CITYVERVE

EVALUATION DELIVERABLES 18.4.1, 18.4.2, 18.4.3

FINAL REPORT

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Contents

Executive Summary

The Evaluation

1. This the summary evaluation report for WP18.4 of the CityVerve project. The main part of this summary report is contained in Annex 1. That lists the KPIs agreed with use cases. Annex 1 is a detailed statement of the types of impact which the individual use cases have outlined and been working towards. The objectives of WP18.4 (which has three deliverables for each of the main themes of CityVerve) are to assess the performance of the use cases which the project has funded.

2. As has been discussed in our previous deliverable (D18.1) re-issued on the 27th April 2018, the use of KPIs in CityVerve have not been to monitor use case performance over the lifetime of the project. For that to happen, use cases would have had to be operational for a substantial part of the project period. As we note above, KPIs have necessarily taken a different focus and fulfil a different purpose from what was envisaged in the work plan since many use cases are only nearing completion towards the very end of CityVerve.

The Project – CityVerve

3. CityVerve's individual pilot projects are co-developed with technology providers and users working together to ensure technical feasibility, desirability of outcome for users, and commercial potential in terms of viable business models developed, this third aspect being the focus of the related work of WP18.6.

4. CityVerve is a 'demonstrator programme' and therefore of a type that uses relatively small examples, in this case of technological innovation in three different theme areas, to determine their potential to achieve across a range of impact categories. These impact categories were defined in WP18.1 and were outlined in a report prepared in the autumn of 2016, six months into the CityVerve project.

Transport Impact Review

5. In the area of Transport, 6 use cases were being pursued at the end of the project with a seventh – smart traffic monitoring being de-scoped earlier in the project. All use cases had operational status at the end of the project but there was considerable variation in the scale of operation with sensing trams being a very limited implementation of ideas that were different significantly from what was envisaged at the start of the project.

6. Two use cases are notified to us as fully operational (City Concierge and Road Safety). Transport use cases produced 9 public service improvement KPIs, 2 business benefit KPIs, 2 citizen engagement KPIs, 6 innovation and technology KPIs and 1 wider impacts KPIs.

7. Our assessment of the status in TRL / SRL / MVP frameworks is that T4 Sensing Trams was developed as a prototype (closer to TRL3), the other use cases were more advanced with demonstration of minimum viable product status and field demonstration in operational environments with Road Safety (T3) and City Concierge (T2) closer to what would be regarded as TRL7 status. T5 was significantly different at the end of the project than what had been expected at the start.

8. Wider use and extension of project impacts are reported as planned or expected for most use cases. Wider use can be divided into two, wider and continued use within the organisational context and outside the context with or without the agency (users) originally involved.

9. In the case of Transport use cases, all use case innovation is somewhat likely to find wider application in the original context. Wider uptake of innovations developed in the Transport theme is more difficult to assess the likelihood of at this stage.

10. All Transport use cases report significant learning effects, confirming the observation that considerable effort had to be expended in developing the use cases to operational status.

11. Use case leads - as providers - and use case users - as technology / service co-developers and users - have all acquired significant knowledge of how to implement innovations of this kind in the context of an IoT environment.

Energy and Environment Impact Review

12. In the energy and environment theme, the project ended with 8 use cases of which 7 were partly operational – to varying degrees – by the end of the formal project period. One use case appears to be fully operational. A ninth use case initially specified was re-allocated to the transport area although we note its original KPI statement in our list in Annex 1.

13. The theme use cases produced a total of 16 public service improvement KPIs, 7 business benefit KPIs, 2 citizen engagement KPIs, 4 innovation and technology KPIs and 9 wider impact KPIs.

14. In the energy and environment theme, development has reached TRL7 (operational demonstration of the prototype) in five cases for which we have evidence (EE2, EE4, EE5, EE6, and EE7). Some use cases have not yet been reported on. Our view at this stage is that these use cases have progressed to an advanced stage despite some complexity and difficulties. EE6 and EE5 (Smart Lighting and Smart Parking) were significantly different at the end of the project than at the beginning.

15. Wider use and extension of project impacts are reported as planned or expected for most use cases.

16. Energy and environment use case histories give evidence of significant learning effects occurring during the development of use cases. These learning effects underpin specific technology installation but also provide the basis for working in the IoT context. Such learning effects are valuable resource for both use case leads – the technology vendors – and users –potential clients for such installation, but important vectors for further use.

Health and Social Care Impact Review

17. In the area of health and social care, 2 use cases were operational at the end of the project with the COPD use case (No.1) delayed. Of the second of the two use cases that were operational, one was split into three parts. This third use case – Neighbourhood Team support had three parts, all of which were substantially operational at end of project. The second use case was spilt into two parts, each part of this use case was partly but not substantially operational at end of project.

18. Analysis of numbers of KPIs by type and by use case and theme show that for the use cases of this theme, there were 5 public service improvement KPIs, 7 business (operational) benefit KPIs, 11 citizen engagement KPIs, 4 KPIs noting externalities, 7 innovation and technology KPIs and 3 wider impacts.

19. In the health and social care theme use cases, the smart logistics use cases (HSC3 sub cases) appear to be demonstrated in the operational environment, while HSC2 and HSC1 are at much earlier stages, and although there is a definition of a project / service, there is as yet no evidence of efficacy. We note that the more complex projects in this theme area are the last developed in operational sense, which is not perhaps surprising. HSC1 was somewhat different from the original specification while HSC2 and HSC3 were more different, each having been subdivided and HSC3 being in three parts at the end of the project.

20. Wider use and extension of project impacts are reported as planned or expected for most use cases.

21. Health and social care use case histories also give evidence of significant learning effects occurring during the development of use cases. However, while these learning effects are significant and are more pronounced in the area of health and social care than in the other theme areas, they indicate that this theme has had more challenges than the others in terms of integrating systems within the IoT framework and within the existing institutional and organisational environment. The ethical approval limiting the progress of the COPD use case is an instructive case in point.

Impacts of CityVerve as Demonstrator and Package of Measures

22. The performance of CityVerve in integrating with other organisational aspects is uneven. A number of use cases (EE5, T1, T4, T6 and HSC1) were significantly impacted by existing institutional / organisational practices or arrangements that slowed progress down or required significant changes to use case design.

23. In some cases, given the relatively short period of the project and the ambition of the use cases and the integrative character of the project, it might have been more realistic to narrow use case design at an earlier stage. But such narrowing would have limited the learning experience which the project has provided to use case leads / technology providers and their co-innovators in service delivery organisations (MSP, MCC, UoM). A difficult balance has to be struck in any project between clarity of objectives and vision/creativity/innovation. Projects that are too narrow and merely apply existing or very new to market technologies should not be in receipt of public funds, yet their impacts can be easily measured.

24. CityVerve set a minor goal to explore interconnections between the use cases of different themes. Initially there were discussions that identified potential connections, between for example environment and or transport use case goals and health and social care goals. These connections have been explored and more has been understood about how the connections might work, but no substantive innovative activity in terms of product or service development has been possible in this regard during CityVerve.

25. The ambition and complexity of the project has led to re-orientation, re-design of use cases and some de-scoping – removal of use cases. This is unavoidable in a development project, particularly one at such a scale as CityVerve. The evidence of the scale of the virements in the project has demonstrated the need in CityVerve for changes to initial plans, and revision to plans throughout the project.

26. Virement itself is not necessarily a problem for a project when adaption to circumstances requires re-prioritization. However, when virements are delayed and organisations are unwilling for financial reasons to commit resources until virements are processed and agreed, projects can be held up. The degree to which this has happened in CityVerve suggests that this is an important issue for this particular innovation project and would be so for others similarly configured with relatively tight time-scales and complex dependencies between elements of the project itself and the project context e.g. regulatory bodies, pre-

existing commercial contracts with third parties that are not formally part of the project consortium. While larger organisations may be in a position to self-fund innovation, smaller organisations may not be so able, and even large organisations that are publicly funded (the NHS for example) will be unable to commit resources without cast-iron guarantees of balancing payments from the funding body.

27. The ability to remake plans and adapt is central to successful innovation projects and in CityVerve there has been significant adaptation when obstacles were encountered. In CityVerve adaptation and remaking of plans has been accomplished mostly well with, in some cases, users taking the lead role in contributing to the innovation itself (in EE and HSC use cases).

28. In our outline of potential enabling and limiting factors, individual component failure to deliver was noted as potentially important block or limiter. In a small number of cases mainly concerned with the development of software, there have been limitations on use case outcomes and impact. Alternative sourcing or multiple sourcing of key components might have allowed use cases to avoid being blocked – and failing to deliver operational use cases.

29. CityVerve use case leads and users have worked closely to ensure user - in the sense of wider user - involvement and acceptance and have met with success. The project environment and location has been effectively supporting the CityVerve project. This has resulted from a number of factors including the professional and organised approach of those directly involved in use cases (as leads or users) and an effective public relations strategy.

30. Use case leads and use case users have shown willingness to take risks in terms of working on innovations that were relatively new to them, and which could, if implemented, substantially change organisational practice, displacing existing technologies and altering ways of working.

31. The time allowed for the operation of the project has been seen by some participants as too short, although this is not a unanimous view across all the use case participants. The majority view is though that a period of two years was challenging for the level of innovation required and the extent of coordination – of the elements of CityVerve between themselves – and between CityVerve and the various environments in which it has been implemented. We point to the fact that while many use cases are operational at end of project, very few are fully operational and operational in the terms envisaged at the start of the project.

32. Use cases and users have usually possessed strong technical capabilities or been able to access them, allowing for more demanding and adventurous use cases and innovation achievements.

33. The KPIs developed in the CityVerve project reflect a commitment of the project partners to the typical objectives of a demonstrator programme, which is to show how impacts would arise in a wide range of impact categories: public service benefits; business benefits; citizen engagement; and technological development.

1.0 Introduction to the Report

This report is D18.4.1/2/3 and combines the assessment of the achievements of the CityVerve use cases in three themes, Transport, Energy and Environment, and Health and Social Care.

The report is in four main parts. It has been prepared by the University of Manchester which is a participant in the CityVerve project.

The deliverables have been prepared in the period April 2018 to July 2018. They are based on documentary review and interviews by University staff which have taken place with use case leads, use case users and a small number of other staff of organisations that are part of CityVerve. The interviews follow up on the KPIs developed earlier in the CityVerve project and were carried out to determine whether the KPIs remained relevant to the measurement of impacts of the use cases developed in CityVerve, and potentially a guide to those seeking to implement other Smart City/IoT demonstration and research technological development projects. The KPIs provided here in the Annexes and described in the individual theme sections therefore serve two purposes:

- They seek to ensure that the use cases developed and implemented by CityVerve have set and achieved important goals, justifying the public and private investments in time and money made over the course of the last two years;
- And they also provide a basis for those seeking to implement smart city innovation projects to understand what kinds of impact are possible, and how impacts should be reliably measured.

The report next explains the evaluation approach in Section 2 and then provides three sections (Part A, B and C) to outline and comment on the KPIs developed for the use cases of each theme. Part D summarizes findings after which follow seven annexes containing the use cases, a short review of the literature on the evaluation of demonstrators and IoT / Smart City innovation, a glossary, our analysis of factors affecting project success, a TRL classification for reference purposes, an outline of the data sources used and finally the references.

2.0 Evaluation of CityVerve in WP18.4

2.1 CityVerve – the Evaluation Priorities

The objectives of WP18.4 (which has three deliverables for each of the main themes of CityVerve) are to assess the performance of the use cases which the project has funded. CityVerve is a 'demonstrator programme' and therefore of a type that uses relatively small examples, in this case of technological innovation in three different theme areas, to determine their potential to achieve across a range of impact categories. These impact categories were defined in WP18.1 and were outlined in a report prepared in the autumn of 2016, six months into the CityVerve project. These impact categories formed the basis at use case level of key performance indicators (KPIs) that could be used to establish the extent to which impacts had been met by the end of the project. Those four impact categories are shown below (reproduced from our earlier report):

1) Economic
   a) New improved city services
   b) New business opportunities
   c) Skills / job creation

2) Social
   a) Citizen engagement and connection
   b) Citizen aspirations for CityVerve[1]
   c) Well-being / health

3) Environmental
   a) Energy savings
   b) Security and public realm
   c) Mobility

4) Technology
   a) Platform use and development
   b) Sensors
   c) Trust

5) Community Goals

Table 1

CityVerve's individual pilot projects are co-developed with technology providers and users working together to ensure technical feasibility, desirability of outcome for users, and commercial potential in terms of viable business models developed, this third aspect being the focus of the related work of WP18.6. In addition, we should note that the individual projects can and mainly do rely upon infrastructural systems of the project which have been developed outside the main three theme activities but which support the development of the use cases, their operation, and potentially their wider deployment as part of a CityVerve legacy. Such infrastructural systems are the outcomes of the technical work conducted by project partners in WPs 7-11, and the CityVerve project management and governance framework of WP19.

As we have noted above, CityVerve is a demonstrator. The primary purpose of demonstrators – demonstration projects – is not to deliver an impact but to *demonstrate* what impacts are in scope, and that it is both possible and likely that such impacts will arise. An evaluation of a demonstrator should obtain this information and it should also aim to understand the conditions under which impact arises so that if others wish to apply the technologies which have been demonstrated, this can be done with a greater chance of success.

[1] Aspirational KPIs reflect the expectations of citizens for impact from CityVerve activities. A document from FutureEverything explains the rationale and form of these KPIs.

Practically therefore an evaluation of a demonstrator will fulfil its mandate to assess use case impact by addressing the following: a) assessing how can the impacts which use cases are intended to cause should be captured [Task 1]; b) testing to see whether those impacts and any other impacts have arisen in practice from the implementation of the use cases [Task 2]. And to complete the evaluation of a demonstrator, one further task must be addressed: determining what conditions support and what conditions mitigate the successful implementation of the technologies [Task 3]. The use of KPIs supports the attempt to assess how impacts could be captured [Task 1] and whether they do arise in practice [Task 2]. For each use case section we have three sub-sections: a) a use case history; b) a summary of the impacts that have been demonstrated; c) an account of the Enabling Factors which affected success.

2.2 The Evaluation of Demonstrator Projects and Programmes

The evaluation of demonstrator programmes or policies provides a particular challenge for those wishing to know exactly what has been achieved from the use of often extensive resources of time and money. While demonstrator programmes show off – 'demonstrate' – one or more *known* technologies – and in this case a complex set of interacting technologies based on IoT – there is often a high level of uncertainty about how the technology is actually to be used. Where such uncertainty about how technologies will be used is significant as can be the case in parts of the market for IoT products and services, there is the likelihood of market failures. These arise when prospective users fail to appreciate the actual benefits they could achieve as a result of *asymmetric information*, and where there are *positive externalities* from learning about how best to implement and use technologies. It is because there is significant learning from the implementation that there is uncertainty over what demonstrators can achieve and how the findings from demonstrators can be *generalized*. This uncertainty arises from the following specific causes:

- There is uncertainty over what is actually being achieved and learning during the project may lead to wider and greater benefits that originally assessed (ontology issues);
- Demonstration projects are short term and may be limited in scope so the lessons learned may be based on very limited experience, and here in the case of CityVerve, use cases are generally small, involve only one or two users;
- Learning is vital and needs to be captured but is often not recorded because of the pressure to achieve against a strict timetable;
- Normally, demonstrators do not employ a control group;

It is therefore as Bergen (1965) noted, difficult to generalize from demonstrators, and the assessment of additionality is challenging such that methods and principles generally widely approved of for its measurement (by for example the UK Government) (HM Treasury, 2011, p. 103; 2018) are cannot easily be followed in this context.

2.3 KPIs in CityVerve

As has been discussed in our previous deliverable (D18.1) re-issued on the 27th April 2018, the use of KPIs in CityVerve have not been used to monitor use case performance over the lifetime of the project. For that to happen, use cases would have had to be operational for a substantial part of the project period. As we note above, KPIs have necessarily taken a different focus and fulfil a different purpose from what was envisaged in the work plan since many use cases are only nearing completion towards the very end of CityVerve.

The approach taken at the start of the project in asking for detailed information on the evidence that would be used to support the measures of performance for the use cases remains valid as it is this detailed information, which we call the KPI parameters, which can help ensure that the data collected to support the claims of impact are or would be accurate, reliable and provide valid measures of impact.

KPI Parameter	For each KPI	Evaluation Aspect
1	Indicate precisely the information that will be collected and the existing entity to which it applies	Target Setting
2	Indicate whether comparison of the KPI (the baseline) will be a) internal, i.e. with another use case activity b) temporal – over time c) external – and therefore which comparator is to be used (e.g. road safety statistics in other geographical areas)	Target Setting
3	Indicate the presence of any plan for pre-collection to develop historic data series for comparison	Target Setting
4	Indicate the source of information	Management
5	Identify the cost of the information, if any	Management
6	Designate a responsible person for collection and the safe recording	Management
7	Identify the frequency of collection – ideally KPIs need to be available monthly	Target Setting
8	State the point in time when data will become available – how long after the start of operation of the use case	Target Setting
9	Identify any legal or ethical barriers to the collection of data and the steps which the use case users will take to deal with them	Management

Table 2

2.4 Reporting Use Cases

Within each theme report, each use case that is considered viable but not necessarily operating is considered. The write up of the use case is done on the basis of documentation and interview; see Annex 6 Data Sources Used in the Preparation of this Report for details. Use cases are written up by the Study Team but in some cases uses cases report the exact comments made in the interviews.

PART A TASK 18.4.1 TRANSPORT USE CASES (UOM)

A.1 Introduction to the Transport Use Cases

The Transport use case theme was led by Transport for Greater Manchester and had a further 9 partners. 265 man months were allocated to the work and the work of the use cases was dependent upon a further 6 other work packages involving just 3 organisations. 3 work packages were dependent upon the use cases and these involved 3 organisations. The seven initial use cases including an analytics use case involved a total of 37 separate tasks. There was a complex set of dependencies therefore involving multiple actors and the need for coordination.

A.2 The Use Cases

A2.1 T1 "Talkative" bus system

A2.1.1 Use Case History

Republic of Things led this use case UC which did not progress quite as expected. The Description of Work (DOW) was a highly ambitious plan with multiple aims(Cisco International Limited, 2017), although no specific levels or numbers were given by which to measure success. The ambition of the initial project plan was to a limited degree reflected in the KPIs adopted (see below in the section on impacts).

Talkative Bus System. Developing the bus market (by increasing bus patronage and attracting current non users to make journeys by bus) is a key priority for Greater Manchester's devolution deal, which includes government legislation support for franchising of buses in Greater Manchester. Market research suggests that there are many GM residents across all market segments who may transfer their travel mode to bus, if we get the product right. Our aim is to improve the journey experience for existing users of the system - especially for the elderly, young, vulnerable and those with mobility disabilities (including deaf and blind). CityVerve will experiment with how to convert the bus stop estate (from 'flag and pole' bus stops to 'super' bus stops) into interactive locations which reflect and enrich the environment and communities in which they are located. We intend to provide location relevant content to users of each stop which will enhance the users awareness of the "place" in which the stop is located. This will be achieved technically through the exploitation of location-based services, sensors/beacons, mobile apps and intelligent digital signage. Relevant stakeholders for this enriched environment will include the local arts communities, where early consultation has already identified a keen interest in this use case, given the current lack of 'real-time, or even weekly, digital magazine' about on-going events in Manchester; and in this way this use case will interplay with WP4 and WP5. From a user behaviour perspective, we will test a hypothesis that enabling people to 'check-in' to their bus stop, that lets bus operators know they are waiting for their service will lead to increased use and satisfaction of the bus system. From a service enablement perspective, we will, through turning bus stops into rich data collection environments on passenger demand, provide IoT data that will enable new 'pop-up mass transit' services to evolve, such as the DfT funded Simply Connect project, and will be operating a pilot over the same timescales as this project. Finally we will also explore opportunities to exploit Internet of Things technology to enable remote asset monitoring of the 12,000 bus stop estate. The team will develop a flexible model based on common and/or open standards. This approach will deliver new applications and services to users in an ongoing manner and enable us to respond to customer feedback and changing requirements. This open and flexible approach will enable TfGM to respond to Greater Manchester's evolving transport needs and embrace new innovations and partners such as the SimplyConnect project.

Box 1 (from the DOW, Version 6)

At the end the agreement between Republic of Things (RoT) and TfGM led to RoT providing a communication platform and TfGM providing the equipment for a modular platform that has been tested on 3 locations to showcase and evaluate how IoT works outside major city areas. The limited time and mis-alignment of agendas between the key actors prevented full implementation of the planned work e.g. there was a discussion to install Amazon storage lockers on the bus stops, which can change the bus-stop to be more like an interchange which then opens up other opportunities for public transport network to deliver goods. Nevertheless, this use case has generated an activity that is likely to – and is – to continue. TfGM still wants to develop the talkative bus-stops further as an experimental platform and is working out the value proposition. This use-case has also enabled TfGM to create the opportunities for showcasing innovate technologies as buses transport will be transformed in the next 10 years – one future outcome is that there may be no scheduled buses, just 'on-demand' transport.

A2.1.2 Demonstrating Impact

The first KPI noted here is that the concept / use case should achieve a target for improvement in customer satisfaction to be established once baseline data is available, for example "80% of users think the service is better than standard bus system". This KPI would also include specific analysis of improvement for users with limited accessibility. This first KPI is dependent upon baseline data and this is not yet available. A second KPI (the number

of community organisations that use the bus stop to disseminate information over first six months demonstration (target: at least 2)) was not realizable, given the development of the use case. A third KPI (Evidence of cross work package activity and initiatives for new applications taken forward during lifetime of CityVerve) was only partly achieved. However, the use case has achieved impacts in terms of how the interactive / talking bus stop could operate, and what its implications are - even though these are not the ones expected – and defined by the use case leads.

A2.1.3 Enabling Factors

This use case resulted ultimately in greater understanding of how interactive bus-stops might work and what services they might provide. It also led to installation plans for Leigh, which is outside the original location defined for the CityVerve project of the Oxford Road corridor. It is possible that the initial plan for Talkative bus stops was too ambitious and the retrenchment that took place in the use case was necessary because the original design was not feasible in the time available. Other limitations / factors that have affected progress here were technical difficulties and asbestos affecting installation at Leigh. Actual installation is only occurring post-project at Leigh, and at two locations on Oxford Road.

A.2.2 T2 City Concierge

A2.2.1 Use Case History

The use case began with a business model and a plan to scale up and commercialise with the solution seen as a basic way-finding, but this has evolved over the lifetime through 4 iterations into an event information and way-finding solution with different associated business models (objectives and possible impacts). Since Sparta Digital had an application that was almost ready to operate at the start of CityVerve, Sparta worked on a lot of different use cases as well as City Concierge across CityVerve. In this particular use case, layers and layers of other coding were added over the top of the original application leading to the risks of unanticipated conflicts between the individual software components. However, the experience of working with lots of partners meant the result was a tested product in multiple scenarios.

A2.2.2 Demonstrating Impact

The main impacts achieved are described in the KPIs. KPI1 was achieved, but KPI2 (Uptake at events) was a challenge and this KPI was not achieved. The target was over-ambitious and based on uptake at a different type of event (PRIDE) with a much more consistent and targeted social media presence than the Christmas Markets. KPI should have been to deliver –over the life of CityVerve – 5,000 downloads. KPI3 was achieved as TfGM are going to use the application for other means beyond CityVerve. Roll-out and use in other cities is a distinct possibility, and is largely based on the work done in CityVerve. There was also interest from other Smart Cities around Europe, including Dublin Docklands. There is a possibility that these links will lead to adoption of the technologies developed here but it is not, at this stage, a strong likelihood.

A2.2.3 Enabling Factors

Evolution of the app and other activity happened through informal relationships that developed over the course of the project, and which were prompted by the more formal meetings etc. A lot happened outside the formal meetings etc. Engagement with other businesses and organisations was less than expected, the firm does not engage with a huge rang of organisations such as MMU, MCC, Chime. However, the collaborative working involved developing similar expectations – in effect a collaborative mind-set emerged. The *platform of platforms* idea helps innovation actors work together – having this as part of the design of CityVerve was a useful way of ensuring people worked together.

A.2.3 T3 Road Safety

A2.3.1 Use Case History

This use-case began prior to CityVerve with funding that allowed the use case lead (Satsafe Ltd) to begin testing a product by the start of CityVerve programme. During the project, various user groups were targeted as possible users

and a number of ideas for technology implementation were devised (see WP18.6). Ultimately, installation of technology was achieved in the Bruntwood logistics fleet, by a taxi firm after negotiation within the Manchester City Council taxi and private hire licencing authority and within the vehicles operated by some young drivers. A wider implementation of the technology through formal endorsement and or purchase of the technology by Manchester City Council was not possible owing to the restrictions imposed on public sector bodies by procurement law.

A2.3.2 Demonstrating Impact

KPIs to define impact were agreed in terms largely of business model and uptake, rather than in terms of demonstration of the specific aspects of the technology: KPI1 was that at least one insurance company would consider using the technology demonstrated during CityVerve as part of their insurance policy offer; and KPI2 was that 80% of the 5000 licensed taxi drivers in Manchester would be willing to use the telematics technology and associated insurance policy. These are commercial / business benefit KPIs. At an earlier stage in the KPI development process, other KPIs were nominated but the way in which they would be evidenced was difficult to establish. These extra KPIs remain relevant to the use case and could in time be ways in which this technology finds impact. These KPIs were as follows: KPI6: Health and mobility of elderly people is maintained; KPI7: Improved user experience (customers of Community Transport, including wheelchair users); KPI8: Reduce operating costs of insurers. These other KPIs which were not agreed with the use case but which were discussed earlier in the project refer to and denote important forms of impact which the technology developed in this use case could create. Environmental impacts from improved vehicle efficiency could be important long term benefits of the technologies developed. Furthermore, driver monitoring for older drivers could be valuable, with the result in terms of increasing vehicle safety.

A2.3.3 Enabling Factors

The use case lead was active throughout the project in exploring the various target markets / potential users and identifying ways in which the technology could be adapted to meet their various needs. Access to the range of organisations including the City Council provided options for selecting potential user groups, even if such groups as the City Council were not able to act as direct purchasers of the innovation. GPS monitoring through satellite technology raises issues of privacy and security which are important public interest matters. The use case has had to take account of this issue and ensure anonymization of data.

A.2.4 T4 Sensing Trams

A2.4.1 Use Case History

Ultimately the use case is not operational, although TfGM /MCC remain interested in the possibilities raised by the use case. The Greater Manchester tram fleet operating on the City's network had Wi-Fi enabled and were therefore ready to be incorporated in some way within an IoT system. The DOW reports: "An initial passenger counting use case will be demonstrated, and project partners will integrate new IoT sensor feeds with existing CCTV systems at the Metrolink stops, with the ability to connect and interact with people and their 'things' to be explored through the Open Innovation programme." The objective was to use IoT to ensure that trams were clean and tidy and that usage rates could be measured. This would give benefits in terms of improved user experience and in terms of load management and schedule planning.

A2.4.2 Demonstrating Impact

The use case has not been successful in implementing a working example. Some useful capabilities have been developed and there is consensus within TfGM that the general technology area is worth further exploration. There were six KPIs identified at the KPI review stage (February, 2018) when it was still thought possible that there would be a working installation of some form. The impacts which the KPIs were to measure were as follows: a) Ridership change/ticket income change; b) Level of passenger satisfaction; c) Level of passenger wellbeing and safety; d) Level of ticket fraud/payment protection; e) Level of data usage (to assess capacity of installed equipment and take up of the services provided); f) speed and experience of network connectivity. These KPIs were not approved by the evaluation team as the parameter information was not clearly identified. We report the KPIs as they were stated in February but note that they are not finalized.

A2.4.3 Enabling Factors

A number of factors appear to have restricted development and implementation of the use case: there was concern at Metrolink about how the information generated by the sensors would be used: installation within the tram network could not take place as this would have required taking trams out of service and this was not possible for operational reasons; TfGM contractors would not be allowed to carry out work on the trams. While the attempt was therefore made to find ways of implementing the technology, and exploring options, few practical steps were taken to facilitate implementation because of the barriers identified above.

A.2.5 T5 Next-Gen Cycling

A2.5.1 Use Case History

In this use case, sensors record the movement of bikes. The data gathered from sensors is then combined with other data sources to assess bike usage, and traffic and movement patterns in the City. Initially there were significant delays in getting the use case implemented. Two forms of sensor were operated, those on Mobike, which is a fleet of bikes, and See.Sense data which is a sensor installed on private cycles (with the permission of users). The See.Sense involvement was fortunate but not initially planned: See.sense are not partners, they are suppliers, and they part paid for sensors. The sensors (ICON lights) are co funded by BT, TfGM and See.Sense.

This use case changed greatly during the project. Initially the use case aimed to introduce eBikes as a scaleable and replicable demonstrator. However, the funding in the project was insufficient to realize this because the cost of an eBike is £5K per item. The use case was then re-scoped which resulted in a refocusing the UC on the IoT technology for bikes and next level new business models for cycling. The final component is using IoT data analytics to show how the city and transport planners can better plan our infrastructure. Therefore, the model of UC changed from an SME offering a product into a new business model where the SME is providing data service. The final solution was to use Mobike, which is essentially a docked system that allows the transport planners (i.e. TfGM) to gather data and insight from the operators to see how the service is operated, where people are arriving, how people are using it as a moto-mobile, where they cycle to catch the bus. The data is gathered in the BT hub that allows the cross referencing of data to see how people move around the city. Additionally, the data gathered from See.Sense sensors give us more insight about cyclists; contrastingly, with the Mobike it is possible to know how people use the cycle to move around and get around the city. All accumulated data and insight is now being used into the planning of cycling infrastructure planning.

A2.5.2 Demonstrating Impact

KPIs which were developed to provide specific measurable indicators of the impact of the use case are as follows: a) Cycling usage insight (locations/time) is used by TfGM and/or MCC in decisions regarding cycling infrastructure (e.g. parking, cycle paths, traffic lights); b) CityVerve technology enables assessment of road surface quality; c) Trialists of CityVerve cycling technology are engaged in CityVerve more broadly (80% attend a Workshop); d) CityVerve cycling trialists are willing to share data about their cycling habits with the CityVerve ecosystem (90% target); e) CityVerve cycling technology encourages trialists to maintain or increase the level of cycling they undertake over the course of the trial (Health benefits).

TfGM is considering how to follow up. There has been discussion with British Cycling Association and TfGM about analysing which cycle path are used and how much, some discussion of the state of infrastructure, road roughness. Other ideas are about what can be done with that e.g. reactive and proactive maintenance, notification of deterioration of roads. The use case has created awareness in a wide variety of places about the scope for using the technology for the measurement of actual usage, where journeys are being made, and this can help shape road design and other aspects of public policy including decisions about planning and the location of buildings. Cycling usage insights have not been completed yet owing to lack of data. Specifically, the intelligence provided by the data fed from bike usage contributes towards the strategic eLine agenda of TfGM. TfGM is creating a massive cycling infrastructure in Manchester that costing 1.5 billion.

A2.5.3 Enabling Factors

This was a difficult use case to implement as it involved a number of parties who were not originally within the project and there were challenges acquiring and implementing the technology. The use case made some progress through public engagement with users and a forum was created to facilitate this. The use case has changed its focus significantly during the project, but the adaptation has been successful in terms of identifying how a variety of impacts could arise and could be measured.

A.2.6 T6 Air Quality Monitoring

A2.6.1 Use Case History

This use-case was originally part of the environment theme but was transferred under the traffic theme and was then supervised by TfGM. TfGM has been collecting air quality data for over 10 years and the use case provided a way of exploring how the data could be used. This was an ambitious use case design at the start of the project. Below in Box 2 are details of what was envisaged in the DOW at the start of the project.

Task 13.4 [Sep 16- Sep 17] Air Quality Monitoring. Air quality has re-emerged as a serious issue facing cities across the world. Poor air quality exacerbates health conditions and causes other problems for the population. In March 2016 Transport for Greater Manchester on behalf of the Greater Manchester Combined Authority commenced formal consultation on the Greater Manchester low emission strategy and air quality action plan. The action plan proposes 35 action points and the table below shows the alignment between the action plan and theCity Verve work packages. The purpose of this task is to provide the modelling, monitoring, analytics and applications to connect the other City Verve work packages to provide a holistic air quality management approach in line with the air quality action plan. The core monitoring, emissions modelling and dispersion will be provided under this work package. This will provide information through to dissemination mechanisms and provide triggers for contingency responses. Contingent responses could include messages on VMS, targeted tweets or SMS and changes to transport operations. The AQ data to be linked for use within AToM. The proposed methodology builds on the work undertaken on two successful air quality management projects that used central Manchester as their test locations. AQUARIA funded by the Department of Transport and SimplifAI funded by Innovate UK.

Task 13.4.1 Map and resolve h/w & connectivity gaps (Sparta)

Task 13.4.2 Current AQM & Targets Review (MCC)

Task 13.4.3 Street/Campus Deployment (Sparta)

Task 13.4.4 Real-time Air Quality Information Service Creation (Sparta)

Lead: Sparta; Contributing Partners: MSP, MCC, UoM, MMU, MSP, TfGM, Cisco

Box 2

The use case which was ultimately implemented was considerably limited in terms of sensor deployment and partner involvement, compared with the original plan. The sensor technologies which the use case sought to implement were undergoing rapid change and a number of possible sensor types were considered, as were a number of suppliers. During the later stages of the project when it became difficult to follow the original plan, TfGM increased its involvement but pursued a more limited objective of identifying how low cost scalable sensors could be used to provide useful information for dynamic traffic management. The use-case then focused on installing low-cost sensors (e.g. below £1k per sensor) to get thorough coverage of the larger city area. The data which was gathered was then deposited in the BT data hub (Platform of Platforms) from where a direct data feed links with TfGM traffic management system. The traffic system is considering air-quality of different city areas for traffic management. The system is scalable since any new sensor can be easily linked with the hub and the aggregated data feed because the data is generated and gathered in the same format.

A2.6.2 Demonstrating Impact

Initially two KPIs were identified to measure impacts from the air quality use case: a) CityVerve air quality sensor data was to produce reliable and consistent data (DEFRA fixed station used as a baseline); b) CityVerve air quality sensor data has allowed TfGM to coordinate actions to react to poor air quality. In the event, this was not possible but the project did implement a monitoring system which continues to work, albeit on a small scale, although the use of the data which are generated by the sensors and monitoring system does not yet lead to action to control

traffic flows. It does not yet play a part, as was once envisaged, in giving information through CityVerve developed applications from the Health Theme to those with medical conditions that could be worsened by poor air quality. This cross-theme impact had been considered an important potential impact of the combination of two use cases from different themes (Air Quality Monitoring from Transport – originally Energy and Environment - and COPD / HSC1 from Health). For reasons related to the progress of each of these use cases individually, the opportunities to identify ways in which these two use cases could be linked could not be pursued in a way that led to a technology implementation within the lifetime of CityVerve [2016-2018].

A2.6.3 Enabling Factors

The range of air quality monitoring technologies available presented an important difficulty for this use case. The range of technologies and the differences in standards and levels of performance of these technologies that were available to the large group of participants in the use case made it hard to agree a consensus on which to use, and where they should be used. The resulting implementation use case was therefore smaller than expected.

PART B TASK 18.4.2 ENERGY & ENVIRONMENT USE CASES (UOM)

B.1 Description of the Energy and Environment Use Cases

In the Energy and Environment Theme there were originally 8 use cases. During the project a number of cases underwent modification; a case was introduced and then dropped. An air quality case was revised and transferred out of this theme to Transport. We report on all the cases which are active at the end of the project of which there were 8. The EE theme was led by MSP (Manchester Science Park) and involved a further 8 partners. 360 man months were allocated to the work and there were 5 work packages on which the work of the theme's use cases were dependent which one organisation only involved (CISCO). 1 work package was dependent upon the use cases of the theme and this involved just one organisation. The dependencies within the theme's use cases, looked at from the point of the view of the number of interrelationships between the constituent parts, suggests less effort might have been needed in coordination than in Transport, but the difference is marginal as the number of average number of tasks per use case is very similar.

B.2 The Use Cases

B.2.1 EE1 Building Retrofit

B2.1.1 Use Case History

This use case worked towards the deployment of IOT to digitise buildings. Asset Mapping led this use case and the partners are Manchester Metropolitan University (MMU), Manchester Science Park (MSP) and University of Manchester (UoM). Asset Mapping connects a secure Internet of Things (IoT) gateway to the Building Management System (BMS), which allows the building and facility managers to see their assets' location and maintenance information on one platform; see constant stream of live data from all heating, cooling and ventilation systems throughout the building. Operators and facilities managers are therefore able to make informed decisions to run buildings better. The use case technology results not only in more efficient building operating management, but in improved tenant experience. This ranges from better air quality to equipment that is always working and a proactive facilities management team to support them in an agile workplace.

B2.1.2 Demonstrating Impact

All KPI for the use case were met. The first KPI was about connecting the assets to BMS. The CityLabs (MSP project) has been connected to BMS. Wellness sensors were also installed. This is around the second KPI-"help the environment". Sensors were installed to look at CO2 levels, BOC, humidity, temperature and noise to understand how healthy the building/room is. They were deployed within CityLabs, and the University of Manchester Kilburn building. This is generating data which is being pulled so that it might be shown to relevant people to help them make decisions based on that. For instance, Citylabs are acting on the information that is being provided to improve the ventilation within that room. And the last KPI is developing an understanding of energy consumption and applying it for cost reduction. To meet this KPI, a sub-use case was designed with the Business School of Manchester Metropolitan University. Asset Mapping implemented IOT gateway protocol in the buildings to retrieve the metering data (energy information) and the data is compared with the occupancy sensors (Hoxton cameras; installed as a part of the use case) to look at occupancy against energy consumption. The idea behind is that when the occupancy (number of students within the building) is low, it can redirect the students to go to a particular room or to a local library and close down the other parts of the building. The sensors were installed in March 2018; however, the data analysis process did not start until June 2018 due to two reasons. Firstly, there were some technical problems at (Hoxton-suppliers') cameras; it showed a high volume of people while there was not. So Asset Mapping worked quite closely with the supplier to fix the problems. Secondly, on the energy side, the energy data retrieved from MMU showed gross energy consumption instead of hourly or minute wise consumption. So, Asset Mapping had to work on its platform to break the energy consumption data to minute wise intervals so that the use case could suggest minute-wise occupancy level patterns and the much energy consumption could be saved by closing down certain sections of the building when the occupancy was low. At the beginning, Asset Mapping was unaware that they were going to get gross energy consumption from the BMS. Impacts are likely to be more stablished as all the sensors are going to remain. The use case leads plan to continue working with MMU and the

University of Manchester on the very same project for the next 6 months so that analysis of the data gathered from the energy meters and occupancy sensors could be completed. They are also looking to deploy environmental sensors for Greater Manchester Fire Rescue Services. They had some kits left as a part of CityVerve, which will be deployed there. This opportunity came through MCC. Outside CityVerve, Asset Mapping is working in the building digitisation and healthy homes sector. Also, they are very active in the agricultural sector, where they look at temperature, and humidity within farms; how healthy the farm environment is for animals/birds.

B2.1.3 Enabling Factors

The relationships and understanding of what they need and how the need could be achieved was generally good. In terms of implementing at the level of technology – i.e. the building digitisation perspective – by talking to building owners, facility mangers it was possible to ensure that the technology was implemented relatively quickly and problems overcome. However, one of the challenges which the use case faced, and which it overcame to a significant degree was changing the mind-set of individuals. Building users were not always confident about employing new technologies. It was a difficult to convince them of the benefits of the new technology. This was addressed through discussions and demonstrations within the lifetime of the use case, including first demonstration was done in June where the IOT gateway in Citylabs was shown off in terms of how the data is flowing; and what how the data looks like. Training sessions were also performed with MSP and MMU.

B.2.2 EE2 Compliance Cost Reduction (healthy water)

B.2.2.1 Use Case History

Compliance cost reduction was a use case involving SPICA Technologies as the provider of the use case solution and MFT, MCC and MMU as users. The aim of the use case was to trial the application of sensors for water temperature, in order to control water-borne pathogens.

Installation took place in the hospitals (Eye, Children's, MRI), and Bruntwood premises – Oxford Tower and MCC. There was an initial expectation that Asset Mapping would work with Spica Tech AM's system but this system was not ready in time and the changes to the hospital work order processes prevented greater integration of the SPICA technology with existing and new systems and technologies. The actual period of experimentation of technologies in MFT has therefore been much shorter than planned. Installation was not done until Sep 2017, and there has been no monitoring of the performance of the systems until January 2018, by which time there has been only 5 months of useable data. A six month delay in the Sigfox installation was the main reason for holding up installation and the flow of data. It was hard to get resources and then the Sigfox installation was 6 months late.

B.2.2.2 Demonstrating Impact

Use case lead and users confirmed the KPIs for this use case. A further benefit not explicit in the KPIs but which is emerging is the reduction in scalding risk. KPIs and impact measures have been validated by BSRIA. The use case technology trialled demonstrates clearly potential for risk reduction and cost savings / greater intelligence provided by improved monitoring. This was not previously possible. Savings in terms of health outcomes are difficult to identify and cost – but the risk reduction is a very important issue for MFT. Risk reduction could save a lot of money on treatment, and on litigation, if that arises. Improved energy efficiency is another potential benefit and could be significant although the mechanisms by which information on excessive heating could be passed to the relevant controller systematically are not yet defined. Initial plans were for the technology – in the hospital context – to help to control legionella. The user (MFT) noted the possibility that monitoring would also control pseudomonas, a particularly problem for patients in high-dependency units. Tests of analysis of water quality which are taking place in July 2018 will confirm whether control of this pathogen is likely. Wider impact is likely as the user (MFT) will be allowed to retain its sensors and is ready to install them elsewhere in the organisation to improve water temperature / quality.

B.2.2.3 Enabling Factors

From the MFT view point, this use case had a fortunate combination of capabilities and a willingness to collaborate that led to information sharing information and imaginative solutions to problems that emerged along the way. Spica is one of the most responsive firms that the MFT manager has worked with in a long career in facilities management and IT system design and implementation.

There will be further opportunities for dissemination of the technology and understanding of it through the forthcoming NHS (National] Estates conference in October 2018. There is also considerable interest elsewhere in the Trust from other specialists outside the estates function in the benefits of the technology. The technology will be used elsewhere in the Trust. Overall, it is therefore likely that the technology will be used more widely on the current site, i.e. it is capable of replication, scalable replication and extensible replication (all three of our types of extension)]

But, the project should have lasted longer – another 6 months or even a year. The need for a 3-year project is in the view of the users especially important where use cases are embedded in organisations where there is a PFI partner which has its own complex procedures to follow. In this case the PFI partner has 3 months grace to respond to questions for costing and approval.

MFT were able to benefit from the larger number of sensors available to them as other partners in the project were not able to install them, which meant there were more sensors for MFT and that then led to a better understanding of the possible benefits of using them. The facilities management partner for MFT, Sodexho, believes that this technology or a very similar one could be more widely used in its other operations.

B.2.3 EE3 Next-gen BMS

B2.3.1 Use Case History

The Next-Gen BMS use case involved the development and implementation a range of interconnected technologies and would eventually comprise three separate use cases. The first concept for Net Gen-BMS was an IoT building management environment. This concept was widened after around six months when a second use case was adopted in December 2016 when CISCO proposed a sub-case case / separate use case to develop the "digital ceiling". The technology was not however approved for use in the MSP 1 building. (Cisco International Limited, 2017). A third use case, involving a battery storage system situated on the MSP Bruntwood Bright Building was adopted in Q6 and Q7 but is not referred to in the various Descriptions of Work. The development of the use case over time and the incorporation of new elements into it is evidenced in the comparison between the descriptions of work in the 2016 Second Level Plan and the 2017 Second Level Plan shown below Box 3.

DOW 4.0 (Cisco International Limited, 2016)	DOW 6.0 (Cisco International Limited, 2017)
Task 13.3 *[Sep 16-May 18]* Next-Gen BMS. The new-build use case will be to test a next-gen IoT building management environment, a key transformative technology for future intelligent buildings and smart workspaces. This will enable granular control, lower energy consumption, and a more responsive and adaptive environment. A controlled environment has been evidenced to improve social outcomes in areas such as healthcare and education. Task 13.3.1 Map next-gen IoT BMS to identified site (Siemens) Task 13.3.2 Prior-state usage patterns (drawn from 13.1.3) (Cisco) Task 13.3.3 H/w install (Cisco) Task 13.3.4 End User Applications (MMU) Task 13.3.5 EU training (Cisco) Task 13.3.6 Operational test, feedback (Siemens) Task 13.3.7 Full production plan (Cisco) *Lead*: Siemens; *Contributing Partners*: Cisco, MSP, UoM, MMU, Asset Mapping	Task 13.3 [Sep 16- May 18] Next-Gen BMS. The new-build use case will be to test a next-gen IoT building management environment, a key transformative technology for future intelligent buildings and smart workspaces. This will enable granular control, lower energy consumption, and a more responsive and adaptive environment. A controlled environment with the use of PoE lighting system (Digital Ceiling) has been evidenced to improve social outcomes and productivity in areas such as office space as well as in healthcare and education. Task 13.3.1 Map next-gen IoT BMS to identified site (Siemens) Task 13.3.2 Building usage patterns (Siemens) Task 13.3.3 H/w install (Siemens) Task 13.3.4 End User Applications (MMU) Task 13.3.5 EU training (Siemens) Task 13.3.6 Operational test, feedback (Siemens) Task 13.3.7 Full production plan (Siemens, PrismTech) Task 13.3.8 Multiprotocol DSR and Hedging adapter (PrismTech) Lead: Siemens; Contributing Partners: Cisco, MSP, UoM, MMU, PrismTech

Box 3

B2.3.2 Demonstrating Impact

While there were three separate but related technology use cases, two sets of KPIs were finally reported to cover the entirety of the activity across the whole Next Gen BMS use case: The first three relate to the original aims for the use case: a) Increased revenue generation from the building infrastructure (Building Demand Side Mgt in Day Ahead Markets); b) Lower overall CO2 contribution from the building (Building Demand Side Mgt in Day Ahead Markets); c) Influence reform of Building Regulations Act 2012 (engage in policy review process and submit case study evidence) while the second set include impacts that arose from the third use case, as well as aspects of the first use case: a) Energy trading revenues; b) Off-grid cost reduction; c) Carbon emissions reduction. Both sub-use case 1 and sub-use case 3 appear to have potential for further use in existing locations (the battery based energy storage system) and Siemens reports the likelihood of sales and further work resulting from their involvement in sub-use case 1. The KPI assignment process (WP18.1) which had played a limited part in shaping other use goal setting was less important here in that the objectives that were set for the use cases were technology led.

B2.3.3 Enabling Factors

This use case developed three separate sub-use cases which were in principle to explore similar overall goals but through very different technologies. The experience, expertise and understanding of these established use case leads ensured that these different technologies in which the use case leads were expert were shown to make a contribution to realizing various energy efficiency and environmental objectives. However, the "digital ceiling" sub-use case (the second sub-use case) was not implemented. These were loosely joined up technologies and did not necessarily require extensive connections between the activities of the different use cases. This made it possible for progress to be made more easily in implementation (with the exception of sub-use case 2). The development of the third sub-use case was a desirable addition to the energy and environment portfolio of use cases and was possible because of the strong technical knowledge of the use case participants.

B.2.4 EE4 Workplace Utilisation

B2.4.1 Use Case History

Workplace Utilisation was a use case involving SPICA Technologies as the provider of the use case solution and MFT, MCC and CISCO as users. The aim of the use case was to trial the application of sensors to determine workplace use levels and also workplace working conditions, and to determine how this information could be used to improve the use of space in those facilities, including the productivity of those working there.

In MFT, this was successful although the areas where the technology was installed were fewer – one building did not get the installation as there was insufficient connectivity. This building was also located outside the Trust firewall, so that was an additional problem that could not easily be solved. Where there was good connectivity – in Cobbett House and PFI Buildings - the system was installed and worked well. 73 devices were installed in two locations. The system was installed and working in November 2017 and by April 2018 it has been possible to assess its operation and analyse the data which has been produced. Overall, however, fewer installation sites were found than were planned.

B.2.4.2 Demonstrating Impact

User and use case interviews confirmed the KPIs registered in our list, and confirmed the KPI approach as appropriate to the measurement of impact. The demonstration of the technology did not though demonstrate how all this information from the sensors could be used. For example, the analysis of Lux measurements could have a number of implications for the management of organisational space and staff. However, the amount of time remaining after installation has been insufficient to test these various applications. In regard to another type of information that the sensors could measure - CO_2 levels – the use case has concluded that such information could be useful, but there has been no practical demonstration of how the information could be used.

The implementation of the use case has shown that this particular technology would not be permanently installed in organisations but would be moved around from location to location as the need for information on workplace utilisation arose. This is how MFT intends to use the technology in future.

There has been interest from other organisations and the project's technical lead – who is a consultant employed by the Trust - is planning to demonstrate the technology at the forthcoming NHS facilities management conference in the autumn of 2018. The facilities manager for the Trust, the company Sodexo, is considering wider use of this system elsewhere in the properties which it is contracted to manage.

B.2.4.3 Enabling Factors

The implementation of this use case relied upon what the users and use case lead report as a 'team effort' with interested participants working flexibly and coordinating their work. Effective communication between building users and building owners and the use of training events where those not directly involved in the development of the technology but who were expected to use it have been organized. Another factor for successful development of the use case was the contribution made by a technical expert working as a consultant for the Trust (David Bailey) who had knowledge of the technologies involved who was able to find solutions to problems of installation and operation.

B.2.5 EE5 Smart Cleaning

B.2.5.1 Use Case History

This use case did not work well for MFT, or for the Bright Building implementation (CISCO / MSP). For MFT there were lots of connectivity problems and while some elements of the system were installed, they were not successful. Theft was also an issue – either of the units themselves or of components of the systems, in particular the batteries, which made it impossible to trial the system and assess its potential contribution to cleaning operations. In Bright, the Sigfox installation was delayed. There were no operating examples as late as April 2018.

For MFT, the original plan had been to introduce a product that was virtually ready to market. However, this product did not work in the MFT context as the design of the technology was inappropriate to the context and

users could not understand or operate it. Technological incompatibility arose because the soap and towel dispensers in MFT could not be connected to the technology.

B.2.5.2 Demonstrating Impact

Use case leads regard the technology as demonstrated in terms of feasibility and the exercise as highly valuable as a learning experience, but the use case overall has no evidence of actual operational effectiveness. Understanding of how the technology would be used elsewhere has been developed and here is also understanding of the business model under which the technology could be used more widely. While there is nothing planned at present, some MSP buildings are likely to see wider use in the future beyond the end of the project.

B.2.5.3 Enabling Factors

In this case, impacts have not been achieved and the principle reasons were the incompatibility of the technology with existing systems and its unsuitability for the conditions in which it was to be applied/ installed. Despite considerable efforts in trying to find ways of implementing the technology, for MFT, the use case was not a success. The principal difficulty arose from the fact that the technology that was to be demonstrated was too close to the market, and was not adaptable to the context in which it was meant to be used. In effect, what was provided initially was an innovation already at TRL9 and not adaptable and able to meet the specific conditions in which it was meant to be used.

B.2.6 EE6 Smart Place Lighting

B.2.6.1 Use Case History

There were some difficulties finding a site for this use case and the initial plan was not implemented since the company with the contract to provide lighting to MCC would not permit the project partner who had been appointed (Telensa) to connect to the technology that was already installed. (MCC's lighting contract had been with AMEY.) The site for demonstration and the general direction of the project had therefore to change significantly, and MSP, which was a user, had to engage in the implementation more directly, taking over from Telensa, which left the project.

This was not therefore a multi-stakeholder project to the same degree as initially planned. The University, MCC and MFT did not participate to any significantly. The University was unable to participate in as it could not change major parts of its infrastructure. At the time of interviewing, the system installed in MSP is still not working in terms of delivering control of the lighting and this might be the result of a simple IT problem such as sim-card not being on the right network, however, as is noted below, the use case has delivered in important ways.

B2.6.2 Demonstrating Impact

The project ultimately did facilitate demonstration of the effectiveness and efficiency of the smart place lighting and this has been an important and significant outcome. Additional benefits have also been noted which were not anticipated at the start. They were: a) monitoring of the car park space for security purposes; b) movement patterns of pedestrians can be observed and the need for new paths / access could be assessed through the technology.

All the data can go to the platform of platforms, although none of it is currently moved. At the time of interview (April 2018) CISCO is currently moving it onto the platform A further potential benefit is that the technology could have demand side response possibilities and they could be significant. This would put into the hands of users the ability to carry out demand side response in the event of an event on the grid such as the demand for more power elsewhere or the failure of the supply to the grid.

B2.6.3 Enabling Factors

As noted above, the intended project lead was Telensa and when that company left the project, CISCO found an alternative technology supplier. This firm was called Holophane, it provided the luminaires, and these are a modular outdoor light which is extensible. This can be built at increasing scale in order to extend lighting coverage. All those in MSP working on the car parks were involved, as was CISCO. A firm called TVLights was also engaged (https://www.tvilight.com/) and provided its IoT control system for the outdoor lights. Their system is unlike Lora

or Sigfox and it uses a proprietary wireless mesh. This communication system is different and is not yet working, but it is practical and could be effective.

MSP's involvement led them to survey the car parks, and building managers had to get involved. The design process conducted by Holophane could have been better and their project management was a little disorganized, and there were problems with the documentation they provided about installation, but once the sorting out of the technicalities had been done the project was able to move ahead. Changes had to be made to the infrastructure of the car parking areas in terms of trimming the hedges. This was learning about how the technology is installed and this learning has become a capability. A programme for installation involved having to close parts of the car park.

B.2.7 EE7 Smart Parking

B2.7.1 Use Case History

This use case did not proceed exactly as planned as CISCO had to stand in for Telensa who left the project. The approach to continuing the use case was that CISCO bought equipment from Parquery, a Swiss firm (https://parquery.com/) and this was the main technology component for the use case. Originally, the use case had the following description: on the basis that 30% of all traffic congestion results from drivers seeking to locate places to park, an attempt will be made to "leverage the street lighting infrastructure to enable new smart city applications including smart parking. Through gamification activities, the technology works by recording in real time car parking usage and then the app allows the manager of the car park to allocate spaces through to ensure optimal usage" (Cisco International Limited, 2016). The booking system which was eventually installed was a management tool which MSP thought had great potential. But the version of the app provided by Sparta Digital which allows the whole system to work has not yet been provided and the system is not yet operational at time of interview (April, 2018).

B2.7.2 Demonstrating Impact

The technology was considered to be useful by MSP to control a non-charged car parking space which is where visitors park. The management objective for MSP is not to overflow the car park but to ensure use to capacity only, i.e. to optimize use of the car park space.

In effect the system is a load management / rationing mechanism for the car parking space resource which minimizes the amount of space that is wasted providing for visitors. This frees up space that can be used for paying users. But the system can be used very widely – for all forms of parking management and it can also be used to count people and it can be used for surveillance. Some elementary monitoring of behaviour is also possible. It can be used for all forms of traffic management.

Replication is important and likely. Cameras are able to cover 300 spaces each. The cameras are easy to install and to connect up to the system – infrastructure is not a big capital investment – there is a charge for the software service but this is 3 pounds per space per month – and this is quite inexpensive. As parking is a very important issue for many organisations, the technology demonstrated here is likely to be used more widely.

B2.7.3 Enabling Factors

Here the design and effective management of the project – with the involvement of CISCO and an experienced use case *user* allowed adaptation to circumstances when the main technology partner left the project. The availability of high quality alternative technology from Parquery also ensured that the use case could go ahead.

B.2.8 EE8 Smart Bins

B2.8.1 Use Case History

Smart Bins was not an original use case but was introduced after around 1 year of the project in August 2017 when a reference design was developed. The use case developed from ideas about enforcement and community engagement. Progress on the use case was slow although by the end of CityVerve, a prototype smart bin with QR codes was demonstrated. QR codes allow members of the public to identify bins and report their condition to the authorities. The use case reported 9 KPIs.

B2.8.2 Demonstrating Impact

The 9 KPIs reported for Smart Bins comprised the following: a) Clean-up events are triggered by QR data; b) End users report increased satisfaction with bin service as a result of being able to report the status of their bins; c) Monitoring information is collected and available for sub-contractors to use to improve their performance; d) Smart Bins technology supports SLA enforcement; e) Reduction in cost of managing bin estate (clean ups); f) Reduction in cost of managing bin estate as QR Code Bin Management reduces the number of bin inspections necessary; g) The number of interactions between members of the public and the QR code system increases over time; h) Smart Bins innovation improves transaction cost (compared to commercial norms); i) Extend Roll-out to all bins (Manchester City Council) within 6 months of initial demonstration. This was an ambitious set of objectives to realize for the end of project and by the end of May, 2018, a demonstration of one bin had been organized. No data had been collected.

B2.8.3 Enabling Factors

This use case emerged during the project and then made some progress. A virement delay affected the use case lead which was unable to shoulder the risk of the project and the use case development therefore slowed. Ultimately one prototype was developed.

PART C TASK 18.4.3 HEALTH & SOCIAL CARE USE CASES (UOM)

C.1 Introduction to the Health and Social Care Use Cases

Health and Social Care theme was led by MFT (*Manchester* University NHS Foundation Trust (*MFT*). At the start of the project the Trust was known as Central Manchester Foundation Trust. There were 7 partner organisations and 275 man months were allocated to the use cases. The use cases of the work package were dependent upon 8 other work packages which involved 4 organisations. 2 further work packages were dependent upon the uses cases of the health and social care theme, involving 2 organisations. In common with the other theme's use cases, there were complex dependencies with other parts of CityVerve activity. In April 2018, key performance indicators were prepared for and agreed with 3 Health and Social Care use cases. Within the three cases there had been some sub-division of use case activity with the result that at the end of the project when interviewing of use cases took place and when KPIs were finalized, HSC2 had been divided into two separate but linked activities and HSC3 had been subdivided into three activities.

HSC1 (COPD) was still approaching completion at the time our review of KPIs took place, with delays resulting from a variety of factors underlining the difficulties of coordinating important yet initially small scale intervention work in the context of health (the NHS) where high level approval for changes to organisational protocol are required to make any change however small. HSC2 defined initially in WP14 (14.2) was a community wellness activity that was split into two parts, one centring around an app to promote and measure physical activity – BeeActive, and a second activity to promote engagement with community organisations. This second activity was operated through PlaceCal, a calendar centred initiative using both internet / electronic and paper based engagement activities. The final use case here was the Neighbourhood Team Support activity which ultimately split into three parts, all of which aimed generally to support remote working: a) Smart Homes, b) Smart Logistics and c) Smart Video.

C.2 The Use Cases

C.2.1 HSC1 Chronic condition Management

C2.1.1 Use Case History

The use case progressed well in the first year. But then there was an unforeseen circumstance that led to a considerable delay namely getting proper ethical approval for deploying the solution with the patients. The ethical approval process ran for about 14 months. Ethical approval was necessary because the project required collection of different levels of sensitive information. For instance, the use case application aims to collect personal information such as customers' age gender, habits (smoking, drinking etc.). On the other hand, the IOT sensors installed within homes collect information tracks customers' movement inside/outside the homes, and progress of their health symptoms. The ethical approval process within NHS is highly exhaustive and time consuming. It required multi-level details and documents. Ethical approval was secured just three weeks before the end of the project which meant that the elements around data validation and acquiring data and data analytics could not be performed before the project end date.

At the beginning, the plan was to install sensor kits at 100-200 homes. However, it was found that as the partners had to pay for the 30% of the total costs, adequate investments in terms of procuring sensor kits for 100 homes could not be made. Finally, the kits were installed in only 5 homes/labs of volunteers (not COPD patients). One of these sensors has been placed at an energy lab so that the sensors could be calibrated and to confirm that the environmental sensors' values are within the valued range. Before, the end of the project, the intention is to install the kits in 30 homes.

C2.1.2 Demonstrating Impact

COPD did not finalize KPIs but indicated that the following impacts would occur in an operational case, and that there was evidence that the use case, although not implemented, had demonstrated the *acceptability of IOT intervention* for treatment for COPD, that *improved self-efficacy* (self-treatment) and therefore *improved mobility* would result. COPD is well-justified as a use case topic, as the condition is a major cause of morbidity and mortality. In severe cases it is an illness requiring urgent hospital admission and it places a high economic burden upon suffers and society generally. No measures were provided (no KPIs) to measure additionality of the COPD use case were provided; such a comparison would have required complex research design involved, lengthy test period, recruitment of controls and a double-blind framework to properly establish efficacy.

Depending upon the outcome, validation of the data and KPIs that were set up, the process of implementation can take up different exploitation routes. If NHS takes interest, that would be best in terms of exploitation routes. Partnering with NHS will help eliminating the need for establishing communication channels to reach out to the customers (patients) for technology deployment as NHS would allow using their channels. There are other alternative as well but these are commercially sensitive. The overall aim is that this is a scalable solution within greater Manchester or in other cities. This is a straightforward solution and would not require redevelopment of the technology. For the time being, the use case leads plan to continue with the project using their own resources and to collect data and analyse it in order to determine the scale of impacts and what commercial opportunities might arise subsequently. [As 18.6 notes, the device could be packaged as a 3rd party complementary service.]

C2.1.3 Enabling Factors

This was an ambitious use case that required development and progress on many fronts, technical, user-engagement, regulatory, and financial. Despite the difficulties, the use case team was appropriately sized, and qualified in terms of technical abilities. No one factor (for example ethical approval) could be said to have delayed the progress of the use case. It is possible that had the use case been able to make use of more resources, it would have achieved implementation by the end of the two year project lifetime.

C.2.2a HSC2 Beeactive

C2.2a.1 Use Case History

BeeActive began, as did HSC1, with clear overall objectives but encountered some difficulties when software provided within the team did not work as expected. Beeactive is a physical activity app which tracks activity (steps) and prompts people to engage in missions to increase their walking whilst exploring the local area. The app pulls data from various sources (e.g., weather, traffic, air quality, location, time, personal calendar) to prompt people to "get off bus a few stops early & walk to work because traffic is busy ahead" or "walk around the city and explore the blue plaques in your local area" or "go for a walk around Whitworth Park, because it's a dry sunny day". The University of Manchester is the lead for this use case and the technology partner is Clicks & Links.

C2.2a.2 Demonstrating Impact

BeeActive reported four KPIs: a) an indicator *Measure numbers of people who download BeeActive* to assess acceptance of the concept of such an application; b) a measure of usage: *Measure numbers of people who actively use the BeeActive app;* c) a measure to demonstrate usage was proposed but was not clarified by end of project; d) a change in activity levels was proposed to *measure change in behaviour (step increase) in those using BeeActive (from the baseline).*

While there is limited data from downloads and use there is some but it has not been made available to the evaluation team at the time of writing. The use case leads believe that the concept can be replicated outside CityVerve as a behavioural change tool, but it can also be used for research and then can be used for public health. The use case lead believes the technology is easily replicable if the technology provider maintains it on their platform beyond the end of the project. In terms of scalability, it can be scaled in the greater Manchester, across the UK and potentially internationally with appropriate engagement.

C2.2a.3 Enabling Factors

Challenges arose with the technical aspects of this use case. Minimum viable product has been delivered on Android, but not IOS, and the intention was to provide two releases of the app. The initial release will be the minimum viable product, which will facilitate some generic alerts to prompt people to go for walk. For instance, during the lunch time, the people will get a prompt to go for walk. It would be very generic; could be applied to anybody and does not require too much of technical inputs. This part of the app is already available. The second iteration of the app was supposed to be an IOT demonstrator but lacks the desired features at project end and has only a very low number of downloads.

With hindsight, it might have been more effective to have put the design of the app out to market or worked with a range of software developers and been clearer about the specification and the deadline dates. The short period of time available to get the project completed might also have led to lack of progress within the time frame of CityVerve in delivering working versions which could then generate data for validation of use case KPIs.

C.2.2b HSC2 eCalendar "PlaceCal"

C2.2b.1 Use Case History

PlaceCal was not something specifically within the project to start with but grew out of work within the Health and Social Care theme called the 'community wellnesses'. Existing projects were felt to be capable of built upon and the use case lead (MMU staff) involved decided to take advantage of their know-how and exploit IOT capabilities provided by the project to improve the softer side of 'social prescribing'. The use case leads first asked the older people through their community networks in Hulme and Moss side why they feel isolated and the lack of events was recorded as one of the main reasons. However, when the use case leads looked around, they saw multiple events and information regarding such events were available on Facebook, twitter and other social networking websites. The problem was that since the older people hardly use social networking websites, they are unaware of such events. The idea then became to pool together all the APIs and events that are available on different platforms and put them in one place. Older People may not use internet and therefore, the idea was to have a pdf generator so that the people and groups who work with older people for instance, libraries, community centres, and churches would be able to pull up anything on anything and print it up. The use case leads also did a lot of flyers in peoples' homes. Now GPs are involved and appear to be enthusiastic. When GPs come across a patient that seems socially isolated, the GPs can use PlaceCal and offer information to the patient on what sort of events that are happening around so that the patient can participate. 16 organisations are giving feeds and it is growing.

C2.2b.2 Demonstrating Impact

When KPIs were revised in February, there were five indicators of impact although not all of these were subsequently finalized as parameter information was not confirmed. The KPIs were: a) Number of API and calendar feeds from organisations into PlaceCal (new service which aggregates community activities and is more efficient in that it joins up disparate event information); b) Technology audits with community organisations; c) Testing calendar interface and interviews with 15 older users; d) PlaceCal Website activity; e) Feedback from launch event.

C2.2b.3 Enabling Factors

This was a successful use case in that many of the objectives for it were realized. However, a number of objectives that the use case could have realized and which were identified as the use case progressed could not be delivered because of lack of financial resource or time. The use case benefited from expertise held within the use case participants on initiatives in the area of ageing.

C.2.3a HSC3 Neighbourhood Team Support Smart Homes Project

C.2.3a.1 Use Case History

MFT leads this use case. In this use case, MFT installs sensors at the homes of people that are living under conditions of fuel poverty within Greater Manchester. Through the sensors, MFT receives information on whether

the homes are adequately heated and if not, MFT offers the tenants help in terms of connecting them with energy advisory groups. These advisory groups help the tenants with information regarding available grants/support for fixing boilers; draft proofing, fixing windows, and radiators etc. and even assist in maximising the tenants' income so that they could pay for the fuel bills and live healthy lives. MFT started with a grand idea of reaching out to 1000 homes and for a brief period of time, the project was called "a thousand homes". The use case progressed slowly due to several reasons. Firstly, there was a delay in identifying the cohort. MFT initially collaborated with Southway Housing, a landlord to get access to the tenants who are living in homes that might be living below fuel poverty level. Although Southway Housing showed the willingness to help MFT, it was difficult for them to allocate dedicated people who would work on this use case alongside MFT's team. Also, there arose issues regarding data sharing which made it difficult for MFT to get the names and addresses of people who might be interested in taking part in the project. To avoid such issues, MFT used its own database. MFT matched the people who were in receipt of social care service from MFTs' community alarms but also were tenants of Southway housing. Once these customers were identified, MFT then used the community alarm teams to approach the customers.

Secondly, the delay in the release of funds slowed down the project by almost 8-9 months. The technology partner of MFT was unable to purchase the equipment because of unavailability/non-release of funds. Thirdly, MFT faced ICT issues, in particular, utilising new technologies on a poor broadband service. Lastly, MFT struggled while communicating with different stakeholders involved in the use case including Manchester City Council, MFT, Southway Housing, community alarms and technology partner. Getting every stakeholder's consensus on issues such as putting logos (in the appropriate size, order and shape) on the leaflets provided to the customers was proved to a big concern. Due to the delay and limited time left in completion of the project, MFT has been able to install the sensors in only 20 homes.

C.2.3a.2 Demonstrating Impact

There were ten KPIs identified for this use case, and while data to support them has not been made available, the KPIs are considered to be a realistic way of measuring the impacts achieved. The KPIs were as follows: a) the first was what would permit *people to stay at home with increased support. In some cases avoided hospital or residential home admission*; b) the use case also suggested that the citizen could *stay at home as connected directly to other services including community and or voluntary organisations;* c) Early intervention through a *Proactive approach connecting to citizens to improve wellbeing, improving engagement, mitigating social isolation and increase service offering.* Would reduce disease incidence; d) A KPI to measure the economic and the resulting health benefits was proposed: *Reducing the cost of managing long term conditions which are impacted by environmental factors (i.e. Fuel Poverty/Social Isolation);* e) By *offering a technology solution/service to vulnerable citizens to use sensors to reduce the overall cost of delivering/meeting care and support needs to delaying the deterioration of some condition,* the use case could potentially provide a business benefit to individuals and to organisations; f) the proposal of a *Smart Home feedback* KPI was a monitoring KPI to assess internally the performance of the use case against benchmark and potentially against other cohorts; the KPI g) which was to *provide family and carers with option of sensors* was a proposal to allow other users to participate – this is in part a design feature of the use case yet to be implemented; h) the use of information from this source could be passed to *other services, e.g. primary care, using technology and information from project to inform social prescribing decisions. Early identification, alignment to the right services, at the right time*, which represents both business and public sector benefits; i) a further and related KPI was proposed that the use would provide *early intervention and proactive approach to support citizens to live at home, increasing independence* and that would have broad impacts as externalities and that this would be achieved in part through *improving support from existing agencies and service teams which visit citizens*; j) the final of these KPIs was a compliance aspect, which is important, and consisted in *providing a leaflet and consent form for services to use to advise citizens of sensors and benefits of installation.*

MFT has initiated the process to prepare the budget required for scaling the project to include 50-100 homes so that external grants could be applied. And MFT expects to partner with Manchester Local Care Organisation (MLCO) team to implement the project. MLCO runs a programme called "high impact primary care" under which contacts are made with citizens who are frequently unwell (uses GP and secondary service care/medication very frequently) so that their health conditions could be improved and their visits to GPs could be reduced. MFT believes that the smart homes project can contribute to this cause particularly for COPD patients by improving the conditions of the house they live in. However, in order to initiate the collaboration with MLCO and GPs, ethics and data privacy issues need to be addressed.

C.2.3a.3 Enabling Factors

The main factors behind the achievement of the impacts are the decision to use MFT's own data about citizens who might be interested in participating in the project; using the intimate relationship and trust that already existed between MFT's community alarm teams and citizens to reach out to the potential customers. Information sharing with other organisations outside the formal project was a barrier to progress.

C.2.3b HSC3 Neighbourhood Team Support Smart Logistics Project

C.2.3b.1 Use Case History

This use case facilitates the development of smart and efficient ways of ordering unplanned essential equipment to improve service outputs and patient satisfaction. MFT leads this use case while Republic of Things is the technology partner. Currently the equipment delivery services used by MFT are on contractual arrangements with the city council for MFT's health staff and community services. While MFT's health staff works from 8-10 PM and also runs an open night service seven days a week, the equipment delivery system only works from 8.30-4.30 on weekdays. So, there is a mismatch. Also, there is a behavioural work pattern whereby if a nurse goes to see a patient and identifies that they need particular equipment, they have two options. Either they wait until they go back to their base and to make the order on the fixed device in the office or if they need it urgently, they could go to one of the satellite stores (small stores keeping small number of items). So, the idea was to have an enhanced service so that travel journeys could be eliminated for getting the equipment.

The use case installs Wi-Fi in a van and smart devices for the staff and delivery from 10 am-7 pm on weekdays and 10 am-6 pm during the weekends. A tablet is used which helps the nurses to order when they are actually with the patient. The patient will know that the tool will be delivered on the same day. The staff can directly go to the next patient. However, the use case faced several problems which caused a massive delay. The problems were mainly around getting funding for the enhanced delivery arrangement i.e., the vehicle and the driver. They had to be commissioned by MSIL- Manchester support for independent living, the equipment provider. Unfortunately, the money did not come on time for the fixed costs (vehicle and the costs for two drivers) which caused a massive delay. Again there was a delay in getting the money for the smart devices. At first, the costs for van and drivers were not budgeted.

As the use case leads stated "At the start of the project it is difficult to envisage the entire set of equipment one may need to complete the project", some agility was required; but in practice, this was not easily achieved. The use cases thought they would be allowed flexibility in using the money and that the tablet would come as part of the technology offered by the technical partner. However, that was not the case. The partner provided one tablet for the van. MFT then had to again request for tablets for the health staff separately. Delivery started to operate in January 2018 and IPADs were given to the core teams in February 2018. These were then extended out to all the nursing teams and therapy teams. Since February 2018, data has been collected about the orders made, and what sorts of orders were made for. Although the delivery system went live in February 2018, as this is a massive change to the health staff's work pattern, it was necessary in the first few months to make sure that the health staff got used to this new way of making orders. Therefore, as only of June 2018, the enhanced delivery mechanism at a considerable capacity is being used for the first time.

C.2.3b.2 Demonstrating Impact

The second of HSC3 sub-use cases had 7 KPIs. This sub-use case aimed to provide logistical support to those with medical needs who are at home (or possibly in residential or nursing home care) or supporting those servicing them. This is a logistical support activity that essentially ensures that equipment or consumables are provided in such a way that independent living is maintained. The first KPI was: a) *Improved service delivery – to 7 days a week extended hours* which is a measure of how widely the support activity could be provided*;* a second KPI defined how the operational effectiveness of the service would be assessed; *b) Reduction in delays between assessment and equipment delivery measuring time ordered and time delivered;* a third KPI focused on the financial improvements; c) *Financial improvements & cost saving (staff time/repeat visits, costs of unplanned ED presentations);* a fourth KPI focused on the extent to which the use case was able to expand to accommodate to the needs of a target population; d) *Number of users supported by new service;* a fifth KPI proposed measures to assess users' satisfaction with quality e) *Quality assurance / feedback / audit with service users;* a

sixth measure defined an important operational aspect of the use case, the ease of access for auditing f) *Ability to have Immediate access to data for audit purposes;* the final KPI in this group defines success and impact in terms of the number of staff users g) *Improved technological approach to equipment supply*.

C.2.3b.3 Enabling Factors

Unanticipated costs as regards the IT provision and the commissioning of the van service and budgeting issues including delay in processing virement appear to be significant in this case and led to delay. This is regrettable as the use case is quickly beginning to generate data to demonstrate the value and impact of the work done.

C.2.3c HSC3 Neighbourhood Team Support Smart Video Project

C.2.3c.1 Use Case History

The project faced severe delay particularly because of the technical solution – a key component of the use case was slow to emerge. The goal posts and deadlines shifted over time. At one point the use case leads could not continue with the technical provider and at that point an in-house alternative solution was found using Skype for Business. The 'Skype business solution' which used IPADs (quite simplistic model) began to allow the consultation calls using skype. Then however, the technical partner (Cisco) managed to implement the solution (Cisco technology) that had been proposed at the beginning by the use case lead. As a result of the delay in implementing the solution from Cisco's side, the project went live in June 2018, just 4 weeks before the project end date. In total, Cisco technology was implemented in 8 nursing homes. The use case lead indicated few possible reasons behind Cisco's inability to offer the solution on time. "*There were some problems with the data centres which controls the consultation calls. Also, I think they did not fully understand the infrastructure issues. On one side, they were connecting NHS side which has got entry connectivity to make it secured; then on the other hand, you are connecting that out to nursing homes that have very low-level broadband. There was no communication issue from us. The requirements were clearly communicated to the technology partner through in-person meetings and are well-documented.*"

C.2.3c.2 Demonstrating Impact

The third sub-use case provided video link technology to nursing homes to examine the scope of telemedicine to the nursing / care home context could work in practice. The first KPI noted here a) *Overall reduction in no. of Hospital admissions from nursing homes. (NH)* would be a significant impact – there is however no data yet being provided to establish whether this benefit is realized. A second and third related impact is concern reduction in GPS attendance and GP time spent as a result of being able to use video technology b) *Reduction in travel time for unplanned visits by GP to Buccleuch Lodge (IMC)* c) *Reduction in no. of unplanned/ urgent visits from GP to Buccleuch Lodge (IMC);* A fourth KPI noted the importance of measuring as an impact the patient satisfaction and a fifth, the quality of the service, while a sixth identified the need to measure confidence in the technology amongst staff: d) *Patient satisfaction not adversely affected by using video conferencing. (NH & IMC);* e) *% of consultations via video conference are without technical difficulties. (NH & IMC);* f) *Increase in staff satisfaction/ confidence in using video conferencing. (NH & IMC);* A final KPI sought to measure impact closely related to impact a, the reduction in requests from help from outside services (in this case the ambulance service: g) *Overall reduction in calls to NWAS from nursing homes*

As the technical provider has agreed to continue the project for 6 months outside the project, further evaluation of the success (impact) of the project can be done, and if the results are good, the system could be implemented in all nursing homes. It could be scaled up to all the nursing home team across the city and possibly extended to residential homes as well where there are less complicated patients. However, the use case lead has not made any concrete plan. Also, before developing any solid plan, the use case lead intends to evaluate if the performance of the Cisco solution is better than Skype and is worth the price it pays for the service; because Skype is very cost effective and requires less overhead costs. On the other hand, extending Cisco's solution across the city will require massive investments.

C.2.3c.3 Enabling Factors

The success of this use case was ultimately to demonstrate an idea rather than to develop and test a specific new technology. The use of Skype as a solution has been a successful work-around when faced with the difficulties of developing / sourcing a new technology.

Part D Summary

D1 CityVerve Impacts Summary

D1.1 Transport

In the area of Transport, 6 uses were being pursued at the end of the project with a seventh – smart traffic monitoring being de-scoped earlier in the project. All use cases had operational status at the end of the project but there was considerable variation in the scale of operation with sending trams being a very limited implementation of ideas that were different significantly from what was envisaged at the start of the project. Two use cases are notified to us as fully operational (City Concierge and Road Safety). Transport use cases produced 9 public service improvement KPIs, 2 business benefit KPIs, 2 citizen engagement KPIs, 6 innovation and technology KPIs and 1 wider impacts KPIs.

Our assessment of the status in TRL / SRL / MVP frameworks is that T4 Sensing Trams was developed as a prototype (closer to TRL3), the other use cases were more advanced with demonstration of minimum viable product status and field demonstration in operational environments with Road Safety (T3) and City Concierge (T2) closer to what would be regarded as TRL7 status. T5 was significantly different at the end of the project than what had been expected at the start.

Wider use and extension of project impacts are reported as planned or expected for most use cases. Wider use can be divided into two, wider and continued use within the organisational context and outside the context with or without the agency originally involved. In the case of Transport use cases, all use case innovation is somewhat likely to find wider application in the original context. Wider uptake of innovations developed in the Transport theme is more difficult to assess the likelihood of at this stage.

All Transport use cases report significant learning effects, confirming the observation that considerable effort had to be expended in developing the use cases to operational status. Use case leads as providers and use case users as technology / service co-developers and users have all acquired significant knowledge of how to implement innovations of this kind in the context of an IoT environment.

D1.2 Energy and Environment

In the energy and environment theme, the project ended with 8 use cases of which 7 were partly operational – to varying degrees – by the end of the formal project period. One use case appears to be fully operational. A ninth use case initially specified was re-allocated to the transport area although we note its original KPI statement in our list in Annex 1. The theme use cases produced a total of 16 public service improvement KPIs, 7 business benefit KPIs, 2 citizen engagement KPIs, 4 innovation and technology KPIs and 9 wider impact KPIs.

In the energy and environment theme, development has reached TRL7 (operational demonstration of the prototype) in five cases for which we have evidence (EE2, EE4, EE5, EE6, and EE7). Some use cases have not yet been reported on. Our view at this stage is that these use cases have progressed to an advanced stage despite some complexity and difficulties. EE6 and EE5 (Smart Lighting and Smart Parking) were significantly different at the end of the project than at the beginning.

Wider use and extension of project impacts are reported as planned or expected for most use cases.

Energy and environment use case histories give evidence of significant learning effects occurring during the development of use cases. These learning effects underpin specific technology installation but also provide the basis for working in the IoT context. Such learning effects are valuable resource for both use case leads – the technology vendors – and users –potential clients for such installation.

D1.3 Health and Social Care

In the area of health and social care, 2 use cases were operational at the end of the project with the COPD use case (No.1) delayed. Of the second of the two use cases that were operational, one was split into three parts. This third use case – Neighbourhood Team support had three parts, all of which were substantially operational at end of project. The second use case was spilt into two parts, each part of this use case was partly but not substantially operational at end of project. Analysis of numbers of KPIs by type and by use case and theme show that for the use cases of this theme, there were 5 public service improvement KPIs, 7 business (operational) benefit KPIs, 11 citizen engagement KPIs, 4 KPIs noting externalities, 7 innovation and technology KPIs and 3 wider impacts.

In the health and social care theme use cases, the smart logistics use cases (HSC3 sub cases) appear to be demonstrated in the operational environment, while HSC2 and HSC1 are at much earlier stages, and although there is a definition of a project / service, there is as yet no evidence of efficacy. We note that the more complex projects in this theme area are the last developed in operational sense, which not perhaps surprising. HSC1 was somewhat different from the original specification while HSC2 and HSC3 were more different, each having been subdivided and HSC3 being in three parts at the end of the project.

Wider use and extension of project impacts are reported as planned or expected for most use cases.

Health and social care use case histories also give evidence of significant learning effects occurring during the development of use cases. However, while these learning effects are significant and are more pronounced in the area of health and social care than in the other theme areas, they indicate that this theme has had more challenges than the others in terms of integrating systems within the IoT framework and within the existing institutional and organisational environment. The example of ethical approval limiting the progress of the COPD use case is very instructive here.

D2 Types of Impacts Identified by the KPI

D2.1 Impact Types Across the Use Cases

The Study Team has carried out analysis of the types of impact achieved by individual use cases. This information is presented below. The figure shows that individual use case impacts were mostly in multiple categories (i.e. the impacts identified were across a range of impact types) although there were two use cases where the impacts were limited to public service improvements only.

Use case leads and users were not constrained to a minimum number of impact types when creating their KPIs. The public service improvement category and the public service improvement and wider impact category could in retrospect have been merged.

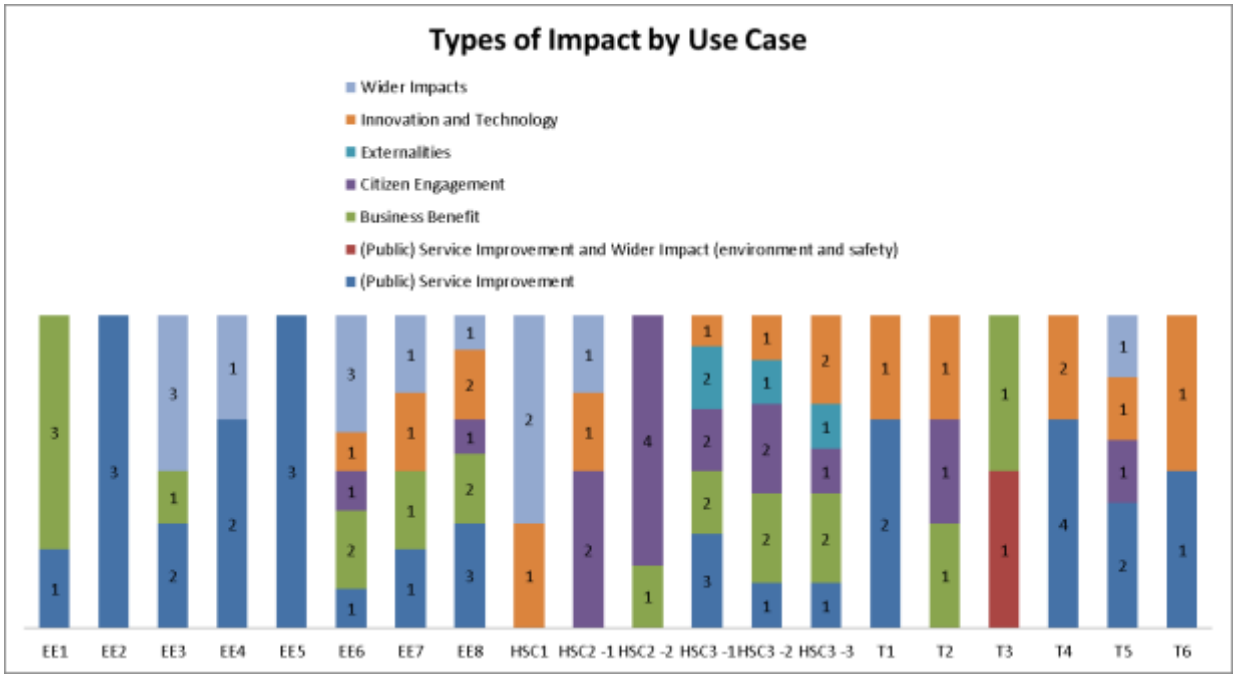

Figure 1

D2.2 Impacts Types at Theme Level

Analysis of the impact types at theme level as displayed in the following figure shows that at the theme level there is no real clustering of impacts of a particular category.

We suggest that use case leads and use case users with whom the use cases were developed were aware of the varied forms of impact their use cases could achieve and used the full range of impact types to define the possible effects. This appears to have been the case in all theme areas.

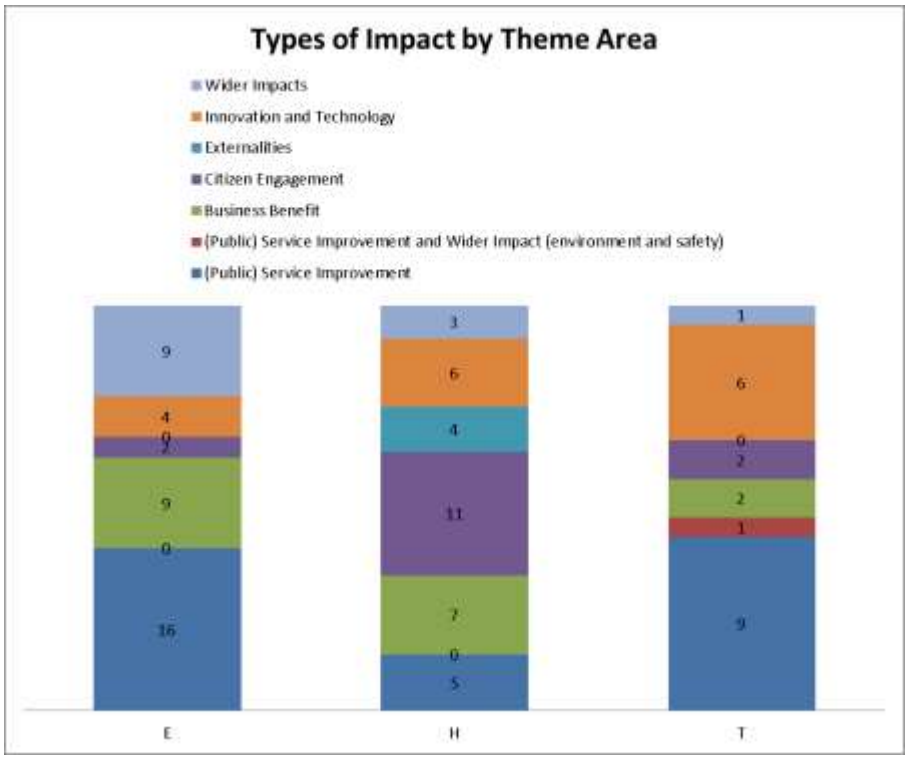

Figure 2

D2.3 Ranking of the Impact Types across Theme

The main form of impact type identified by use cases was public service improvement while business benefit, citizen engagement and innovation and technology impact types were very similar in the number of KPIs identified for them.

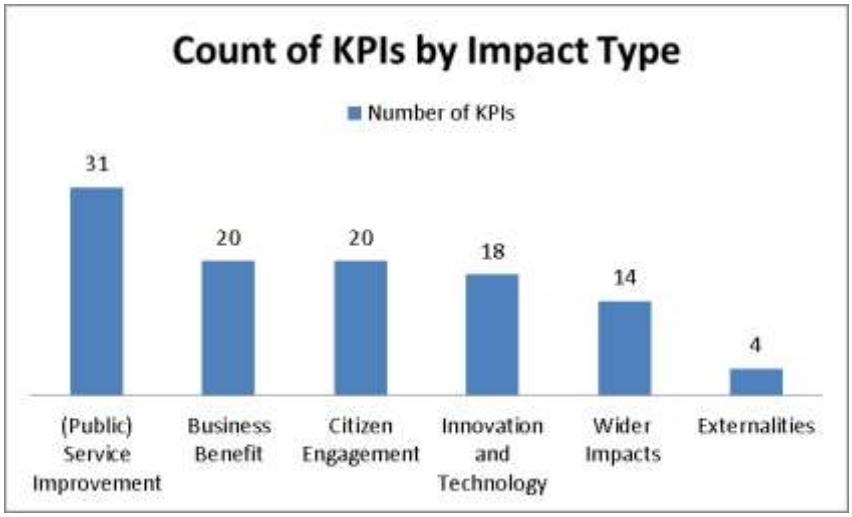

Figure 3

D2.4 Availability of Data

As has been mentioned elsewhere in this report, a minority of use cases had completed the analysis of data collected by the end of the CityVerve project, and a significant minority of use cases had yet to start collection. However, it is understood that a significant number of use cases will begin to report data within the next few months - the Final quarter of 2018. If this data is provided by use cases, it will be possible to give more accurate estimates of impact by the end of by early 2019. Below we provide a table of KPIs defined currently per each use case and the number of KPIs that might be measurable for each use case at 6 months after the project end Table 3. Many use cases will be able to provide data for all KPIs, some will not provide any as the use case is likely to close. The extent to which this reporting is possible will be dependent also upon the willingness of project participants to continue to monitor their use cases beyond the project.

Use Case	KPIs Currently Specified	KPIs with Data and Analysis within 6 Months from Project End
EE1	4	4
EE2	3	3
EE3	6	3
EE4	3	3
EE5	3	3
EE6	8	8
EE7	4	4
EE8	8	0
HSC1	3	3
HSC2 Beeactive	4	4
HSC2 eCalendar	5	5
HSC3 N'hood Team Support Smart Homes Project	10	10
HSC3 N'hood Team Support Smart Logistics Project	7	7
HSC3 N'hood Team Support Smart Video Project	7	7
T1	3	3
T2	3	3
T3	2	2
T4	6	0
T5	5	5
T6	2	2

Table 3

D3 Evaluating CityVerve as a Demonstrator

The organisational design of CityVerve has produced an integrated set of technological development projects with related and underpinning infrastructural aspects supporting a set of use cases in three main theme areas, as well as a number of subsidiary innovation activities such as the open innovation work package. It is clear from the review of use cases that these use cases have relied to varying degrees on other parts of the project. Some have relied heavily, others less so. It is also clear that the use cases and the underlying infrastructural aspects of the project have also needed to take account of existing business systems and organisational processes. The performance of CityVerve in integrating with other organisational aspects is uneven. A number of use cases (EE5, T1, T4, T6 and HSC1) were significantly impacted by existing institutional / organisational practices or arrangements that slowed progress down or required significant changes to use case design. In some cases, given the relatively short period of the project and the ambition of the use cases and the integrative character of the project, it might have been more realistic to narrow use case design at an earlier stage. But such narrowing would have limited the learning experience which the project has provided to use case leads / technology providers and their co-innovators in service delivery organisations (MSP, MCC, UoM).

CityVerve set a minor goal to explore interconnections between the use cases of different themes. Initially there were discussions that identified potential connections, between for example environment and or transport use case goals and health and social care goals. These connections have been explored and more has been understood about how the connections might work, but no substantive innovative activity has been possible in this regard.

The ambition and complexity of the project has led to re-orientation, re-design of use cases and some de-scoping – removal of use cases. This is unavoidable in a development project, particularly one at such a scale as CityVerve. The evidence of the scale of the virements in the project has demonstrated the need in CityVerve for changes to initial plans, and revision to plans throughout the project.

Virement itself is not necessarily a problem for a project when adaption to circumstances requires re-prioritization. However, when virements are delayed and organisations are unwilling for financial reasons to commit resources until virements are processed and agreed, projects can be held up. The degree to which this has happened in CityVerve suggests that this is an important issue for this particular innovation project and would be so for others similarly configured with relatively tight time-scales and complex dependencies between elements of the project itself and the project context. While larger organisations may be in a position to self-fund innovation, smaller organisations may not be so able, and even large organisations that are publicly funded (the NHS for example) will be unable to commit resources without cast-iron guarantees of balancing payments from the funding body.

The ability to remake plans and adapt is central to successful innovation projects and in CityVerve there has been significant adaptation when obstacles were encountered. In CityVerve adaptation and remaking of plans has been accomplished mostly well with, in some cases users taking the lead role in contributing to the innovation itself (in EE and HSC use cases).

CityVerve has also benefited from strong collaborative working in the majority of the use cases although there have been some use cases where this has not been evident.

In our outline of potential enabling and limiting factors, individual component failure to deliver was noted as potentially important block or limiter. In a small number of cases mainly concerned with the development of software, there have been limitations on use case outcomes and impact. Alternative sourcing or multiple sourcing of key components might have allowed use cases to avoid being blocked – and failing to deliver operational use cases.

CityVerve use case leads and users have worked closely to ensure user - in the sense of *wider user* - involvement and acceptance and have very widely met with success. The project environment and the communities involved at the project location have supported the CityVerve project effectively. This has resulted from a number of factors including the professional and organised approach of those directly involved use cases (as leads or users) and an effective public relations strategy.

Use case leads and use case users have shown willingness to take risks in terms of working on technologies that were relatively new to them, and which could, if implemented, substantially change organisational practice, displacing existing technologies and altering ways of working.

The time allowed for the operation of the project has been seen by some participants as too short, although this is not a unanimous view across all the use case participants. The majority view is though that a period of two years was challenging for the level of innovation required and the extent of coordination – of the elements of CityVerve between themselves – and between CityVerve and the various environments in which it has been implemented. We point to the fact that while many use cases are operational at end of project, very few are fully operational and operational in the terms envisaged at the start of the project.

Use cases and users have usually possessed strong technical capabilities or been able to access them, allowing for more demanding and adventurous use cases and innovation achievements.

Annex 1 CityVerve Use Case KPIs

[our KPI groups are in the order EE, HSC and T]

KPI DETAILS					TECHNICAL REVIEW			KPI PARAMETERS							
Theme	**Use Case / WP**	**KPI #**	**KPI Titles (Documented prior to Q5 PMO meeting)**	**Issues with KPI title, i.e. different versions presented**	**Recommendation of Technical Review**	**Details of action needed**	**Use Case Response (if requires for action)**	**Information to be collected to measure the KPI**	**Baseline**	**Plan for pre-collection**	**Source of information**	**Cost of information (if applicable)**	**Person responsible for collection**	**Freq. measured**	**KPI Type**

E + E	**EE1 Building Retrofit**	**1**	Create centralised Documentation for Building information and asset details		**Accept**			KPI1: Reductions in speed and cost of the digitalisation process (time required to import CAD files, floor plans, and connect to a BMS (when present). Provide a system where documentation is centralised and disparate information can be accessed in one location	Internal	AM baseline data available (2 day baseline)	Asset Mapping baseline data	Training	Use Case lead	Single measure	**(Public) Service Improvement**
E + E		**2**	Augment BMS data through the deployment of IoT sensors, enabling building owners to understand the health of their buildings outside of BMS feeds		**Accept**			KPI2: Increased visibility of asset location and removal of data siloes.	Temporal (Over time using environmental data provided by FM team).	Building owners/FM team to provide baseline to be compared with data from install point	Building and facilities managers and Asset Mapping	N/A	Asset Mapping and Building/ FM	Daily	**Business Benefit**

E + E		**3**	BMS optimisation – review configuration of BMS and ensure it is running at an optimal level		**Accept**			KPI3: Existing BMS configuration details to be reviewed by BMS specialist.	External (Recommendations requires comparison with existing BMS configuration)	Baseline data already generated by use case lead.	Building and facilities managers and Asset Mapping	collect and review costs	Theme lead to allow Asset Mapping to view BMS configuration.	Single measure	**Business Benefit**
E + E		**4**	Reduction in building costs through the use of occupancy sensors. Buildings operating 24/7 can reduce opening hours based on data displaying busy times.		**Accept**			KPI4: Collection of student, faculty and visitor footfall in Manchester Met University.	Temporal (Compare weekly costs to run the building and footfall over period from install date).	N/A	TBC	TBC	Partners, such as Manchester Metropolitan University to deploy footfall sensors.	Weekly review of data to monitor trends and peak times.	**Business Benefit**

E + E	**EE2 Compliance Cost Reduction (healthy water)**	**1**	Cost savings, Identifying outlets which can be removed, reduction in time spent manually monitoring outlets.		**Accept**			KPI1: Identification of outlets that can be removed or that require increased flushing, count of outlets that cannot be manually accessed (plus old KPI3? KPI3: time and resources spent checking building water supply complies with legislation on water borne bacteria before and after solution.)	Temporal	SPICA has baseline cost data. Also requires cost data from service provider/estates teams	Feedback from Keith Sammonds (compliance manager)	Time of Spica and MFT estates team	Lynda Gillson (Spica) with support from Keith Sammonds (MFT)	Single measure	**(Public) Service Improvement**
E + E		**2**	Risk reduction, provision of data on outlets that cannot be accessed manually, identification of other risks eg. Scalding.		**Accept**	N/A		KPI2: Devicepoint® alarm counts and frequency	Temporal	N/A	Devicepoint® data	Time of Spica and MFT estates team	Lynda Gillson (Spica) with support from Keith Sammonds (MFT)	Monthly	**(Public) Service Improvement**

E + E		**3**	Accuracy and trust - BSRIA review and approval of solution		**Accept**	N/A		BISRIA study	External	N/A	BSRIA + SPCIA	study already funded	Use Case Lead	Single measure	**(Public) Service Improvement**
E + E	**EE3 Next-gen BMS (I)**	**1**	Increased revenue generation from the building infrastructure (Building Demand Side Mgt in Day Ahead Markets).		**Accept**	N/A		KPI1: Energy Market Pricing Information from Energy Exchange	Internal	N/A	Siemens	N/A	Tom O'Reilly	Half Hourly	**Business Benefit**
E + E		**2**	Lower overall CO2 contribution from the building (Building Demand Side Mgt in Day Ahead Markets).		**Accept**	N/A		KPI2: Metering Data and Calculation methodology for conversion to GHG equivalent	Internal	Metering historic data	Siemens	N/A	Tom O'Reilly	Half Hourly	**(Public) Service Improvement**
E + E		**3**	Influence reform of Building Regulations Act 2012 (engage in policy review process and submit case study evidence).		**Accept**	N/A		KPI3: Cost Benefit Analysis based on KPI 1 and 2 data informing the ROI	Internal	N/A	Siemens	N/A	Tom O'Reilly	Single measure	**Wider Impacts**

E + E	**EE3 Next-gen BMS (II)**	**1**	Energy trading revenues		**Accept**	N/A		The amount of energy trading revenues that can be created and used ot off-set the costs of energy use by Bruntwood customers	Internal	N/A	energy trading partner	N/A	Darren Williams, Bruntwood	Annual revenue based on 12 x monthly statements	**(Public) Service Improvement**
E + E		**2**	Off-grid cost reduction		**Accept**	N/A		Measure of 3 types of costs/levies related to energy usage: 1) Transmission Network Usage Charge - transmission of energy from pwer station to site of usage, 2) Usage of peak price energy - time of day price differentials, 3) capacity market levy - charges for using peak demand energy	Internal	N/A	battery data plus energy bills	Capital and degredations costs of battery	Darren Williams and George Bartley, Bruntwood	Annual revenue based on 12 x monthly statements	**Wider Impacts**

E + E		**3**	Carbon emissions reduction		**Accept**	N/A		Measure of reduction in usage of grid at times when fuel being used for energy has a higer carbon intensity profile (peak times = powering up coal power stations). This is an ambition for KPIs beyind the life of CityVerve as data is not widely available from the National Grid regarding carbon intensity.	External and Internal	TBC	TBC	TBC	George Bartley, Bruntwood	TBC - this is a "desirable KPI but probably beyond the scope of CityVerve	**Wider Impacts**
E + E	**EE4 Workplace Utilisation**	**1**	Opportunities for cost savings through efficient use of space and productivity improvements.		**Accept**			Sensor data on environmental changes, comparison before and after any interventions	Internal	N/A	Devicepoint® data, tenant feedback	Time to analyse data and implement any changes	TBC	Single measure	**Wider Impacts**

E + E		**2**	Building users report an improved ability to find the right space for their use in the building		**Accept**			Survey of building users based on feedback from publically available information (comfort app provides real time information to building users to help them find the right space within the building).	Internal	N/A	Questionnaire sent to building users at installation sites	Time of use case leads/ tenants to review / complete surveys	Lynda Gillson (Spica)	2 x measures	**(Public) Service Improvement**
		3	Evidence of improved environmental conditions leading to a more productive work environment		**Accept**			Alarm occurrence, response times to alarms, long term data trend analysis: real time alerts on environmental conditions can allow for early intervention and long term monitoring proves adherence to optimal conditions	Internal	N/A	Devicepoint® data and publically available research on acceptable environmental readings	N/A	Lynda Gillson (Spica)	Monthly	**(Public) Service Improvement**

E + E	**EE5 Smart Cleaning**	**1**	Quality Improvement. Fewer complaints about cleanliness are received. Building users report healthy environment.		**Accept**	N/A		Compliance/ complaints figures and Customer Satisfaction	Internal	This report is already produced monthly so we can compare historical reports to post sensor install stats.	Compliance reporting based on Sodexo 24/7 helpline data (ticket tracking), on-site feedback buttons.	Installation and monitoring of feedback buttons	Lynda Gillson (Spica) with support from Tracy Bradbury (Sodexo)	Monthly	**(Public) Service Improvement**
E + E		**2**	Support the development of outcome-based cleaning contracts		**Accept**	N/A		Interviews and feedback from Sodexo staff	Internal	Sodexo to provide details and feedback on existing contract terms	Interviews with Sodexo staff	Time of use case lead and Sodexo staff	Lynda Gillson (Spica) with support from Tracy Bradbury (Sodexo)	Single measure	**(Public) Service Improvement**
E + E		**3**	Efficiency Improvement. Less wasted cleaning time and quicker response to issues.		**Accept**	N/A		Reports generated from Devicepoint® showing alarm counts, number of times washrooms are cleaned and alarm response times	Internal	The number of times washrooms are cleaning can be taken from existing cleaning schedule.	Interviews with Sodexo staff	Time of use case lead and Sodexo staff	Lynda Gillson (Spica) with support from Tracy Bradbury (Sodexo)	Monthly	**(Public) Service Improvement**

E + E	**EE6 Smart Place Lighting**	**1**	Responsive lighting is operational and 80% of customers are satisfied with responsive lighting.		**Accept**	N/A		System operational data shows that the lighting system is responding to customer needs and a survey of users finds that at least 80% report satisfaction with the responsive lighting. A further target is 0% of users report a decline in satisfaction)	Internal	Customer Engagement plan	LIGHTING SYSTEMS	< £1500	G. Bartley/ C. Morley	Monthly and twice	**(Public) Service Improvement**
E + E		**2**	Reduced energy consumption costs (from lighting)		**Accept**	N/A		MSP Measure Energy Consumption	Temporal	Current energy data	Bruntwood Energy Services	< £500	GBartley/ CMorley	Bi-monthly	**Business Benefit**
E + E		**3**	Reduced maintenance costs associated with lighting (no. of maintenance events and subcontractor response time and costs of cleaning up)		**Accept**	N/A		Maintenance events + subcontractor response time	Temporal	Current Maintenance data	Bruntwood FM Services +NEW LIGHTING SYSTEMS	< £500	GBartley/ CMorley	Bi-monthly	**Business Benefit**

E + E		**4**	All customers are informed about the demonstration of the responsive lighting system		**Accept**	N/A		Level of Customer awareness	Temporal	Customer Engagement plan	MSP Customers	< £500	GBartley/ CMorley	Bi-monthly	**Citizen Engagement**
E + E		**5**	Lighting System data is used to develop a new application (Open Innovation WP)		**Accept**	N/A		Open Innovation use of Lighting Data in a new application	Internal	engagement with Open Innovation	MSP	< £500	GBartley/ CMorley	Quarterly	**Innovation and Technology**
E + E		**6**	Lighting systems is extended/rolled-out to additional lighting on same Campus		**Accept**	N/A		Additional Lights added by MSP from Initial design and additional sites	Internal	MSP Managers to be surveyed	MSP	< £500	GBartley/ CMorley	DELETED ?	**Wider Impacts**
E + E		**7**	Reduction in light pollution		**Accept**	N/A		MSP assessment of reduction in light pollution	Temporal	Customer Engagement plan	MSP	< £500	GBartley/ CMorley	DELETED ?	**Wider Impacts**
E + E		**8**	Increase in customers who agree they "feel safer" as a result of the responsive lighting system		**Accept**	N/A		Increase in Customers who confirm the new lighting improves the feeling of safety	Temporal	Customer Engagement plan	MSP	< £500	GBartley/ CMorley	DELETED ?	**Wider Impacts**

E + E	**EE7 Smart Parking**	**1**	Parking system responds to user requests to book parking.		**Accept**	N/A		KPI1: SYSTEM OPERATIONAL DATA THAT SHOWS SYSTEM RESPONDING TO CUSTOMERS + Customers are surveyed on before and after on quality of parking offered	Internal	Customer Engagement plan	Sparta System Reports + MSP customers	< £1500	GBartley/ Cmorley	2 x measures	**(Public) Service Improvement**
E + E		**2**	More efficient use of parking spaces across all car parks		**Accept**	N/A		KPI2: Time/Car Parking Space + Annual £/Car parking Space	Internal	Current Revenue / Park reports	MSP Finance	< £500	Helen Schofield	Monthly	**Business Benefit**
E + E		**3**	Parking System data is available on the Pllatform-of-Platforms for potential new application development		**Accept**	N/A		KPI4: Open Innovation use of Parking Data in a new application	Internal	Engagement with Open Innovation	MSP	< £500	GBartley/ CMorley	Quarterly	**Innovation and Technology**
E + E		**4**	Extend Roll-out to additional parking on same Campus (Roll out extended to other sites)		**Accept**	N/A		KPI5: Additional Lights added by MSP from Initial design + Additional MSP sites where the parking will be added	Temporal	N/A	MSP/MSP customers	< £500	GBartley/ CMorley	Bi-monthly	**Wider Impacts**

E + E	**EE8 Smart Bins**	**1**	Clean-up events are triggered by QR data		**Accept**			This KPI shows that the system is operational and responding to user input. The number of events that are triggered will be recorded as evidence.	Internal	N/A	RoT	TBC	Andrew B	Monthly	**(Public) Service Improvement**
E + E		**2**	End users report increased satisfaction with bin service as a result of being able to report the status of their bins		**Accept**			A target can be created once the baseline is established by MCC. A customer survey will then be caried out.	Internal	MCC to provide baseline satisfaction data if available.	MCC/RoT	TBC	Dave Sabet	Monthly	**(Public) Service Improvement**
E + E		**3**	Monitoring information is collected and available for sub-contractors to use to improve their performance		**Accept**			This KPI demonstrates that the technology provides data that Contractors can use to improve their performance. This is a binary YES / NO measure.	Internal	N/A	RoT/MCC	TBC	Andrew B and Dave Sabet	Single measure	**(Public) Service Improvement**

E + E		**4**	Smart Bins technology supports SLA enforcement		**Accept**			This KPI demonstrates that the technology provides data that Manchester City Council can use to monitor contractor performance against Service level agreement (SLA). This is a binary YES / NO measure.	Internal	Current MCC SLA data	MCC	TBC	Dave Sabet	Quarterly	**Business Benefit**
E + E		**5**	Reduction in cost of managing bin estate (clean ups)		**Accept**			Reduction in clean-up costs from over-spills for relevant bins over the course of the demonstration period	Internal	cost at start of trial	MCC	TBC	Dave Sabet	Quarterly	**Business Benefit**
			Reduction in cost of managing bin estate as QR Code Bin Management reduces the number of bin inspections necessary		**Accept**			Reduction in number of bin inspections	Internal	Current Cost of bin inspections	MCC	TBC	Dave Sabet	Quarterly	**Innovation and Technology**

E + E		**6**	The number of interactions between members of the public and the QR code system increases over time		**Accept**			This KPI demonstrates that the technology is continuing to be adopted by members of the public over the course of the demonstration period	Internal	Number of interactions with QR code system	RoT	TBC	Andrew B	Monthly	**Citizen Engagement**
E + E		**8**	Smart Bins innovation improves transaction cost (compared to commercial norms)		**Accept**			Cost of Transaction compared to industry norms	Internal	Telensa cost data of an alternative solution	Telensa	TBC	Dave Sabet	Quarterly	**Innovation and Technology**
E + E		**9**	Extend Roll-out to all bins (Manchester City Council) within 6 months of initial demonstration		**Accept**			Evidence that all bins on the register have been allocated a QR code within 6 months of initial demonstration.	Internal	N/A	MCC	TBC	Andrew B	Monthly	**Wider Impacts**
E + E	**EE9 Air Quality**	**1**	CityVerve provides means to model energy consumption patterns and occupancy in 2 buildings		**Accept**	N/A		KPI2: an energy analytics platform is available to researchers (MMU and UoM) that provides capacity to model	Internal	N/A	MMU	N/A	Use Case Lead	Single measure	**Innovation and Technology**

								consumption patterns and occupancy in 2 buildings (MMU Business School and MSP Bright Building)							
E + E	**Theme level (E+E)**	**1**	Security of supply	N/A	**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Wider Impacts**
E + E	**Theme level (E+E)**	**2**	Cost – reductions and presuming revenues	N/A	**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part									**(Public) Service Improvement**

						of Task 18.4									
E + E	**Theme level (E+E)**	**3**	Environment – CO2 / Air Quality	N/A	**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Wider Impacts**

E + E	**Theme level (E+E)**	**4**	Wellness (air quality / air flow)	N/A	**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Wider Impacts**
E + E	**Theme level (E+E)**	**5**	Customer engagement	N/A	**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Citizen Engagement**

E + E	**Theme level (E+E)**	**6**	Service delivery costs	N/A	**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**(Public) Service Improvement**
CP R	**Local Communities Platform**	**1**	Number of people accessing community platform				Other (specify in Notes Column at end of row)	Records of access to CityVerve community platform	Internal	N/A	Platform	TBC	Andrew Ramsay	Monthly	**Citizen Engagement**
CP R		**2**	Access to CityVerve applications through the community platform				Other (specify in Notes Column at end of row)	Number of applications accessed through community platform	Internal	N/A	Platform	TBC	Andrew Ramsay	Monthly	**Innovation and Technology**

CPR		**3**	Community platform release				Other (specify in Notes Column at end of row)	Community platform accessible in Corridor deployment area	Internal	N/A	Platform	TBC	Andrew Ramsay	Ad Hoc	**(Public) Service Improvement**
CPR		**4**	Live pilots in MAG, BRiGHT BUILDING, Visit Manchester, UoM, MMU and the Oxford Road Corridor					Partner Project Manager to confirm live community platform in each premises	Internal	N/A	Partners Project Managers for each Piot	TBC	Andrew Ramsay to co-ordinate responses from Partner Project Managers	Single measure	**Innovation and Technology**
CPR	**IoT Artworks**	**1**	New commissioning opportunities for FAULT LINES artists (FE)	N/A	**Accept**	N/A		Documentation of commissioning opportunities	Internal	TBC	Future Everything	N/A	Feimatta Conteh	Single measure	**Business Benefit**
CPR		**2**	Interaction with art and cultural exhibits (FE) (MMU)	Interaction with art and cultural exhibits, numbers of attendees, evaluation.	**Modify**	**Clarify elements:** Is it possible to define what an acceptable or ideal level of interactions would		Records of attendees at art / cultural exhibits + records of Plinth Visits (sample taken) + Views on Buzzin App.	Internal	TBC	Future Everything / Sparta Digital	N/A	Feimatta Conteh / Kevin Moss	Ad hoc	**Citizen Engagement**

						be to contextualise this or add a comparator?									
CPR		**3**	Dissemination of art and cultural exhibits (FE) (MMU)	Dissemination and coverage of artworks and wider project	**Modify**	**Clarify elements:** Is it possible to define what an acceptable or ideal level of dissemination would be that contextualises this or adds a comparator?		Documentation of reach of dissemination	Internal	TBC	Future Everything / MMU	N/A	Feimatta Conteh / Jane Anderson	Single measure	**Wider Impacts**
CPR	**Manchester Plinth**	1	Interaction with art and cultural exhibits	Interaction with art and cultural exhibits				Plinth Visits (sample), and views on Buzzin App	Internal		MMU/SPARTA		Jane Anderson	Single measure	**Citizen Engagement**

CPR		**2**	Dissemination of art and cultural exhibits	Dissemination of art and cultural exhibits				Documentation of reach of dissemination	Internal		MMU/SPARTA		Jane Anderson	Single measure	**Citizen Engagement**
CPR		**3**	Digital survey connected with cultural exhibition (SD) (MMU)	Digital survey connected with cultural exhibition (SD) (MMU)		**Clarify elements:**Is the KPI measuring the fact that the capability to conduct a survey is possible or does it relate to the results of the survey? If the latter, please specify what the survey is intended to measure		Responses to survey on cultural exhibit	Internal	TBC	Sparta Digital	TBC	Kevin Moss	Ad hoc	**Citizen Engagement**
CPR	**Local Rewards**	**1**	Gamification in Buzzin' app (SD)	Gamification in Buzzin' app (SD)	**Accept**	N/A		Releases of Buzzin' app available for download	Internal	N/A	Sparta Digital	N/A	Kevin Moss	Single measure	**(Public) Service Improvement**

CPR		**2**	Application developed in Community Wellness use case (C+L)	Application developed in Community Wellness use case (C+L)	**Accept**			BeeActive app available for download	Internal	N/A	Sparta Digital	N/A	Gerben Kijne	Single measure	**Business Benefit**
CPR		**3**	Game & Rewards Architecture built into BeeActive app (C+L)	Game & Rewards Architecture built into BeeActive app (C+L)	**Accept**			Game & Rewards Architecture built into BeeActive app (C+L)	Internal	N/A	Sparta Digital	N/A	Gerben Kijne	Single measure	**Innovation and Technology**
CPR	**Theme level (CPR)**	**1**	Visibility of the project within the corridor area.		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Wider Impacts**

CPR	**Theme level (CPR)**	**2**	Connecting people (platform, gamification, beeactive).		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4								**Citizen Engagement**
CPR	**Theme level (CPR)**	**3**	Dissemination and outreach.		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4								**Citizen Engagement**

CPR	**Theme level (CPR)**	**4**	Community KPIs – citizen measures of success.		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Wider Impacts**
KPI DETAILS					**TECHNICAL REVIEW**			**KPI PARAMETERS**							
Theme	**Use Case / WP**	**KPI #**	**KPI Titles (Documented prior to Q5 PMO meeting)**	**Issues with KPI title, i.e. different versions presented**	**Recommendation of Technical Review**	**Details of action needed**	**Use Case Response (if requires for action)**	**Information to be collected to measure the KPI**	**Baseline**	**Plan for pre-collection**	**Source of information**	**Cost of information (if applicable)**	**Person responsible for collection**	**Freq. measured**	**KPI Type**

HSC	**HSC1 Chronic condition m'ment**	**1**	Acceptability of IOT intervention		**Modify**	**Clarify elements:** 1. This KPI contains two separate measures of acceptability for two different user groups. We suggest this is separated into 2 KPIs and a target is added, e.g.: KPI1: 90% of GPs recruited prescribe inhaler when encountering the related condition KPI2: 90% of patients are		KPI1: No information available	External	TBC	TBC	TBC	TBC	TBC	**Innovation and Technology**

						using the inhalers provided. 2. Please provide parameter information (in the columns to the right)									

HSC		**2**	Improved self-efficacy		**Modify**	**Clarify elements:** 1. Please specify what the intervention is and how you will measure the effect 2. Please provide parameter information (in the columns to the right)		KPI2: No information available	Temporal	TBC	TBC	TBC	TBC	TBC	**Wider Impacts**
HSC		**3**	Improved mobility		**Modify**	**Clarify elements:** 1. Clearer title needed that indicates intervention and measure, e.g. "sensors detect increase in patient mobility levels." 2. Please		KPI3: No information available	Temporal	TBC	TBC	TBC	TBC	TBC	**Wider Impacts**

						provide parameter information (in the columns to the right)									
HSC	**HSC2 Beeactive**	**1**	Measure numbers of people who download BeeActive		**Accept**			KPI1: numbers of people who download the BeeActive app	Temporal	N/A	The app – number of registered users (Clicks & Links)			Monthly	**Citizen Engagement**

HSC		**2**	Measure numbers of people who actively use the BeeActive app		**Accept**			KPI2: numbers of people who actively use the BeeActive app ('active use' is deemed as people who access the app 3 times per week or more. Ambition for 50% of those who donwload the app to become active users)	Temporal	N/A	The app – number of logins? (Clicks & Links)	N/A	Clicks and Links	Monthly	**Citizen Engagement**
HSC		**3**	Demonstrate use of IoT for BeeActive – show that the technology works - which sensors BeeActive collects/uses data from		**Modify**	**Clarify elements:** It is not clear whether this KPI is a measure of mobility or interoperability. E.g. if it is a measure of interoperability the KPI could be re-phrased as	Other (specify in Notes Column at end of row)	KPI3: which IoT technologies/sensors BeeActive collects data from	Internal	N/A	The app - data sensors that BeeActive will pull data from	N/A	Clicks and Links	Monthly	**Innovation and Technology**

						" BeeActive users interact with [target] % of sensors or IoT tech areas."									
HSC		**4**	Measure change in behaviour (step increase) in those using BeeActive (from the baseline)		**Accept**	N/A		Baseline steps data over week 1 of using BeeActive + step count data to show change from baseline	Temporal	Baseline to be taken at start of trial	The app – step count (Clicks & Links)	N/A	Clicks and Links	Monthly	**Wider Impacts**

HSC	**HSC2 eCalendar**	**1**	Number of API and calendar feeds from organisations into PlaceCal (new service which aggregates community activities and is more efficient in that it joins up disparite event information)		**Accept**	N/A		KPI1: The number of calendar feeds (events data from organisations) successfully embedded into the PlaceCal Database and website	Temporal	N/A	PlaceCal database	N/A	Kim Foale	Single measure	**Citizen Engagement**
HSC		**2**	Technology audits with community organisations		**Advise removal of KPI**	**Clarify elements:** This is an input rather than an indicator of performance. Please clarify what the indicator measures / tells us		KPI2: Interviews and questionnaires with community organisations to assess their level of technical competency (baseline) and technical needs (Baseline stats show that 20% of health users do not engage with social care services.)	External	N/A	Interviews with 25 community partners by Stephen Walsh (MCC)	N/A	Stephen Walsh (MCC)	Single measure	**Citizen Engagement**

HSC		**3**	Testing calendar interface and interviews with 15 older users		**Modify**	**Clarify elements:** What does this activity tell us about performance? E.g. Is this is about how useful the older users find it, you could re-phrase it accordingly and add a target for the no. of users that find the calendar very / quite / not useful.		KPI3: Feedback form circulated to 15 users to assess the design and functionality of PlaceCal site and whether they see it is as useful	Internal	N/A	Data from feedback forms	N/A	Kim Foale	Single measure	**Citizen Engagement**

HSC		**4**	PlaceCal Website activity		**Modify**	**Clarify elements:** 1. Is it possible to add a baseline or specify the intended increase over lifetime that it is live?		KPI4: Data analytics from PlaceCal website backend	Temporal	N/A	PlaceCal technical backend data	N/A	Kim Foale	Monthly	**Business Benefit**
HSC		5	Feedback from launch event		**Modify**	**Clarify elements:** What was the objective of launch event? What does the feedback indicate in terms of performance?		TBC		TBC	TBC	TBC	TBC	TBC	**Citizen Engagement**

HSC	**HSC3 N'hood Team Support Smart Homes Project**	**1**	Citizen enabled/able to stay at home with increased support. In some cases avoided hospital or residential home admission. No baseline data available as service does not exit at present		**Accept**			1 - Escalation triggered by a sensor in the home. Community Alarm Team (CAT) responding to dashboard alerts. Range of options to address alert. Data collection: CAT/Dashboard/H&SC Team responding to alert	No baseline	Monitoring data will be used	CAT team will map info, and start data capture from 26th Feb 2018 until end of project	None during CityVerve	Community Alarms Team	Community Alarms Team Weekly	**Public Service**
HSC		**2**	Citizen stayed at home as connected directly to other services including community and or voluntary organisations. Early intervention by introducing sensors/a new phase to assist in preventing/mitigating more complex and costly interventions.		**Accept**			2 - Escalation to a third party community asset triggered by a sensor in the home. Data collection: CAT/Dashboard/Responding team	No baseline	Monitoring data will be used	Responding Team will keep info on responses and mitigating actions	None during CityVerve	Dashboard & Data & IG Task Group	Dashboard - Weekly	**(Public) Service Improvement**

HSC		**3**	Proactive approach connecting to citizens to improve wellbeing, improving engagement, mitigating social isolation and increase service offering.		**Accept**			3 - Community Alarm Team / Southway Housing H&SC teams / GPs/ High Impact Primary Care Data Collection: Cohort Survey at end of project	No baseline	Monitoring data will be used	Dashboard will record information and to whom actions were assigned	None during CityVerve	To discuss with partner services	Responding Team - Weekly	**(Public) Service Improvement**
HSC		**4**	Reducing the cost of managing long term conditions which are impacted by environmental factors (i.e. Fuel Poverty/Social Isolation)		**Accept**			1 - Escalation to a third party community asset triggered by a sensor in the home Data Collection: CAT/Dashboard/H&SC Team responding to alert	No baseline	Monitoring data will be used	CAT team will map information	None during CityVerve	To discuss with partner services	Will be discussed with partner services	**Business Benefit**

HSC		**5**	Offering a technology solution/service to vulnerable citizens to use sensors to reduce the overall cost of delivering/meeting care and support needs to delaying the deterioration of some condition		**Accept**			2 - Community Alarm Team / Southway Housing H&SC teams / GPs/ High Impact Primary Care Data Collection: CAT/Dashboard/Service Team responding to alert	No baseline	Monitoring data will be used	Responding Team will keep information regarding responses and mitigating actions	None during CityVerve	To discuss with partner services	Will be discussed with partner services	**Business Benefit**
HSC		**6**	Smart Home feedback and suggestions for improvement		**Accept**			1 - Cohort survey at the beginning and end of the project survey to include details of citizens' wellbeing pre and post sensor instalment.	No baseline	Data from survey will be compared	CAT team will map information	None during CityVerve	To discuss with partner services	Monthly	**Citizen Engagement**
HSC		**7**	Providing family and carers with option of sensors		**Accept**			Take up volumes	No baseline	Monitoring data will be used	Responding Team will keep information regarding responses and	None curing CityVerve	To discuss with partner services	Monthly	**Citizen Engagement**

											mitigating actions				
HSC		**8**	Other services, e.g. primary care, using technology and information from project to inform social prescribing decisions.Early identification, alignment to the right services, at the right time		**Accept**			Capture the learning from the Smart Homes project and how it informs Early Health	No baseline	Monitoring data and info from other services	CAT team will map information	None curing CityVerve	To discuss with partner services	Monthly	**Innovation and Technology**

HSC		**9**	Early intervention and proactive approach to support citizens to live at home, increasing independence. Improving support from existing agencies and service teams which visit citizens.		**Accept**			Number of escalations triggered by a sensor in the home / Increased number of sensors installed. Data Collection: CAT/Dashboard/Service Team responding to alert	No baseline	Monitoring data and info from other services	Responding Team will keep information regarding responses and mitigating actions	None during CityVerve	To discuss with partner services	Monthly	**Externalities**
HSC		**10**	– Providing a leaflet and consent form for services to use to advise citizens of sensors and benefits of installation.		**Accept**			2 - Number of new requests for sensors	No baseline	Monitoring data will be used	CAT team will map information	None during CityVerve	Responding Team	Monthly	**Externalities**
HSC	**HSC3 N'hood Team Support Smart Logisti**	**1**	Improved service delivery – to 7 days a week extended hours		**Accept**			From MCC Transport spec / requirements (contract agreement)	No baseline	Via ELMS / Lorenzo / subjective analysis	ELMS from 15 02 18 until end of project	n/a	DT / TJ ELMS	Monthly	**(Public) Service Improvement**

HSC	**cs Project**	**2**	Reduction in delays between assessment and equipment delivery measuring time ordered and time delivered		**Accept**			ELMS data and measured against similar period in previous year	No baseline	Via ELMS	Transport Spec / contract & ELMS from 15 02 18 until end of project	n/a	DT / TJ ELMS	Monthly	**Business Benefit**
HSC		**3**	Financial improvements & cost saving (staff time/repeat visits, costs of unplanned ED presentations)		**Accept**			Measured against number of equipment ordered previous year teams in scope, Number of orders via C/V x cost of unplanned ED presentation or admission	No baseline	Staff costs, on costs & NHS tariffs for ED presentation/hospital admission	Staff baseline data & NHS costs, ED & admission NHS costs	n/a	ICS	End of project	**Business Benefit**
HSC		**4**	Number of users supported by new service		**Accept**			Number of patients, types of equipment, percentage prevented admission	No baseline	n/a	ELMS	n/a	ELMS	End of Project	**Citizen Engagement**
HSC		**5**	Quality assurance / feedback / audit with service users		**Accept**			Via user spot audit feedback (SPA Patient feedback form)	No baseline	n/a	Quality assurance audit / feedback from 15 03 18 until end of project	n/a	DT/MFT	Monthly	**Citizen Engagement**

HSC		**6**	Ability to have Immediate access to data for audit purposes		**Accept**			ELMS / EMIS / MiCare	No baseline	ELMS	ELMS & EMIS / MiCare	n/a	ELMS	As required and final end of project report	**Innovation and Technology**
HSC		**7**	Improved technological approach to equipment supply		**Accept**			Number of staff with smart devices to enable in situ ordering, Named staff to show how many are utilising, Use of smart devices	No baseline	n/a	ICS & MCC & CBA ELMS	n/a	Project team & programme board	Duration of life of project	**Externalities**
HSC	**HSC3 N'hood Team Support Smart Video Project**	**1**	Overall reduction in no. of Hospital admissions from nursing homes. (NH)		**Accept**			NWAS Conveyance Data from postcodes which will include residential homes.	NWAS (Conveyance Data)	Baseline data for 2016/17 period from postcodes of NWAS calls, which will include residential homes.	NWAS Conveyance Data	n/a	Phil Brown (via CCG)	End of Project	**(Public) Service Improvement**
HSC		**2**	Reduction in travel time for unplanned visits by GP to Buccleuch Lodge (IMC)		**Accept**			Didsbury Medical Practice to capture whether unplanned visit to Buccleuch Lodge is avoided. This can then be calculated into how much travel time has been saved.	n/a	N/A	GP Data collection pro-forma	n/a	Sarah Sales (Didsbury Medical Practice)	Monthly	**Business Benefit**

HSC		**3**	Reduction in no. of unplanned/ urgent visits from GP to Buccleuch Lodge (IMC)		**Accept**			Didsbury Medical Practice to capture whether unplanned visit to Buccleach Lodge is avoided.	n/a	N/A	GP Data collection pro-forma	n/a	Sarah Sales (Didsbury Medical Practice)	Monthly	**Business Benefit**
HSC		**4**	Patient satisfaction not adversely affected by using video conferencing. (NH & IMC)		**Accept**			Baseline patient satisfaction questionnaire to be completed and this will be compared to patient satisfaction questionnaire post video call.	n/a	Pre commencement patient satisfaction survey (50% of intermediate Care Patients).	Patient Satisfaction question naire	n/a	Fiona Carroll (Intermediate Care) + Nursing Home Leads as applicable.	Pre Project & End of Project	**Citizen Engagement**
HSC		**5**	% of consultations via video conference are without technical difficulties. (NH & IMC)		**Accept**			Didsbury Medical Practice to capture success of video call.	n/a	N/A	GP and Intermediate Care Data Collection Pro-formas	n/a	Sarah Sales & Fiona Carroll + Nursing Home Leads as app.	Monthly	**Innovation and Technology**
HSC		**6**	Increase in staff satisfaction/ confidence in using video conferencing. (NH & IMC)		**Accept**			Staff satisfaction questionnaire to be completed pre and post project.	n/a	Pre commencement staff satisfaction survey to take place. 50% staff to be surveyed	Staff satisfaction question naire	n/a	Sarah Sales & Fiona Carroll + Nursing Home Leads as app.	Pre Project & End of Project	**Innovation and Technology**

HSC		**7**	Overall reduction in calls to NWAS from nursing homes. (NH)		**Accept**			NWAS Call Data from postcodes which will include residential homes.	NWAS (Call Data)	Baseline data for 2016/17 period from postcodes of NWAS calls, which will include residential homes.	NWAS Call Data	n/a	Phil Brown (via CCG)	End of Project	**Externalities**
HSC	**Theme level (HSC)**	**1**	Improve empowerment of patients/citizens in managing their own care		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**(Public) Service Improvement**

HSC	**Theme level (HSC)**	**2**	Better adherence to treatment		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**(Public) Service Improvement**
HSC	**Theme level (HSC)**	**3**	Improve emotional and physical well-being		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Wider Impacts**

HSC	**Theme level (HSC)**	**4**	Engage with LCO/ACO to understand criteria for inclusion in future strategy		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Business Benefit**
HSC	**Theme level (HSC)**	**5**	Promote use cases more widely		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Business Benefit**

HSC	**Theme level (HSC)**	**6**	Promote deployment of IOT solutions across healthcare systems delivering aspects (e.g. FM).		**N/A**	No technical review completed as KPIs will be separately reviewed and revised as part of Task 18.4									**Innovation and Technology**
KPI DETAILS					**TECHNICAL REVIEW**			**KPI PARAMETERS**							
Theme	**T1 "Talkative" bus system**	**KPI #**	**KPI Titles (Documented prior to Q5 PMO meeting)**	**Issues with KPI title, i.e. different versions presented**	**Recommendation of Technical Review**	**Details of action needed**	**Use Case Response (if requires for action)**	**Information to be collected to measure the KPI**	**Baseline**	**Plan for pre-collection**	**Source of information**	**Cost of information (if applicable)**	**Person responsible for collection**	**Freq. measured**	**KPI Type**
T'port		**2**	The Talkative Bus System is established for community use during CityVerve		**Accept**			No. of community organisations that use the bus stop to disseminate information over first six months demonstration (target: at least 2).	Internal	N/A	TBS uploads	None	Andy Beechner	Single measure - 6 months after demonstration started	**(Public) Service Improvement**

T'port		**3**	The Talkative Bus System is linked with CityVerve culture and the public realm and the Open Innovation WP for the development of new applications.		**Accept**			Evidence of cross work package activity and initiatives for new applications taken forward during lifetime of CityVerve.	Intermal	N/A	CityVerve activity	None	Andy Beechner	Single measure	**Innovation and Technology**
T'port	**T2 City Concierge**	**1**	Wayfinding and Navigation App maturity (TRL7: demonstration)		**Accept**	N/A		Wayfinding and Navigation App demonstrates features of Technology Readiness Level 7 (Demo)	Temporal	Yes	Use Case Lead	N/A	Use Case Lead	Single measure	**Innovation and Technology**
T'port		**2**	App uptake and use by 0.5% of attendees at nominated event		**Accept**	N/A		App uptake and use by 0.5% of visitors at Manchester Christmas Markets (total visits = 2 million)	Internal	Yes	Use Case Lead	N/A	Use Case Lead	Single measure	**Citizen Engagement**

T'port		**3**	Commercial viability validated by party external to CityVerve, e.g. confirmed follow on funding.		**Accept**			Expression of interest from external partners for the points of interest functionality.	External	N/A	Use Case Lead and external party	N/A	Use Case Lead	Single measure	**Business Benefit**
T'port	**T3 Road Safety**	**1**	At least 1 insurance company is considering using the technology created during this project		**Accept**			Demonstration that at lease 1 insurance company is considering using the technology demonstrated during CityVerve as part of their insurance policy offer.	Internal	N/A	Use Case Lead	N/A	Use Case Lead	Single measure	**Business Benefit**

T'port		**2**	A potential Gross Written Premium (GWP) of approximately £8,000,000 is powered by Satsafe (based on at least 80% of licensed taxi providers in Manchester being willing to adopt the SatSafe technology and any associated insurance premium and an average insurance premium of £2000/annum/individual before weighting for group policies).		**Accept**			Based on a demonstration that 80% of the 5000 licensed taxi drivers in Manchester would be willing to use the telematics technology and associated insurance policy.	Internal	The Use Case lead has baseline data on the average cost of an insurance policy for taxi drivers and the number of taxi drivers in Manchester.	Use Case Lead	N/A	Use Case Lead	Single measure	**(Public) Service Improvement and Wider Impact (environment and safety)**

T'port	**T4 Sensing Trams**	**1**	Ridership change/ticket income change		**Modify**	**Clarify elements:** 1. Add directionality: increased or decreased? 2. Please clarify in the description of what will actually be measured how this will be attributed to the IoT dimension, e.g. will users be alerted to the approach of a sensing tram to enable them to choose to ride it? 3. Please complete		No information available	TBC	TBC	TBC	TBC	TBC	TBC	**(Public) Service Improvement**

						parameter information (in the columns to the right).									

T'port		**2**	Level of passenger satisfaction		**Modify**	**Clarify elements:** 1. Add directionality: increased or decreased? 2. Please complete parameter information (in the columns to the right).		No information available	TBC	TBC	TBC	TBC	TBC	TBC	**(Public) Service Improvement**
T'port		**3**	Level of passenger wellbeing and safety		**Modify**	**Clarify elements:** 1. Add directionality: increased or decreased? 2. Please complete parameter information (in the columns to the right).		No information available	TBC	TBC	TBC	TBC	TBC	TBC	**(Public) Service Improvement**

T'port		**4**	Level of ticket fraud/payment protection		**Modify**	**Clarify elements:** 1. Add directionality: increased or decreased? 2. Please complete parameter information (in the columns to the right).		No information available	TBC	TBC	TBC	TBC	TBC	TBC	**(Public) Service Improvement**
T'port		**5**	Level of data usage		**Modify**	**Clarify elements:** 1. Add directionality: increased or decreased? 2. Please complete parameter information (in the columns to the right).		No information available	TBC	TBC	TBC	TBC	TBC	TBC	**Innovation and Technology**

T'port		**6**	Speed and experience of network connectivity		**Modify**	**Clarify elements:**1. Add directionality: increased speed as a result of ...2. Please complete parameter information (in the columns to the right).		No information available	TBC	TBC	TBC	TBC	TBC	TBC	**Innovation and Technology**
T'port	**T5 Next-Gen Cycling**	**1**	Cycling usage insight (locations/time) is used by TfGM and/or MCC in decisions regarding cycling infrastructure *(e.g. parking, cycle paths, traffic lights)*		**Accept**	N/A		Processed information is used by TfGM / MCC in future evaluation and planning.	Internal	N/A	TfGM/ MCC	N/A	See.Sense /BT TfGM/BT	Single measure	**(Public) Service Improvement**

T'port		**2**	CityVerve technology enables assessment of road surface quality.		**Accept**	N/A		Road surface assessment is possible using processed data at end of demonstration period	Internal	N/A	MCC / TfGM to validate	N/A	See.Sense /BT TfGM/BT	Single measure	**(Public) Service Improvement**
T'port		**3**	Trialists of CityVerve cycling technology are engaged in CityVerve more broadly *(80% attend the XXX Workshop).*		**Accept**	N/A		Number of trialists that participate in workshop (out of total of 180) (organised by FE)	Internal	N/A	FE attendance data plus engagement data (TBC)	N/A	FE/BT	Single measure	**Citizen Engagement**
T'port		**4**	CityVerve cycling trialists are willing to share data about their cycling habits with the CityVerve ecosystem (90% target)		**Accept**	N/A		Number of trialists that agree to share data with CityVerve Platform (out of 180)	Internal	N/A	Seesense tracker	N/A	See.Sense /BT	Single measure	**Innovation and Technology**

T'port		**5**	CityVerve cycling technology encourages trialists to maintain or increase the level of cycling they undertake over the course of the trial (Health benefits)		**Accept**	N/A		Persistence rate (unique users per day/week/months) for each trialist	Temporal	Baseline = usage at start of trial	Seesense tracker	N/A	See.Sense /BT	Daily/weekly/monthy	**Wider Impacts**
T'port	**T6 Air quality monitoring**	**1**	CityVerve air quality sensor data has been found to produce reliable and consistent data (DEFRA fixed station used as a baseline).		**Accept**	N/A		CityVerve air quality sensor data is within acceptable range of DEFRA station data	External	baseline = 0	Use Case Lead	N/A	Use Case Lead	TBC	**Innovation and Technology**
T'port		**2**	CityVerve air quality sensor data has allowed TfGM to coordinate actions to react to poor air quality.		**Accept**	N/A		Number of actions coordinated as a result of CityVerve air quality data that would not have occurred without this data	External	baseline data = DEFRA equipment	Use Case Lead	N/A	Use Case Lead	TBC	**(Public) Service Improvement**

T'port	***T7 Smart Traffic Monitoring***	***N/A***	**Pre-demonstration. KPIs cannot be deveolped during CityVerve.*	N/A	**N/A**	N/A									
T'port	***Green Travel Planner (not a Use Case - do not include)***	***1***	***KPI:*** *modelling total assessment with student dissertations*		**Modify**	**Clarify elements:** 1. The title of the KPI does not meet the definition of a KPI (what is being measured and what does it demonstrate?). NB. as this is not a Use Case there is no formal requirement for this activity to produce KPIs or for the evaluati									

						on team to monitor them. 2. If proceed with the KPI, please complete KPI parameter information (in the columns to the right).									

T'port		***2***	***KPI2:*** *end user feedback assessment*		**Modify**	**Clarify elements:** 1. The title of the KPI does not meet the definition of a KPI (what is being measured and what does it demonstrate?). NB. as this is not a Use Case there is no formal requirement for this activity to produce KPIs or for the evaluation team to monitor them. 2. If proceed with the KPI,									

						please complete KPI parameter information (in the columns to the right).									

T'port		***3***	***KPI3:*** *Responses to 7 reports and presentations to local, national and international stakeholders*		**Accept**	1. NB. As this is not a Use Case there is no formal requirement for this activity to produce KPIs or for the evaluation team to monitor them. 2. If proceed with the KPI, please complete KPI parameter information (in the columns to the right).								

Annex 2 Evaluation of the IoT in the Smart City – Key Issues

Evaluation of the Use Cases

The objective of this evaluation conducted as WP18.4 (1/2/3) of the CityVerve project has been to measure the impact of Internet of Things (IoT) technologies resulting from trialling and demonstration within a Smart City (SC) context of the Manchester Oxford Road corridor. To achieve this objective, in 18.1 the Study Team were tasked with proposing a set of key performance indicators which have been adopted and agreed with each use case and which define the impacts that each use case has sought to realize.

These KPIs were developed and first published at the end of 2016. In light of the progress of the project use cases, an updated version of the KPIs was issued in April 2018 (Luke Georghiou, John Rigby, Lisa Dale-Clough, & Nikolay Mehandjiev Revised April 2018). This updated version presented some new KPIs, the need for which had arisen from changes to use case aims, the dropping of certain use cases, and the incorporation of some new ones. As the Study Team have noted in their revised version of 18.1, while the focus of evaluative work has remained upon the impacts which use cases have aimed to deliver, a number of other issues have become material to properly understanding how CityVerve use cases have performed and what they tell us about how to implement IoT in a Smart City context. We consider two issues that are relevant to the evaluation of CityVerve and then we discuss the implications for the evaluation we have conducted of the CityVerve use cases (Rigby, Georghiou, & Dale-Clough, 2018 forthcoming).

The Innovation Context

While CityVerve is considered and indeed labelled a demonstrator, much of the technology which has been trialled during the project has not been capable of immediate application and use. Indeed, the project has seen significant changes to use case design through organisational adaptation and in some cases the abandonment or re-specification of the use cases. While the main categories of impact we outlined at the start of the project remain valid for the use cases in this technology, the specific implementations of use cases have led to the possibility of different forms of impact. Key performance indicators that are accurately to state and measure possible benefits of use cases have accordingly been revised during the project, in some cases more than once. Innovation theory emphases that the introduction of and development of new technologies is inherently uncertain, and involves the contributions of users (a practice which lies at the heart of the CityVerve approach) who need to understand how new technologies fit into their ways of working and practice (L. Suchman, 1987, 2007; L. Suchman, Trigg, & Blomberg, 2002). The contributions of users to innovation is now widely regarded as essential and ubiquitous, a phenomenon known as co-creation (Brodie, Hollebeek, Juric, & Ilic, 2011; Gronroos & Voima, 2013; Payne, Storbacka, & Frow, 2008; Ritzer & Jurgenson, 2010), and explored recently in the smart-city context by Paskaleva and Cooper (2018).The use of specific and tacit understandings and personal knowledge are key aspects of technological innovation and knowledge generation (Polanyi, 1958). Technological development programmes, especially of the R&D kind, often see learning on the part of participants, which evaluation theory has begun to term behavioural additionality (Buisseret, Cameron, & Georghiou, 1995).

Technology Demonstration

A number of writers have made observations about demonstration projects and their limitations in terms of impact which can be legitimately claimed for them. An early paper on this subject (Bergen, 1965) identifies the first of these limits, namely, the uncertainty surrounding the exact theory or rationale which applies to demonstrator projects (ontology). Other limitations on the accurate assessment of demonstrators notwithstanding the concreteness of demonstration arise from a) the short term nature of demonstrators; b) the limitations in the scope of the

demonstrator, including the fact that demonstration may be of a single project instance; c) the need for learning and adaptation during the demonstration project which may not be properly captured; d) and the absence usually of control groups. The effect of these various limitations is to made generalization of impact difficult and the assessment of additionality highly problematic for evaluators, programme managers and funding bodies.

In the case of CityVerve however, the whole project itself is considered to be a demonstrator. There are therefore two senses in which demonstration takes place with respect to CityVerve: a) a way of demonstrating individual technologies (as discussed above); and b) of a way of implementing, at a larger scale, one or more IoT technologies in an integrated fashion, and with the help of interconnecting infrastructures, procedures and processes. We have in the previous paragraph discussed the way in which single demonstrations are challenging for evaluation. We believe that a broader system level evaluation of CityVerve is beyond the scope of our evaluation but it is important for this evaluation, which is at the level of the individual use cases, to recognize the context in which the use cases have been developed. Below we consider the implications for evaluation.

Implications for the Evaluation

There are a number of implications for the evaluation of CityVerve that result from the issues discussed above. Firstly, as regards impacts, in some cases impacts will be tentative in that they may not have occurred at all during the lifetime of the project. Under this condition, KPIs that indicate how such impacts might be measured in the specific instance and more widely are valuable outcomes of the project, even if they are not direct measures of impact as such. In other instances, where use cases have been operational, impacts may be concrete and real effects may occur. This represents the ideal. But input or output additionality are challenging to assess in these circumstances. Generalization is also challenging.

Examination of and understanding of the processes involved in use case implementation are of great importance where demonstrator programmes are being studied. Understanding of process (and learning effects, which are termed behavioural additionality where they are thought of as impacts of the project) is important and highly relevant to wide impact and the attempt to generalize either about what supports an individual use case, or what supports a demonstrator programme qua system.

Our evaluation focus for use cases looks at impacts and then at factors that support impact. Each use case evaluation report is in three parts therefore, a case history to provide context and introduction, and then two reports of use case performance, one referring to the demonstration of impact, the other referring to the Enabling Factors.

Annex 3 Glossary

AM	Asset Mapping
BSRIA	Building Services Research and Information Association
BT	British Telecom
C&L	Clicks and Links
CISCO	CISCO
CMFT	Central Manchester Foundation Trust - now Manchester Foundation Trust
DOW	Description of Work – applies to CityVerve Second Level Plan – general statement of aims and responsibilities for partners
FE	FutureEverything
Hypercat	Hypercat is a new public private (open) format for sharing of information / data to facilitate use of Internet of Things (IoT) across device types – sensors and control mechanisms
IoT	Internet of Things – a network, not necessarily using The Internet – of interconnected devices, potentially a
KILTER	Kilter
MCC	Manchester City Council
MFT	Manchester Foundation Trust
MMU	Manchester Metropolitan University
Mobike	Mobike, a bicycle lease company founded by Beijing Mobike Technology Co., Ltd
MSP	Manchester Science Park (Bruntwood)
OS	Ordnance Survey
Platform of Platforms	Secure, integrated data system and catalogue operated by CityVerve, based on Hypercat (see above), bringing together data from existing use cases to serve their specific needs, and also to provide cross use-case and cross-theme opportunities for innovative services development; also supports open innovation activities within CityVerve (WP15) and beyond the project.
PMO	Project Monitoring Officer
RoT	Republic of Things
SG	Smart Gateways
SIEMENS	SIEMENS
SPARTA	SPARTA
Spica	Spica Technologies Ltd
SPICA	SPICA
TfGM	Transport for Greater Manchester
UOM	University of Manchester

Annex 4 Project Factors affecting Success

Successful outcomes of innovation projects rely upon appropriate provision of resources to help realize a project plan. By appropriate resources we mean sufficient, timely and relevant material resources including finance, time, and knowledge (explicit and implicit) for the task in hand.

While innovation projects such as CityVerve are on a smaller scale than those developed within so-called complex product systems (COPS) innovations, they are nevertheless complex and difficult because, as demonstration projects that involve *significant development*, they rely upon teams of actors from more than one organisation who face uncertainties about both their actual objectives and the means by which those objectives are to be met.

Progress within an innovation project involves successfully matching resources with the challenges that exist at different stages, as the project's aims and methods are narrowed down from initial plans to yield a new material reality in the form of a finished and tested innovation.

In this process of narrowing, there are actions which can be seen in retrospect to have helped, and there are also actions and states of affairs which in retrospect have slowed the process or made it impossible to make progress. As projects adapt to changes in objectives and seek to match resources to these new requirements, it may be necessary to move financial resources between types of material input, between tasks and between actors in the project. Where permission is required to move resources around the project, as has been the case in this project, a process known as virement takes place.

Analysis of virement in CityVerve suggests that there has been more than the occasional need to move resources around. This is not a fault necessarily with the design or operation of the project, but it is an indicator of the uncertainty involved in the delivery of the project objectives. During CityVerve there were 46 changes to allocation with 14 virements (which are groups of re-allocations), and around £2million has been subject to reallocation. 18 of the project partners have been subject to virement.

We now consider the causes why individual use cases have been able to proceed or why their progress has been limited. We note firstly however that changes to project objectives and or methods is not necessarily likely to accelerate or slow down a project. It is whether and how the project team adapts to the challenges that it faces which determines project success.

Enablers

- Team working
- Clear collective understanding of project goals and methods
- Advanced planning for contingencies
- Willingness and readiness to adapt to the need for change to objectives or methods
- Communication of new needs between partners
- Specific and relevant technical knowledge present within the organisation or within reach from outside
- Provision in a timely way of sufficient financial resources
- High organisational priorities for the work (organisational motivation)
- Willingness to take risk
- User acceptance

Limitations

- Lack of team working and shared purpose
- Absence of collective understanding of project goals and methods
- Lack of alternatives in plan (for objectives or methods) leading to inflexibility
- Poor communication
- Absence of technical knowledge and know-how

- Loss of key staff
- Low organisational priority
- Failure or delay in components
- Lack of acceptance by users

Annex 5 Technology Readiness Levels

TRL 1 – basic principles observed

TRL 2 – technology concept formulated

TRL 3 – experimental proof of concept

TRL 4 – technology validated in lab

TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)

TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)

TRL 7 – system prototype demonstration in operational environment

TRL 8 – system complete and qualified

TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

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General Annexes

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G. Technology readiness levels (TRL)

Where a topic description refers to a TRL, the following definitions apply, unless otherwise specified:

Annex 6 Data Sources Used in the Preparation of this Report

This report has been prepared by using data from a number of sources.

Interviews have been undertaken with CityVerve use case leads, use case users, and CityVerve participants and their staff who while not directly involved in the delivery of specific use cases were likely to have information about the performance, outcomes and dependent and enabling factors relating to use cases.

A number of documents have been reviewed to provide evidence for this evaluation. These include but are not limited to: the Description of Work, which exists in a number of versions and has been continually updated during the project to reflect changes; and day to day project documents, such as meeting minutes of monthly and weekly meetings. These documents are available on the Box cloud storage provided for the CityVerve project.

The Interview Protocols for use case leads and use case users are given below.

Annex 6.1 Interview Protocol CityVerve WP18.4 and 18.6

INTERVIEW PROTOCOL for Use Case Leads

Expected duration: 45-60 minutes per Use Case
Purpose: to establish the impacts of CityVerve at Use Case level, based on the KPIs and development activity, and to assess opportunities extend CityVerve and areas for future IoT/Smart City innovation.

Please obtain consent to digitally record the interview at the start of the recording.

Section 1: Questions about Use Case Business Model and Narrative

Interview Questions:

General overview

1. How do you feel the Use Case progressed?
2. Was the work done by the end of the project different from what was planned at the start?
3. What were the key resources mobilised during CityVerve?
4. What were the key propositions of the business model of your Use Case?
5. Who were your "customers"? [if not already clear]
6. What channels did you use to reach your customers [if relevant]

Cost Structure
1. Related to the service provided in the conventional way, is the cost of your CityVerve solution higher or lower?
Compared to the service provided before CityVerve, are the sources of costs more diversified or less?

Revenue Streams
1. Is the revenue generated by your solution more or less than the revenue of the service provided in the conventional way?
2. Compared to the service provided before CityVerve, are the sources of revenues more diversified or less?

Ecosystem Dimension:
To what extent do you agree or disagree with the following statements:

1. The business model behind my product/service is dependent on other CityVerve partners.
2. The business model behind my product/service is dependent on the CityVerve technology platform.
3. The business model behind my product/service was formed iteratively in interaction with other CityVerve partners.
4. My company has participated in the creation of the CityVerve ecosystem.

Please tell us more about it and how it affected your business model.

If there are any business scenarios which you decided will not be taken forward as a basis for your business plan, please tell us more about them. What was the business model underlying them?

Disruption Strategies and CityVerve Business Models
To what extent do you agree or disagree with the following statement:

1**.** My business model is operationalising a disruptive strategy such as the creation of new markets/ competences/allocation of resources or creation of new business models.

Please tell us more about this - which disruptive strategy and how your model is operationalising it.

Section 2: Questions about Use Case Impact

Interview questions:

1. What impacts did this use case achieve?
1.1 The impacts recorded as KPIs as the intended outputs and outcomes
1.2 Any other impacts not recorded as KPIs? E.g. relating to the offer to the End User, the benefit to the business/Use Case lead, the innovation or technology being demonstrated, citizen engagement or other social, environmental, or economic benefits.

2. What were the main factors that helped realize these impacts?
2.1 E.g. particular people, resources, meetings or other interactions, technological or other infrastructure or support ….
2.2 Were the KPIs in your view the right way to measure the impacts?

3. Were there any impacts envisaged at the start of CityVerve or in the reference design that the Use Case did not achieve?

If so,

a. What were they? Specify the impact in detail – e.g. whether it relates to the offer to the End User, the benefit to the business/Use Case lead, the innovation or technology being demonstrated, citizen engagement or other social, environmental, or economic benefits.
b. Why were these impacts not realized?
c. Would you consider KPIs to be the right way of measuring this type of impact for this Use Case?

Section 3: Questions about Use Case / CityVerve extension and future innovation.

1. Your legacy form states X replication opportunities have been identified, How likely is it that it will be achieved?
2. What other duplication of your use case is planned?

3. Your legacy form states X scale up opportunities have been identified - How likely is it that it will be achieved?
4. What other scale up activity is planned?

5. Your legacy form states, XX has been adopted by a CityVerve partner, how likely is it that this will be finalised?
6. What other extension activity is planned? How likely is it that it will be achieved?

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