University of Cambridge
Centre for Digital Built Britain

CDBB L2C PROGRAMME

Standards landscape and information management systems

urban innovation labs

WP6: Design of experiment for integrating or indexing diverse or non-schema based information

Executive summary

A use case and user journey led approach has been adopted for the development of the Test Case. It tells the story of a vulnerable member of society, Gwen, a victim of fuel poverty. After years on the waiting list for better standard accommodation, she is finally successful with a new development by the Housing Association. The development director for the Juniper Green scheme is Ken, an experienced hand who has been working on large schemes in the Middle East for many years and is now eager to make a difference.

The test case seeks to develop a demand side regulated solution for the Housing Association. This would mean that Gwen can maintain sufficient heat in her new flat so her health is not impacted, so she feels safe, secure and warm, and she does not feel threatened by the electricity charges. In addition, it would help Ken manage the electricity demand and supply in the Juniper Green development and participate in grid scale DSR (Demand Side Response) to provide lower electricity bills to Housing Association clients, whilst having sufficient sight of the energy used by the clients so interventions are possible before clients succumb to ill health. Finally, this solution provides information to support the building and build system preventative maintenance programme, while feeding back on the asset performance for continuous improvement interventions, thus informing the strategic planning and design for phase 2 of the development.

This test case is designed to verify the work conducted as part of this L2C standard landscape and information management systems, and to understand the practical challenges of integrating such a diverse landscape of information. The information needed for the test case falls across very different disciplines from across the asset lifecycle, with static and dynamic data, and will include both engineering and perceptive information. This also comes with the additional challenge that some of the information sources are not well defined at this juncture.

It is a challenging test that will help establish the ability of existing methods within the built environment for data integration across diverse landscapes. The test case will also enable alternative methods from different sectors to be tested, particularly in the field of computer science, and determine viability as near-term alternatives. These will help inform the roadmap for the data structures under consideration for the forthcoming stages for the CDBB.

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1. Introduction

The disciplines of computer science and data science are developing at a ferocious pace across a diverse number of sectors. There is a hypothesis that the technical challenge that CDBB is seeking to address with the Level 3 and Level 4 programme may be fast tracked, in part with the same methods used by the data giants in search engines or big data analytics. This activity will design an experiment to test the hypothesis for commissioning by CDBB.

2. Methodology

A use case will be selected from the work completed as part of WP2: Standards Landscape and WP3: Information Pathways. A user journey approach will be taken to the experiment design to 'bring it to life' and to demonstrate some of the complexities involved.

3. Use case description

3.1. Actors

Gwen: A 86-year female living on her own since the death of her husband of 60 years, two years ago. She has 2 children who live 20 and 100 miles away, respectively. She has income primarily from her state pension and whatever additional money provided by the state for winter fuel allowance. Gwen has recently been discharged from hospital having contracted pneumonia while in hospital for some minor surgery. She is very independent, will never complain about anything and is chartable often to her own detriment. Her children have tried to get Gwen to move closer to them or even have a 'granny flat' but she refuses, having lived in the area all of her life. After many years of living in a damp, rundown 1960s flat, she is about to move into a new flat in the Juniper Green development provided by the Housing Association.

Ken: A very experienced development director, recently returned from 10 years working on mega projects in the Middle East. While being proud of the work he has done, having spent years working on large projects, he felt a detachment with those who use it day after day. On returning the UK he was shocked by the quality of housing, the conditions in which vulnerable members of society were living and the apparent inability to provide the basic services to people. Ken thought, "If Elon Musk can send a car to Mars, I want to make sure that my next job allows people to have a good quality of life, be comfortable and live well within their means." When looking for a new role in the UK, Ken was impressed by the Housing Association, with their strong social values and ambition to leverage technology for positive impact. He joined the Housing Association as Development Director for the Juniper Green development.

3.2. Use case

The Housing Association had identified that fuel poverty was a major issue for many of their clients. This occurred to such an extent that individuals would often not heat their properties as they needed to in winter. This causes physical health issues, making possible social isolation worse, and compounding their mental health. It also causes the Housing Association challenges as properties often become damp, requiring remedial work. They recognise that solving fuel poverty is a complex issue, but they are motivated to use their development projects as a vehicle to improve the matter where they can.

When Ken joined the Housing Association, he read their Business Plan in detail. This was structured around ISO9001 and he was drawn to the strategic triangle that showed a clear linkage from the vision, through to the mission, with clear outcomes defined and a supporting strategy to achieve the outcome. This is shown in Figure 1. In discussion with his new CEO, she said, “we need the Juniper Green development to be an exemplar for how we leverage technology to eradicate fuel poverty for our clients.”

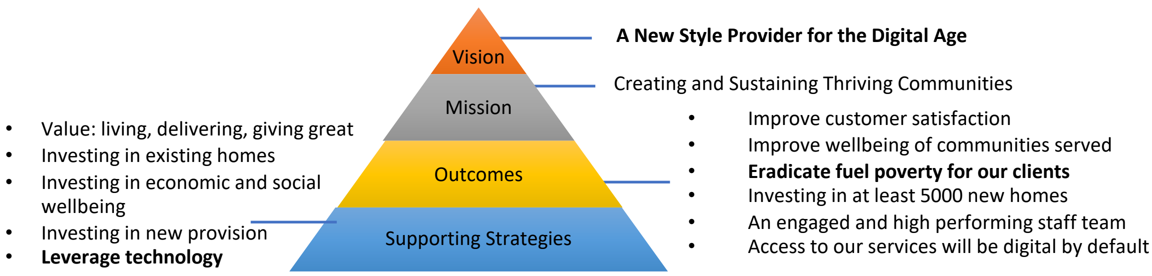

Figure 1 - Strategic Triangle for the Housing Association

Ken was impressed by the bold ambition of the CEO and started to map out how this could be achieved. His was drawn to a piece of work by the Centre for Digital Built Britain that put forward a framework where organisational outcomes could be linked to information about the built environment, from planning through to the socioeconomic impact. This model is shown in Figure 2.

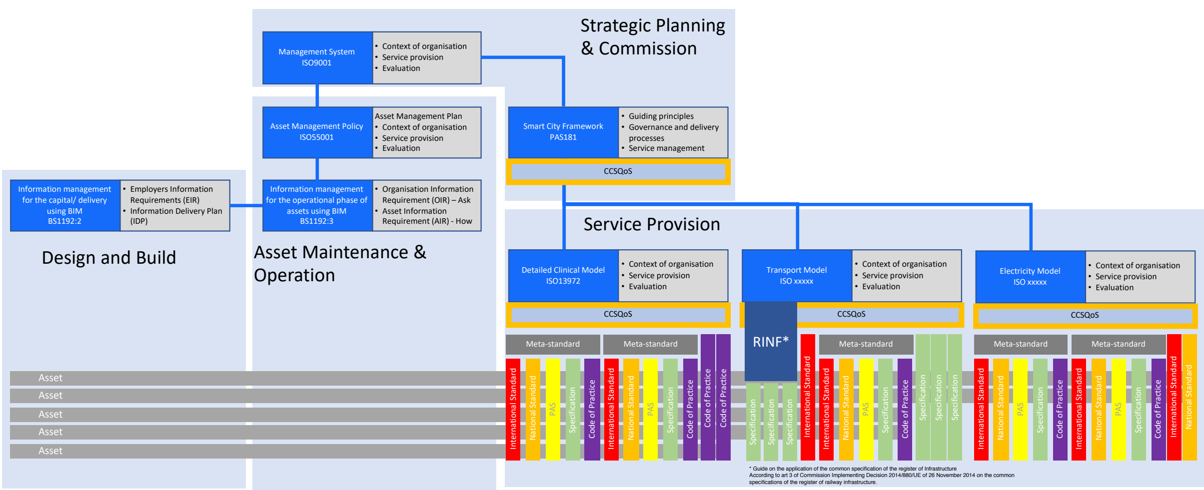

Figure 2 - Overall asset and service outcome lifecycle framework

Ken was aware and an advocate of the concept of smart grids, and of the benefit of manging the demand of electricity. This would give the Housing Association the potential to provide a service where the energy used by their clients could be aggregated and actively managed based on their demands and priorities. It would also give the Housing Association the ability to invest in development scale solar generation and storage that would allow participation in the grid DSR programme. It would also be a change for their clients, as they would have a different relationship with the electricity supplied. He formed a user group that included future residents, including Gwen. Ken explained the concept to the user group, who were broadly supportive of the principles and very much in favour of the reduced energy bills, but nervous about 'big brother' taking control of their appliances and sharing information about their patterns of behaviour. Ken noted all of their concerns and committed to develop an information architecture and security concept that would be mindful of their comments.

Ken was aware that in order to achieve the full benefit of a demand regulated solution for the Juniper Green development, the Housing Association would become a System Operator at a micro level. He would need to create an information architecture that would allow all those involved to have the appropriate information while respecting their privacy. This is shown in Figure 3.

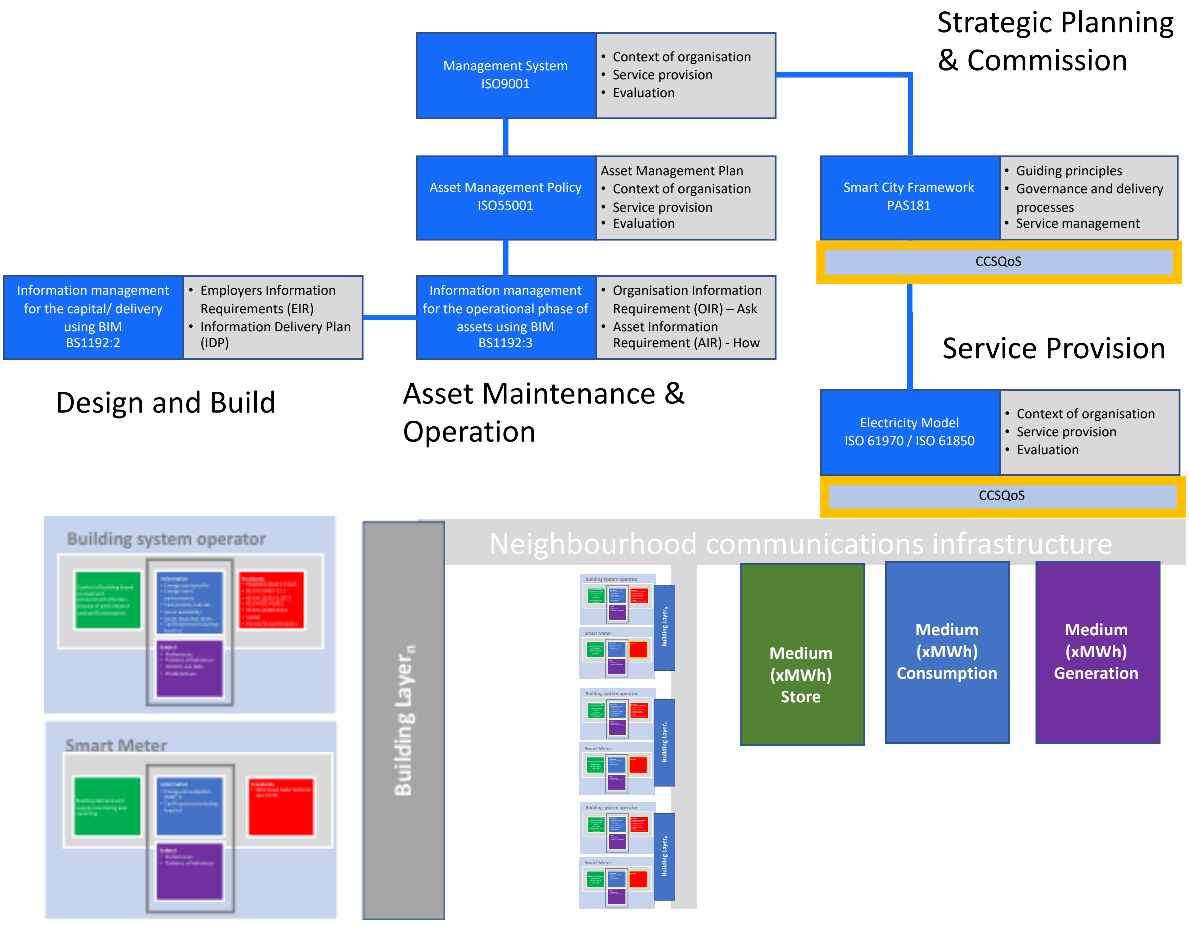

Figure 3 – Schematic lifecycle framework for test case

3.3. Information definition

From this overall architecture, the key layers of information were described detailing purpose, associated standards and storage location. This is shown the following series of tables: Table 1, Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7.

Layer	**Development framework (SCF)**
Aspect	Comments
Standard	• PAS181: for SCF. • PAS 184: Data structure.
Capability	• Ensure that all clients have electricity supplied to achieve their needs at all times. • Analyse patterns of behaviour that would indicate poor health decisions are recognised. • Respond to priority states.
Capacity	• Analyse medium to long term demand profile (MW,t) to drive provision decisions. • Invest in generation and storage (or contract with) suppliers and aggregators. • Model electricity supply mix and potential failure modes. • Provision of energy for the vulnerable.
State	• Client need. • Client feedback . • Amount of load to be shed (MW,t). • Use of aggregated and anonymised commercial, personal, or location data.
Quality of Service	• Maintenance of frequency, voltage, and response time specifications. • Compliance with Balancing and settlement code (BSC). • Compliance with the Grid code. • Customer satisfaction.
Key operational information:	• Health profile. • Affordability indication. • Energy asset profile. • Energy asset performance. • Task priority rule set. • Energy Asset availability. • Energy asset response time. • Tariff options. • Energy consumption (MW, t) predicted. • Energy asset consumption historic. • Energy asset consumption (MW,t) measured. • Environmental conditions. • Connection and Use of System Code data (CUSC). • Network connection status. • Smart meter data (demand regulated data via concentrated AMI). • Demand (unregulated) data via internet, and so on.
Information location	• Project drive in a variety of pdf, word and excel files.

Table 1 - Development framework

Layer	Asset Management plan
Aspect	Comments
Standard	• ISO55001
Key information:	• SAMP • Asset risk and opportunity planning. • Asset Management Plans.
Information location	• Project drive in a variety of pdf, word and excel files.

Table 2 - Asset Management plan

Layer	Maintenance and Operation
Aspect	Comments
Standard	• BS1192:3. :4, :5
Key information	• Operational Information Requirement. • Asset Information Requirement. • O&M manuals. • Maintenance schedules. • Maintenance records. • Asset condition. • Condition reports.
Information location	• Project drive in a variety of pdf, word and excel files. • CDE • AMS • CAFM • BMS

Table 3 - Maintenance and Operation

Layer	Design and Build
Aspect	Comments
Standard	• BS1192:2, :4, :5
Key information	• Employers Information Requirements. • Planning. • Calculations. • Design by discipline. • Bill of material. • Inspection and test reports. • Handover O&M. • Cost plan. • Programme.

Layer	**Design and Build**
Aspect	Comments
Information location	• CDE • ERP • Planning system.

Table 4 – Design and Build

Layer	**Juniper Green system operator**
Aspect	Comments
Standard	• IEC 61970: Common data model. • IEC 61850-7-420: program interfaces for exchange of information with Distributed Energy Resources.
Capability	• Assess aggregated consumption (MW,t) measured data. • Assess aggregated consumption historic data. • Assess current and near future environmental conditions. • Predict consumption (MW,t). • Evaluate load shedding profiles. • Select district load shedding options. • Command network load shedding of industrial plant (where possible). • Command network load shedding of domestic plant (where possible). • Command network storage dispatch (where possible). • Update and communicate dynamic tariffs to alter consumer behaviour. • Access to regulated and unregulated time stamped near real time data. • Respond to priority states.
Capacity	• Analyse medium to long term demand profile (MW,t) to drive provision decisions. • Invest in generation and storage (or contract with) suppliers and aggregators. • Model electricity supply mix and potential failure modes.
State	• Amount of load to be shed (MW,t). • Use of aggregated and anonymised commercial, personal, or location data.
Quality of Service	• Maintenance of frequency, voltage, and response time specifications. • Compliance with Balancing and settlement code (BSC). • Compliance with the Grid code.
Key operational information	• Energy asset profile. • Energy asset performance. • Task priority rule set. • Energy Asset availability. • Energy asset response time. • Tariff options. • Energy consumption (MW, t) predicted. • Energy asset consumption historic. • Energy asset consumption (MW,t) measured. • Environmental conditions.

Layer	Juniper Green system operator
Aspect	Comments
	• Connection and Use of System Code data (CUSC). • Network connection status. • Smart meter data (demand regulated data via concentrated AMI). • Demand (unregulated) data via internet and so on.
Information location	• Housing association own system.

Table 5 – System Operator

Layer	Building
Aspect	Comments
Standard	• IEC 61970: Common data model. • IEC 61850-7-420: program interfaces for exchange of information with Distributed Energy Resources. • BS EN 50491-12-1: building management systems. • BS EN 15232-1:2017: energy performance of buildings. • BS EN 14908:2014: open data in buildings.
Capability	• Provide contracted load shed (xkW,t). • Provide consumption (xkW,t) data. • Provide consumption historic data. • Provide future consumption (xkW,t) schedules. • Provide local environmental conditions. • Respond to load shedding command requests. • Interact with dynamic tariffs and end consumers. • Access to regulated and unregulated time stamped near real time data.
Capacity	• Provide contracted load reduction (xkW,t).
State	• Remaining capacity (amount of load) to be shed (MW,t). • Use of behavioural data.
Quality of Service	• Performance against tariff and contract (xKw,t).
Key operational information:	• Energy asset performance. • Task priority rule set(s). • Asset availability. • Energy asset response times. • Tariff options (including feed in). • Energy consumption (MW, t). • Smart meter data (demand regulated data via concentrated AMI). • Demand (unregulated) data via internet and so on. • User behaviours and user needs (end user and supply chain user included)
Information location	• Housing association own system. • Building management system. • DCC connection.

Table 6 – Building

Layer	**Device**
Aspect	Comments
Standard	• IEC 61970: Common data model. • ZSE • IEE802.11n • ANSI 210 • BS 50494-12-1 • IEC 62457 • IEC 62443 • IEC62351
Capability	• Provide contracted load shed (xkW,t). • Provide consumption (xkW,t) data. • Provide consumption historic data. • Provide future consumption (xkW,t) schedules. • Provide local environmental conditions. • Respond to load shedding command requests. • Interact with dynamic tariffs and end consumers. • Access to regulated and unregulated time stamped near real time data.
Capacity	• Provide contracted load reduction (xkW,t).
State	• Amount of load to be shed (MW,t). • Use of behavioural data.
Quality of Service	• Performance against tariff and contract (xKw,t).
Key operational information:	• Task priority. • Lod profile. • Time profile. • Control profile.
Information location	• Housing association own system. • Building management system. • Individual devices.

Table 7 – Device

4. Test case

This test case is designed to verify the work conducted as part of this L2C standard landscape and information management systems, and to understand the practical challenges of integrating such a diverse landscape of information. The information needed for the test case is across very different disciplines, from across the asset lifecycle, with static and dynamic data and will include both engineering and perceptive information. This comes with the additional challenge that some of the information sources are not well defined at this juncture.

Having defined the user story, use case and information, the test scenario for consideration is:

> How to design and integrate the physical and logical systems defined, to enable:
>
> - Gwen to maintain sufficient heat in her new flat so that her health is not impacted, so she feels safe, secure and warm, and does not feel threatened by the electricity charges.
> - Ken to:
>   - Manage the electricity demand and supply in the Juniper Green development and participate in grid scale DSR (Demand Side Response).
>   - Provide lower electricity bills to Housing Association clients.
>   - Have sufficient sight of the energy used by the clients so interventions are possible before clients succumb to ill health.
>   - Provide information to support the building and build system preventative maintenance programme,
>   - Feedback on the asset performance for continuous improvement interventions and inform the strategic planning and design for phase 2 of the development.

5. Conclusions and Recommendations

A challenging test case has been developed that will help establish the ability of existing methods within the built environment for data integration across diverse landscape. The test case will also enable alternative methods from different sectors to be tested, particularly in the field of computer science, and determine viability as near-term alternatives. These will help inform the roadmap for the data structures under consideration for the forthcoming stages for the CDBB.

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