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ElectriCity Innovation Challenge 2015: Experiences

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Summary

ElectriCity Innovation Challenge 2015 was an open innovation contest in Gothenburg, Sweden. The main purpose was to surge public interest and involvement in ElectriCity, a demonstration arena for next-generation's electrified bus systems. The contest furthermore aimed to catalyse innovation that can contribute to making public transport more attractive, and to test a novel innovation platform that assembles data from buses and bus stops. The outcome was six events with a total of more than 800 attendants, 48 viable prototypes with potential to increase the modal share of electrified public transport and feedback on the innovation platform's potential for development.

Keywords: Public transport, EV, PHEV, demonstration, case-study

1 Introduction

Road transport is the single largest source category contributing to the total national greenhouse gas emissions in Sweden [1]. Road transportation in 2013 consumed 79TWh, which is about 21% of the nation's total annual energy usage [2]. This caused greenhouse gas emissions of nearly 17,200kt CO2-equivalents [1]. The major contributor is passenger car trips. The Swedish public transport industry has therefore formed a nationwide co-operation, called the Swedish doubling project [3]. Key purposes are to reduce carbon dioxide and to increase energy efficiency throughout the transport system. The long-term goal of the project, which involves all employers in the public transport sector, is to double the market share held by public transport by 2020, compared to 2006 levels. Beyond environmental gains, a doubling of public transport also has potential to improve road safety, to reduce congestion and to contribute to a transport system that offers equal opportunities. According to the Swedish Public Transport Association, it would moreover trigger an annual economic growth of around 460 million USD [3]. However, to achieve these objectives, the attractiveness of public transport must be increased substantially.

Gothenburg is currently the scene of ElectriCity – a demonstration arena bringing together industry, research and society in the development and testing of new solutions for the next-generation of electrified bus systems. The underlying purpose is to contribute to the goal of doubling the modal share of public transport in Sweden by facilitating development and demonstration of novel products and services that increase efficiency, sustainability and attractiveness. ElectriCity is moreover aimed to serve as a source of inspiration for future urban development.

ElectriCity Innovation Challenge 2015 was an open innovation contest organized by a consortium of 20 organisations representing public and private sectors as well as academia (challenge.goteborgelectricity.se). The purpose of the challenge was threefold:

- Surge public *interest and involvement* in ElectriCity
- Catalyse *innovation* that can contribute to making tomorrow's electric bus trips more attractive
- *Test* the feasibility and usability of the ElectriCity innovation platform

This paper describes the design, implementation and results of the contest. It moreover discusses to what extent it fulfilled its purposes and briefly how open innovation contests, in general, can be used to facilitate the market introduction and uptake of electrified public transport. Lastly, it proposes research questions for future studies.

2 ElectriCity

2.1 ElectriCity Demonstration Arena

Three electric concept buses and seven pre-production models of plug-in hybrid buses form the core of the demonstration arena ElectriCity in Gothenburg, Sweden (goteborgelectricity.se). The buses are demonstrated along a 9,5 km long inner-city route over a period of three years. The route is operated in regular scheduled service and is included in the same ticketing system as the rest of the city's public transport network. A combination of overnight slow charging and fast charging at the end bus stops enables the plug-in hybrid buses to complete around 70% of the route in electric mode. Both the electric and the plug-in hybrid buses are powered by 100% renewable energy.

Additionally to the propulsion system, the concept buses moreover demonstrate several other novel features. The most conspicuous ones are the centrally placed driver position and the extra wide entrance door. The aim is to address the needs for convenient on-board functions and a pleasant environment.

ElectriCity furthermore includes demonstration of several further products and services meant to increase the efficiency, sustainability and attractiveness of tomorrow's public transport solutions. Examples include:

- A new depot concept, including workshop, showroom and traffic management
- Zone management control of bus speed and propulsion
- Novel safety systems such as dynamic warning signals for pedestrians
- Two new fast charging stations, one of them placed indoors
- Six new bus stops, including one indoor bus stop and one soundproofed bus stop
- Lounges, cafés and exhibitions in the vicinity of the bus route
- Seamless wireless internet at buses and bus stops
- Charging of handheld devices at buses and bus stops
- Interactive screens and novel information screens at buses and bus stops.

Figure 1 plots the nine main components of the demonstration arena along the bus route.

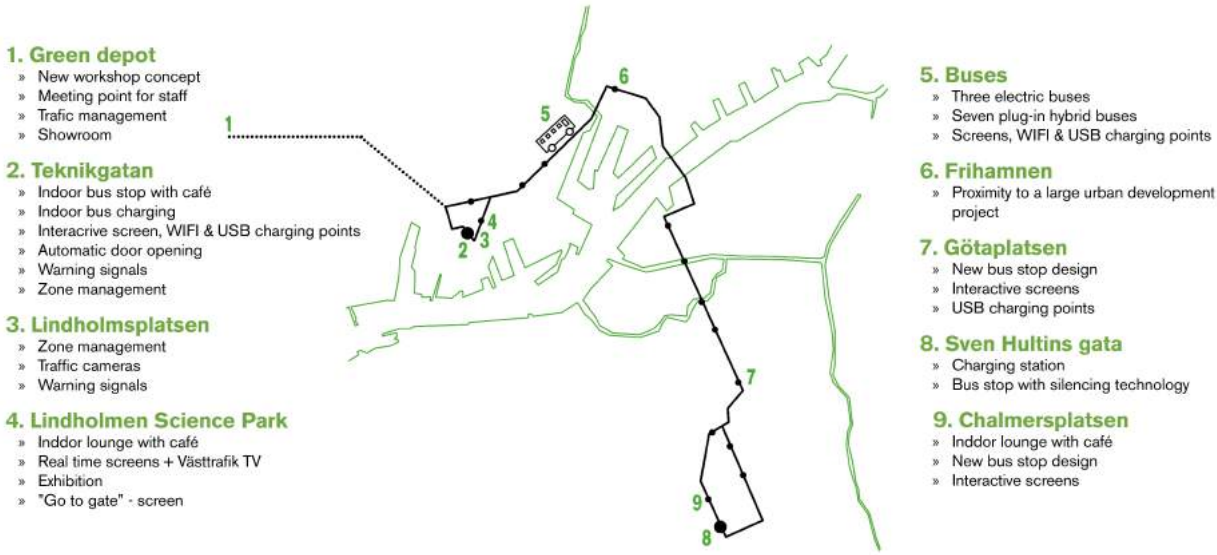

Figure 1: Components of ElectriCity Demonstration Arena

Volvo Group is the initiator of ElectriCity, and is responsible for development of buses and transport solutions. However, the multi-party consortium includes two public institutions (Västra Götalandsregionen and Göteborgs stad), the regional public transport authority (Västtrafik), a public transport operator (Keolis), an energy company (Göteborgs Energi), two local business parks (Lindholmen Science Park and Johanneberg Science Park) three property managers (Akademiska Hus, Chalmersfastigheter and Älvstranden Utveckling) and an NGO that works to strengthen trade and industry in the region (Göteborg Business Region) as well as academia (Chalmers University of Technology). ElectriCity is furthermore co-founded by the Swedish innovation agency (Vinnova) and the Swedish energy agency (Energimyndigheten).

2.2 ElectriCity Innovation Platform

Information about the demonstration arena, and its components, has been made public through the ElectriCity Innovation Platform (platform.goteborgelectricity.se). The innovation platform enables internal and external development of public transport related products and services by compiling information regarding buses, bus stops and charging stations as well as regarding the public transport system as a whole. The overarching aim is to contribute to the attractiveness of public transport by facilitating test, demonstration and evaluation of new ideas at the demonstration arena.

The innovation platform offers static information about the demonstration arena in a digital library. This includes technical specifications of the buses, photos and drawings of the bus stops and information about the charging stations' energy consumptions, among other things.

A novel application-programming interface (API) that assembles real time data from buses and bus stops is also made available via the innovation platform. Access to the API require registration, but is open for all. The API was developed by Cybercom using Ericsson's SEP platform. Data points are supplied by Volvo Bus, Keolis, Västtrafik and Icomera, and include:

- The position of the accelerator pedal
- The temperature outside the bus and inside the driver cabin
- The GPS position of the bus (three versions)
- Whether the bus is at a bus stop and which the next stop is
- Whether the stop button has been pressed
- Air conditioning, stop button, turn signal and pram button instrument cluster indications
- Information about the route and whether the bus has deviated from it
- FMS-version supported by the vehicle
- Mobile network cell information and signal strength
- Information about the WiFi connection and number of users that are connected
- Current positions of the doors and whether the doors are activated for automatic opening/closing
- Position of the ramp/lift
- Total mileage

The structure of the platform is visualized in figure 2.

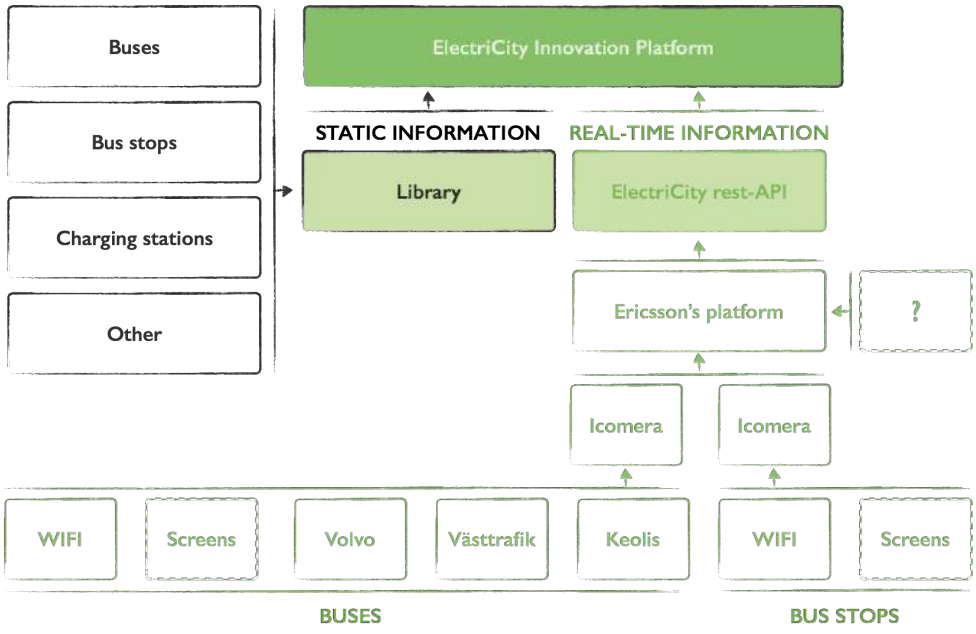

Figure 2: Structure of ElectriCity Innovation Platform

The innovation platform's website furthermore offers support services such as documentation, code examples, a test lab and a discussion forum. These measures are meant to lower initial adoption barriers and increase the attractiveness of developing services. Lastly the website also includes links to other data and information sources in order to provide inspiration and ease development of mash-up solutions..

3 ElectriCity Innovation Challenge 2015

3.1 Purpose

ElectriCity Innovation Challenge 2015 paired the possibilities within the demonstration arena ElectriCity with the joint creative force in the region in order to demonstrate how the attractiveness of tomorrow's bus trips can be augmented. The goal was to engage the public in developing prototypes than can be exposed and tested live in ElectriCity after the contest.

The purpose was threefold. The main stakeholders behind ElectriCity wanted to organize the contest in order to generate public awareness and keep the regional interest and involvement, which they feared would drop after the grand opening of the demonstration arena. They also wanted the contest to fill the demonstration arena with content in order to increase its innovativeness and attractiveness. Lastly, they wanted to test the feasibility and usability of the novel innovation platform in general and the new API in particular.

3.2 Challenges

The overall challenge in for the participants was to develop prototypes of either digital or physical products and services that would increase the attractiveness of tomorrow's bus trips. Submitted prototypes furthermore had to address at least one of the following three challenges:

- Efficient and fun - how can bus trips become a more efficient and fun way to travel?
- Attractive bus stops - how can bus stops be designed to be perceived as safe and attractive?
- Bus trips for all - how can bus trips become accessible and safe for everyone?

3.3 Structure

The structure of ElectriCity Innovation Challenge 2015 followed a five-step process; where four out of five steps have been performed to this date, see Figure 3.

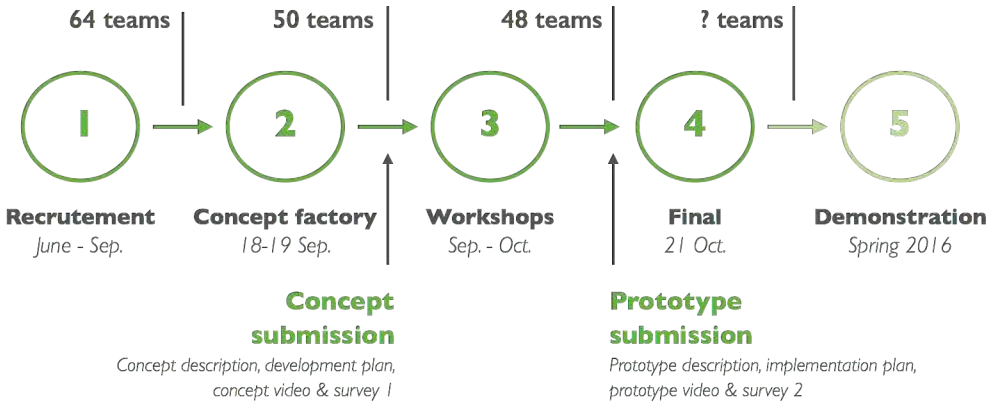

Figure 3: The Contest Process

The Electricity Innovation Challenge 2015 website was launched in June 2015, which manifested the start of the recruitment process. Participants were recruited through partnerships with local universities and through digital and traditional marketing. A 24-hour Concept Factory in September marked the beginning of the contest. During this event, participants received supervision and feedback while developing concepts within the scope of the three contest challenges. During the following weeks, four themed development workshops were arranged, where participants had the opportunity to interact with and get feedback from representatives from the consortium. At the end of the contest period, the teams participated in a final exhibition and pitched their prototypes for an expert jury. Three winners were selected; they won consultation and an opportunity to discuss demonstration, realization and partnership with decision makers within the ElectriCity consortium. Currently, the after-process is taking place, aiming to demonstrate as many of the prototypes as possible on ElectriCity as well as facilitating their market introduction.

4 Results

4.1 Interest and Involvement

261 people divided into 64 teams signed up for participation in the contest. 50 of these teams submitted approved concepts and 48 submitted approved final prototypes. The content's six events were on average attended by at least one representative from 30 of the teams, as can be seen in table 1. In total, the contest events attracted more than 800 attendants, counting the participants, representatives from the contest consortium and the general public.

Event	Participants	Description
Concept factory	43 teams	*24 hours of introduction and supervised development of concepts*
24h with the bus	20 teams	*Workshop on public transport and electric buses at the green depot*
Tomorrow's bus stops	26 teams	*Workshop on bus stops and city planning at Sven Hultins Gata*
The innovation platform	20 teams	*Workshop on the innovation platform and digital prototype development*
From concept to business	22 teams	*Workshop on business plans and practicing of pitching prototypes*
Final exhibition	48 teams	*Public exhibition of prototypes and assessment by expert jury*

Table 1: Attendance at the Innovation Contest's Events

34 of the final 48 teams affirmed that the contest had increased their interest in ElectriCity. 30 of the teams furthermore aimed to continue their development of their prototypes towards demonstration and market introduction after the contest. Nine teams would not and nine teams had not yet decided what to do.

Videos describing the submitted concepts and prototypes were uploaded on Youtube and linked at the contest website. Three weeks after the contest, these videos had generated more than 7000 views in total. The contest, and its results was furthermore highlighted in roughly 35 newspaper articles and website updates before, during and after the contest. Examples of headlines are "open data from ElectriCity enables new innovation" [5], "innovation contest will shape the future of bus travel" [6], and "grand slam for explorer application" [7].

A few weeks after the final exhibition, a web survey was sent to 45 representatives for the ElectriCity consortium that also had been involved in the design and implementation of the contest. It received 23 responses. The survey results indicate that the consortium representatives, on average agreed that the contest offered an opportunity for organizations to promote themselves and to establish new connections with both contest participants and other stakeholders that were involved in the implementation of the contest. The contest moreover succeeded in enhancing "others" interest in ElectriCity, according to the survey results. Lastly, the respondents affirmed that the contest succeeded in surging interest and involvement and a majority of the organizations planned to contribute to the winners continued work after the contest.

4.2 Innovation

The contest generated 48 prototypes of products and services aimed at increasing the attractiveness of tomorrow´s electrified bus trips. A 20-headed expert jury, representing the multi-party consortium behind the demonstration arena, confirmed that 75% of the prototypes met the contest challenge, had a clear connection to the demonstration arena, were innovative, had potential to attract more passengers to public transport and were realizable within a time frame of three years.

The submitted prototypes are described in tables 2-4 below, one for each contest challenge. The tables moreover present the jury representatives' average standpoint regarding the following statements (on a 5 point Likert scale from "1-strongly disagree" to "5-strongly agree"):

- The submission addresses the competition's overall challenge (Ch.)
- The submission has potential to attract new public transport passengers (Po.)
- The submission has a strong connection to ElectriCity (EC.)
- The submission is innovative (In.)
- The submission is possible to realize within three years (Re.)

4.2.1 Efficient and Fun

The 28 prototypes submitted in the "efficient and fun" category are described in table 2.

Team name	Category	Description	Assessment				
			Ch.	Po.	EC.	In.	Re.
Beike	Game	*Move squares, gain points*	4	3	3.6	4.2	3.6
Bengan Boys	Game	*Zap obstacles, avoid crashes*	4.4	3	4.6	3.6	4
BGreen	Loyalty program	*Trade travelled distances for offers*	4	3.6	4.2	3.8	3.8
DevIT	Trip planner	*Alarm reminds user to get off*	3.2	3.6	3	3	2.8
DevKittens	Game	*Gamified link to eco-friendly stores*	3	2.4	3	4.2	3.8
D. Tape Solutions	Trip planner	*Alarm reminds user to get off*	3.4	2.6	3.6	2.6	2.8
hiHats	Loyalty program	*Trade travelled distances for offers*	4.2	3.4	5	4	4.8
Inertia	Trip planner	*Displays the user's carbon footprint*	4.4	3.2	4.2	3.2	3.4
Kod Blå	Trip facilitator	*Wake up at your destination*	2.8	2.4	3.4	2.8	3.6
MekTravel	Loyalty program	*Collect points through your bus pass*	4.2	3.6	3	3.2	2.6
NXplore	Exploration	*Lists activities in vicinity of bus route*	4.4	3.8	4	4	4.8
Omni	Exploration	*Lists culture in vicinity of bus route*	4.4	3.2	3.8	2.8	3.8
OwlDroid	Trip planner	*Planner that includes disturbances*	3.8	2.4	2.8	3	3.8
Prothean Software	Social interaction	*Match people by Facebook profiles*	3	2.2	3.2	2.6	3.2
Qlajd	Game	*A bouncing bus on route 55*	4	3	5	3.8	4
Rebus	Social interaction	*Match people by suggested topics*	3.4	3.2	4	3.8	4
Signal Unknown	Loyalty program	*Gain mileage to compete with others*	3.6	2.8	3.6	2.6	2.6
Snubbar med slips	Trip facilitator	*Wake up at your destination*	4.6	3.2	3.6	3.6	4.2
SocTec	Social interaction	*Gain points by scanning app users*	2.4	1.8	3.2	3.2	2
Spoti5	Loyalty programs	*Eco-travel tool for companies*	4	4	4.2	3.8	3.8
Super Friends	Crowd sharing	*Review buses, bus stops, trips etc.*	2.2	1.8	2.8	2.2	2.2
Taffik	Trip planner	*Compare trip opportunities*	4	3.6	4.2	3.8	3.8
Team BusGen	Social interaction	*Match people by profiles*	3	2.2	3.2	2.2	4
Team Osqar	Social interaction	*Chat triggered by questions*	4	2.8	4.4	3.6	4.2
TeamUno	Exploration	*Lists cultural activities*	3.4	2.6	2.4	2.8	2.8
Tesla	Exploration	*Lists bars, landmarks etc.*	3.6	3.4	3.8	3.2	3.8
Tillf. Gruppnamn	Trip facilitator	*Read books, get notification at stop*	4.2	3.6	4.2	4.2	3.6
VästQuiz	Game	*Quiz*	3.2	2.2	2.6	2.8	3.6

Table 2: Entries in the "Efficient & fun" Category

Five games, five trip planners, five social interaction tools, five loyalty programs, four exploration tools, three trip facilitators and one crowd sharing tool were submitted in the category. The jury´s motivation for picking the contribution submitted by Nxplore as both category winner, and main winner of the contest, was as follows:

"*The winning contribution aids public transport passengers in exploring the city. Updated information regarding points of interest is cleverly identified and beautifully presented for public transport users. The winning contribution has local relevance and global potential. In addition to that, the team behind it has demonstrated that the solution is almost ready to be launched. The winner of the efficient and fun category and the main prize is team Nxplore."*

4.2.2 Attractive Bus Stops

The 11 prototypes submitted in the "attractive bus stops" category are described in table 3.

Team name	Category	Description	Assessment				
			Ch.	Po.	EC.	In.	Re.
4Wheels	Bus stop design	*An art contest*	4	3	2.6	3.2	4
Buzzify	Bus stop design	*Play and learn about clean energy*	3.4	2.8	2.6	2.4	3.4
Da Buzz	Bus stop design	*Novel bus stop design*	3.2	2.2	2	1.6	3
Elements	Bus stop design	*Bus stop with windmill & e-bikes*	3.4	2.4	3.4	3	2.8
Karmen	Game	*Promotes eco-friendly actions*	2.6	2.2	3.4	2.2	4.2
Lux Futura	Bus stop design	*Informative lights at bus stops*	4	3.8	3.8	3.4	4.4
MaxMen	Trip facilitator	*Displays connections at next bus stop*	3.2	2.6	3	1.4	5
The Bus Crew	Exploration	*Lists cultural activities, cafés, etc.*	3.6	3	3.4	2.6	4.8
WestSide	Bus stop design	*Collaborative art tool*	4.2	2.4	2.8	4	4.2
WikmanPettersson	Bus stop design	*Play area at bus stops*	3.4	2.8	2	3.4	4
Volvo_EMC	Bus stop design	*Sensors that detects hazardous gases*	2	1.8	1,6	4,2	2,4

Table 3: Entries in the "Attractive Bus Stops" Category

Eight bus stop designs, one game, one trip facilitator and one exploration tool were submitted in the category. The jury's motivation for picking the contribution submitted by Lux Futura as category winner was as follows:

"*The winning contribution in the "attractive bus stops" category is a contribution that the jury believes addresses one of the main barriers that currently prevents more people from choosing public transport - namely the sense of safety at bus stops. With help of dynamic light, this contribution creates a safe and vibrant environment in and around the bus stops. The winner of the attractive bus stops category is the team Lux Futura*."

4.2.3 Bus Trips for All

The 9 prototypes submitted in the "bus trips for all" category are described in table 4.

Team name	Category	Description	Assessment				
			Ch.	Po.	EC.	In.	Re.
Alive & Clickin'	Crowd sharing	*Tool for sharing info regarding buses*	4	4	4.4	3.8	3.8
El Bús	Trip facilitator	*A little bit of everything*	3	2.8	2.4	2.4	3.2
Ericsson Flamingos	Trip facilitator	*An alarm tool*	2.8	2.4	2.2	2.6	2.6
GhostBusses	Trip facilitator	*GPS-based payment tool*	4.2	4	3	3.2	1.8
Grupp 4	Trip facilitator	*Tool for monitoring travelling kids*	4.6	4.4	3.8	4.2	4.2
Handibus	Trip planner	*Tool for finding bus stops*	3	3.2	3.2	3.8	3.4
Merk	Trip facilitator	*User friendly trip facilitator tool*	4	3	3.2	2.8	4
Semcon	Trip facilitator	*Helps new travellers plan/execute trip*	4.8	4.2	3	4.6	2.8
Team "team name"	Exploration	*Lists restaurants etc. close to route*	4	3.8	3,4	3.2	4

Table 4: Entries in the "Bus Trips for All" Category

Six trip facilitators, one crowd sharing tool, one trip planner and one exploration tool were submitted in the category. The jury's motivation for picking the contribution submitted by Grupp 4 as category winner was as follows:

"*The winning contribution in the bus trips for all category provides a highly developed and carefully considered digital contribution that facilitates all steps associated with children traveling from a to b by the means of public transport. The contribution increases the sense of safety for children and their parents. The winner is group 4 and their app busskompis."*

4.3 Test

30 of the prototypes that were developed during the contest utilized the ElectriCity API. During the time frame of the contest, the teams that developed these prototypes examined the registration process, the documentation and the design of the API. This generated more than 600'000 API request from 30 of the participating teams.

Most of the contest participants' questions and comments regarding the innovation platform and the API were expressed during the competition events, over the phone or through e-mail. However, the discussion forum on the innovation platform website also generated 121 posts divided upon 41 threads. Table 5 illustrates which topics that the threads addressed.

Theme	Threads	Description
The innovation contest	11 threads	*Questions regarding scope, rules, timeline etc.*
Methodological API support	8 threads	*Request for help with achieving preferred outcomes.*
Supplementary information	6 threads	*Requests for maps, graphic profiles, statistics etc.*
API content	5 threads	*Requests for additional data points and meta data.*
API interpretation	4 threads	*Questions regarding meaning of data points or responses.*
API malfunction	4 threads	*Reports of invalid or inconsistent structure or response.*
API unavailability	2 threads	*Reports of downtime.*
API future	2 threads	*Questions regarding future scope and development.*

Table 5: Topics of Discussion Forum Threads

Representatives for the innovation contest consortium answered most of the comments and questions posted in the discussion forum. However, a few occasions of collaboration between the participating teams were discovered.

5 Discussion and Future Work

The purpose of ElectriCity Innovation Challenge 2015 was threefold:

- Surge public *interest and involvement* in ElectriCity
- Catalyse *innovation* that can contribute to making tomorrow's electric bus trips more attractive
- *Test* the feasibility and usability of the ElectriCity innovation platform

The contest fulfilled the purpose of surging public interest and involvement in the ElectriCity demonstration arena due to all the activity and attention created during the contest. It furthermore tested and generated feedback on the feasibility and usability of the ElectriCity API. Adjustments for the innovation platform were also implemented as a direct consequence of comments posted during the contest. The structure of the API, the type of documentation offered, and the descriptions on the website were for example altered.

However, whether the contest fulfilled the purpose of catalysing innovation is a more complex issue. It did on one hand support the development of 48 prototypes, where 75% were rated as both innovative and feasible. On the other hand, none of these prototypes are yet implemented, and can thus not righteously be called innovations in the terms of launched novel solutions readily available to markets, governments and society. The processes to accomplish market entry are either slow moving or have halted. Moreover, the relations between the consortium and the participants are rapidly deteriorating. Hence, the contest did indeed ignite open innovation activities, but did not support the participants through the later stages of their developed products' and services' lifecycles.

Open innovation contest can be used for many different purposes, ranging from solving vast societal problems to offering space and attention to promising innovators. This paper proposes that open innovation contests have potential to aid the market uptake of electrified public transport by achieving a combination of technical development, network formation and market creation.

Open innovation contest can drive open innovation practise in the public transport sector by acting as an intermediate broker that demolishes the walls between focal and distributed stakeholder and invites end-users in co-creation processes. Thus, due to the enhanced knowledge transfer in the innovation ecosystem, some technical development can be expected. The contests furthermore gather stakeholders during both design and implementation phases. This loosely coupled network may evolve into an advocacy coalition that have an influence on focal technologies, on complementary technologies, and on the political process that form the institutional framework. Hence, open innovation contest can aid network formation needed for further development and market entry. Lastly, open innovation contests also have capability to create exposure for emergent products and services, and can thereby enhance public interest and public awareness of novel electrified public transport solutions. Hence, contest can help generate the market demand needed for future market penetration.

However, in order to reap the full advantages of concepts and prototypes generated during open innovation contests, novel supplementary innovation deployment measures are needed in order for sustaining established relations and for aiding the implementation of innovation ideas. These measures should preferably not only focus on the winners, but instead include several of the participants that would like to continue the development of their projects. Otherwise open innovation contest risk to not take full advantage of the efforts that participants and other stakeholders put in during the contest period.

Additional case studies are needed in order to establish the generalizability of the conclusion and for widening the understanding of the capabilities of innovation contest. The authors envisage that the results from this case study will constitute a point of departure for additional research on how open innovation contest an be used to facilitate the market uptake of electrified public transport solutions. The authors propose the following research questions for future studies:

- What capabilities does open innovation contests constitute that can aid market uptake of electrified public transport solutions?
- What roles can open innovation contests play during the different phases of development and market introduction of electrified public transport solutions?
- What types of innovation in relation electrified public transport solutions can open innovation contests drive?

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