Construction Blockchain Consortium

THE BARTLETT FACULTY OF THE BUILT ENVIRONMENT,
UNIVERSITY COLLEGE LONDON

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Summary

The construction industry is entering a period of major disruption caused by new technologies such as Blockchain, the Internet of Things (IoT), Virtual Environments (VE), Artificial Intelligence and Machine Learning (AI), and Building Information Modelling (BIM).

The Construction Blockchain Consortium (CBC) is a construction industry knowledge transfer and technology development consortium based at University College London (UCL), a world-leading university. As an open and impartial platform for collaboration, the CBC represents an excellent vehicle for tracking and testing these emerging technologies, developing an industry-wide vision, and prototyping proof-of-concept systems.

This document presents the 'value proposition' of the consortium and sets out its services and subscription policies.

Value Proposition

The Construction Blockchain Consortium operates in the intersection of five emerging technologies: Building Information Modelling (BIM), Virtual Environments (VE), Distributed Ledger Technologies (Blockchain), Artificial Intelligence (AI) and the Internet of Things (IOT). Figure 1 illustrates the *'application space'* or *'key technologies'* investigated by the CBC in relation to the built environment.

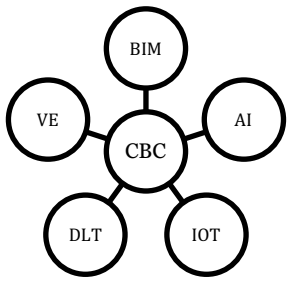

Figure 1: CBC Key Technologies

The benefits of adopting these technologies and their intersection are cultural, behavioural and fiscal. The cultural and behaviour benefits exist to support the industry in digital transformation and to establish trust in its ecosystem. To reap the cultural, behavioural and fiscal benefits, the CBC offers:

- High quality knowledge-sharing seminars and workshops with acknowledged experts in academia and industry – 4 to 6 per annum;
- Briefing of members on emerging technologies and *application space* in relation to the construction sector and the built environment;
- The development of a comprehensive 'DLT and Blockchain vision' for the construction industry revised annually through studies and reports on relevant topics;
- Assessment of commercial tools developed by UCL or other university Partners, with the opportunity to have proof-of-concept projects undertaken by UCL students and academic partners;
- Development of a construction industry open source software library and case study demonstrations.

There are fiscal savings that are generated by adopting these technologies. These benefits include but are not limited to:

- Substantial reductions in legal costs and litigation fees;
- Reduced procurement costs through automated purchasing;
- Other supply chain savings including transaction costs; and
- Improved pricing (and transparency) through automated tendering.

The CBC has a number of specific types of provision bringing unique, high-value opportunities to our members. They are:

- People, e.g. qualified personnel, training;
- Services, e.g. consultancy;

- Products, e.g. technologies developed; and
- Networks, e.g. matching demand with supply.

Additional work on behalf of the consortium is undertaken and funded separately in addition to membership fees and are assessed on a case-by-case basis. Accepted projects constitute the consortium's portfolio of Strategic Partnerships. It is anticipated that consortium members may participate in the creation of shared Intellectual Property (IP).

Offerings

Knowledge Transfer

Companies often do not have the time, skills and resources to monitor technology. The CBC hosts a series of workshops with R&D presentations of company technology and tools, academic research, etc. in the construction ecosystem, to support digital transformation. These presentations by start-ups, academics and key companies, in addition to commissioned reports, constitute a unique capability for network access to knowledge transfer.

Partners and Members have access to public CBC activities covering R&D presentations of company technology and tools, academic research, and others. This brings business advantage by providing access to exclusive and confidential activities in addition to the afore-described public activities. The topics of both the public and exclusive events can be put forward and agreed among the members.

Partners of the CBC have a strategic position to disseminate their firms' activities in this domain amongst others in the sector. This includes those up and downstream in the supply chain, thus gaining a competitive advantage. This is a mutually beneficial knowledge transfer environment, taking account of what other firms across the sector are doing to share experience and best practices.

Reporting & Regulatory Influence

The consortium is developing a comprehensive 'Blockchain Vision' for the construction industry and helping set standards for new technologies and processes. As a collective of experts, we work to make regulations usable in a world of trusted information chains, including regulation, proposals for compliance, approval, inspection and certification. All these aspects are important foci and application domains of Blockchain technology.

The CBC is undertaking and developing a number of studies and reports per year. The topics are agreed among CBC Partners and Members. The CBC's Partners will receive bespoke reports on the application of disruptive technologies in strategic knowledge areas.

Technology Platform

The consortium is developing a framework and deliverables of open source software. Any technology developed by the CBC is available to industry and academia for further development as open source or proprietary technologies. To this end, a number of open source licenses could be used to permit reuse within proprietary software.

The CBC is also developing and operating a construction industry software library and case study demonstrators. The CBC operates as a platform for the assessment of existing and new commercial tools developed by UCL or other academic partners. The CBC is responsible for the development of proof-of-concepts and use cases through its academic partners. In addition, appropriate IP mechanisms for both the CBC and the partners are in place.

The ultimate and overarching goal of the CBC is to develop DLT and Blockchain technologies that can be totally integrated with construction information modelling, including BIM, AR/VR and other exciting technologies that are improving the construction ecosystem.

A smarter research vehicle

In addition to briefing the CBC's Partners on emergent technologies, the CBC is establishing a new way of doing research. This is being achieved by leveraging both academic and industry R&D. Partners are able to share the costs of investigating and testing technological options amongst a pool of interested firms, thus reducing their R&D costs. This would offer a faster, higher quality and more pragmatic utilisation of government investment funds through Research Council grant funding.

This gives the CBC's Partners the opportunity to amend and shape the value proposition by participating in the decision-making of what this research should prioritise. Accordingly, in the long term, this 'smart' research can encourage collaboration and coordination across the industry towards the adoption of disruptive technologies.

Given that the CBC is at the forefront of cutting-edge research in Computer Science (CS) and Information Technology (IT) in the construction industry, partners can have first-hand access to the application and assessment of tools developed by UCL and other university partners, resulting in a win-win situation for both academia and industry.

Benefits for suppliers of technology

Developers of technologies in our *application space* will benefit from the CBC because they will have access to knowledge, domain-related expertise and potentially use cases to develop their

products. Conversely, the CBC could offer a route to commercialisation by providing technology developers with a market ready to test and adopt their products.

Benefits for end users of technology

End users of blockchain and machine learning technologies in the built environment will benefit from access to a pool of technology developers and innovative technological products. The CBC will act as a vessel to match demand with supply and will be the intermediary linking built environment actors to the best technological solutions to advance their competitive advantage.

Workstreams

The CBC works across several relevant and timely themes. Partners, Members and Participants with different expertise have the opportunity to collaborate with each other by working in groups that share common themes. The themes identified below define the different, but interconnected, domains the CBC research agenda covers.

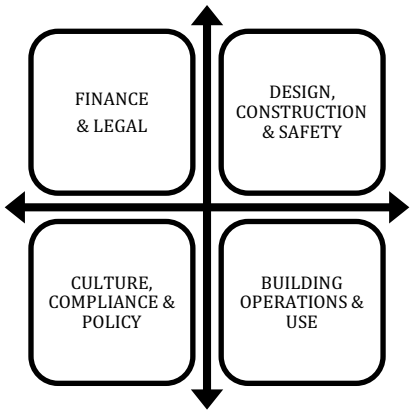

Figure 2: CBC Workstreams

Legal & Financing

Legal Services are entering a period of major disruption caused by new applications of emerging legal technologies. In terms of *LawTech*, we broadly divide uses of technology to facilitate the resolution of disputes between e-commerce parties, typically online suppliers and consumers on Online Dispute Resolutions (ODR). Further application of *LawTech* are:

> **Judicial ODR** - any means of settling 'ordinary' disputes where there is a hearing (using technology) but outside of the courtroom;
>
> ***Corporate ODR*** – the use of technology to manage the resolution of any contractual disputes that may emerge from major multi-partner projects or financial transactions.

Disputes can be categorised as either anticipatory disputes, usually contractual, where the use of ODR in the event of a disagreement is mandatory, and post-hoc disputes, where there is a voluntary decision to litigate after the dispute has arisen. *Algorithmic Dispute Resolution* offers the opportunity to concentrate in anticipatory disputes and ideally, dispute avoidance.

Blockchain technology can be used for case management, discovery and the process of litigation, where automation can be introduced at many stages. Further, the use of blockchain technology to provide trust is an important factor in building agreed repositories of underlying transaction documentation as well as fairness in any automated decision making or negotiated solution.

Blockchain technology has the potential to revolutionise construction financing, given that it carries the underlying principles of cryptocurrencies such as BitCoin. It is widely believed that blockchain technology will soon shape and stand for modern finance. According to Harvard Business Review in 2017: "The Blockchain will do to the Financial system what the internet did to Media".

In the light of that, blockchain will impact construction not only through smart transactions, which follow smart contracts, but also through a massive digital and completely decentralized financial system for construction. As it is distributed, blockchain resists changes and systems failures or attacks. This means we can democratize construction and its financing in a bottom-up rather than top-down approach by supporting peer-to-peer activities of small-scale actors.

The long-term financing of infrastructure and construction is based upon a combination of the projected cash flows of the project, the use of the building and the relative strength of the balance sheets of the developer and contractors. Finance can be by equity investors or syndicates of lending institutions. Security over the assets is often factored into the equation. Techniques often used include special purpose vehicles, limited recourse financing, and securitisation.

Blockchain can be used in fundraising, for example, by crowdfunding through tokenised financing devices, and the governance of the fundraising body, thus encouraging international bodies such as the World Bank to invest in infrastructure projects.

Further use of blockchain can be envisaged in payments, risk management and authentication. This would introduce substantial access to funding for major projects in cities and countries where barriers currently exist. Applications of this technology can dramatically enhance and optimise the delivery of high-quality infrastructure projects universally and, in turn, improve quality of life around the world.

Design & Construction Processes

The construction industry is largely characterised by fragmentation in processes, services and firms. One of its persistent problems is the disconnect between design and construction. This is mainly due to the lack of open and trustworthy information across the supply chain. Blockchain technology has the potential to subvert these effects through the use of open and transparent transactions.

In addition to minimising the interfaces between design and construction, blockchain technology can contribute to improving both in isolation. First, blockchain can facilitate Computer Supported Collaborative Work (CSCW) and Computational Design in general by enabling transparent information flows. Second, blockchain technology can enhance information and change management in BIM systems, both authoring and managing tools.

Therefore, by leveraging smart contracts and creating trusting environments, blockchain technology can improve Supply Chain Management and logistics control.

Operations & Building Services

The Internet of Things (IoT) is changing the way assets and buildings are serviced. Through the use of sensors and connected/smart appliances, buildings could benefit from true life-cycle thinking in the

construction industry. Blockchain technology could facilitate the feasibility, scalability, privacy, and reliability of IoT applications in construction.

With the advent of connected devices pertinent to Building Management Systems (BMS), blockchain could rationalize and regulate information flows to and from building systems reliably and securely.

Culture, Compliance & Policy

The construction industry has become notoriously litigious as projects progressively have larger financial sums at stake. It is also a consequence of being a buyers' market where contractors and subcontractors are forced to price their services more competitively. Blockchain technology has the potential to reverse these current trends by creating an 'Overturned Panoptican Effect' where all parties' behaviour is moderated as they know there is a possibility that their conduct could be scrutinised at a later date.

The detailed and accurate recording of decision making in the design process will disrupt the current relationships between the various parties and the process. This will be achieved by the creation of a more collaborative approach to liability which, in turn, should encourage a less 'defensive' approach to decision making and therefore encourage innovation.

Research into changes in current business practices, such as the use of automation in processes such as materials purchasing and quantity verification, will encourage best practices to develop in areas where current restrictions create market imbalance.

Blockchain technology essentially offers a new view on governance - an 'open sector', according to John Clippinger - that is ready to challenge traditional, top-down leadership paradigms. Whereas many of its traits are held in common with the financial sector, governance and decision theory are the next key application areas. For construction, all record-keeping operations such as permits, transactions and briefs could be digitized through blockchain technology, resulting in immense time and cost benefits.

The applications of blockchain technology in the construction industry have potential implications for privacy and copyright protection. Ethical and professional transformations - in addition to legal ones - are required to leverage blockchain technology. This, in turn, could enhance citizen engagement and transparency in the already increasingly digitised construction industry.

Projects

The CBC investigates transferability of solutions, generic enablers, and use case translations of technology application (from aviation to construction). IP developed for projects will have to be assessed on a case-by-case basis by the CBC's Steering Committee. Where appropriate, IP could be split between academic partners who will have the IP rights for carrying on further research, and industrial partners who will have the IP rights for commercial exploitation.

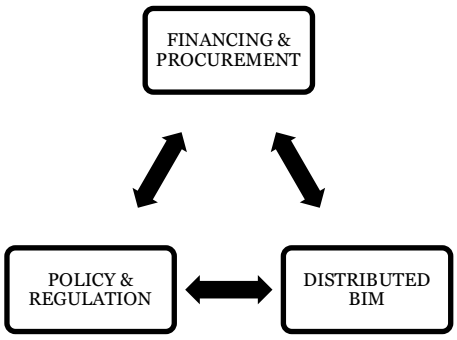

Figure 3: CBC technological offering

Smart Financing & Procurement

Through the CBC's Hackathons we are accelerating open source DLT & Blockchain solutions for the AEC Industry. The collaborative effort is open to many technologies and aims to grow the CBC open-source toolkit for construction contracts. We bring together leading technologists, industry experts, and academic practitioners to investigate the potential disruption and practical application of emerging technologies and actively develop new digital tools for the built environment.

The CBC Contracts Toolkit is being used as an Agile method to specify, develop and test interoperable generic modules (code blocks) for the assemblage of blockchain based construction procurement and automated financial processes. It looks into a set of common 'Legal Objects' and 'Finacial Workflows' that can be used as components of more elaborate procurements and their many variations.

These generic enabling modules are being written in three widely accepted blockchain ecosystems: R3 Corda, Ethereum Solidity, and Hyperledger Fabric and SawTooth. All source code is available on the CBC GitHub repository (https://github.com/constructionblockchain).

The CBC's Academic Leadership is collaborating closely with the community of developers of a number of mainstream blockchain platforms. We are an academic member of the Linux Foundation Hyperledger Initiative and R3 Corda contributors.

Policy & Regulations

The policy, compliance and regulation project are developing industry standards and regulatory framework in collaboration with our industry partners. Areas of interest are IP protection, Automated

Payments and Automated Dispute Resolution. The CBC is a think tank in the field of digital technologies in construction and is working to publish white papers and scientific studies.

Distributed BIM & Smart Supply Chains

The CBC has started to investigate what DLT means for BIM and IOT. We are converging technologies to forge a 'responsibility' chain for the manufacturing and construction sectors. We are exploring how BIM capabilities can be expanded by integrating and inter-operating BIM and Blockchain/DLT technologies.

Participation

The CBC's partnerships with the built environment sectors are organised into three categories: Strategic, Academic and Industrial. Modes of involvement with the CBC are outlined below.

General participation: General members of the public will have ad-hoc collaborations with CBC members and participation in CBC activities.

Members: Members will have access to all events and expert knowledge and advice. In some cases, members may also have some access to project specific funding via UCL.

Partners: Partners will have access to all events, expert knowledge and advice, new technologies and project specific funding via UCL. They will also have influence on the CBC's decision-making processes and will have outreach in built environment sectors.

Benefits	***General***	***Member***	***Strategic Partner***
Access to events	Pay as you go	Free	Free
Access to consultancy of CBC experts	No	Limited	Yes
Access to project-specific funding	No	No	Yes
Development of new IP	No	No	Yes

Table 1: Participation benefits

All those that join will agree to support the projects produced by the CBC through providing use cases, testing software and collaborating with the project leaders. They will also assist in helping to build resilient systems based on the technologies developed by the consortium.

For more information about memberships and partnerships please visit:

- **www.constructionblockchain.org/membership**
- **www.constructionblockchain.org/partnership**

Strategic Partners

ARCADIS ARUP CSTB le futur en construction Foster + Partners IBM

mace SIEMENS SKANSKA Zaha Hadid Architects

Members

Participants