Liverpool Big Data Collaboration

OVERVIEW

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01

// INTRODUCTION

The application of big data in healthcare and related research offers huge potential for patients, clinicians, healthcare providers, commissioners and researchers alike. But realising this potential is not straight forward. It demands combinations of skills, data sets and resources typically beyond any one organisation and it requires an integrated strategy, methodology and programme to develop, fund and apply the joint capability. The Liverpool Big Data Collaboration (LBDC) has been formed to address these challenges - ensuring the benefit of big data in healthcare can be effectively realised on a region wide basis.

LBDC was established through a broad based strategy development process undertaken during 2013, designed to analyse the opportunities and challenges, and to develop the strategy, methodology and programme to realise the potential. The programme was initiated by Royal Liverpool and Broadgreen University Hospital NHS Trust involving the University of Liverpool, Liverpool John Moores University, Liverpool Health Partners, the North West Coast Academic Health Science Network and Liverpool Clinical Commissioning Group. Through consultation and workshop participation this has also included representation from other local trusts and the scientific community. It has been supported by strategy consultants from Ignetica and big data health informatics input from Aridhia and EMC.

LBDC is a current working title reflecting the initial focus in Liverpool, which is anticipated to be revised as the scope expands to the North West Coast region and potentially beyond.

This document presents an overview of the potential provided by big data. It sets out how LBDC is addressing the opportunity and outlines the strategy being pursued. To learn more please visit our website www.liverpoolBDC.com or get in touch using the details online.

On behalf of the LBDC partners, we hope you will join us on this journey.

The Royal Liverpool and Broadgreen University Hospitals NHS Trust

UNIVERSITY OF LIVERPOOL

LIVERPOOL JOHN MOORES UNIVERSITY

LIVERPOOL HEALTH PARTNERS

NHS Liverpool Clinical Commissioning Group

North West Coast Academic Health Science Network

02

// THE BIG DATA OPPORTUNITY

Big data technologies coupled with advanced data science capability enables previously hidden insights to be identified or inferred from vast, ever-expanding and dynamic datasets sufficiently rapidly to be used in live operational and clinical settings as well as research contexts. Application of these insights can be game changing and it is for these reasons big data has become such big-news across multiple sectors.

In healthcare, big data offers the potential to help address some of the key challenges facing the NHS from operational economic pressures, though the challenges associated with increasing chronic conditions and ultimately the progression towards personalised medicine and a wellness (rather than sickness) model of healthcare.

Big data can, in particular, be used to derive probable patient outcomes based on a comprehensive analysis of the current situation. By readily identifying the causal factors, interventions can be taken to reduce the risks of undesirable outcomes or increase the probability of favourable outcomes. Such capability readily aligns with support for chronic condition management and risk avoidance, but can also be applied to operational situations such as the risks of readmissions or healthcare associated infection (HCAI) for example.

Staggeringly 90% of all data in existence today was created in the last two years, and every two days we create as much data as we as did from the beginning of time until 2003, yet only 0.5% is analysed*. Characterised by its volume, velocity and variety, this data can now be analysed using the latest big data technologies. Critically this enables both structured (eg data generated by traditional database systems) and unstructured data (ie images, scans, letters and more) to be included in analysis and modelling to abstract and infer insight which can be applied in operational, clinical and research applications.

Being positioned at the forefront of the field also presents strategic advantages for collaboration partners in terms of leading edge research, clinical and operational opportunities. Additionally it is anticipated that some capabilities, facilities and models could be applied and delivered on a commercial basis providing an incremental revenue opportunity in the medium to long term.

*Sources:
IDC's Digital Universe Study, sponsored by EMC, Dec 2012, Ignetica's Healthcare & Data Archiving Survey (HDAS), Sponsored by Dell, Dec 2011, and IBM, "What is big data", accessed Dec 2013.


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Economic pressures
Increasing cost of chronic disease management and treatment options, together with the need to drive service improvements and operating efficiencies.
Chronic conditions
Increasing scale of chronic condition (accounts for 70% of all healthcare spending but 30% of the population) demands change to preventative measures to avoid spiraling cost pressures.
Improving outcomes
Constant objective to improve outcomes drives ongoing improvement. Stratified medicine offers the potential to tailor treatments to patient bio/genomic profiles for improved effectiveness and improved outcomes.
Operational demands
Fines, costs and productivity impacts associated with potentially preventable events (PPE) including emergency readmissions, trips slips and falls, HCAI demand new approaches to minimise risks.
Moving to a wellness model
To increase healthy lives and reduce the burden of chronic & episodic acute conditions on the NHS, migration to a wellness model is widely recognised,but highly complex in

03

// THE BIG DATA CHALLENGE

The potential of big data is hugely compelling but there are also considerable challenges involved. These have been fully analysed and the strategy developed to effectively address each aspect:

Data sets; having access to, and interoperability with, core health and related data sets are fundamental requirements. But while the local health economy has all of the necessary data, in some cases to huge depth, the data is frequently held separately by each organisation. Enabling access and creating interoperability with appropriate information governance is a major theme.

Data science; to be able to apply the power of big data technologies we need 'data scientists' to derive insights and build the data models and algorithms for use on an operational basis. However, as a new discipline (combining data analysis, programming, statistics and clinical knowledge), good data scientists are in short supply and agreeing means of developing these skills and applying practical solutions in the near term to avoid this becoming constraining is also a key challenge.

Data infrastructure; alongside the data and the data scientists, we also need the core data infrastructure which provides the ability to manipulate the massive data sets on a very rapid basis. This involves 'massively parallel processing' hardware coupled with advanced data manipulation software such as Hadoop. Although infrastructure can be built on a case by case basis, there can be considerable overall cost saving and operating efficiency by building a shared facility. This would of course require funding and cross collaboration agreement, which is one of the further themes.

Funding: Whether operationally, clinically or for research, the application of big data can generate efficiencies, cost savings and incremental revenue. To realise this potential there is an initial need to fund the programme, the work involved in evaluating and developing potential applications of big data (referred to as use cases) and later most critically to develop the core big data facility (informatics hub). Securing funding is therefore a critical requirement, which requires a progressive approach of initial programme 'pump-priming', demonstrating success, seeking further funding based on the success and so on. Commercialisation offers self funding potential but this too requires expert market analysis, proposition development, service design and ultimately sales/marketing expertise which needs to be addressed within the strategy.

Strategic engagement & communications: Given the challenges outlined, it is of course clear that strategic engagement across the regional health economy will be key to resolving many of the challenges, and ensuring an aligned approach to the application of big data. These strategic conversations also need to extend beyond the region to funding bodies, to research organisations, and to other entities nationally and internationally with whom collaboration could be mutually beneficial. Whilst ultimately involving direct discussion, to build awareness of the collaboration we need to ensure clear effective communications on a local, regional and national basis.

The potential of big data is hugely compelling but there are considerable challenges. The LBDC strategy has been developed to address each aspect through which to optimally realise the full benefit for all stakeholders.

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// THE NEED FOR COLLABORATION

Individual Trusts and Universities in the region could of course seek to apply the potential of big data on an individual basis and indeed projects of this type are already underway. However, to maximise the potential, to simplify realisation and to create a leading edge capability which will place the region as a key player in the healthcare focused big-data revolution, a collaborative approach is essential:

Common data: As outlined above, one of the key challenges is ensuring access to all relevant patient information in the local health economy regardless of the originating organisation. This is a challenge, but a massively greater one if each organisation is separately trying to agree access to other organisations data sets as needed for a particular use case. Instead, on a collaborative basis, this can be agreed, managed and maintained once for the benefit of all of the regional health economy.

Economy of scale: Developing the data scientist expertise and the data infrastructure for each organisation is a major challenge. Through collaboration it is possible to leverage the very significant economies of scale available in big data with greater potential to secure investment and to provide an appealing career route to attract leading data scientists.

Strategic Mass: As a collaboration representing the region incorporating leading Trusts and Universities working to a clear strategy on an operational, clinical and research basis the initiative has the scale and credibility to be of interest on a national and indeed international basis. This will help facilitate strategic engagement, seeking funding for the initiative and ensure it has the scale needed to support an effective communications programme. Each of these factors would be more difficult and proportionately much more costly to achieve on an individual basis.

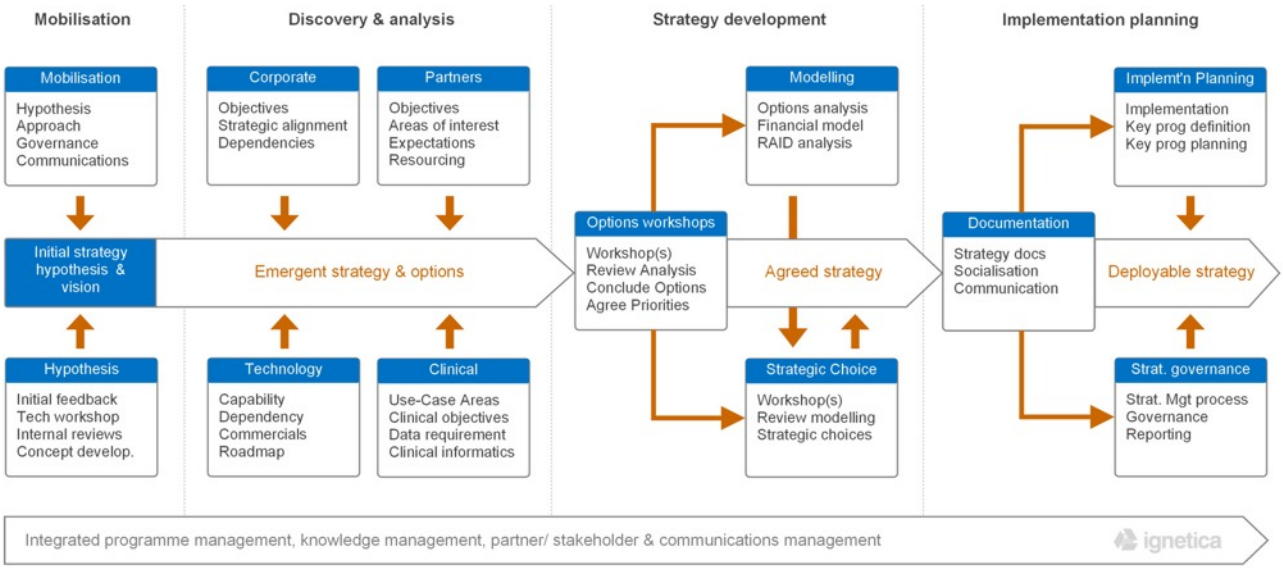
Commercial Opportunity: In the longer term, big data offers the potential to derive incremental revenue from the commercial delivery of service and through commercialisation of analytic models. This relies on the market appeal of the same, and whilst very local service offerings can be interesting, larger scale proven analytic models which are only possible on a regional scale have considerably greater attractiveness.

Developing a collaborative approach will not constrain individual initiatives; on the contrary it will provide the strategy, programme and facilities which can efficiently support each application of big data.

05

// LBDC STRATEGY

Building from the full analysis of the opportunities, challenges and potential collaboration approaches a phased and tiered strategy has been developed, refined and adopted into an implementation programme. The full process (shown below) involved progressive discovery and analysis, through to strategy development with representatives from all collaboration partners and other local health economy stakeholders. Building from the agreed strategy the implementation programme has been developed to derive a finalised and shared strategy as outlined in this document..



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// 5.1 Strategic vision

The collaboration vision is to create a jointly owned big data informatics facility dedicated to realising the full potential of big data for operational, clinical and research purposes - all centred on improving patient outcomes. Whilst focussed on serving the needs of the collaboration parties and the local health economy, the vision also includes serving commercial markets for data set, analytics and in the longer term predictive models with associated incremental revenue potential.

The big data informatics facility (or informatics hub) will include core informatics infrastructure, data safe-haven, and data science capability alongside the operational and commercial management to operate as an effective self sustaining collaborative enterprise.

Realising this vision is not a single step process: Progressive integrated steps and phases will be required and the strategy provides the structure and approach for each.

- In the first instance the programme will be formally approved, funded and mobilised under the authority of the collaboration steering-board and associated programme board governance.

- Under the programme board's supervision, the programme team is then tasked with implementation of the first phase of the strategy. As set out in the following section this involves a series of activities to engage across the region, to address core data/IG issues, establish medium term funding streams whilst developing a portfolio of initial applications of big data (use-cases) to deliver early beneficial results. In part these are anticipated to use interim solutions in advance of the full informatics hub capability being available.

- In parallel and flowing into phase two, work will progress on analysis and planning for the informatics hub and seeking funding for the same. This is a sizeable project involving data infrastructure, data science resourcing, initial data profiling and pilot data projects alongside proposition and business development workstreams.

- Flowing from the success of the first programme phases and in particular finalisation of the informatics hub plans and securing the necessary funding to develop the capability, the programme will move into facility implementation. Beyond this the hub will become an operational business unit and management will move from programme level to operational.

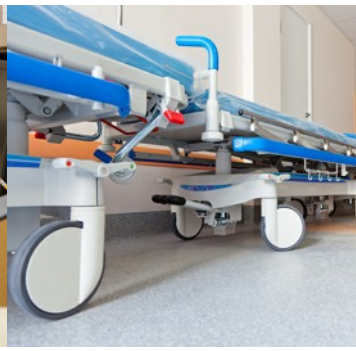
// 5.2 Strategy implementation

Implementation of the strategy will be phased including mobilisation, programme and later informatics hub development and operation as summarised above and including a series of key milestones as defined in the diagram on the following page.

The first step involves mobilising the collaboration with each board formally approving the strategy, finalising the initial programme funding, forming the steering board and commencing the governance process overseeing the programme.

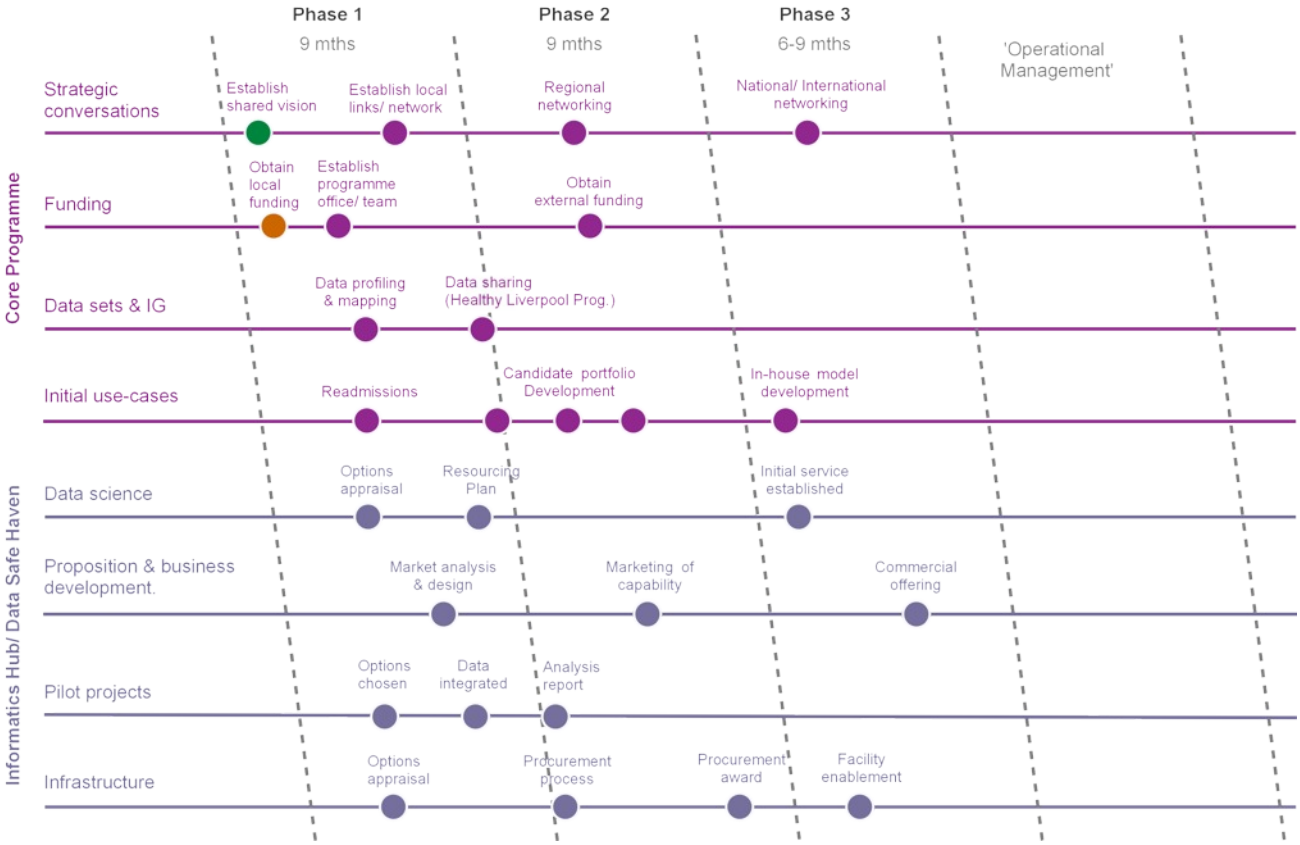
The programme team will address five key strategic themes, the final of which (informatics hub) being sufficiently complex that it is further broken down into subset themes as shown in the diagram and discussed below.





Strategic engagement & communication: At the core of the strategy is the ability to engage and mobilise the support of the local health economy, wider regional networks and international audiences in the programme. This will include linkage to funding discussion, and externally to potential commercial engagements. This series of 'strategic conversations' will be supported by a core communications strategy, resources (including www.liverpoolbdc.com) and by associated public relations activity.

Funding: Seeking funding for development of the informatics hub is a key activity stream of the programme stages. In the first instance the programme team is formed based on confirmation of the initial local programme funding and pump-priming funding to progress six initial use-cases to business case level. Identification of potential funding sources has been undertaken as part of the strategy process, however during the initial programme phase these options need to be fully analysed and applications developed for those which would appear most closely aligned with the collaboration requirements.






Data sets and IG: Ensuring data set information governance and interoperability to be able to access the necessary information sets is a critical requirement of big data. Across the region there are other programmes with similar requirements and potential solutions including for example the 'Healthy Liverpool' programme (HLP). The collaboration will engage with these initiatives wherever possible to ensure an effective, efficient and shared approach can be put in place.

A further aspect will be **mapping & profiling the available data sets**. This is closely linked to the above and is designed to provide a clear data landscape to support considering big data options, future informatics hub arrangements & to evaluate the commercialisation opportunity.

Initial use-cases: Development and implementation of initial use-cases and early stage incubation of a portfolio of candidate use-cases is a key theme of the programme stages.

A big data programme to reduce 30 Day Emergency Readmissions has been analysed to business case level which would use a proven, third party provided analytics model adapted to the local conditions thus bypassing the need for the full data science capability to be in place. Through this approach the collaboration would be able to get a first deployment very rapidly without having to wait until the full informatics hub facility and capability is in place. As such the pressing operational/financial need to reduce emergency readmissions could be addressed with clear patient benefits also being realised. Clearly patient, operational and financial benefit can be identified through the analysis already completed, but there are further programme level benefits which could also accrue. At the simplest level deployment and operation of the solution will provide a learning experience for the collaboration, but the use-case can also present an opportunity for allied research use-cases, for example looking at the impact of alcohol consumption, or medication types on readmission rates. Such spin-off use-cases may present early research wins with which to demonstrate success in support of longer term funding campaigns.

During this phase, a portfolio of up to six candidate use-cases will be developed through to business case level. The process of evaluation, feasibility analysis and business case development will ensure only robust and well planned cases are put forward.

Funding will be required for implementation of initial use-cases once approved at business case level.

Informatics hub analysis and planning:
Planning for the jointly owned Informatics hub incorporating the data safe-haven, data science capability and data infrastructure which will ultimately deliver the big data services is the further key theme of the programme stage. This is a major task, which also closely inter-relates with the funding workstream. Options analysis will be heavily influenced by the availability of funding options and vice versa. The key subset themes include;

- **Data science:** As described, availability of appropriate data science expertise is fundamental to the big data strategy. There are many different ways in which this could be addressed. Combinations of resources within the collaboration, supplemented by training/ development, recruitment, or even procurement "as-a-service" present a full spectrum of options. This workstream is tasked with assessing the potential options and concluding a preferred approach, with this being built into the investment case.

- **Proposition and business development**: Commercialisation of data sets, facilities or (later) analytics models require a full understanding of the market place, competitive analysis and identification of the market positioning, and market potential options for the collaboration. Flowing from this the market proposition and service design can be developed, and marketing commenced. Full sales and marketing plans will need to be developed ready for implementation, and it is likely that both the analysis and future implementation will require external support due to the commercial skills required.

- **Pilot projects**: Closely linked with proposition development will be initial pilot data projects either for internal or external stakeholders designed to test the approach and capability.

- **Infrastructure:** With close parallels to the data science workstream, there are multiple potential options involved in building the data infrastructure. From a completely new facility, through combinations of existing resources to options with external facility provision, multiple options need to be considered. This is a key workstream of the programme and needs to consider all potential options and their implications. It is likely that a series of different options may need to be derived depending on the potential rates of scaling, and the level of funding that can be secured.

- **Investment Case & Implementation Planning**: Flowing from each of the subset themes the full investment case and contingent options need to be derived for the informatics hub, including the legal structure for the joint facility. This will inform the funding stream work, with clear iteration between the available funding options, commercial opportunities and the rates/scale of investment in the facility. As the range of options are narrowed, and the funding secured the implementation plan for the informatics hub will be developed in preparation for deployment once approved and funded.



// 5.3 Business Case

The big data collaboration does not involve a singular business case. Rather there are multiple business cases spanning each use-case, underpinned by the initial investment in the programme and later the investment in the Informatics hub as shown graphically in the diagram on page 16.

Core programme investment

As set out in the Strategy Implementation section the initial investment is to fund the programme team to be able to perform the activities which ensure;

- strategic engagement and communications,
- funding applications,
- data-sets/IG resolution,
- initial use-cases and
- informatics hub analysis and planning

Alongside the core programme team, funding is also required to incubate the initial use-cases to business case level at which stage decisions regarding investment go-ahead can be made subject to the funding principles set out below.

Informatics hub investment

A major workstream for the programme team is evaluation of the informatics hub options alongside investigation of the potential funding routes. The output from this work will be an investment case and implementation plan specifically for the informatics hub. It is anticipated this could require £4-5m over a five year period but could also be considerably less depending on the options taken. Incremental revenue generated through commercialisation will also offset some of the investment costs and this too will be derived as part of the workstream.

Use case investment

A series of funding principles have been agreed during the strategy process which establish that operational use-cases must be able to self fund (from savings, efficiencies or incremental revenue) whilst clinical and research use-cases must be able to attract the specific funding required on their own merit. Having the big data programme in place (and later the informatics hub) will mean the cost per use case will be significantly lower than if tackling each individually.

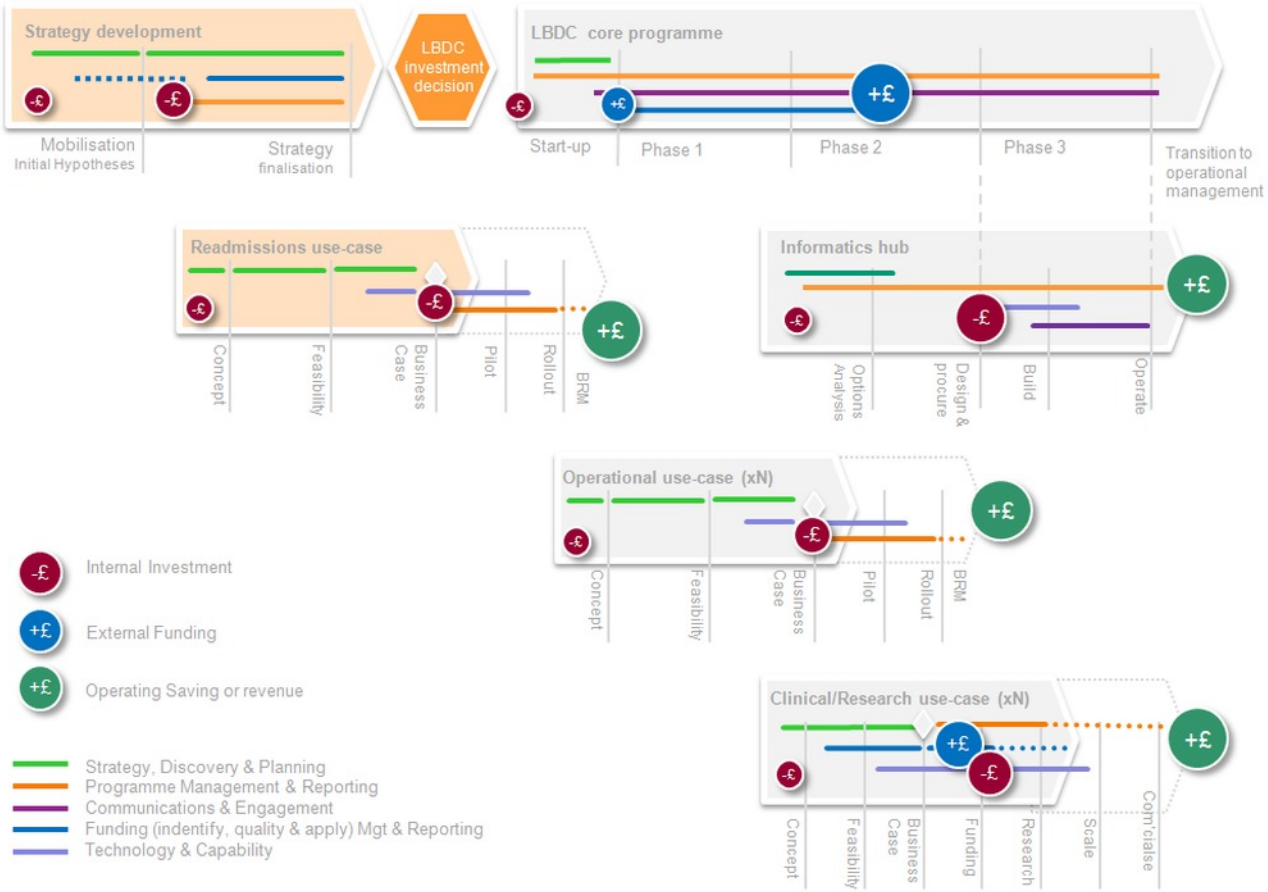
A portfolio of up to six initial use cases will be developed (using the gated methodology defined as part of the strategy) to business case level. Each business case will set out the expected benefits and will need to be able to justify the investment required for implementation in accordance with the funding principles

Beyond the initial 12 month period, funding for development of further use-cases to business case level and for ongoing programme team investment will be required. Once the Informatics Hub is operational it is anticipated the programme will end and responsibility will move to the Informatics hub management team and associated collaboration governance.

// 5.4 Timelines

As shown in the diagram on page 12, a four phase timeline has been developed, involving the initial programme phases, before moving into implementation of the informatics hub and operational management of the facility thereafter.

The implementation timelines will be heavily influenced by the cross project dependencies, in particular the data sets/IG dependencies, the funding applications and the planning conclusions from the informatics hub development work. The final timelines remain sensitive to these dependencies and will be finalised during the mobilisation phase by the programme team. At macro level it is envisaged that phases 1 and 2 having a duration of 9 months each with phase 3 then running for 6-9 months thus realising the full vision within approximately 27 months.

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// APPLYING BIG DATA VIA USE-CASES

The capabilities of big data can be applied in different ways in different situations spanning operations, clinical and research environments. It is through these use-situations or "use-cases", that the benefit of big data can be realised. It is also at this level that the full use-case context can be considered so that the process change involved, the associated investment and anticipated benefit can be defined, enabling the full business case to be considered.

The principle and methodology associated with use-cases is therefore central to the big data strategy.

Fundamentally for big data to be successful, use-cases must be successful. To help ensure this is the case it is essential that effective, transparent and robust development and deployment methodologies are in place. Given this criticality, development of these approaches has been a key workstream during the strategy programme.

The strategy includes definition of the use-case development process from concept, through feasibility, to business case stages and beyond. Between each of these stages, gated approval points ensure only initiatives with sufficient merit progress - thus enabling resources to be directed to those initiatives with greatest merit. A portfolio management process has been developed to ensure full visibility of all candidate use-cases as they progress, ultimately with a single page dashboard view to help ensure full process transparency for all stakeholders.

At the business case stage, use-cases will need to either cost justify (for operational use-cases) or be sufficiently compelling to attract the necessary external funding required (for clinical or research use-cases). Where business cases are approved, further gated stages are involved (pilot, scaled deployment & benefits realisation for operational use-cases and funding, early stage, research, scaling and commercialisation for Clinical use cases) with full portfolio management throughout.

"Use-Cases" are the specific applications of big data which deliver value and for which the investment and anticipated benefit can be defined, managed & realised

Through the development of the use-case methodology and creation of a strategy which is not specific to any one use-case, but is designed to cater for myriad use-cases over time, a framework is in place for effective application of big data with optimum use of the available resources.

6.1 Benefits for collaboration partners

The big-data collaboration (and later informatics hub) offers benefits for each of the stakeholders involved no matter whether their use of big data is operational, clinical, clinical research, pure research or any combination thereof. However an important recognition is that the benefits derived operate on different levels depending on the usage type as shown in the diagram below.

For all groups a common theme is having unified (and appropriately governed) access to the collective clinical and related datasets. Today accessing some of this data (at a point in time) may be possible through negotiation for research purposes but this is extremely laborious and constrained. Through the collaboration and related programmes, access to full, real-time datasets opens up new possibilities across all usage types.

To derive insight and meaning, analysis of "big data" is of course required as shown at the second layer. The big data analytics and associated data science capabilities will address potentially all usage types. However, in the case of pure research, researchers may wish to use the big data analytics capability or they may wish to manipulate the data directly using other approaches.

For operational and clinical use, the analysis needs to be performed on an ongoing 'production' basis so that the necessary insight can be routinely provided to those making decisions. Such capability requires the development of analytic models, algorithms and processes together with user interfaces and related systems development as shown at the third level of the diagram. Whilst critical to operational and clinical use, this capability is unlikely to be required in research projects.

Recognition of these differences and the common areas of benefit lie at the heart of the collaboration. The strategy has therefore been developed to cater for each of these aspects on an equitable basis.

	Type of Use			
Benefit	Operations	Clinical	Clinical research	Pure research
Production Use case	✓	✓	?	?
Analytics	✓	✓	✓	?
Data	✓	✓	✓	✓

07

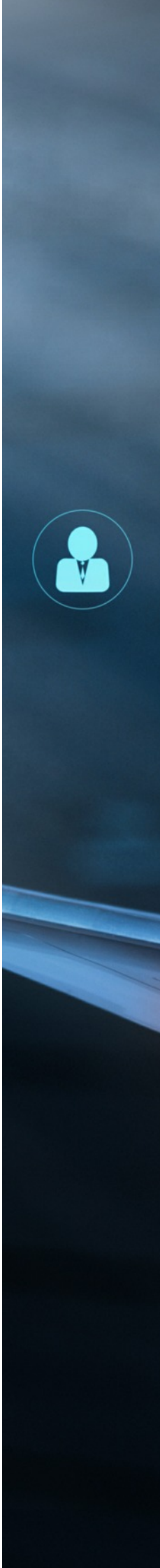
// ENGAGING WITH LBDC

Regional collaboration is essential for the effective application of big data in healthcare. It is also at the heart of the LBDC Strategy.

Initially focused in Liverpool, the scope of the collaboration is now expanding to the wider region and the name will evolve to reflect this change. We hope others will join us on this journey and we would welcome the opportunity to engage with organisations regionally, nationally and internationally on a variety of strategic themes from big data use-cases, through funding and allied initiatives to informatics hub planning and development.

To learn more, to be kept informed of the developments, or to get in touch directly please visit www.liverpoolbdc.com.

We look forward to collaboratively realising the LBDC vision.



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Big data offers huge potential advantage for patients, for the health economy and research community

BIG DATA



// GLOSSARY OF TERMS

Use-cases: The specific applications of big data capability which deliver value and for which the investment and anticipated benefit can be defined, managed and realised.

Candidate use-cases: Potential use cases which are currently being considered at concept, feasibility analysis or business case level (as defined with the portfolio management process). Until the business cases are approved, candidate use cases do not form part of the use case implementation portfolio.

Initial use-cases: A portfolio of use cases approved at business case level to move to implementation as initial applications of big data. For example a use-case to reduce 30 Day Emergency Readmissions has been analysed to business case level and would use a proven 3rd party provided analytics model adapted to the local conditions thus bypassing the need for the full data science capability to be in place.

Analytic models: Algorithms and models which provide the predictive analysis from the data providing actionable information.

Bureau service: A centralised service delivering expertise and/or services back to the collaboration parties.

Chronic conditions: Chronic conditions are those which in most cases cannot be cured, only controlled, and are often life-long and limiting in terms of quality of life eg Diabetes, COPD.

Commercialisation (of big data): Generating incremental revenue from data sets and big data capabilities and models.

Core (collaboration) programme: This involves managing the programme, implementing the strategy on a collaboration wide basis including funding applications, communications, governance, and associated procurement.

Data infrastructure: The technology which provides the ability to rapidly manipulate the big data sets. This involves 'massively parallel processing' hardware coupled with advanced data manipulation software such as Hadoop.

Data science: The term data science is not new but in the context of big data it has emerged as new field of professional expertise. Data scientists derive insights and build data models and algorithms to provide insight on an operational basis. Data science combines expertise in data analysis, programming, statistics and clinical knowledge to provide the depth of insight needed to fully exploit big data in a research, clinical and operational context. Given the growth in demand for such skills based on the rise of big data, good data-scientists are in very short supply.

Data sets: Data sets include the existing e-health information of the local trusts and wider LHE, social data, and progressively bio-marker/genomic data for advanced clinical use-cases. Research data sets provide further richness which can be augmented with bio-marker and genomic data as the collaboration progresses.

Hadoop: Open-source software framework for storage and large scale processing of data-sets.

Informatics hub: The new central facility of the Liverpool big data collaboration, incorporating data infrastructure, data science capability and data safe haven. It will deliver the analytics capability which efficiently supports all of the use-cases and enables commercialisation of data-sets and capabilities. Jointly owned the informatics hub is intended to realising the full potential of big data for operational, clinical and research purposes.

Interoperability: Ensuring the ability to access and work with all relevant patient information in the local health economy regardless of the originating organisation subject to appropriate information governance.



Portfolio management process: A management approach to ensure concepts are robustly tested, approved and managed through an agreed series of stages with a series of gated approval points. The use of a gated portfolio approach ensures only robust concepts are taken forward to business case level. The most deserving projects can then be resourced and progressed with full collaboration visibility, those without sufficient merit being dropped at concept or feasibility stages without consuming further resource.

Predictive analytics: The process of deriving predictive indications of potential future events based on large scale data sets. The predictive insight can then be applied to manage the risk factors involved for improved outcomes.

Pump-priming: The action or activity taken to initiate the collaboration programme by providing the necessary investment/ funding. Specifically in this paper this refers to the pump-priming needed to develop a portfolio of big-data use cases.

Stratified medicine: The process of identifying groups of patients with distinct mechanisms of disease, or particular responses to treatments - this allows identification and development of treatments that are effective for particular groups of patients. Stratified medicine ensures that the right patients gets the right treatment at the right time.

Structured data: Information that typically resides in or is generated by traditional databases which may include demographics, results, histories, transactions and more.

Unstructured data: Information that does not typically reside in a traditional (row-column) database. It is the opposite of structured data and includes for e.g. Imaging (PACS, scans) letters, email, dictation, videos, and social media.

Wellness model: An approach to healthcare in which actions are taken to avoid illness developing, as opposed to a sickness model in which treatment is focused on curing illness that has arisen.

AHSC: Academic Health Science Centre

AHSN: Academic Health Science Network

CLRN: Comprehensive Local Research Network

LBDC: Liverpool Big Data Collaboration www.liverpoolbdc.com

RLBUHT: Royal Liverpool & Broadgreen University Hospitals Trust

ULIV: The University of Liverpool

LJMU: Liverpool John Moores University

LHP: Liverpool Health Partners

CCG: Clinical Commissioning Group.

HLP/Healthy Liverpool Programme: Liverpool CCG led initiative - click here for information

LHE: Local Health Economy.

HCAI: Healthcare Associated Infections.

GTM: Go-to-Market (commercialisation).

PPE: Potentially Preventable Events

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