TagItSmart
Smart tags driven service platform for enabling ecosystems of connected objects

Grant agreement 688061

Final Report on Performed Activities

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Document history

Revision	Date	Modification	Authors
V0.1	20.12.2018.	Initial draft and resourse section	Strahinja Vukoicic
V0.2	21.12.2018.	Sections 2 and 3 updated	Marko Stojanovic
V1.0	27.12.2018.	First submitted version	Strahinja Vukoicic

Section 1 - Summary of the work performed

The most valuable outcome of the project is working platform available online (http://duratag-dashboard.azurewebsites.net) developed during first 5 months of the project and evaluated and validated in trial with stakeholders. The DuraTag project development effort was divided in 4 working packages:

- WP1 Platform specification and architecture
- WP2 Development of the DuraTag platform
- WP3 Validation of deployed platform in trial
- WP4 Administration, Dissemination and Engagement

In WP1 requirements were analysed and functional modules were specified in D1 document. This was done based on interview with company BankPro, which at the same time was an end user, as their spinoffs are doing waste processing.

The TagItSmart architecture was partially reused – FC-scanner SDK component was adapted, but we have developed the rest of the missing modules such as Printing module (it was more feasible to make it from scratch then to use existing one from the TiS project, as it was too specific to certain use case) and Marketplace (http://duratagmarketplace.azurewebsites.net).

In WP2 the platform was developed with product passport interacting with the FC-scanner enabler integrated in the DuraTag and used for populating the passport with additional data. Marketplace was also developed to allow data exchange between different actors to leverage potential for establishing circular economy. This includes APIs and components that are suitable for data provisioning between the stakeholders.

In WP3 evaluation of the platform was done and reported in D3 based on results of validation and beta testing in trial. The beta testing was first done separately for different components, e.g. SmartTags are first encoded without the sensors with replica looking as the sensor and tested in laboratory before executing the trial. The outcomes of the beta testing of the platform was used to employ corrective measures and to apply modifications of particular modules that was not working as specified. Finally, the trial was executed within BankPro, which provided their human resources and their machines during different operations and platform processes. The field trial was executed during first 2 weeks of December 2018 and included testing at 2 different sites. Field trials were scheduled in Belgrade Waste Processing Plant in Vinča, and in BankPro Factory in Kraljevo.

In WP4 coordination of the project was done, as well as technical and promotional activities. Website was developed to promote key features of the platform, as a frontend of the DuraTag platform, also offering login and registration for the stakeholders.

Section 2 - Detailed description

2.1 Concept, Objectives, Set-up and Background

O1: To develop overheating monitoring for waste processing machines based on TagItSmart technology.
TiS mobile SDK was adapted to be used with the developed DuraTag platform. The overheating was measured for different threshold then previously specified as we discovered that irreversible tags cannot be made for temperatures above 65 degrees. The SmartTags are re-specified and the specific amout for the trial was ordered. End product is platform based on SmartTags that have encoding and machine and user management capability.

O2: To develop product passport for the machine and its components.
Product passport is developed as a web platform containing data about machine parts, repair and manual instructions, service book (history of repairs), machine's producer, components material and recycling details. The data sharing option is available over UI and API to different stakeholders.

O3: To execute trial with the deployed and integrated platform.
The trial was done with BankPro, machine manufacturer, and evaluation for different machines provided during 2 weeks. This trial included operational testing of the DuraTag solution with 5 waste briquetting machines (as initially planned) and tags were deployed on an electric motors (AC motors), geared motors and bearings.

2.2 Technical results

In WP1 DuraTag was working on specification of the platform and development of the platform functionalities. The requirements for the platform are specified in D1 deliverable which are further elaborated in D2 providing also specification of the APIs, KPIs and requirements for the platform. The development during first 5 months included development of the DuraTag application with embedded FC-scanner based on TagItSmart scanner code and development of the complete portal, including generation of QR codes, CRUD operations for personel, companies, stakeholders and products. In the second phase of the project (last 4 months) platform was technically validated and confirmed.

KPIs are all met, as shown in D3 where the trial is presented in more details.

KPI	Target value	Achived value	Comment
SmartTags data feedback	>= 100	>750	More then 750 logs from SmartTags made by 5 different users in the system.
Product Passports	2	21	Marketplace is developed with 21 product passports. 5 machines for waste processing and 5 machines for metal processing were included in the trial.

2.3 Web Application with Marketplace

API is built using latest .NET Core Framework, using WebApi technology, as well as MSSQL database with Entity Framework Core as ORM support library.

1.1. Authentication

Authentication is token based authentication, where API, as trusted source, is issuing JWT token based on security claims and generating it into a string.
Later on, every authorized API call needs to have Authorization header with value Bearer + token.
Authentication is also role based, meaning that JWT token that was issued by API has, besides other security claims, role claim of logged in user.

1.2. API controllers

Namespace: namespace DuraTag.Api.Controllers
There are 5 main WebApi controllers that serve as entry points to API:

1. Auth Controller
2. Companies Controller
3. Stakeholders Controller
4. Products Controller
5. QRCodes Controller

1.2.1. Auth Controller

AuthController is used for authenticating users with issuing JWT tokens.
Url: api/auth
Methods:

- POST login – authenticating user with username/password provided and issuing JWT token with claims of that authenticated user.

1.2.2. Companies Controller

CompaniesController is used for managing (CRUD) companies entities and user connected to companies (operators and administrators). This controller requires authentication.
Url: api/companies
Methods:

- POST companies – adding new company to database
- GET companies – getting all companies from the database
- GET companies/:id – getting specific company from the database
- PUT companies/:id – editing specific company in database
- DELETE companies/:id – deleting specific company from database
- POST companies/admins – adding company admin user to database
- GET companies/admins – getting all company admin users from database
- PUT companies/admin/:id – editing specific company admin from database
- DELETE companies/admin/:id – deleting specific company admin from database
- POST companies/operators – adding company operator user to database
- GET companies/operators – getting all company operator users from database
- PUT companies/operator/:id – editing specific company oprerator from database
- DELETE companies/operator/:id – deleting specific company admin from database

1.2.3. Stakeholders Controller

StakeholdersController is used for managing (CRUD) stakeholders entities and user connected to stakeholders (operators and administrators). This controller requires authentication.
Url: api/stakeholders
Methods:

- POST stakeholders – adding new stakeholder to database
- GET stakeholders – getting all stakeholders from the database
- GET stakeholders/:id – getting specific stakeholder from the database
- PUT stakeholders/:id – editing specific stakeholder in database
- DELETE stakeholders/:id – deleting specific stakeholder from database
- POST stakeholders/admins – adding stakeholder admin user to database
- GET stakeholders/admins – getting all stakeholder admin users from database
- PUT stakeholders/admin/:id – editing specific stakeholder admin from database
- DELETE stakeholders/admin/:id – deleting specific stakeholder admin from database
- POST stakeholders/operators – adding stakeholder operator user to database
- GET stakeholders/operators – getting all stakeholder operator users from database

- PUT stakeholders/operator/:id – editing specific stakeholder operator from database
- DELETE stakeholders/operator/:id – deleting specific stakeholder operator from database

1.2.4. Products Controller

ProductsController is used for managing (CRUD) product passports as well as recording logs related to product passports and registering (connecting) new products with QR codes. This controller requires authentication.

Url: api/products

Methods:

- GET products – getting all products from database
- GET products/bearings – getting all products with type bearing from database
- GET products/cylinders – getting all products with type cylinder from database
- GET products/logs – getting all product logs
- GET products/:id/logs – getting product logs that are related to product provided
- GET products/logs/:id – getting specific log
- GET products/unscanned – getting products that are added to database but are still not connected with QR code
- POST products/bearings – adding product with bearing type to the database
- POST products/cylinders – adding product with cylinder type to the database

1.2.5. QRCodes Controller

QRCodesController is used for generating batch of QRCodes. This controller requires authentication.

Url: api/qrcodes

Methods:

- POST qrcodes – used for generating batch of QRcodes. After generation is done, zipped batch of qrcodes are downloaded to user's system.

1.3. Api data layer

Api data layer is composed of several parts. Entity Framework Core is ORM used for persisting entities to database.

1.3.1. Models

Namespace: DuraTag.Api.DataLayer.Models

In this namespace, all the system entity models are described, as well as Application context (used by Entity Framework to map the models to DB entities)

1.3.2. Repository pattern

Repository pattern is used in order to separate concern for all queries that are executed to DB with Entity Framework with well known unit of work implementation.

It consists of 3 parts:

1. Repositories
2. Data managers

1.3.2.1. Repositories

Namespace: DuraTag.Api.DataLayer.Repositories

This namespace holds all repository interfaces with all regular CRUD methods and additional methods described. Also, this namespace holds IUnitOfWork (interface for unit of work implementation).

1.3.2.2. Data Managers

Namespace: DuraTag.Api.DataLayer.DataManager
This namespace holds all data managers which are implementations for appropriate repository interfaces. Also, this namespace holds UnitOfWork that is implementation of IUnitOfWork interface, which unifies all data managers.

2. Dashboard

Dashboard is developed with Angular 6+ framework, coded in Typescript.

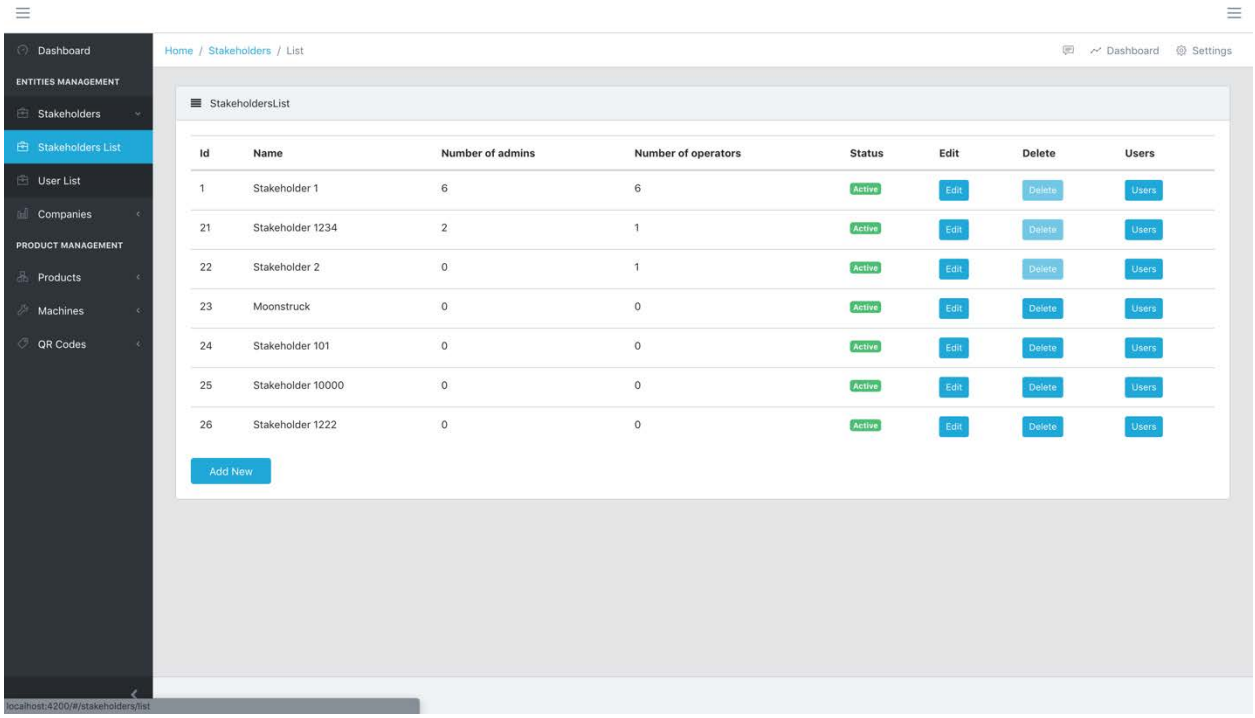
2.1. Stakeholders

Stakeholders modules is composed of 2 parts:

1. Stakeholders List
2. Users List

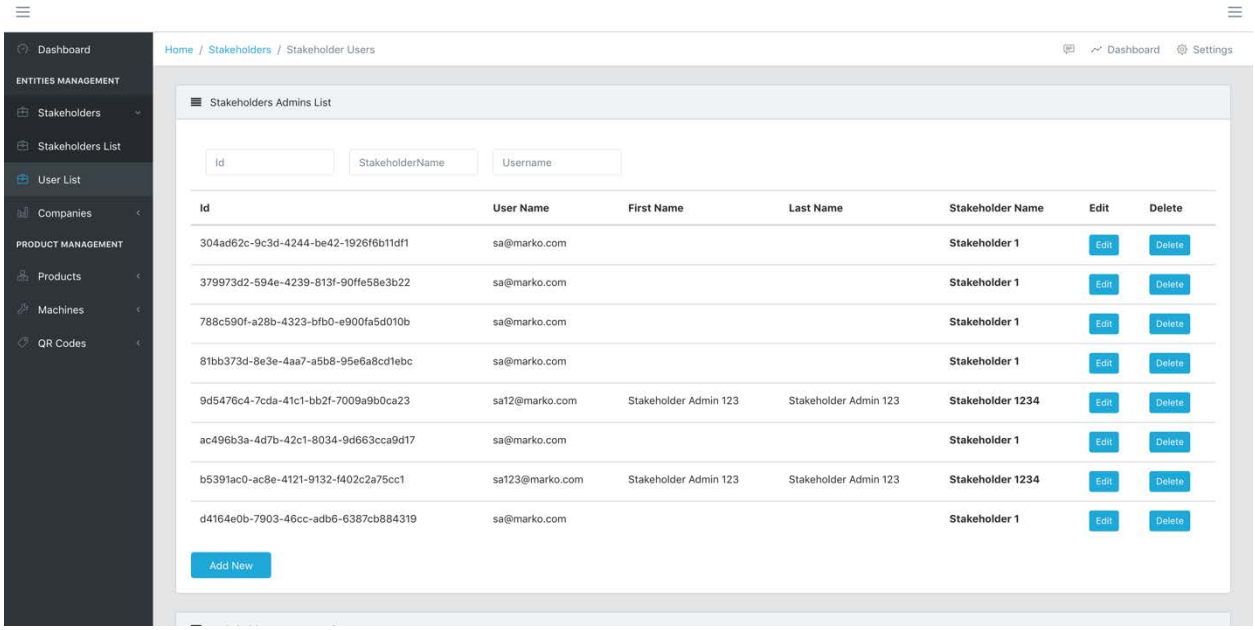
2.1.1. Stakeholders List

Stakeholders List module is used for displaying and managing all stakeholders in the system.



2.1.2. Stakeholders Users List

Users List module is used for displaying and managing all stakeholder users in the system.



2.2. Companies

Companies module is composed of 2 parts:

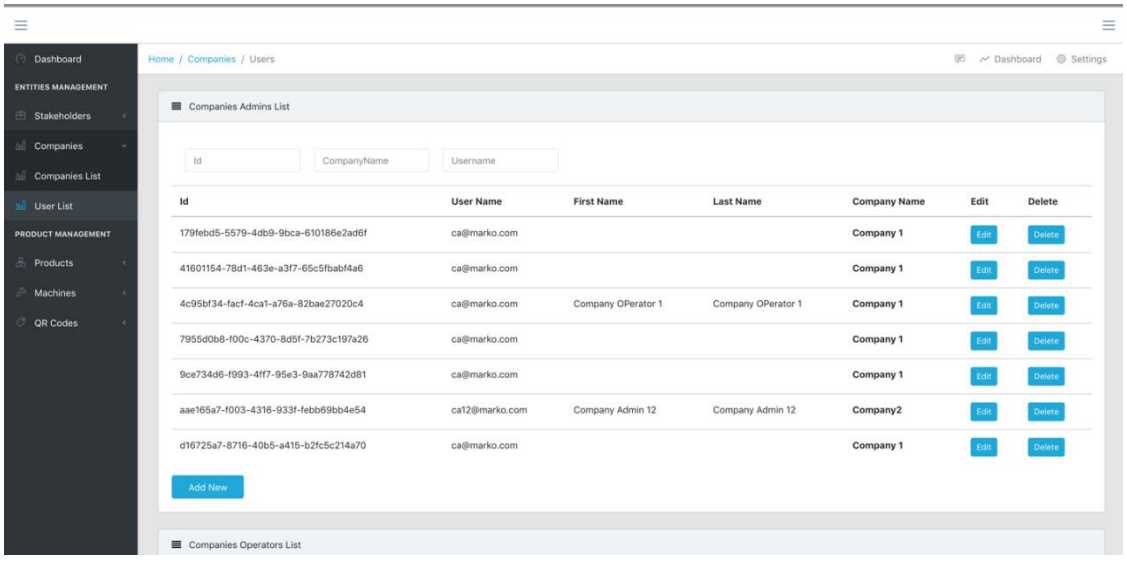
1. Companies List
2. Users List

Companies List module is used for displaying and managing all companies in the system.

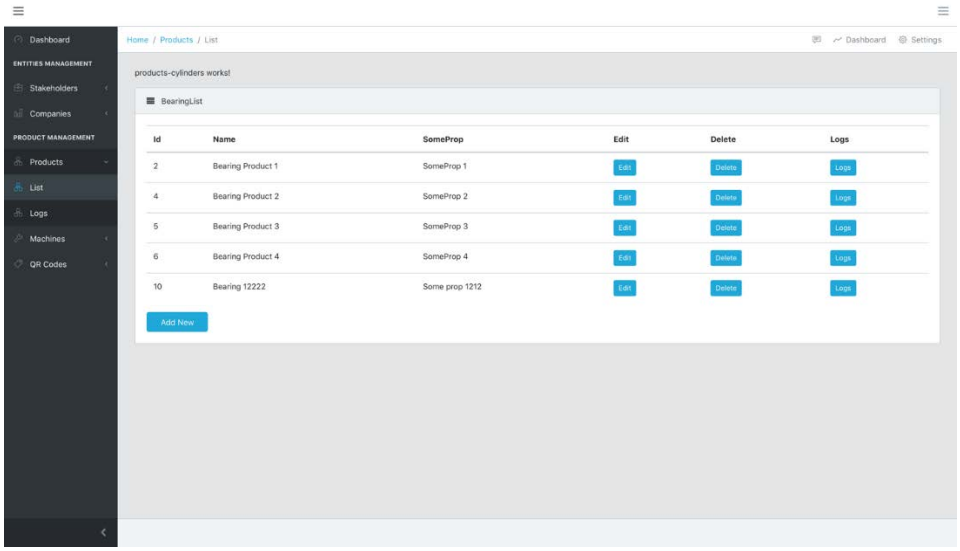
2.2.1. Companies Users List

Users List module is used for displaying and managing all companies users in the system.

Administrator List

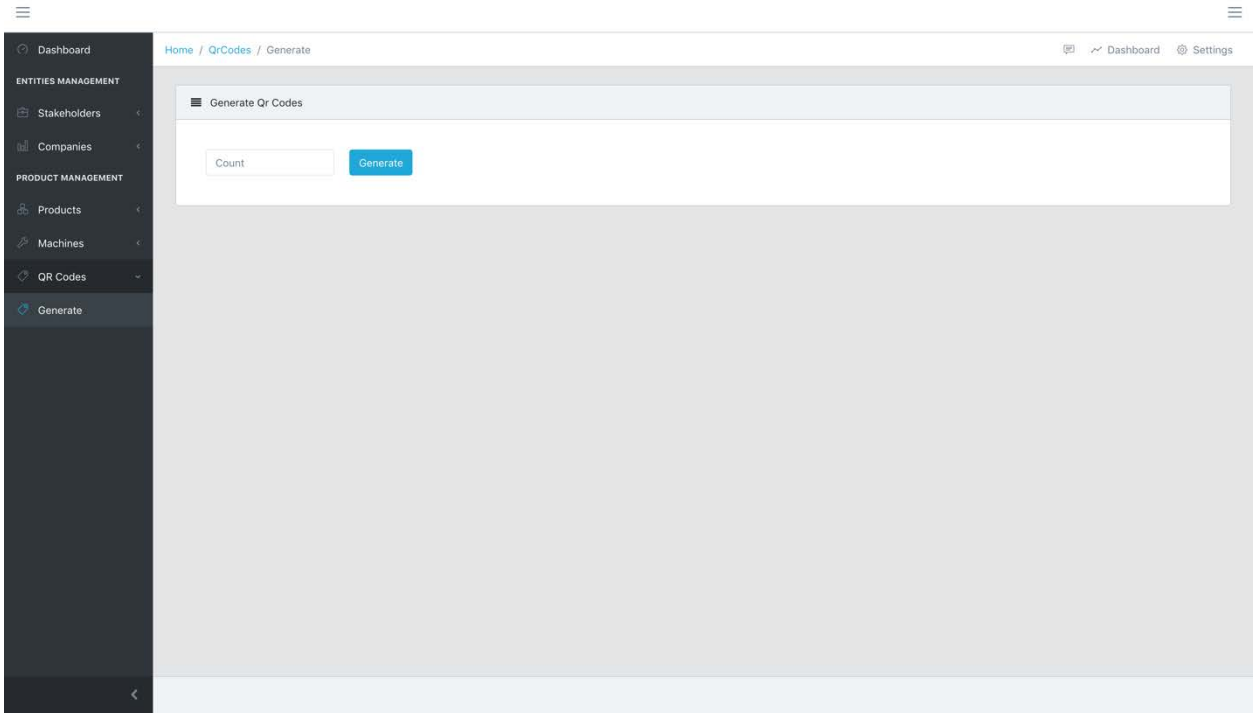


Operators List



2.3. QR codes

QR codes module is used for generating desired number of QR Codes batch.

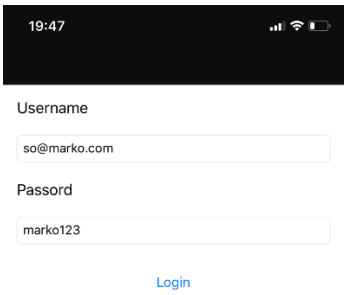


3. Application

Mobile application is built using Xamarin Forms and open source ZXing library for scanning QR Codes. Application is communicating with the API described in the previous sections.

Application has login page and is composed of several parts:

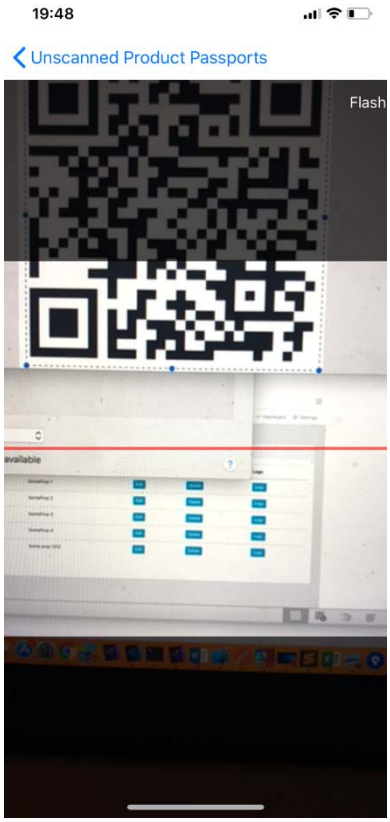
3.1 Login Page



3.2. Unscanned products

This page is used for registering newly added products with QR codes that were stamped on them.

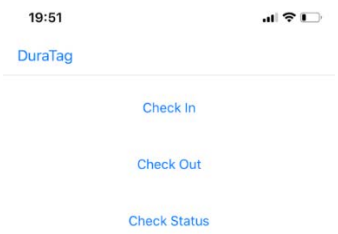
When you click each unscanned product, scanning view is presented where you can scan QR code (QR code is not presented here in full view, because it is impossible to capture screenshot when scanning of the QR code is that fast).



3.3. Scanning Page

On this page, there are 3 functional buttons:

CheckIn – this button is used for user to check in at start of working day for desired product by scanning its QR code. It also checks if there is temperature indicator present on QR code, and it sends corresponding data to API.
CheckOut – this button is used for user to check out at the end of working day for desired product by scanning its QR code. It also checks if there is temperature indicator present on QR code, and it sends corresponding data to API.
CheckStatus – this button is used for user to check status of desired product by scanning its QR code.


19:51
DuraTag
Check In
Check Out
Check Status

2.4 Lessons learned

Main lesson that was learned during the implementation of this pilot, was that feasibility of the autonomous recording with the proposed camera concept was not efficient enough due to light conditions and requirement to have flashlight instaled with the camera for each tag. Some of the tags were deployed inside cases of motors, which made it impossible to have camera installed inside. The size of the tags that we used is too small to be used with the camera at each tagged sensor, thus the automatic detection was not possible from greater distance. Instead, we have used FC-scanner as described in the proposal, to scan tags at several stages of working process, which was also used to monitor the shifts of the workers.

Also, we have focused mainly on the engagement of the different stakeholders to provide design for the market that will functionally be tailored for the target end users. This co-creation experience has helped us gain knowledge about the end user requirements, more specifically, circular economy actors in waste processing industry.

For the SmartTags we discovered that reversible tags cannot be made for temperatures higher than 65 degrees, because ink cannot sustain such temperatures. Our initial requirement was to have reversible tags that react on temperatures above 80 degrees. Instead, we were able to use only irreversible tags that react on temperatures higher than 90 degrees for this pilot.

2.5 Impact

Dissemination material is available at DuraTag website www.duratag.net that was developed to further promote activities of the project. Since the very beginning of the project we have worked on promoting DuraTag solution by participating at regional and international events.

IFAT 2018 Trade Fair for Environmental Technologies Waste and Raw Material Management, Munich (14.05.2018. / 18.05.2018.)
https://www.ifat.de/

More than 141,000 expert visitors from more than 160 countries came to Munich between May 14 and 18, 2018. In total, there were 3,305 exhibitors from 58 countries presenting their products and innovations for the booming environmental industry. DuraTag team, along with our partners from BankPro, has attended IFAT 2018 and successfully participated in one of the most important events in machinery industry. We had a chance to meet numerous companies within the industry and present DuraTag solution. Great deal of stakeholder profiles for DuraTag platform were present at this event and we have received a lot of positive feedback on the idea and several business proposals, to establish cooperation when DuraTag solution is fully developed and deployed.

62nd International Fair of Technics and Technical Discoveries - "62. Međunarodni sajam tehnike i tehničkih dostignuća" (21.05.2018. / 25.05.2018.)
http://sajam.rs/kalendar-2019/sajam-tehnike/

DuraTag team has participated at this years International Fair of Technics and Technical Discoveries, held between 21st and 25th May at the Belgrade Fair. Event included 610 exibitors from 31 countries, with 280 exibitors from abroad. During these exciting 5 days, the fair was visited by 21,593 people from regional countries and EU. Visitors on our booth had opportunity to be introduces with the concept of the DuraTag platform and benefits which platform introduce within machinery industry and circular economy. There were many interested business actors from mechanical and electrical industries, as well as engineers of all profiles.

IoT/Blockchain Meetup (11.06.2018.)
https://www.meetup.com/This-group-is-part-of-the-sociotal-eu-project/photos/28964848/471957635/#471957624

Meetup was organized with focus on IoT and Blockchain (BC) with several interesting talks about cross-domain applications of these two technologies. We have had guests from several companies and universities including OriginTrail, HTEC Control Systems, Minebox, Faculty of Electrical Engineering and Computing, University of Zagreb, and DunavNET. We talked about unique identification of products using SmartTags and special ink reacting on different conditions from environment with interesting use cases. The Blockchain was discussed from several aspects, including its application with SmartTags for transparency in supply chain, decentralized networks, etc.

Startup Summer Camp (13.07.2018.)
https://ntpark.rs/class/letnji-studentski-startap-kamp/

Startup Summer Camp was organized by the Belgrade Science Park with the support of the Swiss Government, City of Belgrade and Center for Career development University of Belgrade. DuraTag Project Manager, Strahinja Vukoičić, has participated in the event as a mentor for young startups to gain skills in defining problems, identifying solutions and target market segments, for their future companies. During the event, we have held a panel section where we presented DuraTag solution and platform, and had an opportunity to explain the technology behind it to the representatives of the sponsorship companies, such as Coca Cola, FlixBus, Interventure, etc.

Data Science Conference 4.0 (18.09.2018.)
https://datasciconference.com/

Data Science Conference 4.0 was held on 18th and 19th of September in Belgrade and DuraTag had its representatives among more than 1000 Data Scientists and Data Enthusiasts from all across Southeastern and Central Europe that were participating in the event. Topics such as Big Data, Data Architecture & Engineering, Machine Learning & Artificial Intelligence, Business Intelligence, Data Science in 4th Industrial Revolution, Open Data, Data Monetization was covered this year. DuraTag CTO, Miloš Solujić, held an interesting presentation at Data Science Conference 4.0 pointing out DuraTag H2020 pilot project as an interesting use case of IoT technology within heavy duty machinery industry.

Reinventing the World – The Power of Industry 4.0 (05.11.2018.)
https://ntpark.rs/2018/09/06/reinventing-the-world-the-power-of-industry-4-0/

November 5th, a very interesting conference and business event was facilitated by Science Technology Park Belgrade, with the support of the Swiss Government. Under ambitious name Reinventing the World – The Power of Industry 4.0 the conference gathered large number of participants from companies and organizations on regional scale, as well as some of the world-class keynote speakers. DuraTag Project Manager, Strahinja Vukoičić, has participated in the event and business meetings with foreign companies, establishing new relations with potential commercial partners. One of the main topics were cutting-edge solutions that our company develops in the industry segment, such as DuraTag platform.

Ecomondo 2018 Leading Expo for the Green and Circular Economy, Rimini (06.11.2018. / 09.11.2018.)
https://en.ecomondo.com/

Ecomondo, the leading Euro-Mediterranean area green and circular economy expo, was held between 6th and 9th November in Rimini, Italy. An international event with an innovative format that brings together all sectors of the circular economy in a single platform: from material and energy recovery to sustainable development. Enabling technologies that are pushing the fourth Industrial revolution could promote the distribution of circular economy models and the development of sharing platforms for goods, services and energy efficiency. DuraTag team, along with our partners from BankPro, has attended Ecomondo 2018. During the 4-days expo, we have met great deal of companies within the circular economy industry and presented DuraTag platform and application. Several very promising cooperation leads has been identified for 2019, to exploit DuraTag platform to enable and enhance commercial potential of circular economy on EU level. During B2B meetings, a lot of qualitative feedback was given from industry experts and stakeholders.

Section 3 - Resources

3.1 Resources deployed

The project involved:

- Strahinja Vukoicic – Project Manager
- Marko Stojanovic
- Milos Decov
- Darko Lukic
- Dragan Kavgic

Marko Stojanovic, Milos Decov, Dragan Kavgic and Darko Lukic were responsible for all technical development work on the DuraTag platform.

CALCULATION OF PERSONNEL COSTS

	Hours dedicated to the project	Hourly rate	Personnel cost
Strahinja Vukoicic	100,00 h	38,00	3 800,00
Marko Stojanovic	1020,00 h	30,00	30 600,00
Milos Decov	744,00 h	25,00	18 600,00
Darko Lukic	280,00 h	25,00	7 000,00
Dragan Kavgic	80,00 h	30,00	2 400,00
TOTAL	**2224,00**		**62 400,00 €**

The other expenses included costs of travel and subcontracting. We have been invited to most of the international events to participate free of charge and for the two events we had to pay travel cost and accomodation, as shown in the table below. The subcontracting costs are allocated for BankPro.

CALCULATION OF OTHER COSTS

	Start	End	Where	Why	Costs
S. VUKOICIC	14.05.2018	18.05.2018	IFAT Munich	Travel and event expenses	1750,00
S. VUKOICIC	06.11.2018	09.11.2018	Ecomondo Rimini	Travel and event expenses	1200,00
BANK PRO	06.11.2018	09.11.2018	Rimini	Travel and event expenses	4560,00
TOTAL					**7 510,00 €**

3.2 Further development and exploitation

Considering the further development plan, we will do deployment of the DuraTag platform with the BankPro stakeholder in other waste processing points and for other companies that acknowledge the benefits of such solution. At first, we will address the Waste Processing Plant in Novi Sad, where we already have a scheduled presentation for the end of January. Such implementations will help us achieve goal of collecting the significant dataset about the machine parts and their usage, in order to exploit actual commercial potential of DuraTag marketplace. We will continue to actively build the ecosystem of stakeholders and companies in machinery industry interacting via DuraTag platform, to create business opportunities for our company as well as for other actors in the market. The social media work will also be in focus for our further dissemination, to ensure better reach to potential audience using social networks (Twitter and LinkedIn) during the upcoming events in 2019.