Education • …	All
Disease / Medical condition	<type>	All
Developer	<username>	All
Country	<text>	Dataset
Price	<any number>	All
Business Space	One or more from: Consumer, Business, Healthcare	All
Platform	…	Applications
Tools	Docker, NPM, Webpack, Gulp, Composer	Applications
Programming Language	….	APIs
Measurements	Blood Pressure Heart Rate Accelerometer Thermometer Oximeter Weight	Device

	Respiration Rate Electrodermal Activity Galvanic Skin Response Pressure Luminance Power Consumption …	
Device type	Wearable, robot, ambient, …	Device
Medical certification	• MDR • MDD MDD towards MDR	Device, App, API
Licenses	CC-by-4.0, CC-by-1.0, OGL 2.0, DL-DE-BY 2.0, OBSD, ARCGIS, Not specified, Open	Datasets
Provider	<name>	Datasets

5 GATEKEEPER business model technical implementation

WP9 has provided T4.6 with interaction flows among the stakeholders involved in the Healthcare Space (Table 7, Table 8) and the Creation Space (Table 9) of the multi-sided market model of GATEKEEPER. "GK Central" is the organization that will provide all services needed for the business spaces (Healthcare, Creation, Consumer).

As the work on the business model progresses, these flows will be revised and further analysed in the next months of the project. The GK Marketplace technical component features already support several flows and T4.6 will continue its development and integration with other GK tools to best serve the business needs during the task extension.

Table 7: Demand by Healthcare entities in the Healthcare Space flow of services

Demand by healthcare entity	Supply by Tech suppliers and GK Central	Supplier	Nature	T4.6 Marketplace related functionality
AI Platform integrated in the hospital information ecosystem for the exploitation of AI solutions in diverse clinical needs	a. GK Platform as service. Customisation & Operation services b) GK Platform licence. Deployment, customisation, & maintenance services	GK Platform supplier	Software + cloud services	to be analysed for V3
a. AI based solutions to diverse clinical or care process management (automated diagnostics) b. AI based solutions for Decision Support and intervention (prediction)	a. AI clinically validated solutions to specific medical problem b. Development of customised solution	AI solution provider / developer	Software	to be analysed for V3
Access to Data Federation's specific data sets for use by AI solutions deployed in clinical setting	Grant access to specific data sets under rules of data governance	GK Data Federation Services Operator	Datasets	6.2.2 IDS-compliant Data Sharing

Medical devices	Medical devices certified and GP platform compliant	Medical device vendor	Hardware	Integration with Validator for MDR validation and relevant filter for Intelligent Discovery
Training for medical staff on design and use of AI solutions for clinical needs	Training courses online and supervised. Training multimedia contents	GK Central	Multimedia contents	to be analysed for V3
Piloting and simulation environment for testing and training on AI offered solutions	Use of AI solutions on simulation mode	AI solution provider / developer	Software	to be analysed for V3
Discovery services of the marketplace technological offering	Intelligent navigation of marketplace. Need and product matching	GK Central	Marketplace service	6.2.6 Intelligent Discovery
Purchase services	Business transaction environment between Health Care customer and Technology Supplier	GK Central	Marketplace service	to be analysed for V3
Design of specific custom AI solution and integration in clinical practice	Co-creation environment for design, customisation, deployment, re-engineering, secondment, etc.	GK Central	AI solution provider / developer	to be analysed for V3

Table 8: Demand by Technology suppliers in the Healthcare Space flow of services

Demand of marketplace services by	Supply of marketplace services by GK Central	Supplier	Nature	T4.6 Marketplace related functionality

Technology Supply				
Space in the marketplace platform to host application software, demonstrations, webinars, wikis, training material and courses, use case examples, etc.	Marketplace platform to offer products and solutions in the Healthcare Space. Smart navigation capabilities for technology offering discovery by HC customers	GK Central	Marketplace service	to be analysed for V3
Piloting environment, simulation environment	Computing infrastructure, data sets for simulation and demonstration, etc.	GK Platform supplier, GK Data Federation Services Operator	Software	to be analysed for V3
Access to GK Data Space and AI/ Big Data infrastructure services	Grant access to specific data sets in the Data Federation Space and AI/BD infrastructure	GK Data Federation Services Operator	Data sets	6.2.2 IDS-compliant Data Sharing and upcoming integrations
Marketing of products and services offered	Marketing & communication to promote marketplace products and services in the HC sector	GK Central	Marketing material	Multimedia addition (images, videos, brochures), Promotional sales supported

Table 9: Creation Space flow of services

Demand of technological services by AI Solutions developer (SME, RTO)	Supply of technological services by HC supply GK Central	Supplier	Nature	T4.6 Marketplace related functionality
Access to GK Platform development space	Grant user access to GK Platform	GK Platform supplier	Software + cloud services	to be analysed for V3

	development space			
Access to GK Data Federation Space for: production, training ML, simulations, …	Grant access to specific data sets in the Data Federation Space	GK Data Federation Services Operator	Data sets	to be analysed for V3
Access to AI/ Big Data infrastructure	Grant access to requested services	GK Data Federation Services Operator	Cloud services	to be analysed for V3
Training services on AI development and GK Data Federation and AI/ BD usage	Training courses, wikis, webinars, examples, documentation	GK Central	Multimedia Contents	to be analysed for V3
Co-creation support for AI solutions design and validation	Medical support for solutions requirements and design of validation test	HC provider	Consultancy	to be analysed for V3
Testing and evaluation environment, including clinical trials for AI solution validation	Test beds for AI evaluation. Patient data cohorts. (Consents for access to data sets from GK data space)	HC provider	Professional work and data sets	to be analysed for V3
Medical models of detection, diagnosis and interventions (clinical guidelines)	Clinical guidelines, evidence-based medicine supporting documentation, professional coaching	HC provider	Professional work	to be analysed for V3
Discovery of marketplace services, available data sets, HC providers services for AI	Smart navigation capabilities for services and data offering discovery by AI developers	GK Central	Marketplace service	6.2.6 Intelligent Discovery

solutions development				

6 GATEKEEPER Marketplace implementation

This section presents the Marketplace implementation in terms of architecture and actual online platform user interface presentation.

6.1 Marketplace Architecture

The architecture follows a standard web application technology stack in order to implement robust action flows (Figure 22) between the user and the Marketplace using recent frameworks and tools validated and well-established in the industry. Specifically, the Marketplace is logically divided into Front-end and Back-end. The former provides user interfacing and experience for Consumers and Providers as well as Marketplace Administrators. The technology and development stacks give a clear idea of the modern frameworks and tools used to build a robust marketplace web application and are in-depth explored in the next section. More details on the technologies follow below.

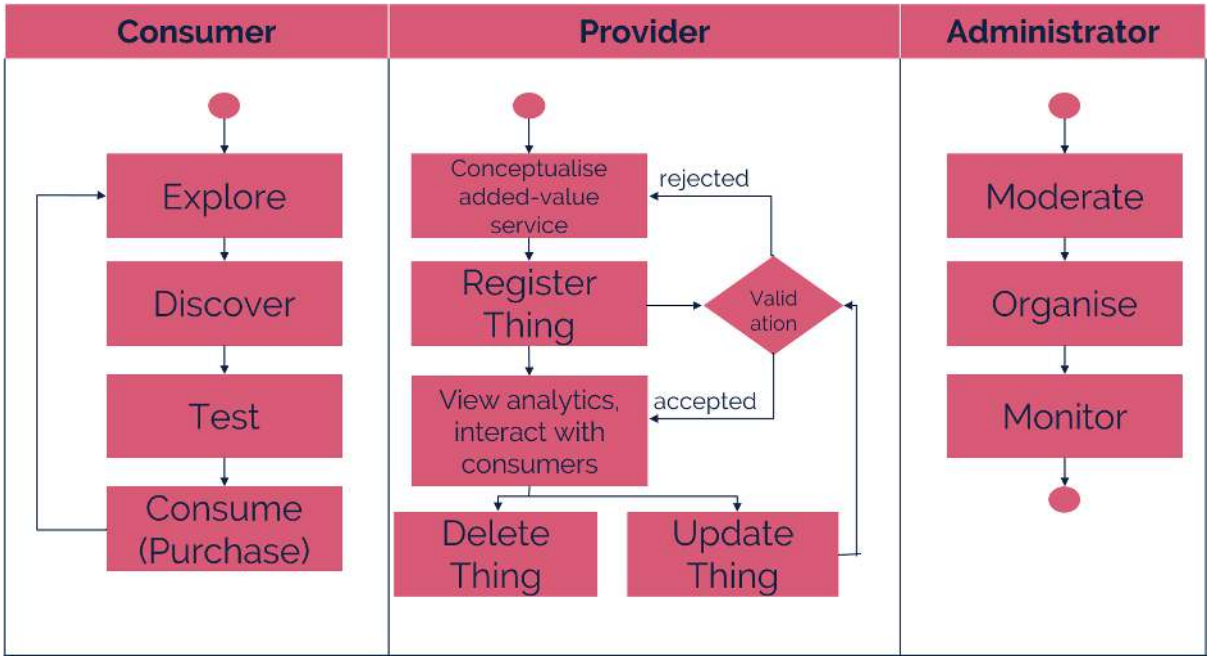

Figure 22 - Marketplace action flows

6.1.1 Technology Stack

These are the core technologies to implement the Marketplace, with PHP being key to it.

PHP

PHP is a widely used, open-source scripting language that encourages rapid development and clean, pragmatic design runs on various platforms (Windows, Linux, Unix, Mac OS X, etc.). It is compatible with almost all servers used today (Apache, IIS, etc.) and supports a wide range of databases. It's free and used for the core of the GATEKEEPER Marketplace.

JQuery

jQuery is a fast, small, and feature-rich JavaScript library. It makes operations such as HTML document traversal and manipulation, event handling, animation, and Ajax much simpler with an easy-to-use API that works across a multitude of browsers. With a combination of versatility and extensibility, jQuery has changed the way that millions of people write JavaScript and constitutes a natural part of the GATEKEEPER Marketplace web application.

CSS

GATEKEEPER Marketplace makes use of certain HTML elements and CSS properties that require the use of an HTML5 doctype. CSS is the language used in order to style an HTML document and describes how HTML elements should be displayed.

Authentication APIs

Provide sign up and login functionality through Keycloak - an open-source Identity and Access Management solution aimed at modern applications and services.

6.1.1.1 Development Stack

The development stack comprises all technologies that support the software lifecycle, from editors, to issue trackers and project management.

GitHub

GitHub Inc. is a web-based hosting service for version control using Git. It is mostly used for computer code. It offers all of the distributed version control and source code management functionality of Git as well as adding its own features.

Visual Studio Code

Visual Studio Code is a code editor redefined and optimized for building and debugging modern web and cloud applications.

Docker

Docker is an open platform for developing, shipping, and running applications. It enables developers to separate the applications from the infrastructure in order to deliver software quickly.

Figma

Figma is a free, online UI tool to create, collaborate, prototype, and handoff.

6.2 Marketplace 2nd Version

In the second version of the GATEKEEPER Marketplace, several views first presented in D4.6 have been revised to better carry out the operations defined in the use cases scenarios and to improve transparency and intuitiveness. Moreover, its features have been extended to include trusted and secure data sharing, testing, interaction with end-users, intelligent discovery, and an administration environment.

The Marketplace is currently deployed in CERTH premises, since it requires public access that would be hindered in the Gatekeeper infrastructure.

The current content includes the open callers' submissions during the 1st Gatekeeper Open Call, which ended in April 2022, and sample input for demo purposes.

6.2.1 Updates to the Marketplace 1st Version pages

This section presents the user interface of the Marketplace as an indication of its capabilities. The current content includes the open callers' submissions during the 1st Gatekeeper Open Call, which ended in April 2022, and sample input for demo purposes.

6.2.1.1 Homepage (updated)

The GK Marketplace homepage is shown in Figure 23. The user does not need to login to explore the available Things. The homepage displays the different Thing categories (Figure 24) and outlines the key research and innovation points of the GK Marketplace, while a search bar is available for quick searches. The most popular and top-rated Things are then presented. At the bottom, the footer includes standard contact and networking information, social media links, and the cookie policy and terms of usage.

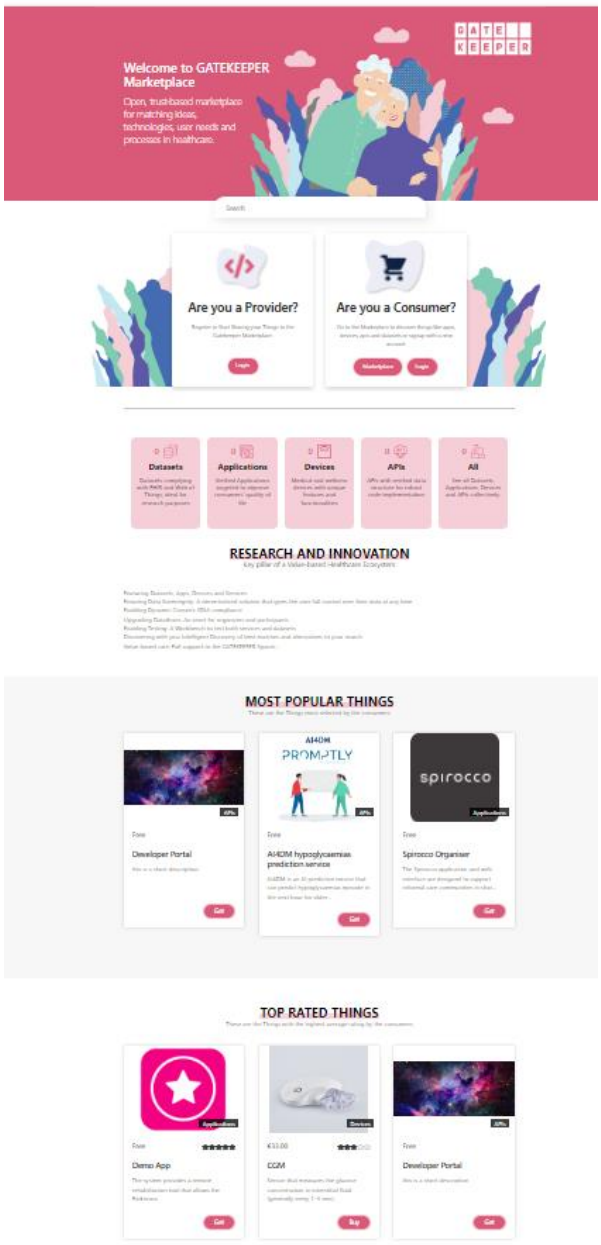

Figure 23 – Homepage

Figure 24 - Thing categories

6.2.1.2 Marketplace Things

Figure 25 shows items from all categories available, unfiltered, with the ability to perform multiple-criteria filtering: picking a single criterion immediately refreshes results without pressing a button or reloading the page or part of it.

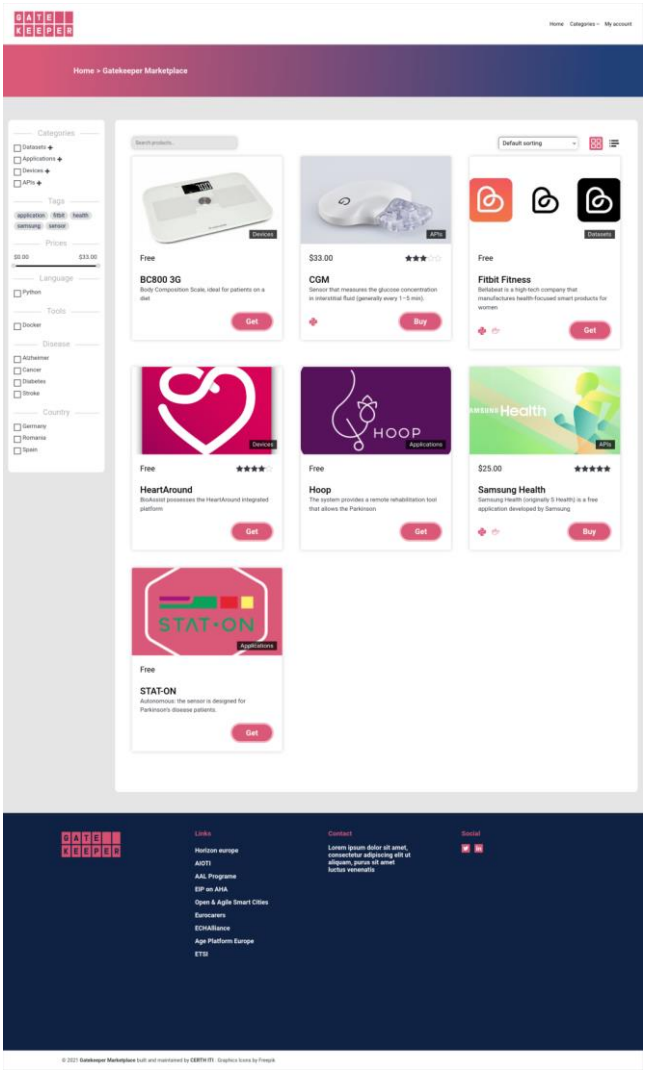

Figure 25 - Marketplace Things

6.2.1.3 Thing details page (updated)

Figure 26 shows an example of a Thing details page and its features such as ratings, policies, Q&A, Provider information, and Thing Description according to the W3C Web of Things standard [9]. Consumers can add the Thing in their cart to later proceed with buying it, while related Things are presented below to aid in discovery.

The badge on the Thing image signifies that the Thing in question has been certified by the GTA Things Certification module, therefore its registration in the Marketplace has been written in the blockchain.

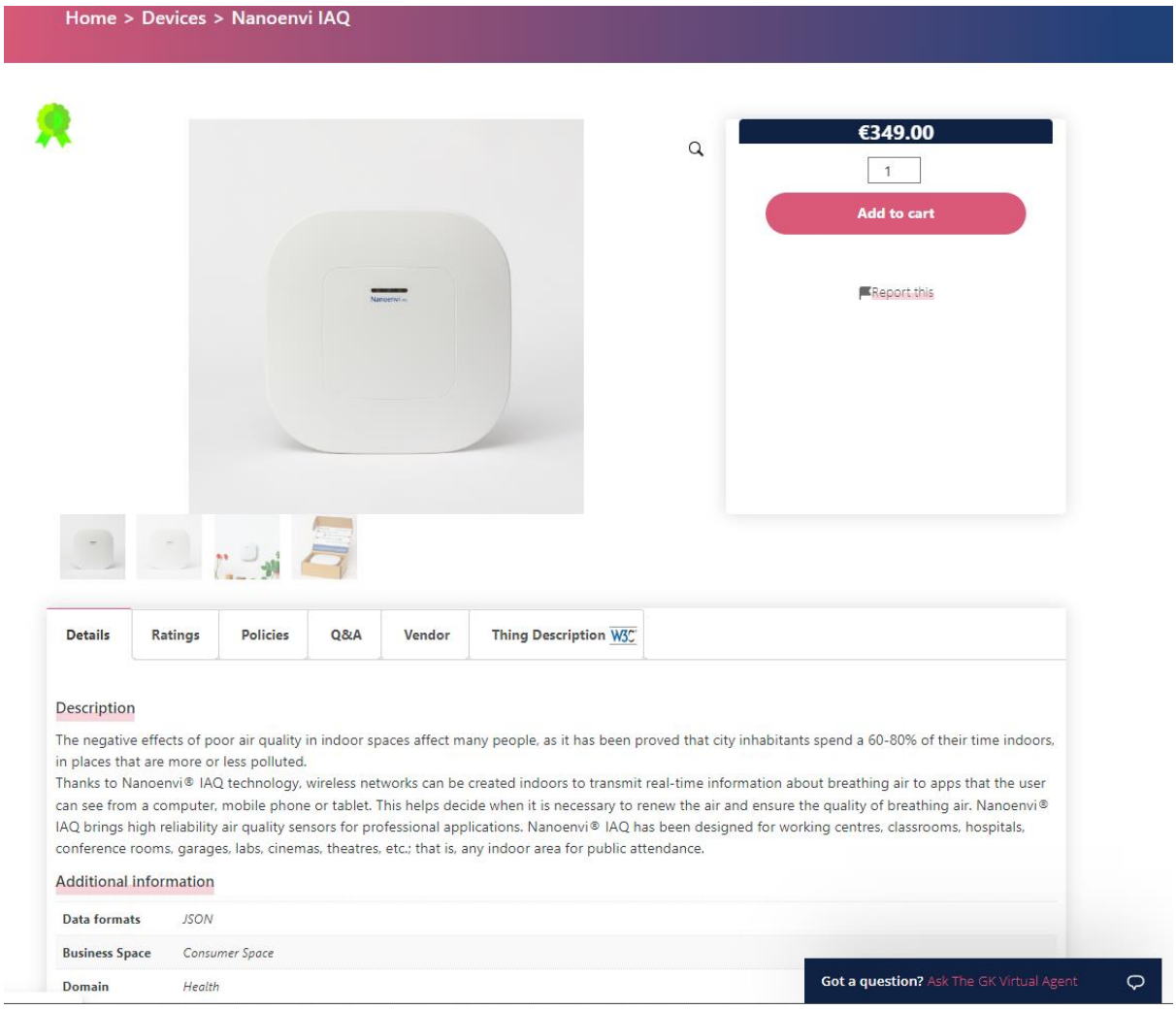

Figure 26 - Thing details page

6.2.1.4 Provider dashboard (updated)

This is the view of a registered Provider. Figure 27 and Figure 28 display the main dashboard, where they can view KPIs for a specified time period and analytics over their store performance, including a visitors' map. The registered Provider can edit their personal information and manage their Things, orders and payments in separate tabs, as well as view statistics.

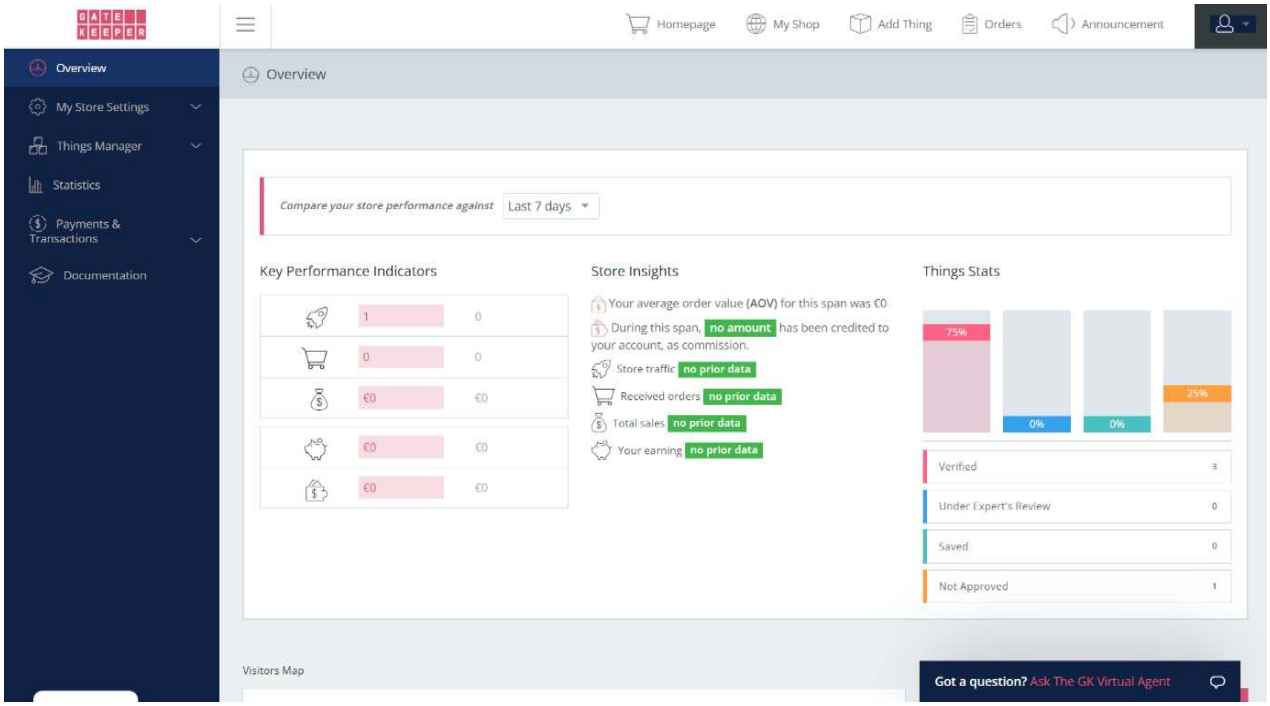

Figure 27 - Provider dashboard I

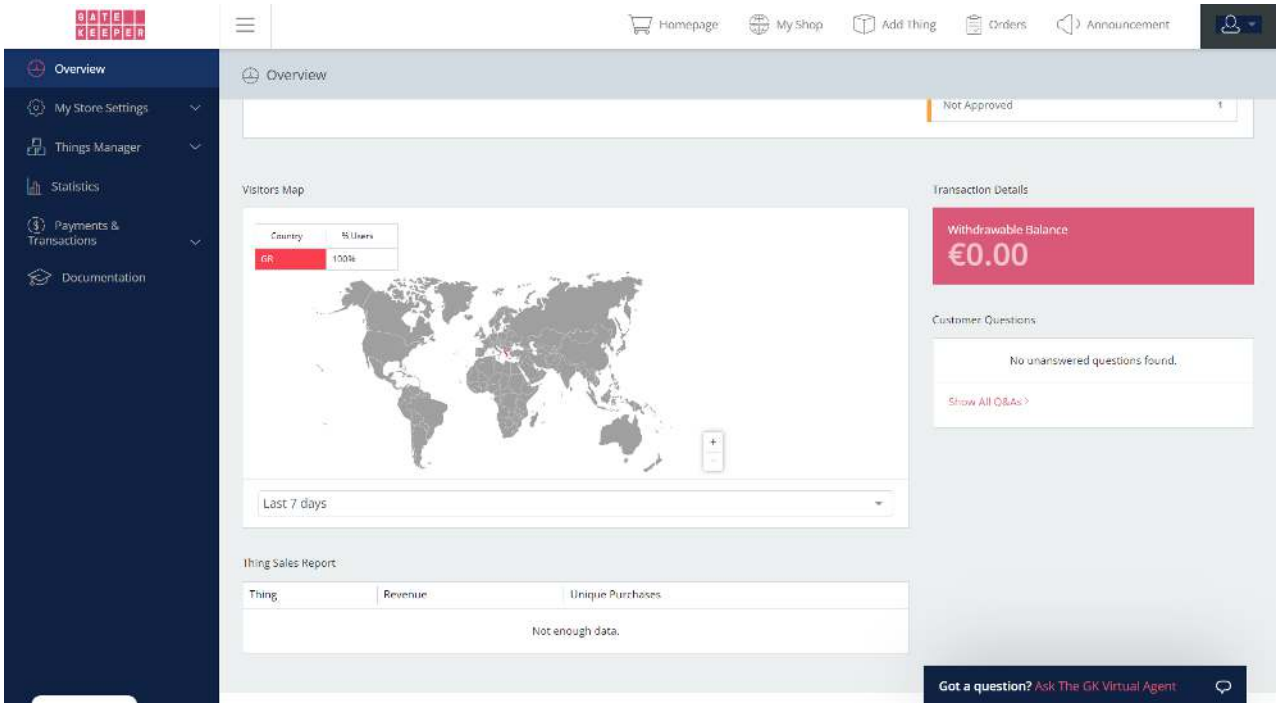

Figure 28 - Provider Dashboard II

6.2.1.5 Thing details' interface (updated)

By following the process shown in Figure 29 and submitting the form shown in Figure 30, a registered Provider can submit a new product to undergo validation and certification by the GTA, or save it in draft version to edit further or submit later.

With regard to Thing Description for Web of Things validation, the Marketplace adheres to the D3.3.2 guidelines.

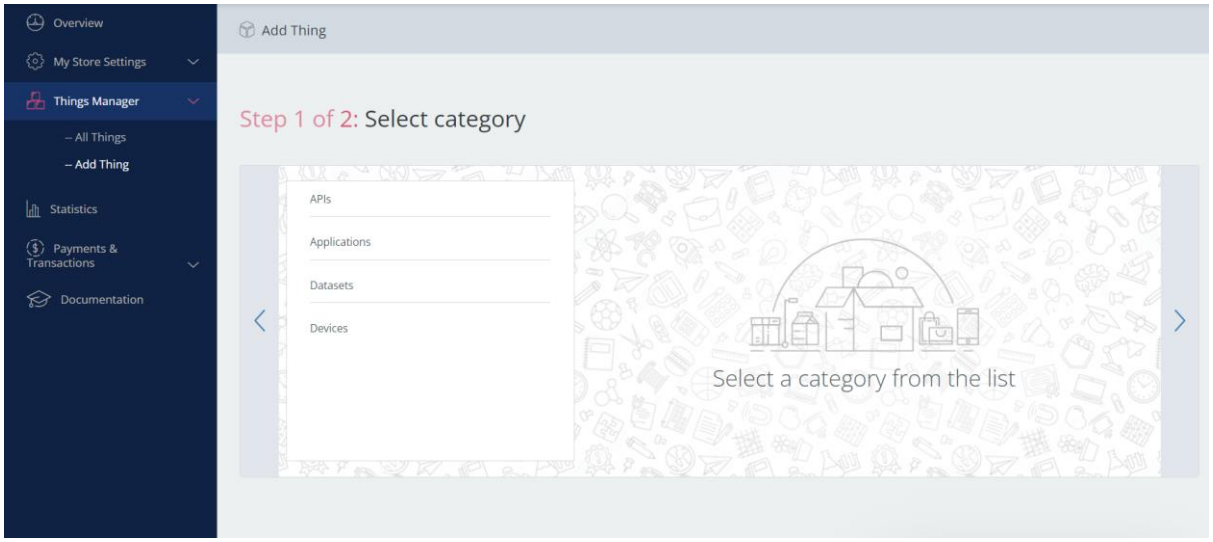

Figure 29 - Provider Add Thing: category selection example

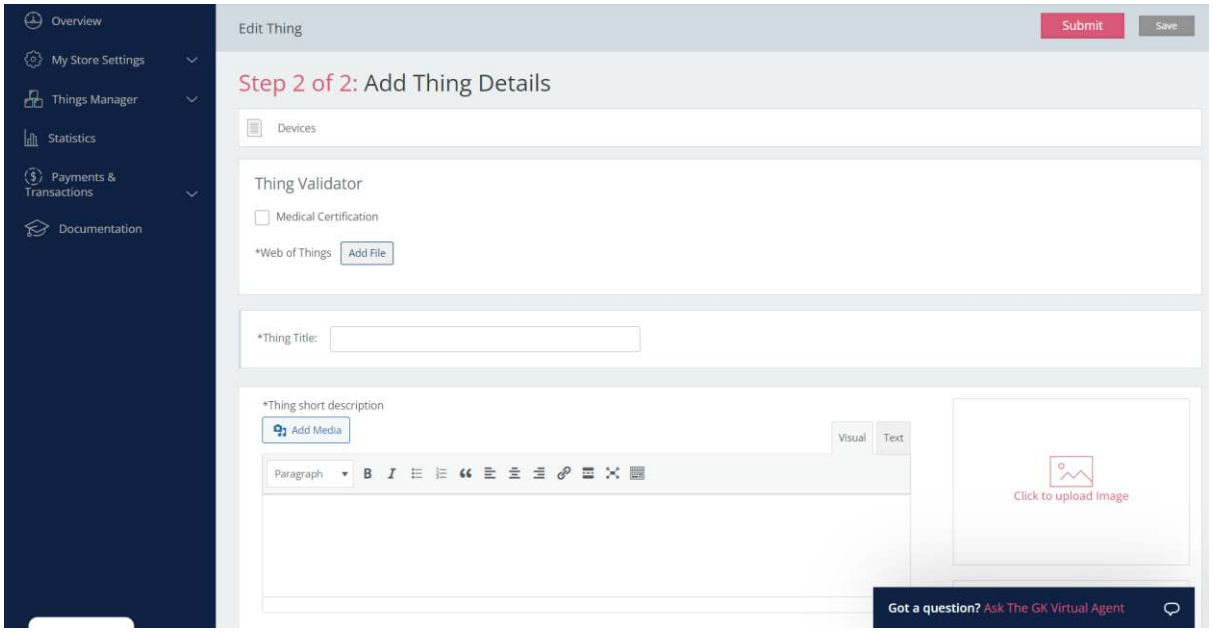

Figure 30 - Provider Add Thing: details form interface

6.2.1.6 Provider All Things' list (updated)

Figure 31 shows the Provider's uploaded Things list. A Provider can view, edit, delete a Thing, or use the GTA Things Validation module to undergo validation of compliance with more standards.

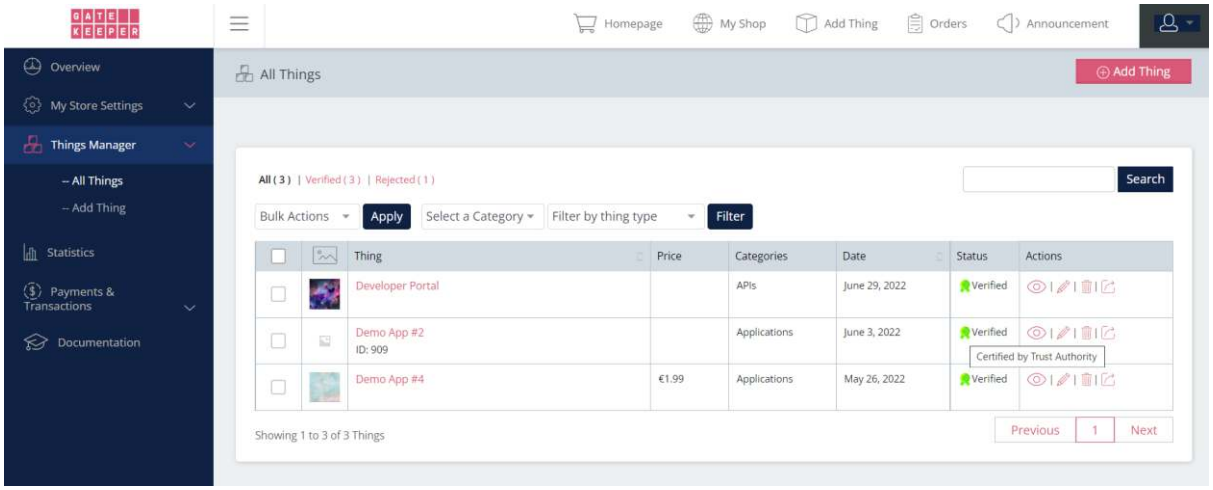

Figure 31 - Provider All Things' list

6.2.1.7 Provider statistics (updated)

Figure 32 displays the Provider interface that shows useful information and statistics of a registered Provider's sales for a specific date range ("Selected Date Range" field in the figure). It also enables the provider to download this information to a CSV file by clicking on the "Download CSV" button.

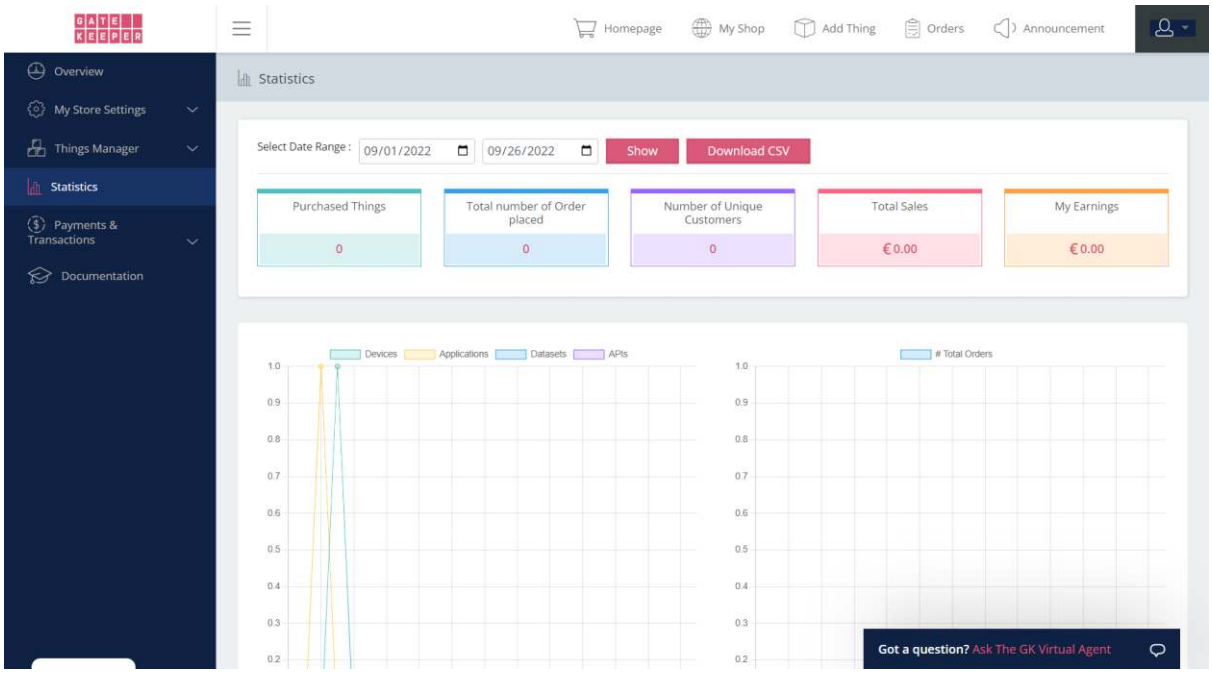

Figure 32 - Provider dashboard statistics

6.2.2 IDS-compliant Data Sharing

The GATEKEEPER Marketplace, through its integration with the Gatekeeper Trust Authority (GTA) developed in T4.5, realises a use case of the International Data Spaces Reference Architecture Model 3.0 (IDS-RAM 3.0) [15].

The IDS aims to guarantee data sovereignty and trust in data transactions. To this end, data sharing is implemented through IDS-Connectors in a decentralised manner. The data owner (here, a Provider) and the data user (here, a Consumer) both participate in the ecosystem with an IDS-Connector. IDS-Connectors only allow data transactions after an agreement which includes a particular data usage control policy is made between the two parties, resulting in not only data access control but also data usage control.

To ensure trust, both participants and technical tools in the IDS are evaluated and certified by an IDS Certification Body (*Static Trust*). The Connectors used for the Marketplace are fully certified with an X.509 certificate. They are also actively monitored by the IDS Dynamic Attribute Provisioning Service (DAPS) *(Dynamic Trust).*

The Marketplace has been integrated with and manages two IDS-Connectors, provided by T4.5, for the provision and the consumption of data. The Connector can handle data provided through an external connection, this way enabling decentralisation, but also through file upload. The IDS-related metadata must be added by the Provider when registering the data in the Marketplace (Figure 33) in addition to the marketing information. At present, the data usage control policies supported are:

- *Provide Access,* which enables unlimited access to the data,
- *Duration Usage,* which allows data usage for a specified time period.
- *N times Usage,* which allows data usage for n times.

In the aim of compliance with IDS, the Marketplace uses the Dataspace Connector data model [16].

6.2.3 Workbench

Before purchasing a dataset, a Consumer can test it through the Workbench feature, which is built on JupyterHub. This way, the potential buyer obtains an overview of the data contained and gains a useful insight into how they can work with it, without the Provider losing the business value of the data or data sovereignty being undermined. The Consumer can afterwards proceed to buying if the dataset pertains to their needs.

Authentication for the multiple users is implemented through the GTA User Management Module (Keycloak). To be consistent with IDS, an agreement needs to first be made between the Provider and the Consumer through the Marketplace IDS-Connectors (Figure 33). Afterwards, the Consumer will gain access to a sample of 100 randomly picked rows from the dataset and will be able to run Python on it in a Jupyter Notebook in their browser, without installation needed. Moreover, a summary containing information about the number of data rows, the number and name of columns, as well as the range of values for numerical data or the number of unique values for categorical data will be provided.

It should be noted that in the case of non-tabular data, such FHIR resources, conversion into tabular is a necessary step implemented before the testing.

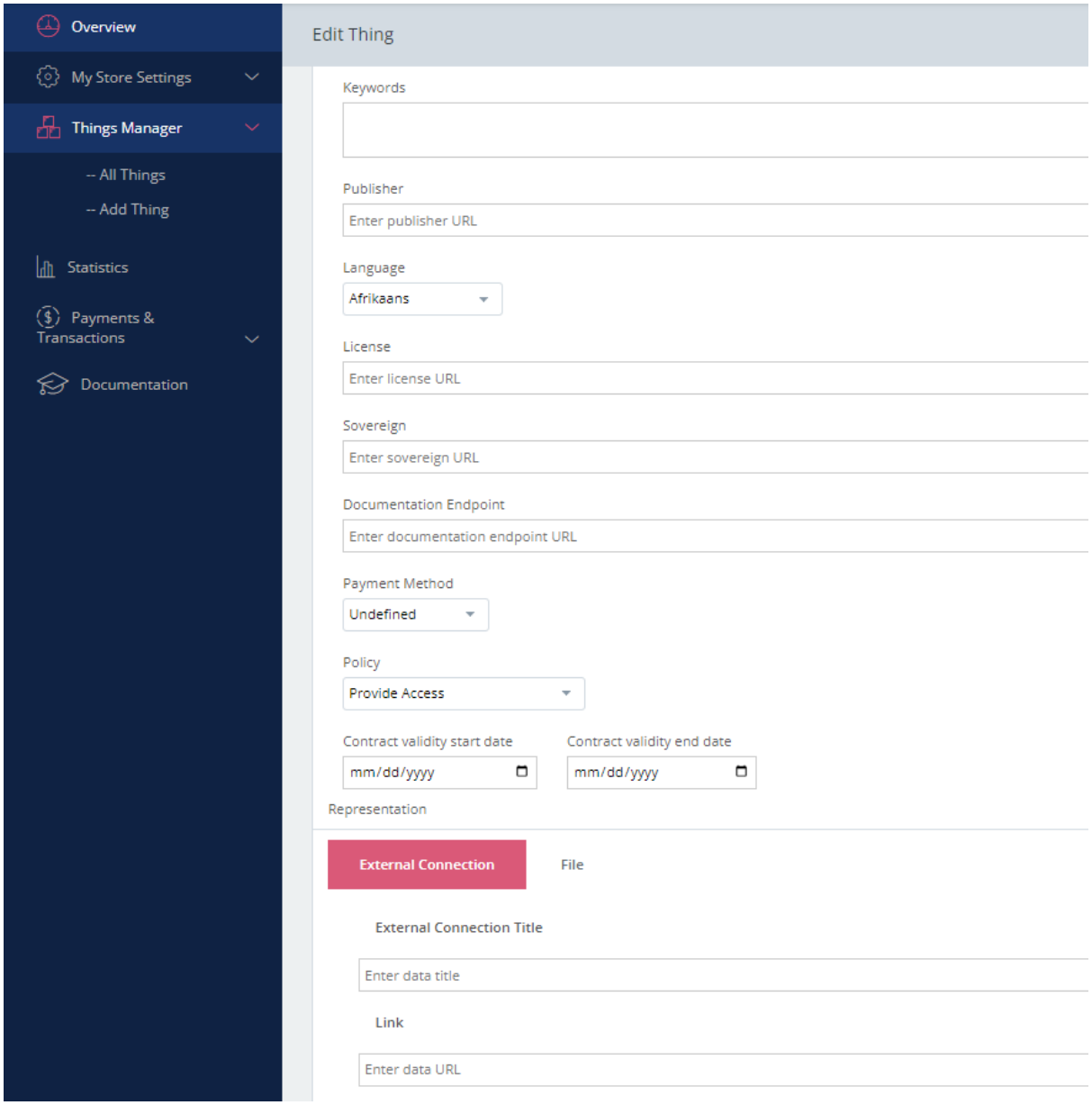

Figure 33 - Metadata input form for IDS-Connector

6.2.4 Datathon organisation

The GATEKEEPER Marketplace supports the organisation of datathons (Figure 34) by taking advantage of IDS-Connectors. In particular, the organiser enables data sharing for the duration of the datathon by selecting time-limited usage as a usage policy.

Datathon Thing submissions undergo automatic validation by the GTA Things Validation on submission, but not semi-automatic validation, as the contribution of Validation Experts would take longer and delay the announcement of the datathon results. Datathon participants can, however, edit the Things submitted at a later stage to undergo semi-automatic validation for different standards.

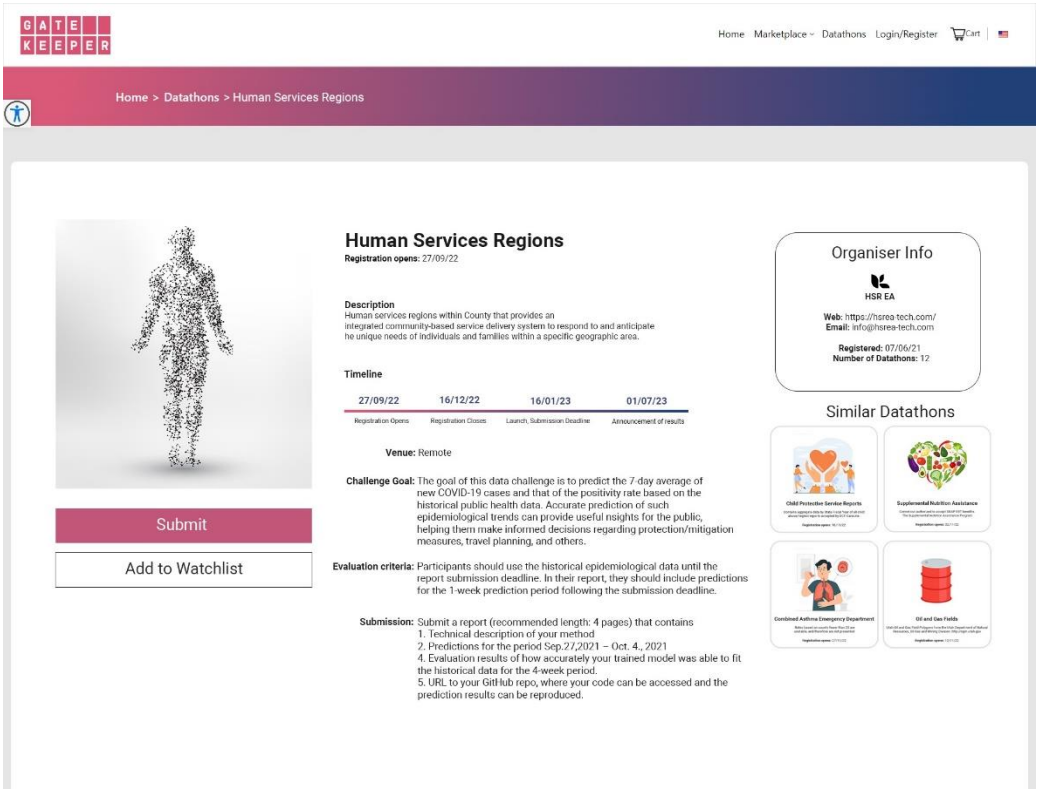

Figure 34 – Datathon details page in the Marketplace

6.2.5 Dialogue-based assistant

Conversational AI, which includes chatbots and voice assistants, enables human-computer interaction. A Conversational Assistant (CA) is a virtual assistant that converses with people using natural language understanding and provides pertinent responses when it is practical to do so in order to provide the most human-like interaction possible. CAs, often referred to as artificial intelligence conversational agents or chatbots, are sophisticated programmable systems that can have natural-language, voice, or text conversations with people by using a knowledge base. By creating textual context, other variants of CAs can converse without a central knowledge to draw replies from, yet discussion may result in unanticipated or even unwelcome utterances.

Generally speaking, top-level CAs convert human language into machine code. To translate speech or gestures into natural language, an optional speech recognizer or optical gesture/handwriting recognizer may be utilized. A Natural Language Understanding Unit (NLU) then processes the computer representation. Additionally, information from NLP techniques like name recognition, part of speech tagging, and a syntactic/semantic parser is added to the input to further enhance it. A dialog manager works with the NLU module to store the dialog's history and current state with the goal of keeping the conversation on a logical path by directing it with appropriate responses or actions. Finally, responses are retrieved from a response selector algorithm by a knowledge base using all the previous data produced by the processors.

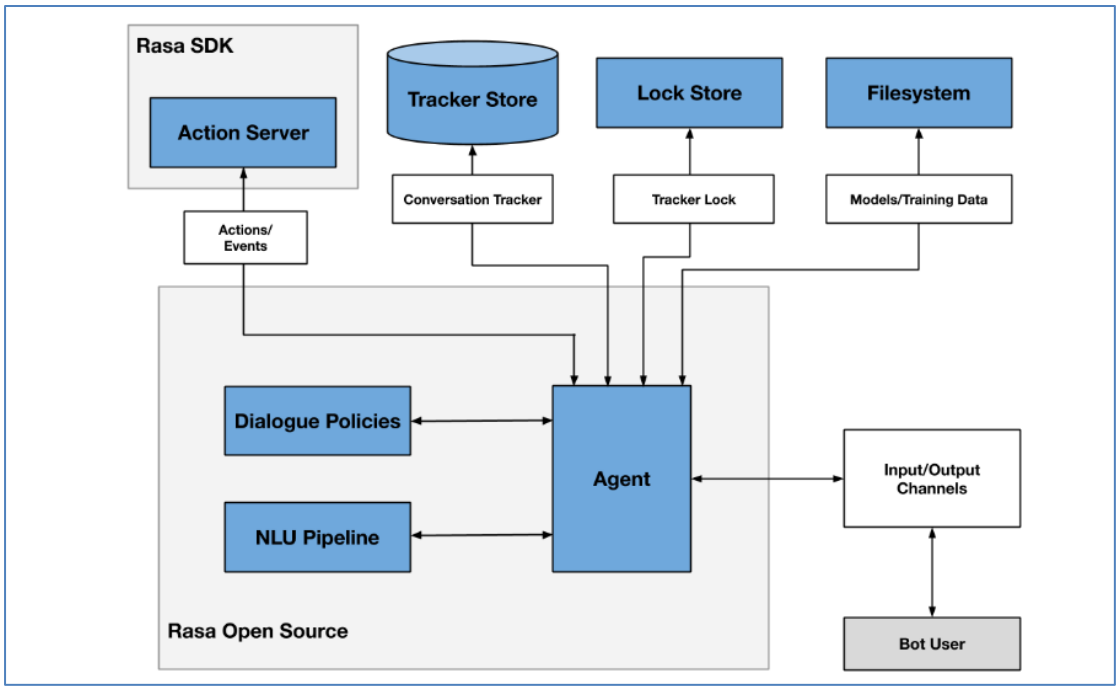

Figure 35 - RASA Conversational Agent High Level Architecture [17]

In most Conversational AI systems, that are composed of a *Natural Language Understanding (NLU)* pipeline and a *Dialogue management pipeline* as their main backbone (Figure 35), there are three main concepts used: *intents, entities, and dialogue*. While the term "entity" refers to a collection of pre-defined categories that are closely tied to rigid designators, the phrase "intent" communicates the user's intention. Also take note of the auxiliary subsystems shown in Figure 35, which are in charge of processing input and output channels, executing operations, and storing information.

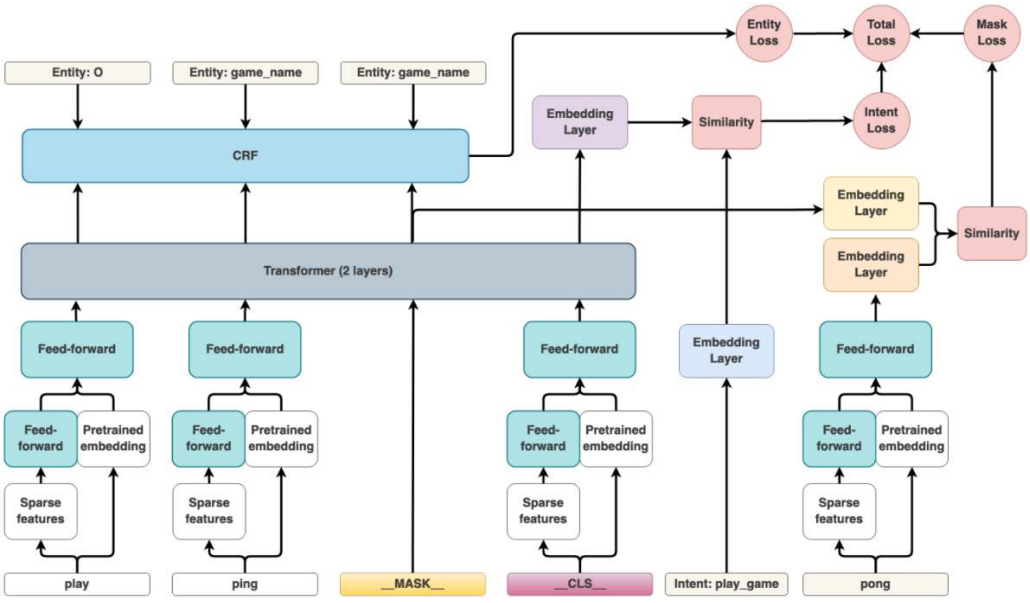

Figure 36 - DIET Classifier Architecture [18]

Entity recognition and intent classification can be accomplished through a multi-task transformer architecture known as DIET (Dual Intent and Entity Transformer) [18]. All

features, both dense and sparse, generated by the earlier methods are input into the model. When a sentence is entered, a collection of tokens — which may be words or subwords — is processed. For sparse features, one-hot encodings are employed, either at the token or character n-gram level. Dropout helps to mitigate the effects of sparsity and avoid overfitting that is brought on by the redundant information in character n-grams. Dense features include pre-trained word embeddings like GloVe [19], BERT [20], or ConveRT [21]. The output of the dense layer is then concatenated with the dense features that have already been trained.

A two-layer transformer [22] with relative position attention [23] is used to encode context for the entire phrase. The size of the layers of the transformer must match those of the input transformer. To adjust the size to the transformer layers, the concatenated features are subsequently transmitted via another entirely linked layer. The model also practices an input masking mechanism that learns to reconstruct hidden information by predicting tokens of input that has been randomly masked. 15% of the input tokens in a sequence are randomly chosen and mask. This is meant to enhance performance [24] by acting as a regularizer and supporting the model in learning more broad properties from text rather than only discriminative features for classification.

After the transformer forecasts the order of entity labels for the entity recognition task, a Conditional Random Field (CRF) is applied as a tagging layer. The transformer's output sequence, which matches the token input sequence, is transmitted to the CRF layer. The goal of intent classification is for the model to learn how to evaluate the user's speech in relation to each of the potential intentions. Finally, the speech is matched with the highest-ranking intent, which is also the most appropriate. Dot-product loss is used to reduce similarity to negative samples and increase similarity to the target label. Figure 36 depicts the architectural layout of the DIET Classifier.

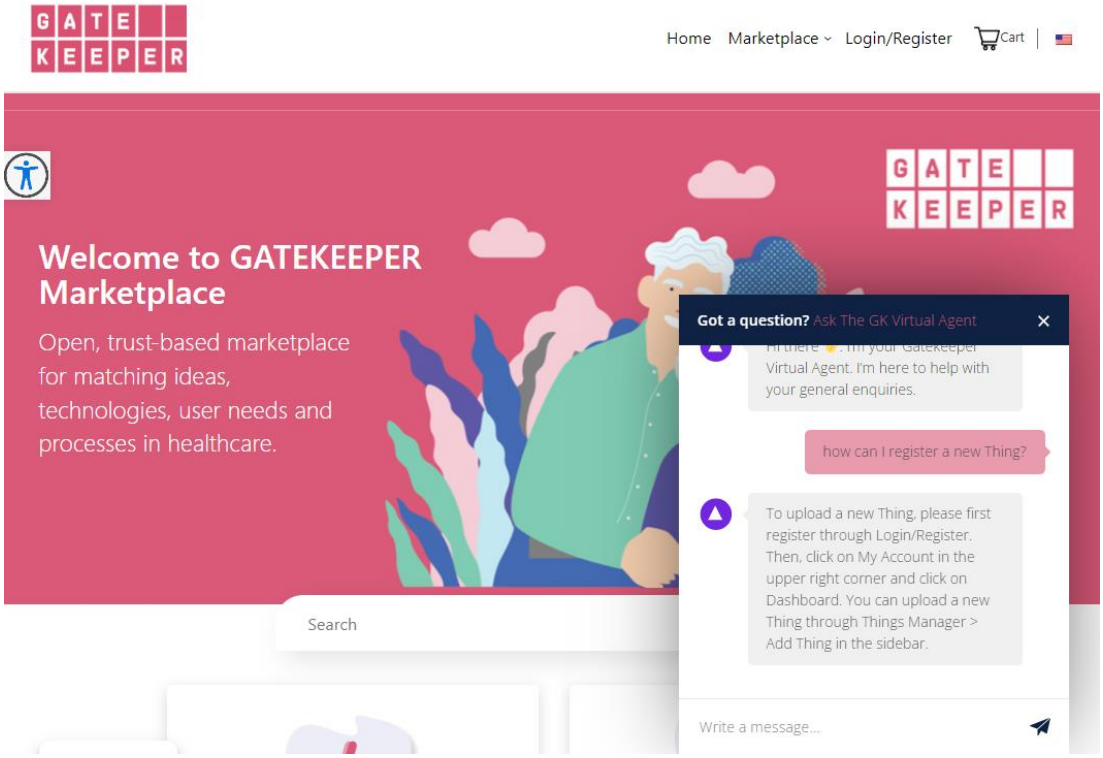

Figure 37 - GATEKEEPER Marketplace's Virtual Assistant

In Figure 37 one can observe a screenshot of the Virtual Assistant (VA) of GATEKEEPER's Marketplace. GATEKEEPER's VA utilizes the methods described in this section to provide virtual guidance to users using the Marketplace. The VA can answer various questions a user may query, while providing an understanding of the various ways a question may be posed, various synonyms etc. The answers are stored in the VA's knowledge base. When the VA understands a user's *intent* for a question, a one-to-one mapping of various recognized *intents* to answers from the knowledge base is utilized to provide the respective answer for the particular user *intent*.

6.2.6 Intelligent Discovery

The GK Marketplace employs a hybrid text- and logic-based similarity method to find the best matches and suggest alternatives to the Consumer. The method combines flexible text-similarity between keywords typed by the users in the search form and the actual available Things and hierarchical relationships between filters chosen by the users. Sources including the Thing title, Thing summary, Thing details, tags, and SKU are available for search, with the Thing title having the highest priority among them. Therefore, when the search query is in the Thing title, the Thing will appear on the top of search results (Figure 38).

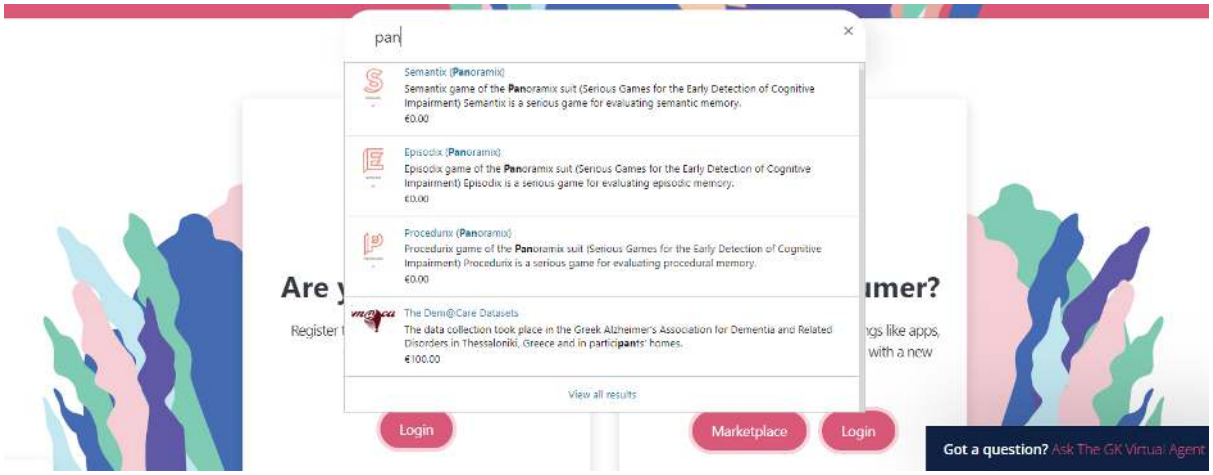

Figure 38 - Search results in the GK Marketplace

A system of tags and attributes working as filters also aids Consumers in discovering available Things (Figure 39). More specifically, the GK Marketplace tags include the intended use, such as "early detection" and "self-monitoring", special user categories ("caregivers"), and domain, such as "IoT" and "smart home". They have been pre-defined, as changes to the tag list while the Marketplace is in use might have caused errors or conflicts, and cross-checked with the description of the awardees of Open Call 1. Attributes can be specific to a Thing category and cover various aspects, such as measurements and programming language. Both attributes and tags are set by the Provider for their Thing during the process of registering it in the Marketplace (Figure 40).

Finally, Consumers can view the most popular and the top-rated Things in the landing page, while the page of each Thing displays related Things to assist in navigation.

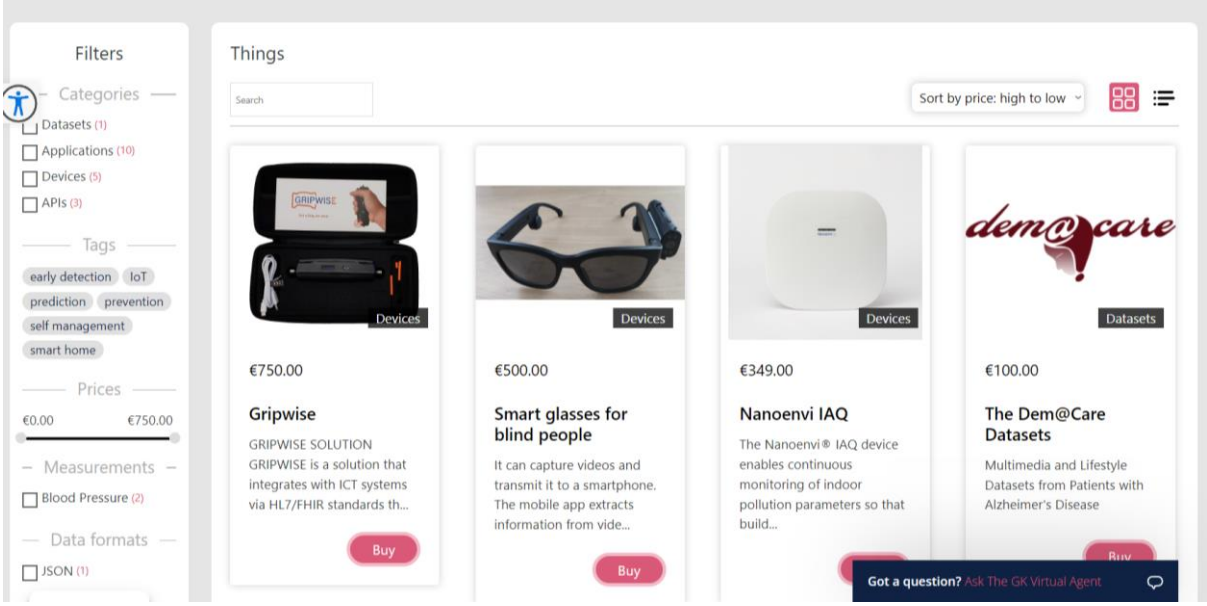

Figure 39 - Filters available to Consumers

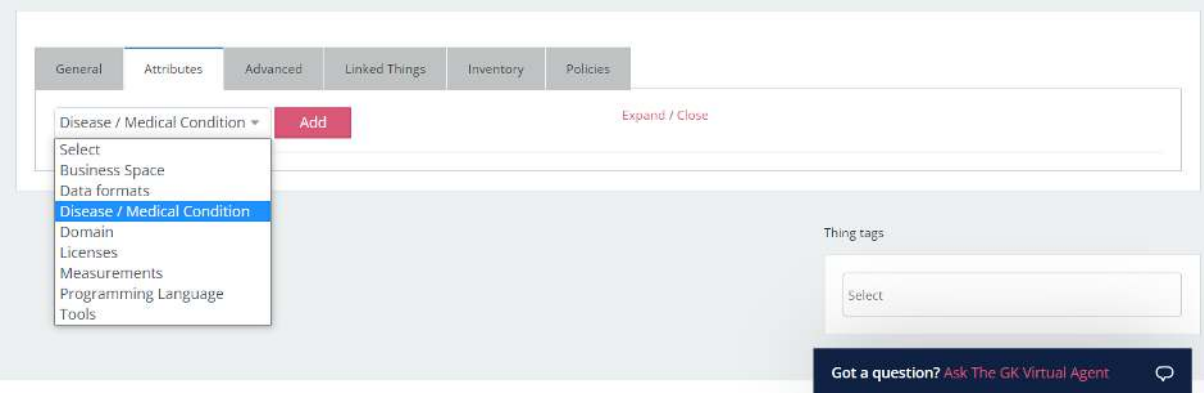

Figure 40 – Addition of Thing attributes and tags before submission

6.2.7 Admin environment

A feature-rich admin environment is available for the GK Marketplace administrator(s), The dashboard includes an overview of the completed transactions and total thing requests, with the ability to specify a date range and to export a report in .csv or .pdf format (Figure 41). Moreover, the admin can edit all Things submitted to modify their properties, such as the Thing category, tags, and images. An overview of the sales and earnings per Provider is also available.

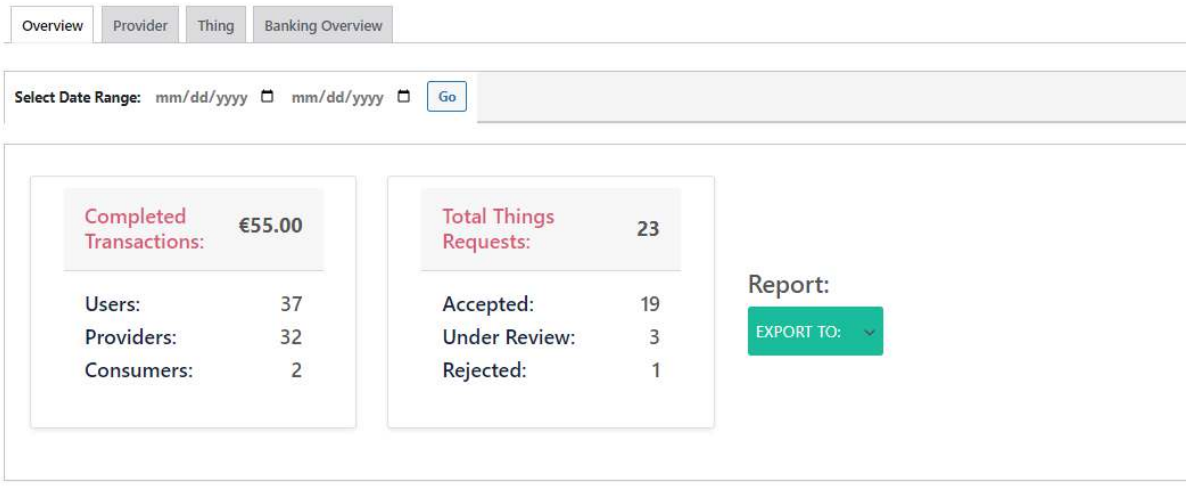

Figure 41 - Admin dashboard

7 Integration with other GK components

7.1 Gatekeeper Trust Authority (T4.5) and Things Management System (T4.2)

The integration with the Gatekeeper Trust Authority comprises integration with its different submodules, while the TMS is also involved in the flows as presented in Figure 42.

The GTA User Management Module provides secure authentication and authorization for the Marketplace end-users, while the GTA Things Validation provides validation scores to the Things according to different standards. These are saved in immutable blockchain by the GTA Things Certification. All actions related to Things (registration, update, deletion, consumption) are also logged in blockchain by the GTA Things Action Tracking module. In the case of data consumption, transactions between Providers and Consumers, who could be or be technically supporting data controllers / data owners and data processors / data users, with the IDS-RAM is displayed in Figure 43.

Figure 42 - Thing Registration flow

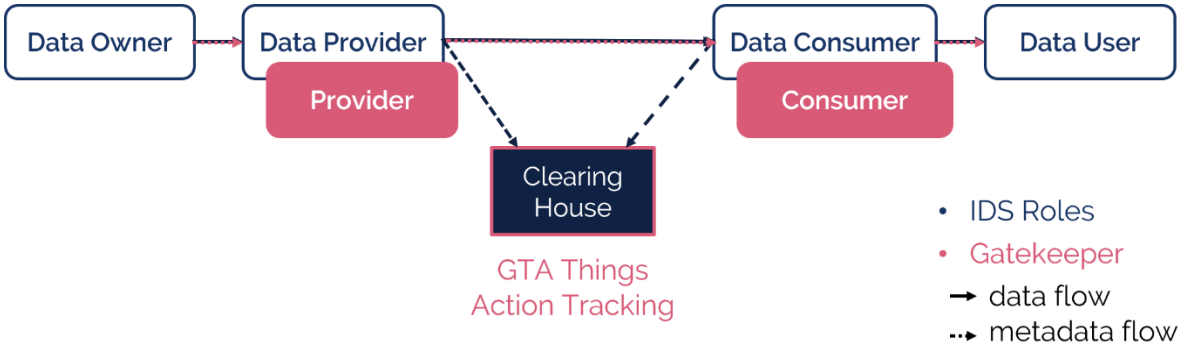

Figure 43 - GTA Things Action Tracking aligned with IDS Clearing House

8 Conclusion

The GATEKEEPER Marketplace is a key component for ecosystem building, novel business models and the exploitation of WoT. The Marketplace is a web application directly accessible to all kinds of users in the ecosystem, intended for all Spaces (Consumer, Healthcare and Business), consortium partners in all clusters, and third-party adopters, including Open Callers.

The added value of the GATEKEEPER Marketplace is to not only enable discovery and monetization, but also provide data sovereignty and allow testing of Things, as well as datathon organization. Furthermore, being part of the GATEKEEPER Platform allows more secure authentication and validated/certified content, as presented in this deliverable.

In the next version, the Marketplace will be updated to fulfil new requirements and align with the GATEKEEPER business model, on which changes are ongoing. Its content will include Things from the D3.8 Catalogue, as well as input from the 2nd open call awardees, during whose registration usability testing will also be performed.

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