INTEGRATING WHOLE LIFE COST INTO THE EVALUATION OF DESIGN-BUILD IN KOREA

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The Korean construction industry is one of Korea's most important industries accounting for around 10% of the GDP of Korea. Korea has faced a rapidly changing environment in its globalisation and internationalisation processes since the market opened up in 1995. Public clients have increasingly become concerned with the cost of capital construction projects. They have been seeking better value for money with more attention being paid to the whole life cost of projects. The use of design-build (D-B) is on the increase with clients perceiving it as providing better value for money. Procurement based on 'Value for Money' and 'Best Value' is high on the Korean government's agenda in order to achieve the delivery of cost-effective projects, ensure competitiveness, and keep up with high quality of projects. However, what is lacking is an appraisal system that can evaluate bids based upon their whole life. In order to meet public clients' multiple needs, whole life cost (WLC) is one of major challenges for D-B in the public sector as a systematic and holistic approach. The research findings are valuable to a public sector client in Korea who is seeking better value for money, encouraging fairness and transparency and expanding competition based on long-term cost ownership. The contribution of this research lies in the proposed WLC process map for D-B and its identified WLC evaluation stages on this map.

Keywords: design-build, process map, South Korea, whole life cost.

INTRODUCTION

The Republic of Korea (hereinafter referred to as 'Korea'), with an estimated population of 48.5 million on a land area of 100,032 sq km, is situated on the Korean Peninsula. The economy of Korea has performed exceptionally well over three decades from the mid-1960s to the mid-1990s, recording an annual growth rate of about 9 per cent. The Korean construction industry is one of Korea's most important industries accounting for around 10% of GDP. Korean construction companies have been successful in overseas market, particularly in the energy sector. They are delivering high technology projects, using the engineering, procurement, construction (EPC) approach. Korea has faced a rapidly changing environment in its globalisation and internationalisation processes since the market opened up when it joined the World Trade Organisation (WTO) in 1995. Public clients have increasingly become concerned with the cost of capital for construction projects. Clients have been seeking better value for money with more attention being paid to the whole life cost of projects. They want lower construction costs with design taking account of the operating and maintenance costs. These are accelerating 'systematic' changes in this industry. Korea has increasingly adopted design-build for public construction projects and it has gained increased market share in the last few years. However, since 2001, the regulations have mandated design-builder selection on a low price basis. Awarding

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a construction contract based only on the lowest price can result in problems such as cost overruns, delays and poor performance (Mahdi *et al.* 2002). There is much greater awareness of the need to change a system based on 'Value for Money' and 'Best Value' is high on the Korean government's agenda (Lee and Lee 2006). However, what has been lacking is an appraisal system that can evaluate bids based on their whole life. This research aims to investigate the status of D-B in Korea by sector as an exploratory research, and presents the challenges of whole life cost for D-B in Korea by reviewing the fundamentals of WLC and the relevant standards and guidelines.

THE UNDERSTANDING OF WHOLE LIFE COST (WLC)

The concept of whole life costing is not new. WLC has been used as a tool since the 1960s (Bartlett *et al.* 2001). It has recently become best practice in construction procurement (Sorrell 2003). However, its management is new and the industry has been looking at adopting a framework that allows organisations to consider service life, WLC and building component performance data during procurement and throughout the building's life (Al-Hajj and Aouad 1999; Hunter *et al.* 2006).

Whole life cost defined

Words like 'full', 'total', 'true', 'through-life', 'whole' and 'life cycle' indicate that there has been an effort to develop traditional accounting approaches for use. There are different terms used in the literature today like, "costs-in-use", "life cycle costs", "whole life costing" and "whole life appraisal". Flanagan and Jewell (2005) identify that the terminology has changed over the years from "cost in use" to "life cycle costing" to "whole life costing". Whole life cost can be defined as: 'The total acquisition and ownership costs of an asset over its whole life including physical / economic / functional / service / design life (see Table 1) and whole life costing is an economic assessment considering all agreed projected significant and relevant cost flows over a period of analysis expressed in monetary value (BS ISO 15686-5 2008).

Fundamental components of WLC

Time value for money
According to BS ISO 15686-5 (2008), the costs can be presented as a discounted cash flow and a cash flow (at the base date prices), which is not discounted. Nevertheless, money today is not the same as money tomorrow. It is based on the principle that, generally, people prefer to receive goods and services now rather than later (HM Treasury 2003). This is referred to as the time value of money and its computation is based on present value and discounting techniques, which are very important when comparing alternatives that have significantly different cash flow characteristics.

Service life planning
Service life planning is an integral part of WLC. Knowledge about durability and service life of single components and whole buildings is important. In theory, many components used in buildings are capable of lasting for a very long time. However, in practice, the life expectancy of components is frequently much shorter for a variety of reasons, such as defective goods, unexpected failure, lack of maintenance, excessive use, abuse, etc. It involves consideration of the likely performance of a facility over the whole life or the chosen time horizon under the applicable environments.

Cost category for WLC
All significant costs attributable to a facility are normally considered in whole life costing. These include all construction, construction-related, and procurement costs at

the beginning and end of the analysis period (Kirk and Dell'Isola 1995). Table 1 shows the different categories for WLC developed by researchers. BS ISO 15686-5 recommends that it is not necessary for every detailed item in each category included to be considered and some additional costs can be required for a certain project. Overall, the generic costs for WLC analysis are categorised in six ways: (1) Initial project costs (or acquisition costs); (2) Operation costs; (3) Maintenance costs; (4) End-of-life costs; (5) Income; and (6) Externalities.

Table 1: Category of costs for WLC

Category	BS ISO 15686-5 (2008)	Flanagan, Jewell, et at. (2005)	Kishk, Al-Hajj, *et al.* (2003)	Task Group (2003)	Kirk and Dell'Isola (1995)
Initial project costs	✓	✓	✓	✓	✓
Operation costs	✓	✓	✓	✓	✓
Occupancy costs		✓			
Maintenance costs	✓	✓	✓	✓	✓
Alteration/replacement costs	✓	✓	✓	✓	✓
Terminal costs	✓	✓	✓	✓	✓
Associated costs (staffing, etc)	✓		✓		✓
Income and Externalities	✓				

Relevant standards and guidelines

Around the world many systems and methodologies have been developed to handle WLC estimates and forecasts. Whilst they provide a system, they are silent upon how the data should be organised to populate and use the system.

Task Group 4: Life Cycle Costs in Construction (European Union)
The Task Group (TG4) "Whole Life Cost" was set up in the framework of the Working Group "Sustainable Construction" in September 2001 (Task Group 4 2003). TG4, composed of representatives of different European sectoral federations, some Member States and Commission DGs (Directorate-General of the Commission), developed the following terms of reference: "Draw up recommendations and guidelines on WLC of construction aimed at improving the sustainability of the built environment" They present the details of the Economically Most Advantageous Tender system with a matrix to assess the quality of the supply chain management, LCC tools in Finland, Netherlands and Norway, and life cycle assessment issues.

The Green Book - HM Treasury (UK)
"The Green Book Appraisal and Evaluation in Central Government", launched by HM Treasury (2003), has been operational since 2003. Although the term 'whole life cost' is not specifically written in the Green Book, it provides an overall methodology for economic assessment as a reference for WLC in the UK. This book presents the key stages of appraisal and evaluation, which are formalised in the acronym ROAMEF (Rational, Objectives, Appraisal, Monitoring, Evaluation and Feedback). The Green Book covers all new policies, programmes and projects (revenue, capital or regulatory) with the underlying practical guidelines.

AE 07: Whole-life costing and cost management (UK, OGC)
This guide published by the UK Office Of Government Commerce (OGC) in 2003, provides a guidelines for cost management by focusing on WLC. This outlines the

principles of WLC management and describes a process made up of (1) A framework for cost management; (2) Establishing baseline costs; (3) Estimating WLC; and (4) Cost management and reporting. It suggests that the investment decision maker, the senior responsible owner and the integrated team should be involved in WLC and cost management. It refers to the Green Book for advice on comparing options based on net present value, sensitivity and economic appraisal, and BS ISO 15686 for WLC.

BS ISO 15686 1 to 5: Building and constructed assets. Service life planning.
The International Organisation for Standardisation is a worldwide federation of national bodies. It consists of five parts: (1) Part 1: General principles; (2) Part 2: Service life prediction procedures; (3) Part 3: Performance audits and reviews; (4) Part 4: Data requirements; and (5) Part 5: Life cycle costing. Part 1 provides the general issues and data needed to forecast service lives, and gives a method of estimating the service life of components or assemblies for use in the specific projects. In 2008, the Part 5 was published to cover the basic principles and processes of life cycle costing, as well as defining terms and indicating how costing should be used in planning the long term performance and sustainability of buildings and other constructed assets. Part 5, in particular, sets out whole life costing and life cycle costing as two different approaches to life costing. WLC includes non-construction costs and benefits, such as income, land, and externalities, while LCC measures only the costs of construction, maintenance, operation, occupancy, and demolition. Compared to the report by TG4, Part 5 elaborates on LCC principles at the different levels of LCC analysis (strategic, system level and detailed level), which can occur at the different stages by the TG4.

The UK Supplement to BS ISO 15686-5: SMLCC
The Standardised Method of Life Cycle Costing for Construction Procurement is accompanied by BS ISO 15686 Part 5 as the UK supplement. The SMLCC sets out to provide (1) A UK standard cost data structure for life cycle costing, which aligns with BS ISO 15686-5 and with the BCIS Standard Form of Capital Cost Analysis and industry recognised occupancy cost codes; (2) A standard method of applying life cycle costing applicable to the key stages of procurement; (3) A process map of the life cycle costing stages to define what should be done at each stage of the design process; (4) Instructions on defining the client's specific requirements; (5) Practical guidance, instructions, definitions and worked examples; and (6) An industry accepted methodology to facilitate a more consistent application of life cycle costing.

DESIGN-BUILD IN KOREA

The use of D-B is on the increase with clients perceiving it as providing better value for money. However, the profitability of D-B has decreased as the lowest bid awarding system has expanded (MLTM 2003). Value and performance improvement are key objectives, rather than just competition on price to achieve better value for D-B (Bartlett *et al.* 2001). This research investigated the status, process and clients of D-B to integrate WLC into D-B in Korea.

Historical Background

In 1975, the Korean government legislated to use a D-B contract: 'Special ordinance of the Public Account Law related to Mega Construction Procurement'. The Samil petrochemical port project was tendered as the first design-build procurement project in 1977 (MLTM 2003). According to the 'Act on Contracts to Which the State is a Party', the term 'Turnkey' equates to 'D-B' or 'Design-Construct'. The growth of D-B increased rapidly since the mid-2000s, rising to 40.3% in 2005 and 40.5% in 2006

(Lee *et al.* 2006), because the Korean government policy and strategy have been continuously oriented towards the activation of D-B in the public sector.

Project delivery systems in the public sector

In order to provide various public procurement delivery methods in Korea, the project delivery system was reorganised by revising enforcement ordinances of 'Act on Contracts to Which the State is a Party' in October 2007.These systems were modified with its size and awarding systems (see Figure 1).

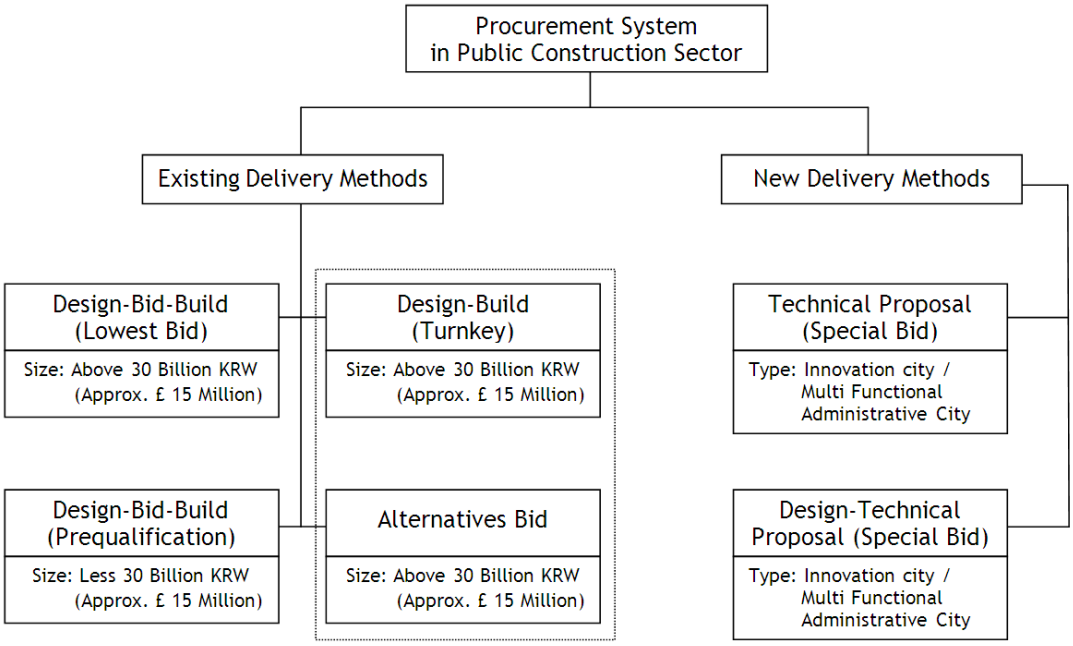

Figure 1 Project Delivery Systems in the Public Sector, Korea (KRW= Korean Won).

Design-Build process including bid evaluation and awarding system

The project delivery system in Korea has been strongly influenced and changed by government policy, rather than through following the private sector (Seo 2003). The D-B process consists of initiation, planning, delivery method investigation, request for proposal, pre-qualification, bid evaluation and contract award. This "Act on Contracts to Which the State is a Party" has been revised in October 2007 to increase fairness and transparency of evaluation. Since 1977, the bid evaluation system have been developed and modified seven times in order to adopt D-B appropriately (MLTM 2003). Before the scheme design evaluation, potential bidders are qualified by pre-qualification evaluation such as performance records; technology; management; and creditability. Once the scheme design documents are submitted, a contract officer requests the central construction technology or design advisory committee to evaluate them. After scrutinising these, six bidders are short-listed and interviewed following evaluation of their scheme design documents based on criteria such as planning ability; constructability; safety; maintenance; economy; and environment. The selected bidder then has to submit the detailed design which is reviewed by a committee. The process takes sixty days from submission until the detailed design is successfully passed by the committee.

CLIENTS OF D-B IN KOREA

Clients are at the core of the project process and their multiple needs are determinants in the success of a construction project. Latham (1994) pointed out that the role of

Government as a client is crucial and the public sector should deliberately set out to obtain better value for money over the long term. The Korean government used to act as a monolithic client with the contractor being selected on the basis of price alone. The successful bid must be responsive to client's multiple needs and it is important for design-builders to have the capability to interpret them.

Classification of construction client in Korea

The Korea National Statistical Office (KNSO) separates clients into four groups by source of funding, the public and private sectors, foreign organisation, and private capital inducement project. Similarly, the Construction Association Korea (CAK) categorises clients into seven types based on funding source: (1) central government; (2) local government; (3) educational authorities; (4) public corporation; (5) private capital inducement corporation; (6) private sector; (7) others. The private sector is subdivided by type of business, the same as the KNSO.

Who are the clients of D-B projects in Korea?

Table 2: The number of Design-Build projects by client in Korea

Year	Central Government	Local Government	Public corporation	others	Total
2003	8	26	44	10	88
2004	10	32	22	4	68
2005	10	48	30	3	91
2006	11	54	55	9	129
Total	39(10.4%)	163(43.4%)	152(40.4%)	27(7.2%)	376

Table 3: The number of Design-Build projects by business sector in Korea

Year	Built Environment	Civil Engineering	Plant Environments	Total
2003	34	38	16	88
2004	31	19	18	68
2005	47	28	16	91
2006	60	40	29	129
Total	127(45.7%)	125(33.2%)	79(21.0%)	376

The Korean construction industry is governed by laws and regulations in a different way to the European construction industry, which is market-driven. For example, the basis of project delivery methods is formed and driven by the public sector client rather than the private sector (Seo 2003). All clients of D-B are public sector clients. According to database of the Ministry of Land, Transport, and Maritime Affairs (2007), there were 376 D-B projects, 26.5% of the total 1,418 public mega projects from 2003 to 2006. The contract amount of D-B was 10.5 trillion KRW (£5.3 billion), 38.8% of the total contract amount of 27 trillion KRW (£13.5 billion). The number of D-B by sector has risen. In particular, the number of D-B by local government and public corporations such as the National Housing Corporation has increased, although the number of D-B by central government has not changed (see Tables 2 and 3).

CHALLENGES OF WLC FOR D-B IN KOREA

Paradigm shift to better value for money and Concept of WLC to D-B evaluation

The bid evaluation should consider not only price competitiveness, but also compliance with users' requirements, reliability of performance, qualitative superiority, and WLC to achieve better value for money. The public client in Korea should concentrate on how better value for money can be achieved through a holistic approach to the evaluation system for a D-B project rather than only the bid price. The contractors should see it as an opportunity to apply their key strengths in management and co-ordination of design and construction works and to be able to present WLC implications to meet client-related issues and requirements.

The challenge in moving to design-build is the stringent and fair selection criteria. Although bid evaluation and awarding systems in Korea have become more varied, the system is still mainly based on the lowest responsive bidder. Furthermore, only the construction cost, that is the initial capital cost, is still taken into consideration. This does not account for the value of a public constructed asset through its service life and so better value of this asset cannot be evaluated nor achieved. Procurement decisions should always be on the basis of value for money over the life of the facility and not on the initial capital cost alone (OGC 2007). According to the UK OGC's AE Guide 07 in 2003, value for money is the optimum combination of WLC and quality to meet the user's requirement. This means that awarding contracts on the basis of lowest price tendered for construction works is rarely value for money. Therefore, it is recommended that the bid price on evaluation criteria should shift from initial construction costs to WLC because long-term costs over the life of a public asset are more reliable indicators of value for money than the initial construction costs.

Whole life cost Process Map for Design-Build

The research is therefore to use three propositions: (1) D-B has became an established procurement route for public sector projects in Korea; (2) Whole life appraisal has became an accepted methodology to evaluate WLC; (3) There is the need for Korea to adopt a WLC approach in the selection process of a successful bidder for D-B.

Whole life costing is a relatively new concept to Korea. The SMLCC, mentioned above, provides a process map of the LCC stages defining what should be done at each stage of the process. This process map generalises whole life costing stages and is not suitable for D-B because D-B process follows a different sequence, compared with the traditional design-bid-build. For instance, a bidder is selected as a design-builder before design development is implemented. Thus, the information at the bid stage may not be sufficient to confirm WLC for a facility. Moreover, this process should be distinguishable by the public client and design-builder to clarify its role in the WLC process. The research has produced a process map of WLC for D-B in Korea by dividing into two parts; (1) public client and (2) design-builder (See Figure 2).

Whole life cost evaluation stages for D-B and data reliability and robustness

Many researchers emphasise that whilst a whole life costing decision-making exercise can be done at any stage of the project, it is most beneficial during the early design stages (Kirk and Dell'Isola 1995; Kishk 2005). When the public client in Korea employs the suggested process map for the key stages of WLC for D-B, selection of a D-B entity should be based on whole life cost-based selection procedures, which require consideration of long-term costs over the service life of a constructed asset that is fair and reasonable to the public. It is recognised that the evaluation will be

based upon data provided by the D-B bidder. The reliability, accuracy, and interpretation of data must be subject to professional judgement. The Figure 2 includes WLC pre-tender and tender evaluation stages to meet client's requirements.

Building Research Establishment in the UK has been carrying out life costing since the 1970s, and has encountered a number of obstacles to accurate costing. These barriers include a lack of reliable data on factors such as maintenance and running costs; the absence of a coherent system for life costing with available operating and maintenance data. Korea is no exception. The cost estimation and data system in Korea was based upon the production rate called "Pum Sem", which considered the direct labour cost, material costs, and equipment cost separately. A major problem of the existing system was that it did not properly reflect the characteristics of each project (Choi *et al.* 2004). Therefore, the unit cost estimation system that is used for previous contract costs of items has been adapted as a new system in the public sector since 2004. However, Choi *et al.* (2004) point out that this system has some limitations in terms of flexibility and reliability. The limitations and problems result from the lack of feedback and cost data management with a properly categorised cost structure through the whole life of a constructed asset. To improve this reliability and robustness of cost data, the framework in this research is suggested. WLC costs at each level are obtained from the WLC database by a new estimation system, and these are input to each WLC evaluation and then fed back to the WLC database after analysing and evaluating using expert judgement to provide solutions and high quality judgement for historical data (See Figure 2).

CONCLUSIONS

Within the space of this short paper it is not possible to describe key stages and all attributes of the WLC pre-tender and tender evaluation systems for selection of the D-B team. Korea has moved from basing the selection on lowest price towards selection on the basis of value for money. Other facets as well as WLC and bid price will be considered including service life planning, design quality, safety performance, technical competence, human resources, and financial strength. Delivering a quality product and achieving the best relationship between the client and the supply chain is very largely dependant on the procurement route that is adopted (OGC 2003). D-B is significantly better than the traditional methods at delivering the greater certainty that comes from integrated systems. This is a key feature of all modern industries, where integrated systems provide the basis for greater control and consistency of performance (Bennett *et al.* 1996). This research has found that the use of D-B in Korea has been rapidly increasing in the public sector since 2001. Requirements to seek best value for money, encourage fairness and transparency and expand competition are viewed. Therefore, understanding WLC in the D-B bid evaluation and WLC evaluation stages in process map are critical for best value of a D-B in the public sector and it is fundamental for improving client's D-B implementation. The contribution of this research lies in the proposed whole life cost process map for D-B and the identified WLC evaluation stages on this map.

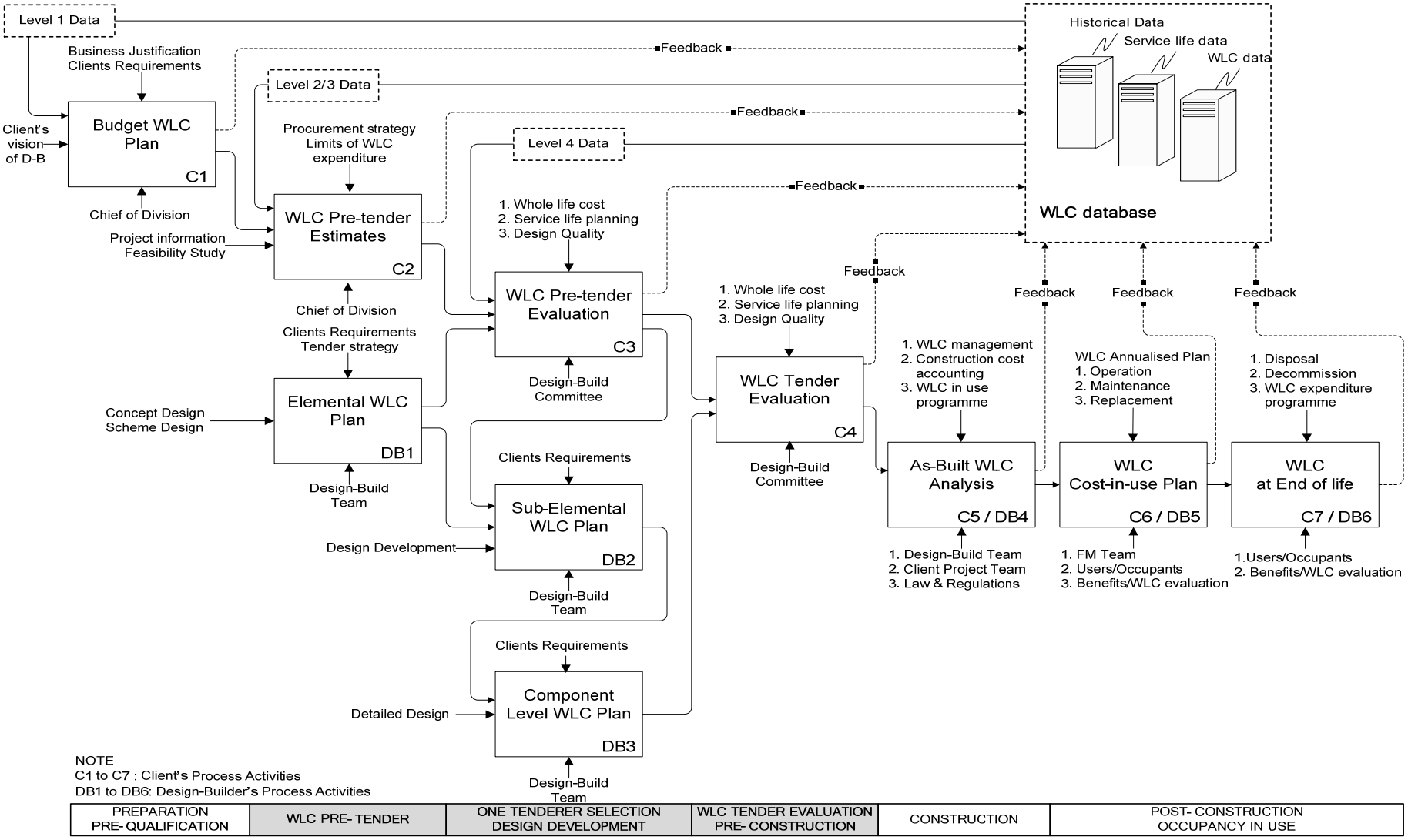

Figure 2 Process map of the key stages of WLC for Design-Build by public client and design-builder

These stages should also provide estimates and evaluation from different levels of data and information availability. To achieve the objectives of a D-B project, strategies, close collaboration and long-term relationships are needed to improve and enhance design-build employed by government clients. Decisions and evaluations made during the WLC tender stages of D-B process are vital for maximising sustainability. Further work needs to be done to define the relationships more deeply and deliveries of activities in each stage of proposed process map over the whole life of a constructed asset.

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