MOTION HUB, THE IMPLEMENTATION OF AN INTEGRATED END-TO-END JOURNEY PLANNER

Eur Ing Dr K Bevis, Dr S Copsey, O Sozcu
University of Hertfordshire
R Fenner
eCar Club Limited.

Abstract

The term "eMobility" and been brought into use partly to encourage use of electric vehicles but more especially to focus on the transformation from electric vehicles as products to electrified personal transport as a service. Under the wider umbrella of Mobility-as-a-Service (MaaS) this has accompanied the growth of car clubs in general. The Motion Hub project has taken this concept a step further to include not just the car journey but the end-to-end journey. The booking of multifaceted journeys is well established in the leisure and business travel industries, where flights, car hire and hotels are regularly booked with a single transaction on a website. To complete an end-to-end scenario Motion Hub provides integration of public transport with electric vehicle and electric bike use.

Building on a previous InnovateUK funded project that reviewed the feasibility of an integrated journey management system, the Motion Hub project has brought together a Car Club, a University, and EV infrastructure company, a bicycle hire company with electric bicycle capabilities and a municipality to implement a scheme and test it on the ground. At the heart of the project has been the development of a website that integrates the public transport booking with the hire of electric vehicles or bicycles. Taking the implementation to a fully working system accessible to members of the public presents a number of significant challenges. This paper identifies those challenges, details the progress and success of the Motion Hub and sets out the lessons learnt about end-to-end travel.

The project was fortunate to have as its municipal partner the Council of a sizeable South East England town, Southend-on-Sea. With a population of 174,800 residents with good road, rail and air links there is considerable traffic in and out of the town. The Council has already shown its commitment to sustainable transport. In the previous six years it had installed a number of electric vehicle charging points for use by the public and latterly had trialled car club activity.

An early challenge in the project was the location of physical infrastructure in an already crowded municipal space in order to provide the local 'spokes' of the system. In addition to its existing charging points, Southend now has four locations where electric cars can be hired, five where electric bikes are available and the local resources to maintain these assets.

Combining a number of web-based services and amalgamating their financial transactions is relatively straightforward. However, introducing the potential for public transport ticketing as well raises additional security, scale and financial constraints. The project has engaged with major players and regulators across the public transport industry.

In the latter stages of this two year project, the Motion Hub was rolled out to the public. The various individual services became available from the single website via one membership application and the use of a single card. The challenge here has been engaging the public and encouraging a change in behaviour. The project has revealed a number of challenges associated with this particular implementation of MaaS and finally recommends both comparative analysis of a set of Maas implementations and using early usage data as a key design tool.

The project was part funded by InnovateUK. The project partners have been eCar Club Limited (now owned by Europcar), UH Ventures Limited and EValu8 Transport innovation Limited (both owned by University of Hertfordshire), Hourbike Limited, Transport Systems Catapult and Southend on Sea Borough Council.

1. Introduction

1.1 Outline of the transport problem

The problems on 21st Century roads in the developed world can be summarised as congestion and with it pollution, travelling times, highway growth, EV charging infrastructure and parking.

Road traffic congestion, particularly in cities is a major source of economic and productivity losses and increased pollution. Solutions include infrastructure sensors include inductance loops, video and image processing, and microwave radars, monitoring vehicle numbers and speed. Being point locators, there is a trade-off between the accuracy of these of their estimates of congestion levels and the number of sensors. At present there is the possibility of introducing co-operative vehicular communications systems. Vehicle to Vehicle communications, V2V, offers the possibility of more adaptive traffic management.(Bauza, 2010)

Pollution has already been mentioned. The introduction of electric vehicles has been one significant move to reduce the fossil fuel components of air pollution at the roadside and the overall CO_2 emissions(Willemsen, 2016). There are numerous studies linking traffic noise and atmospheric pollution to major health problems. One example study across a number of European countries makes clear links to morbidity and mortality (Künzli, 2000).

One response to congestion is to build more highways. Whilst this would be futile in inner cities in inner cities, the wider effect is that in general more highways increases the vehicle miles travelled, VMT[1], which maintain similar levels of congestion. "Regardless of the specific impact on congestion, VMT growth is likely to be larger with more highway capacity relative to less highway capacity" (Noland, 2002).

The ever increasing problem of providing car parking spaces and as a driver finding a vacant space. The search increases commuting time and pollution (Macmahon J., 2018).

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[1] VMT or vehicle miles travelled is a planning measure, normally of the number mile travelled by all vehicles in a given locality over a period of one year.

1.2 Potential Solutions include

Solutions that have been tried around the world are enhanced forms of public transport, car sharing and bike sharing. More recently work has gone on in the fields of Autonomous vehicles and Mobility as a Service. Before developing the ideas around mobility the other choices are summarised.

Car Sharing is now a well proven service. There are studies on its effectiveness and the changes in behaviour and some commentary on the more recent developments (Katzev, 2003, Bardhi, 2012).

Bike sharing has been around for over forty year. The city of La Rochelle with a population of around 80,000 initiated the first successful bike sharing system in France in 1974 with the introduction of the famous "Vélos Jaunes" (Yellow Bikes). By 2003, there were over 300 bikes in use and the city had built 130 km of exclusive bike lanes. In 2005, La Rochelle launched a second generation bike-sharing system with 120 bikes at 12 stations (Figure 4). It was converted to a smart bike system in 2008 and the number of stations increased to 25 while the bike lane network expanded to 150 km. 50 stations with 300 bikes will be available by the end of 2009.

The scheme uses a smart card system which can also be used for electric car sharing, parking and buses. The use of a single smart card enhances the integration of the scheme with the public transport system.


Source: Communauté d'Agglomération de La Rochelle

Figure 1 Bike Station in La Rochelle

More recently the "Boris Bikes" in London and similar schemes across a score of European capitals has demonstrated both the environmental and health benefits to be gained from bike sharing. As developed later in this paper, electric bike sharing removes the fitness limitation too.

Autonomous vehicles is an emotive and at present a poorly understood concept. As cars progress more electronic aids assist the driver and in some cases take over certain actions. Theory and short demonstrations have demonstrated that fully autonomous vehicles have the potential to make massive improvements in congestion, but the path from demonstration to norm is long and tortuous both technologically, legally and behaviourally.

Mobility as a Service, MaaS, can be defined succinctly as a mobility distribution model that delivers users' transport needs through a single interface of a service provider (Hietanen, 2014). The
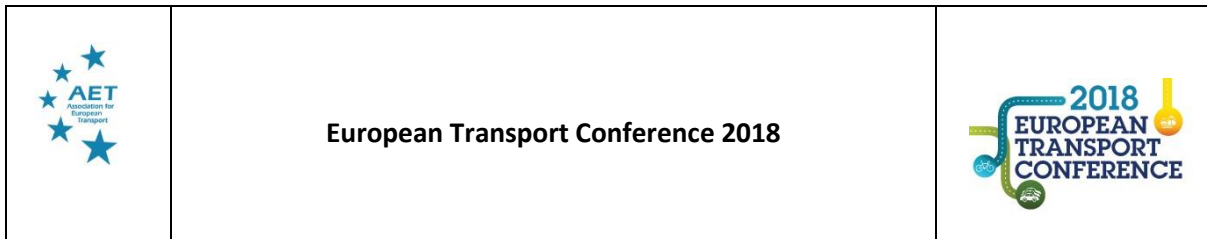
technology is emphasised by identifying the similarity with telecommunications (Cox N.C.J., 2015)and the idea that service be integrated though internet connections.

The MaaS Service is seen also an Mobility Aggregator that seamlessly combines a number of transportation modes so allowing the user to plan a journey and purchase all the parts through a single payment via a smartphone app (Holmberg P.-E., 2016, CIVITAS, 2016). The actual services themselves may well be framed around the user's preferences through collaborative customisation and personalisation (Hietanen, 2014, Kamagianni M., 2017). In their paper discussing the various definitions and their limitations, Jittrapirom's group (Jittrapirom P, 2017) provides an optimistic and forward looking definition that stresses the major reasons for embarking on any MaaS project.

> "A well-functioning MaaS application can reduce stress on over-utilized segments of the transit network by shifting demand from affected parts of the network to less crowded modes of transit, as consumers take into account quality and comfort as major decision factors when considering public transit. MaaS can also help local governments achieve goals related to traffic congestion and pollution by providing consumers with stronger incentives in the form of optimized trips to use fewer private vehicles and more public/shared modes of transportation. While this has the obvious benefit of improving the overall transit network, it would also improve and expand local relationships with public transit agencies to further innovate on top of MaaS. Additionally, it would increase consumer investment in the public/private transit network instead of in private vehicles, which would reduce consumers' stress of the first mile/last mile problem, increase direct revenue for transit agencies, and even increase the economic benefit generated from consumer investment in local, private shared transit offerings."
>
> Jittrapirom P (2017)

Early studies have identified the need for any MaaS scheme to be recognised as an added value service and be measured by its quality of service (Ambrosino G, 2016) and the need for designers to take on board the geographical, cultural and climate differences without losing focus on the people (Ison, 2016). Giesecke has set out a four step model for MaaS:(Giesecke R, 2016).

- The transport offer needs to be clearly specified. It should be applicable to both short and long distances using a variety of means in a smart way.
- The end users need to be able to save costs whilst experiencing an improved level of convenience in terms of accessibility, directness and comfort.
- MaaS needs to include existing offers such as public transport, car and bike sharing and taxi services on demand. IT linkage is of most importance. Availability of real time data and traffic control allows operators to implement modal preferences online
- MaaS needs to be as sustainable as possible - in both the environmental sense it reduce congestions and improve air quality and in the economic sense. It must add value with a reduced income from users (2018).

Jittrapirom adds the degree of personalisation as a design differentiator between competing schemes.

2. The initial Feasibility Study

The feasibility study that came before the MotionHub project provided an initial definition of what an e-mobility hub might be, "E-mobility hubs are defined as combining electric vehicle charging points, electric car club, bike and e-bikes for hire from a single location situated at key transport nodes, bookable from a single website and card system with spokes at key points within the town or city in which it is installed" (Fenner, 2014).

Fenner goes onto to identify four specific learning points that were taken forward into the Motion Hub project. The first was single card access. Whilst there might be a number of different services making up the Mobility-as-a-Service offering at MotionHub, the user would need to be aware of a single provider. Requiring a single transaction.

Secondly the level of detail embodied in the feasibility study set the criteria for selecting a suitable software supplier to work on the MotionHub website and back office. Of particular importance was the need to integrate a set of disparate web based services, the most complex of these being those associated with public transport.

Thirdly, there was a clear need for much wider stakeholder involvement. Hence the Transport Systems catapult was asked to join the Motion Hub Consortium. The final point was that the software would need to have a degree of flexibility so that the progress of the development could be staged and modified to compensate for other constraints.
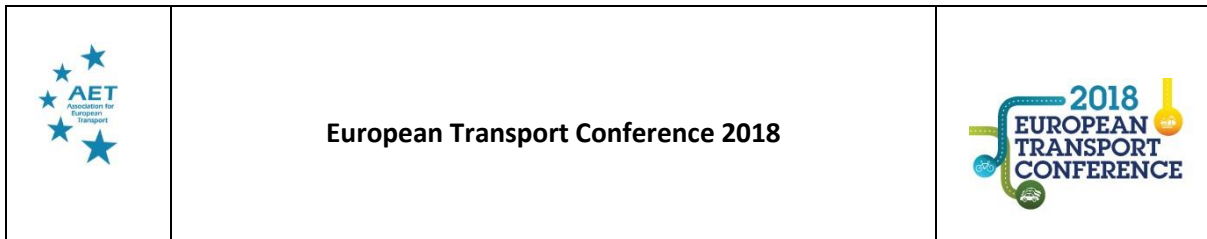
2.1 Partners

During the feasibility stage the following partners and suppliers were identified; first the project partners, E-Car Club Ltd, Southend on Sea Borough Council, EValu8 Transport Innovations Limited (activity and staff subsequently moved to UH Ventures Limited), HourBike and Transport Systems Catapult.

2.1.1 E-Car Club Ltd

E-Car is an entirely electric pay-per-use car club operating in 10 regions across the United Kingdom. Founded in 2011 in order to improve local mobility whilst simultaneously reducing both the cost and environmental impact of each journey decision made, E-Car is a true pioneer of flexible low carbon travel solutions. With partners including British Gas and automotive OEMs Renault and Nissan, E-Car has a track record of working with the very best in the sector. Having developed the UK's first entirely electric car sharing solution, E-Car is constantly looking to improve both its own operating systems and the way in which its members use and transition between options in our increasingly multi-modal transport ecosystem.

2.1.2 Southend on Sea Borough Council

Southend-on-Sea Borough Council (SBC) is an innovative municipality with a clear focus on sustainable transport. A CIVINET member with a strong track record of delivering LSTF and Eurpoean funded projects. It has created a specialist social enterprise "Sustainable Motion CIC" which is heavily involved in community based transport projects, bicycle recycling and hire and has considerable experience in managing and maintaining e-bikes. Other projects have included EU

Smart Cities Action Cluster programme, European Interreg Boosting Advance Passenger Transport (BAPTS) and European Safer Mobility for Elderly Road Users (SaMERU).

2.1.3 EValu8 Transport Innovations Limited and UH Ventures Limited

EValu8 Transport Innovations Limited specialises in Electric Vehicles and charging infrastructure and supports organisations to assist them towards more sustainable transport choices. The company set up and managed the Source East charging network containing over 600 charging points until 2017. EValu8 has successfully delivered the £7m East of England Plugged-in-Places project, an ERDF project supporting sustainable transport, was the lead partner on a £3m DECC project on Energy storage and managed the InnovateUK feasibility study project for integrated transport solutions, that preceded MotionHub. Subsequent to 2017 its work and staff have transitioned to UH Ventures Limited. Both companies are wholly owned by the University of Hertfordshire.

2.1.4 HourBike

Hourbike was formed in 2007 to provide a bicycle based solution to the growing need for short distance mobility in urban areas, reducing vehicle based congestion and emissions as well as improving the health and vitality of its subscribers. The automated bicycle sharing system used by Hourbike was first launched in 2009, and now supports the rental and return of over 4000 bikes in 5 EU countries. This includes 8 schemes in the UK in Liverpool, Oxford, Northampton, Lincoln, Reading, Southport, Dumfries and Sheffield. Employing approx. 20 people directly and subcontracting another 15 individuals makes Hourbike the UK's largest operator outside of the London scheme. Ebike provision has been a part of the functionality of the rental system since 2013.

2.1.5 Transport Systems Catapult

The Transport Systems Catapult (one of seven elite technology and innovation centres in the UK) was established in 2013 to drive and promote Intelligent Mobility - using new and emerging technologies to transport people and goods more smartly and efficiently. Its remit is to help UK businesses create products and services that meet the needs of the world's transport systems as they respond to ever-stretching demands. TSC's Customer Experience Business Unit (CE) is engaged on MotionHub and it utilises the expertise from the three other units, Automated Transport Systems, Modelling and Visualisation and Information Exchange. The CE team has been involved in Innovate UK Travellers Needs Project and the DfT sponsored Innovation in Rail Franchise.

2.2 Suppliers

The key suppliers identified during the feasibility stage were APT Controls, Hangar 19 and Comfy Saddle.

2.2.1 APT Controls

The charging equipment used on Motion Hub are eVolt Urban chargers supplied by APT Controls Ltd. These match other chargers installed in Southend. APT Controls Ltd has been supplying charging infrastructure since 2010 and has been appointed to set up charging networks for 85 Councils across the UK including the East of England Plugged-in-Places programme. With close to 6000 commercial charging points installed APT Controls offer the widest product range available on the market. The company has a much longer history of supplying car park automation equipment. It is now owned by

SWARCO Ltd who are a road marking and traffic management solutions business formed in 1969, consisting of 3500 employees and present in over 70 countries worldwide.

2.2.2 Hangar19
Hangar19 provide system solutions to the eMobility sector and field of integrated transportation. With the Internet becoming a major delivery platform for complex software applications, Hangar19 is providing Motion Hub with its "Web engineering", i.e. the web-based systems and applications. Hangar19 is a member of the UKEVSE infrastructure industry group and of EMI3 who support intelligent transport system development across Europe.

2.2.2 Comfy Saddle
The Comfy Saddle are a community interest company set up in Southend to support sustainable transport in the Borough. They specialise in bike solutions and have vast experience in both selling and maintaining bikes and e-bikes. Their ability to undertake maintenance locally for the bike scheme and help to move bikes between stations is an important feature within MotionHub.

3. Implementation of the physical infrastructure of MotionHUb.
Southend Council already had a number of electric car charging stations set up under the previous Plugged in Places project with EValu8. Each station consists of two charging points. These were located at

- Civic Centre, Victoria Avenue, Southend-on-Sea SS1 9SB
- London Road, Southend, SS1 1PL
- Hamlet Court Road, Hamlet Court Road, Southend, SS0 7ES
- Seaway Car Park, Southend, Chancellor Road, Southend, SS1 2AS
- Warrior Square Car Park, Southend, SS1 2JH

Together with charging points at two car dealerships and other commercial installations, at the start of the Motion Hub project, there were a total of eighteen charging points with associated parking bays across the borough.

The shortlist of sites for electric cars and for electric bikes had to be woven in and complement the existing infrastructure. Southend has an airport, eight railway stations and at least three significant bus termini. The areas of interest were:

- The airport – train link, Hotels, restaurants and industrial area
- Victoria Station – a main interchange with buses, shopping centre, Courts, Library and Civic Centre
- Central Station - a local line, again with buses, shopping centre, courts and academic campus
- Westcliff – the residential area to the West of central Southend.

Installations on or near highways and car parks do have their limitations. Beyond the convenience of the user and the effect on or difficulties presented by the landscape, there can be practical limitations about dimensions or the supply of electricity with sufficient power. There are obviously traffic management considerations, especially on the highway. A less obvious limitation can be the

ownership of the land. Just like any other part of the built environment, a charging post or a bike docking station is built onto the ground and the consent to build can be an intractable obstacle for these developments. The actual locations chosen will be a compromise between the ideal and the possible. Although the project aimed at installing facilities for thirty bikes (three sets of docking stations) and eight cars (four charging posts with two bays each) near other transport hubs, the starting point had to be a shortlist of four docking stations and seven charging posts.

After reviewing a number of potential sites with site visits and discussions with Southend Borough staff, the shortlist was drawn up and after more site visits, internal discussions and negotiations a final list was actioned. The choices are listed in Table 1 and displayed on the map in Figure 2.

Under normal circumstances, the unpredictable obstacles to progress on infrastructure projects are supply issues and the weather. Once the various negotiations were completed the project moved forward and the installations were all completed before the winter of 2017-18. The spring of 2018 was set for the public launch of the system. Here two other issues arose which were totally out of the project team's control. The Highways Group in Southend Council scheduled in a major refurbishment of a large stretch of the London Road. All on street parking was put out of action whilst that work progressed, so the new eCar bays and the two existing EV bays were off limits. At the same time with Local Government elections due in May, Purdah would start on 27th March and prevent any Councillor making supportive announcements. A roadshow was held at the top of Pier Hill in Southend High Street on Thursday 22nd March. Southend Council staff, Hour Bike and Ecar were in attendance promoting Motionhub to the public and local businesses. The day was a success with James Lock a TV celebrity in attendance. This gave scope for press coverage of a service aimed at use by the travelling members of the public, before the onset of Purdah.

Type	Location	Reason for choice	Reason for rejection	Choice
eBike docking station	Victoria Station	Centrally located, high travelling foot falls	gradient	
	Civic Centre	Centrally located, buy-in from council employees		✓
	City Beach	Tourist hot spot		✓
	City Esplanade	Tourist hot spot		✓
eCar - Charging posts	Victoria Station	Centrally located, high travelling foot falls	Traffic management and taxi rank	
	Civic Centre	Centrally located, buy-in from council employees, potentially as an upgrade		✓
	London Road	Near shops, an addition to existing infrastructure		✓
	The Airport	High traveller foot fall, along with car rental provision	No consent achieved	
	Short Street Car Park	Main car park near Victoria Station		✓

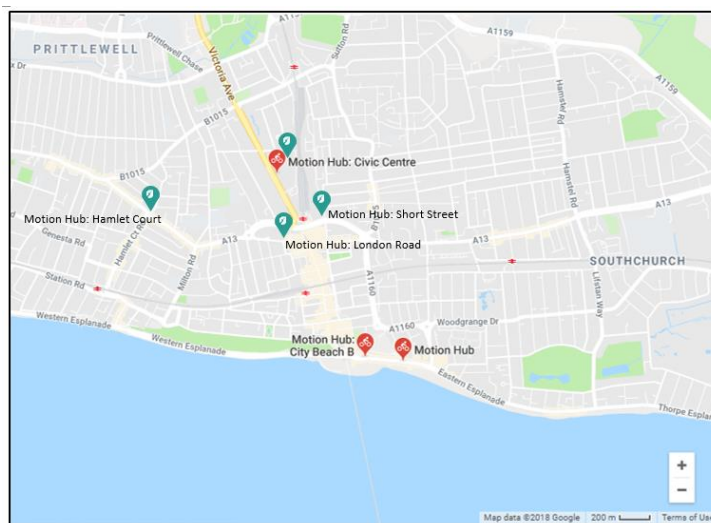|	Central Station	Travelling foot falls and near University campus	Would require remodelling of laybys	
	York Road Car Park	Near Bus station, high foot fall in day time	Exposed, lack of perceived security at night.	✓
	Hamlet Court Road Car Park	Services Westcliff, an addition to existing infrastructure		✓

Table 1 Location choices

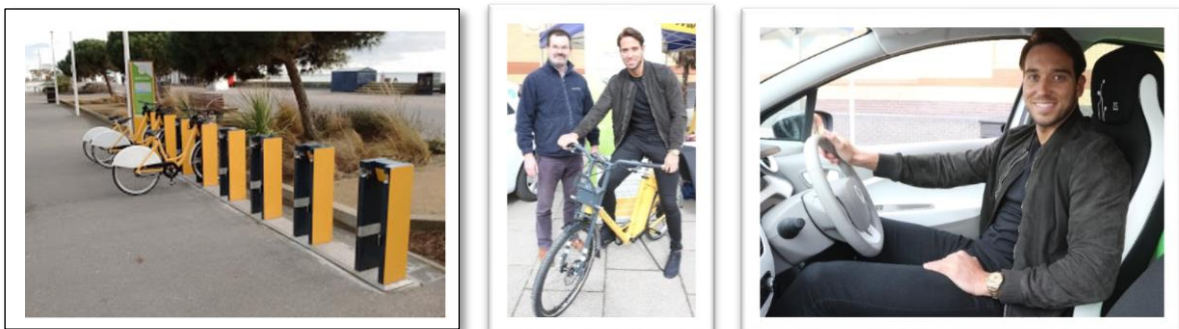*Figure 2 HourBike electric bike docking stations and eCar charging locations*

Figure 3 TV Celebrity James Lock at the Roadshow

4. Implementation of the virtual infrastructure of MotionHUb, the website heart.

To realise the aims of Motion Hub, it was necessary to bring together a number of independent operations and present then to the user through one unified web and mobile portal with an increased level of system functionality. Each of the constituent operations, eCarClub, Hourbike, EV charging network and elements of public transport can be accessed independently via their own website. These elements can be seen in figure 4 together with route planning and behaviour change.
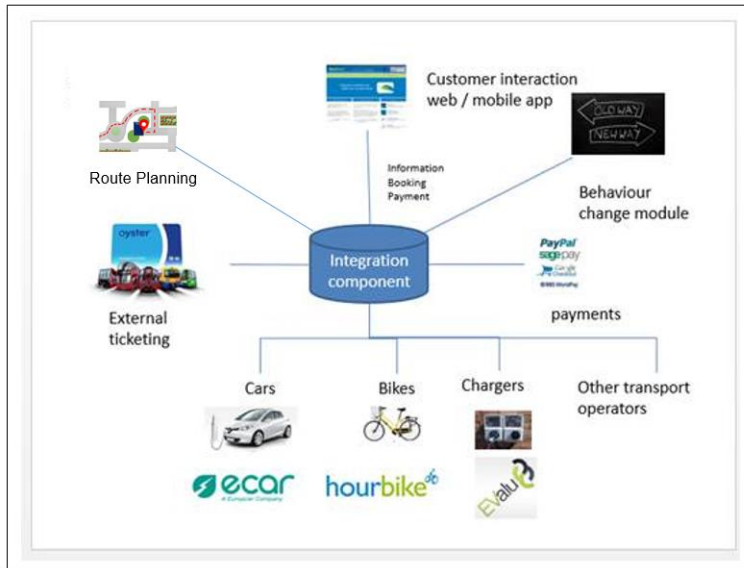
Figure 4 Early conception of Motion Hub structure

The figure briefly illustrates the software development objectives of the project. These are to provide:

1. An integrated journey planner, containing public transport and hub items
2. An overarching booking platform to enable all parts of journey to be booked from a single site
3. Implementation of an active 'Mobility as a Service' (MaaS) trial involving public users.
4. Inclusion of Behavioural Change incentives to encourage sustainable transport use
5. Tests of business models to evaluate effective approaches

Not only are the constituent parts independent operations but each has its own membership scheme, booking process and payment handling process. MotionHub, eCar and Hourbike are at least project partners so co-operation is mandated through a clear legal collaboration agreement. All the other operators must be treated as totally separate businesses trading with MotionHub. There are two other layers of regulatory complexity that have to be built into MotionHub. Users are passing personal information into the MotionHub portal. This places obligations on all the partners to comply with the regulations on handing confidential personal data. The implementation of the European Union's General Data Protection Regulation, GDPR,(EU, 2018) did not add the design complexity. It simply meant that the partners and the MotionHub project had to make explicit statements confirming their own compliance.

The passing of online payments between organisations is not only a regulatory issue but also one of secure communication between differing systems. To set up a complete payment handling system which could take payments for tickets and ensure those tickets were available or delivered whilst being a valid intention was actually financially and practically beyond the scope of this project. Such systems require significant through put to achieve economically viable costings. The final implementation of Motion Hub uses a combination of PayPal integration, Direct Debit mandates and

an external rail ticket brokerage agency to cater for the differing individual operational requirements.

The contracted software design has progressed through three macro stages:

1. Systems: The system design developed into a Mobility as a Service, MaaS, protocol. Specifically having reviewed how each trading partner interfaced with its clients, the architecture was designed in a way that respected the capabilities and interfaces of the MotionHub partners.

2. Interfaces: APIs (interfaces) were created to link MotionHub to each partner's system. Motionhub can then find vehicles, check availability, register new users (and in background replicate that registrations with each partner), check users' balances, place reservations and manage finances. Finance management is there to simplify the users' experience of topping up balances for online wallets, processing online payments and setting up direct debits. The focus here was to provide a single portal customer interface with simple connections to the other business operations and with no planning or behaviour components. This was a test bed to verify that all the operations were capable of being integrated and to identify the challenges to full integration.

3. GUI/Front End: It was important that the MotionHub web application's front end would provide the user, through its graphical user interface, GUI, the ability to visualise and access the relevant data form the partners' systems. Building on the previous stage of development the initial focus here was ensuring that all user data could be successfully entered through the MotionHub frontend and that all the relevant data could be accessed and visualised. The focus second stage was to improve ergonomics and of use, to add a clear route planning facility and to implement the project's behaviour change aspects. Ideally route planning should include pre-trip planning, on trip information and dynamic guidance (Stopka, 2014).

In terms of the software objectives that the project set out to achieve, by the end of the InnovateUK funded part of the project, the software achievements have been:

- Customer Interactive web/mobile application – The my.motionhub.org application provides a single point site that serves all the aspects of searching, finding and booking (Objectives 1, 2 and 3)

- Behaviour change - The my.motionhub.org application shows clients the $kgCo_2$ saving of their journey choices and sets them targets as well as showing their calories burned due to their travel options (Objective 4). See screen shots in figures 5 and 6.

- eCar vehicle integration – searching for and booking of vehicles (a specific part of Objective 1)

- Searching for bike and topping up your bike wallet through motionHub (a specific part of Objective 1)

- A connection to 'third party rail integrator' providing the ticket fulfilment, fully integrated in MotionHub. (The final key stages of Objectives 1 and 2)
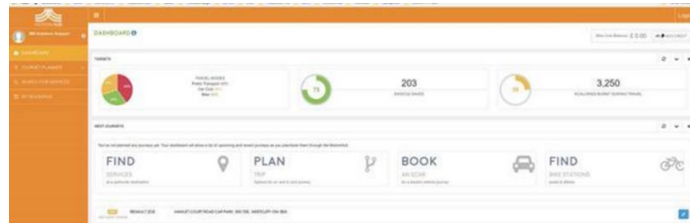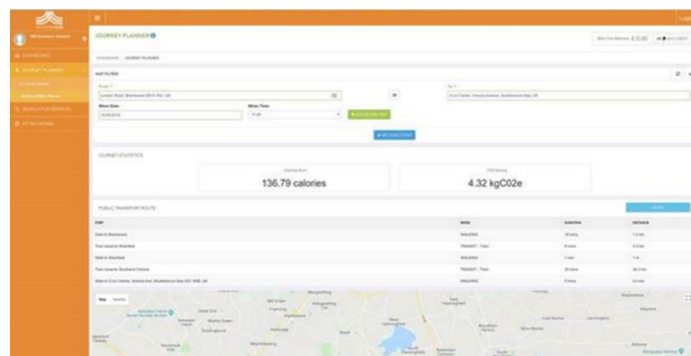
Figure 5 my.motionhub screen shot A

Figure 6 my.motionhub screen shot B

There have been two key variations between the initial intent and the final software implementation. As the use of electric vehicles was an important part for providing a sustainable car club as part of MotionHub, the integration of EV charging points into the system would have provided additional data on charging point availability. But a free market for EV charging infrastructure means there are multiple networks even in relatively compact towns like Southend on Sea. EV chargepoint access has therefore not been fully integrated into MotionHub. The eCar specific chargepoints in Southend are run on the Hubeleon network managed by Hangar19, but such isolated connections have meant that there has been no drive for integration into MotionHUb in terms of availability for use.

Secondly in the financial transacting, the project has needed to walk a fine line between the existing systems of Hourbike and eCar Club which each have their way of billing the users and the regulatory aspects of rail ticket sale. "PayPal integration" is provided just for the Hourbike payments. eCar operates based on the direct debit mandate at present. The third party rail integrator also has another payment broker system again which complies the regulations covering rail operators. So Motionhub has had to provide the mechanism for people to pay into the different systems all through the one website. Both the alert and the risk is that the project itself cannot steer the other businesses. So it must be continually alert to changes made by those businesses.

5. Conclusions
In close co-operation with a municipality, the MotionHub project has been able to install the physical components of a rounded MaaS proposition. Use of these different transport operations has been integrated into one website with its equivalent mobile app.
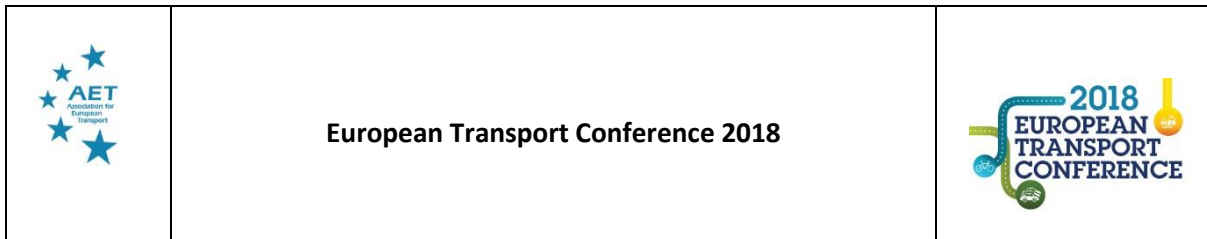
For a relatively small project, it has been demonstrated that it is possible to provide a service where the complete journey can be booked and paid for at a single point. In doing so, the project revealed the difficulties associated with combining the financial processes of a number of operators and in particular with the integration into the major transport operators.

An important conclusion from this part of the work is that future implementations may be better managed when integrating down from the large to the smaller operators rather than from the directly from an external app provider, but this will require further investigation.

Having begun the project by installing new on-street hardware, it should not have been surprising that the legal processes, the civil engineering and the electrical hook-ups each brought their own delays. Consequently the actual launch of MotionHub has been nearer to the end of the funded project. The system is now working and users are engaging, but the MotionHub will need to run for a longer period in order to attract consistent users. Again, the project has become aware that promoting the service to the large customer base of the train operator is likely to be more successful than promotions solely from the project partners. The municipality's contribution to promotion to the Southend community has been enthusiastic. It has not been mentioned elsewhere in this paper but the municipality was hampered by Purdah, the period around local government elections when both councillors and council officials are prevented from the kind of positive engagement with the public which would have supported the promotion of MotionHub.
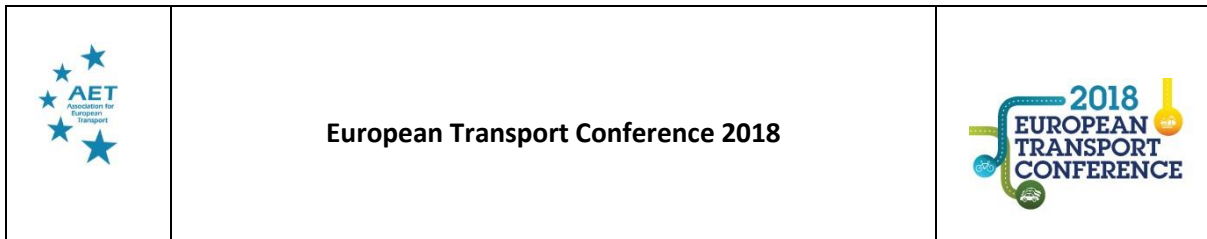
Whilst it was shown that there are systems that do integrate a number of forms of transport to provide the user with a more connected journey, these have either been attempted by a national public transport provider or predate the internet based technology that is currently available. The challenge in MotionHub has been to integrate electric car, electric bike, rail and bus services in a real life situation. The installations have been completed, the cars and bikes are available, the website is functioning and the people of Southend are beginning to make use of the service. It is right here to acknowledge the input from the residents and workers in Southend who are voluntarily making use of MotionHub and so are providing the data to enable further analysis.

Finally, the work fits squarely within one of the UK Government's Four Grand Challenges in its Industrial Strategy (Department for Business, 2017). The Mobility Challenge includes "We will look for opportunities to improve customers' experience, drive efficiency and enable people to move around more freely".

6. Recommendations and further work.

The most important next step is to accumulate actual usage data and analyse performance. As the MotionHub is rolled out to other sites, the analysis will become a key development tool. An obvious site for expansion will be at the University of Hertfordshire, its close municipality of Hatfield and the surrounding county of Hertfordshire, all of which is close to London. The University already has electric car sharing, bike sharing and paperless ticketing on it's own bus service (Copsey, 2014)

La Rochelle has been mentioned in this paper as it was the first city to install a successful bike sharing scheme in 1974. By 1999 is had an electric car sharing scheme too (ELtis, 2014). Although at that time EVs were powered by nickel cadmium batteries, there was no problem with range as the

average journeys appear to be only 8 kms. Users can access bike, electric cars and buses using the same SMART Card (Midgley P., 2009). The population of La Rochelle was around 135,000 in 2014.

Southend is a town with a population of around 174,000. Once the Motion Hub project has been running for a period and has acquired user and journey data, then a very useful comparative study could be undertaken with the La Rochelle system.

The Motion Hub project has run from 2016 to 2018. Before 2016, MaaS was a concept under discussion, but during the projects life a number of other MaaS systems have been brought on stream. A summary review shows a wide range on interpretation of MaaS. There will now be a follow up paper discussing their differing offerings. However, very direct comparisons can be made with Hanover's Mobility Shop, set up in 2016 (CIVITAS 2016, Jittrapirom P, 2017) and the WHIM implementation across seven cities and towns in the West Midlands (Jittrapirom P, 2017, 2018), see www.whimapp.com/uk. in particular it would be good to compare actual performance of MotionHub, Mobility Shop and WHIM.

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