Alternative models for infrastructure delivery

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DR MARTIN BARNES, the originator of the NEC Engineering and Construction Contract, in his Smeaton Lecture in 1999, pointed out that virtually no civil engineering was carried out in the UK, after the Romans left, until the 17th century, the two notable major works being the Exeter Ship Canal (1567) and the drainage the Fens. This all changed between the 1760s and the 1850s. John Smeaton, who is often regarded as the founder of civil engineering and whose largest project was the Forth and Clyde Canal linking the eastern side of Scotland to the western side, developed his approach to managing works. In 1768, he set down his management scheme for the construction phase with detailed tables of responsibility. His team comprised the engineer in chief, the resident engineer and the 'surveyors' for the various geographical sections working under him, and contractors (as opposed to direct labour). This 'master – servant' model has remained in use for the majority of civil engineering projects for more than 200 years and is still used on projects managed in the traditional manner.

Sir Joseph Bazalgette, who was responsible for constructing the major sewer projects and the embankments on the Thames River in London, developed a standard form of contract in the 1860s, which was adopted by the Metropolitan Board of Works. This form of contract remained as the principal model for contracts for more than 100 years and was the model for the first edition of the ICE contract published in 1945. This form of contract also served as a model for contract forms in many parts of the world, including South Africa, entrenching the master – servant relationship developed by Smeaton.

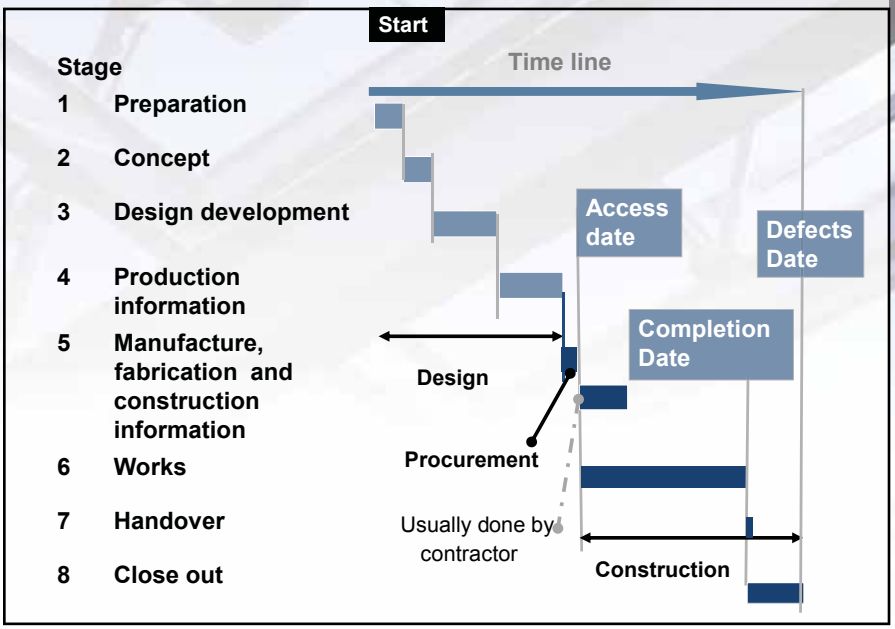
Dr Barnes pointed out, in his lecture, that "the basic interaction between engineer and contractor, for example, has mutated over the last 150 years from 'master and servant' to a simple collaboration between two specialist contributors. The boundaries of the traditional interactions have also moved in response to the same pressures to improve. In earlier times, for example, contractors made none of the decisions about what was to be built and all the decisions about how it was to be built. Now, we have developed operational and commercial relationships, which will enable the boundary between design and construction to be placed anywhere that preferences might dictate, on a particular project, and even varied between different parts of the same project."

It is of interest to note that in the UK, the Office of Government Commerce's (2006) Common Minimum Standards require that procurement strategies and contract types support the development of collaborative relationships between the government client and its suppliers, and facilitate the early appointment of integrated supply teams. This standard also states that "traditional, non-integrated procurement approaches should not be used unless it can be clearly shown that they offer best value for money. This means that in practice, they will seldom be used." This article explores alternative delivery models for infrastructure delivery and the role that the public sector needs to play in facilitating their implementation.

The traditional approach to the delivery of public infrastructure

A project is defined at any stage in the project-delivery stage by the project brief, project programme, design, and project cost. A project brief flows out of planning processes and is progressively developed through a number of stages of development. The work flow (key activities) of an identified project may be linked to stages and key deliverables, as described in table 1. Projects involving maintenance of infrastructure do not require stages 3, 4 and 5 as the information at stage 2 is sufficient to proceed directly to stage 6.) The historic approach to infrastructure delivery has been the design-by-employer contracting strategy, whereby the contractor undertakes only construction on the basis of full designs issued by the employer. This contracting strategy requires that the design and specifications be adequately developed before tenders are invited so that these can

FIGURE 1: Typical timelines for a design by employer contracting strategy



be priced. This enables the design to meet the employer's requirements closely and the construction contract, when awarded, can proceed without major change, delay or disruption. If, however, the contractor's works are delayed by the fault of the design team, the contractor may claim against the employer for additional costs and/or time to complete the contract. (See figure 1). Virtually all public-sector infrastructure projects in South Africa are currently delivered using the traditional pre-planned approach to construction shown in figure 1, which requires that the design and specifications be adequately developed and approved by clients before tenders are invited. This allows the tenders to be priced as lump sums or in terms of a bill of quantities, prior to the award of a contract, and the design professionals to be paid a percentage of the cost of construction when it becomes known. This approach works best when:

- the client has adequate in-house capabilities and capacity either to undertake the design or to brief consultants and to oversee the design process
- there is adequate time to complete the design and associated documentation before tenders for construction are invited.

Clients are today under pressure to deliver projects on time, on budget, within shorter

TABLE 1: The work flow associated with construction works

STAGE NO	DESCRIPTION	KEY DELIVERABLE	KEY ACTIVITIES
1	Preparation	Client-accepted strategic brief setting out the project information	• Define the project objectives, business need, acceptance criteria and client priorities and aspirations • Confirm the scope of the project • Establish the project criteria, including the function, mix of uses, scale, location, quality, value, time, safety, health, environment and sustainability • Where necessary, conduct preliminary investigations or desktop studies to obtain data • Identify procedures, organisational structure, key constraints, statutory permissions and strategies to take the project forward • Establish the control budget for the project • Develop a strategic brief that sets out the project information, including the procurement strategy to implement the project
2	Concept	Client-accepted concept report, setting out the integrated concept for the project	• Establish the feasibility of satisfying the strategic brief for the project with or without modification • Investigate alternative solutions • Establish the detailed brief, scope, scale, form, and cost plan for the project, including, where necessary, obtaining site studies, as well as construction and specialist advice • Recommend the preferred design option • Determine the initial design criteria, design options, cost plan for the project • Produce a site development plan or other suitable schematic layouts of the works • Develop a concept report that sets out the integrated concept for the project
3	Design development	Client-accepted design development report, setting out the integrated developed design for the project	• Develop, in detail, the accepted concept to finalise the design and definition criteria • Establish the detailed form, character, function and cost plan, defining all components in terms of overall size, typical detail, performance and outline specification, as relevant • Confirm or revise the cost plan included in the concept report
4	Production information	Completed and client-accepted production information	• Produce the final detailing, performance definition, specification, sizing and positioning of all systems and components enabling either construction (where the contractor is able to build directly from the information prepared) or the production of manufacturing and installation information for construction
5	Manufacture, fabrication and construction information	Client-accepted manufacture, fabrication and construction information	**Client's representative:** Review the manufacture, fabrication and construction information prepared by others, based on the production information for design intent and conformance with scope of work **Contractor:** Produce the manufacture, fabrication and construction information based on the production information
6	Works	Completed works that are capable of being occupied or used and accepted by the client	**Contractor** • Provide temporary works • Provide permanent works in accordance with the contract • Manage risks associated with health and safety on the site • Correct notified defects that prevented the client or end user from using the works and others from performing their work • **Client's representative:** Confirm that design intent is met
7	Hand over	Works that have been taken over by the user complete with record information	• Finalisation and assembly of record information including drawings, specifications, manuals, guarantees and statutory certificates that accurately reflect the infrastructure acquired, rehabilitated, refurbished or maintained • Handing over the works and record information to the user and, if necessary, training of end-user staff in the operation of the works
8	Close out	Completed contract	• Correction of all defects that are detected during the defects liability period • Completion of the contract by finalising all outstanding contractual obligations, including the finalisation and payment of amounts due after the defects correction period • Evaluation of package outcomes • Compilation of a completion report for the package, outlining what was achieved in terms of key performance indicators and suggestions for improvements on future packages of a similar nature • Entering of relevant data into a database

timeframes. This has led to the fast tracking of the traditional pre-planned approach to construction by the streamlining of procedures to minimise delays between activities and to permit activities to be undertaken out of sequence. This has resulted in tenders for construction works being awarded where the works are not fully or precisely scoped. In many instances, this has led to very disappointing outcomes, e.g. the final cost of the construction works for the 2010 World Cup stadia increased by approximately 100% from the pre-award estimates to the time that contracts were completed. Where the percentage of the 'unknowns' is significant at the time that the contract is priced, this fast-track approach degenerates into a 'pay-as-you-go system', as illustrated in figure 2.

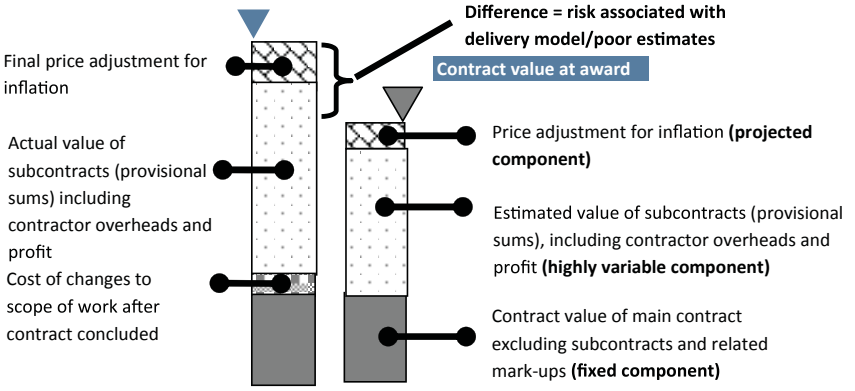


FIGURE 2: 'Pay-as-you-go', traditional, pre-planned, fast-track approach to projects

Alternative approaches

Alternative price-based contracting strategies

An alternative to the design-by-employer contracting strategy is the so-called design-and-construct contracting strategy. In this strategy, the contractor undertakes most of the design and all construction in accordance with the employer's brief, as well as his detailed tender submission, usually for a lump sum price. This option provides single-point accountability and allows the construction to commence before the detailed design has been completed. A variation to the design-and-construct contracting strategy is the develop-and-construct contracting strategy. This strategy is similar to that of design and construct, except that the employer issues a concept design as a baseline document for the design.

The stages for the delivery of infrastructure described in Table 1 serve as the scope of work for the appointment of the contractor for each

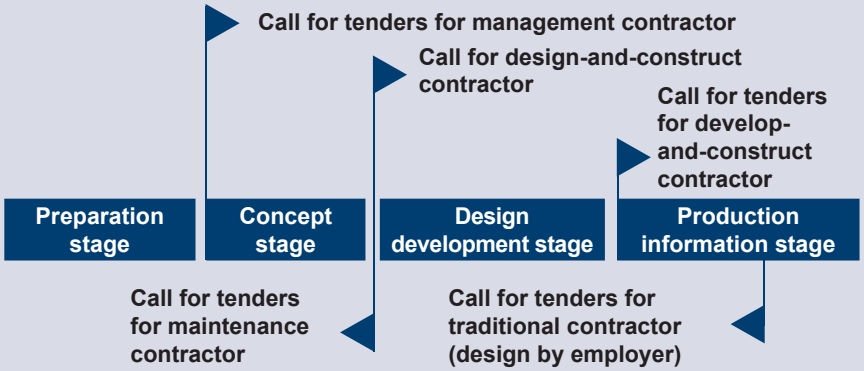


FIGURE 3: Procurement stages for different contracting strategies

of these contracting strategies, as illustrated in figure 3. Contractors are able to price the scope of work in terms of a lump sum amount or in terms of an activity schedule by breaking down the scope of work into priced activities linked to a programme. A cost-reimbursable contract is a contract in which the contractor is paid for his actual expenditure plus a fee as illustrated in figure 4. Wages, salaries, materials, plant and equipment can be reimbursed at open market or competitively tendered prices with deductions for all discounts, rebates and taxes that can be recovered. Some of the items of equipment can be reimbursed at prices that are agreed in terms of the contract or at a percentage up or down of published hire lists, such as those published by the Contractor's Plant Hire Association in their publication *Hire SA in Africa*. Overhead charges for telephones, hand tools, personal safety equipment, refreshments, first aid facilities, toilet facilities, etc., can be included in a percentage overhead charge applied to wages and salaries of those working on site. Charges can be based on actual cost. Fees to cover items – such as profit, company overheads, finance changes, insurances, superintendence, and performance bonds, as relevant – can then be added. Such contracts can be competitively tendered as tenderers can compete on the basis of margins and rates, i.e. the percentages that are to be applied to the various cost components, the rates tendered for equipment, and the fees.

In the management – contractor contracting strategy, a management contractor provides consultation during the design stage, and is responsible for planning and managing all post-contract activities, including any design of the works or portion thereof, and for the performance of the whole of the contract. Any trade contracts are between the management

contractor and the various trade contractors (see figure 5). In the management-contractor contracting strategy, the contractor is paid for his actual costs (subcontract amounts and prices for work done himself), plus a fee, and can be appointed once a strategic brief has been developed during the preparation stage (see figure 3). ISO 6707-2, Building and civil engineering – Vocabulary – Part 2: Contract terms, defines a target-cost contract as "a cost reimbursement contract in which a preliminary target cost is estimated and on completion of the work, the difference between the target cost and the actual cost is apportioned between the client and the contractor on an agreed basis". A target contract is accordingly a contract in which the financial risks are shared by the employer and the contractor in agreed proportions. In a target contract, the employer and the contractor need to agree on:

- the target
- how to pay the contractor for work done
- how to adjust the target to compensate the contractor for changes in the scope and timing of the works, the failure by the employer to act timeously in accordance with the provisions of the contract, encountering physical conditions which are considered unlikely to have been foreseen, price inflation, etc.
- how to incentivise the contractor to propose changes to the scope that result in financial savings

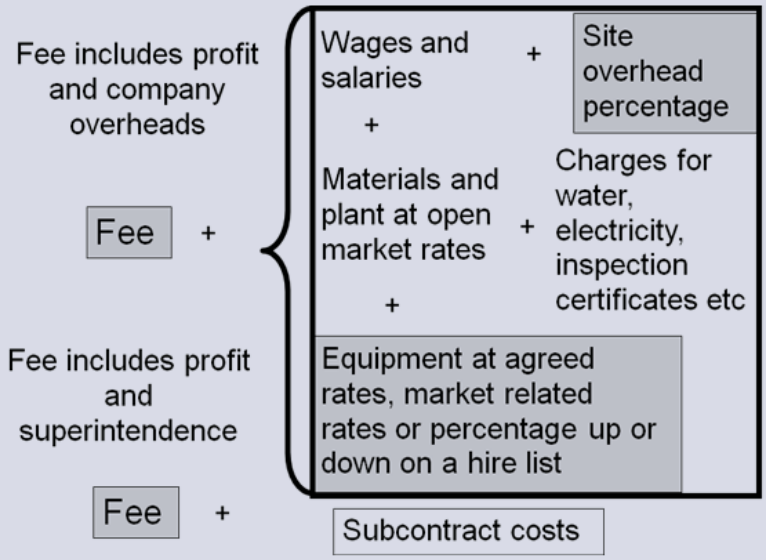
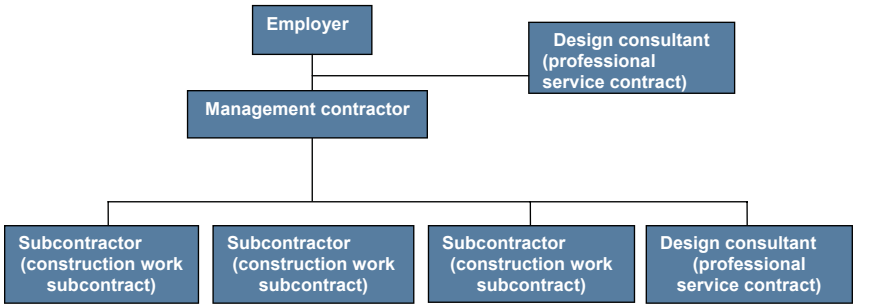


FIGURE 4: Price for work done to date in a NEC3 Engineering and Construction Contract – Option E: Cost-reimbursable contract

FIGURE 5: Typical management – contractor relationships



- how to share any savings or overruns.

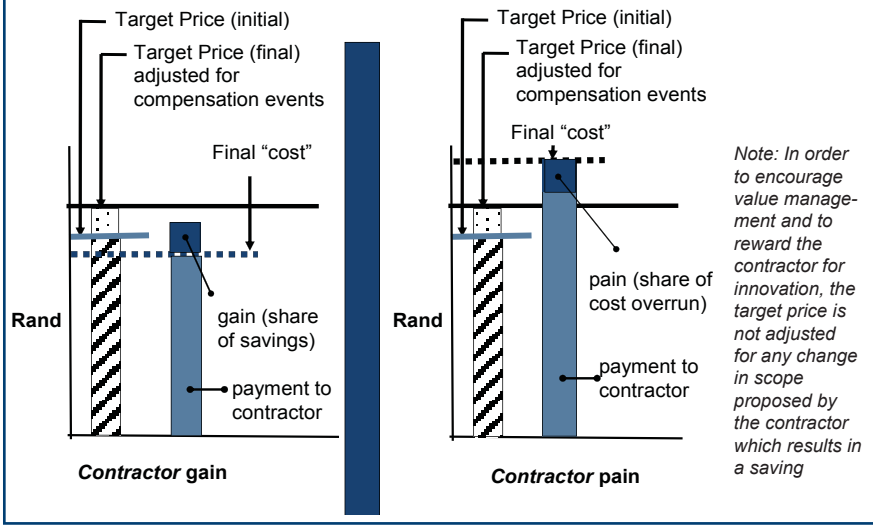
Figure 6 illustrates the NEC3 Engineering and Construction Contract target-cost contract concept. A target price is agreed between the employer and the contractor to control productivity. The initial target price is adjusted for compensation events, e.g. scope changes and events which are at the employer's risk, except those associated with scope changes proposed by the contractor, throughout the contract, to arrive at a final cost to keep the target equitable. The contractor is paid his costs, profit and overheads on a monthly basis as the work proceeds on a monthly forecast basis (see figure 4). The difference between the final cost and the amount paid to the contractor when the work is completed is shared between the employer and contractor in agreed proportions:

- The target contracts approach permits the employer to know where the money is being spent.
- These reward strong contractor performance, enable financial risk to be shared between the parties.
- In addition, the contracts promote collaboration or a culture whereby both parties have a direct interest in decisions that are made regarding the cost and timing of the contract, and permit an early contractor involvement in the project to make inputs into the design process.

Contracts, based on a design-and-construct, develop-and-construct or design-by-employer contracting strategy can be awarded on the basis of a tendered target cost whenever the scope of work is known (see figure 4). Alternatively, contractors can be engaged in terms of any of the abovementioned contracting strategies at an earlier stage, should these compete on the basis of margins and rates, i.e. the percentages that are to be applied to the various cost components, the rates tendered for equipment, and the fees. Escape clauses can be included in the contract for termination in the event that a target price cannot be agreed upon when the scope of work is known. This enables an integrated design approach to take place even if the design-by-employer contracting strategy is adopted.

Framework contracts

FIGURE 6: Target contract principles as provided in the NEC3 Engineering and Construction Contract (Options C and D)



ISO 10845-1, Construction procurement – Part 1: Processes, methods and procedures, defines a framework agreement as "an agreement between an organisation and one or more contractors, the purpose of which is to establish the terms governing contracts to be awarded during a given period, in particular with regard to price and, where appropriate, the quantity envisaged". Framework agreements allow the employer to procure work on an as-instructed basis over a set term, without necessarily committing to any quantum of work.

Framework agreements:

- are entered into following a competitive selection process
- need to establish the following as a minimum:
  - the basic terms of the contract
  - the term of the contract (typically three to four years)
  - the broad scope of the work, which may form the basis of a package order
  - the basis by which contractors are to be remunerated for instructed work
  - the manner in which competition between framework contractors may be reopened, where more than one contractor is admitted to a framework agreement.

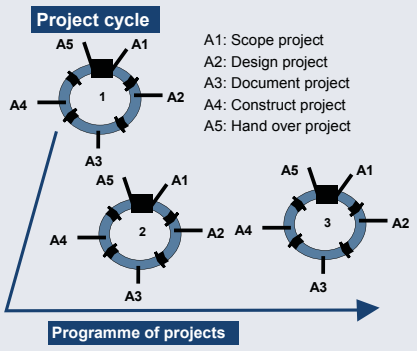
A work package is a works within the scope of work of a framework agreement that is instructed within a stated period of time. A package order is an instruction to carry out a work package and may only be issued within the term of the agreement.

Typically, at the commencement of any programme (series of projects), the only 'knowns' are the allocated medium-term budget, a list of short-term priorities, and possibly an indicative broad brush breakdown of the budget into prioritised projects for the first year of the programme. Individual projects within a programme need to be scoped, designed and documented so that construction may take place. This cycle needs to be repeated so that as projects are identified, these can be scoped, designed and documented so that construction occurs on a continuous basis over the period of a programme (see figure 7).

Accordingly, the delivery model needs to be capable of procuring services in the absence of a well-defined scope of work once a strategic brief has been prepared for a project.

Target-cost contracts can form the platform for framework agreements. A framework contract can either be awarded on the basis of tendered margins, rates and fees, and when

FIGURE 7: Project cycle within a programme of projects



the scope of work is known, a target price can be negotiated, or on the basis of a target price for the first work package. The tendered margins, rates and fees will then apply to all the package orders and the target price for each work package negotiated. Framework contracts enable learnings to be taken from one work package to the next and enable a team to work together on an integrated approach over a period of time.

The cidb's generic Specification for Social and Economic Deliverables in Construction Works Contracts (2007) can be used in conjunction with this model. This specification provides for the delivery of a wide range of social and economic deliverables through the performance of a construction contract as set out in table 2.

The deliverables outlined in table 2 may be readily incorporated into the scope of work associated with a particular work package, by reference to this specification and the completion of project-specific variables (specification data). Contractors may be required to achieve a particular deliverable and be penalised financially should they fail to do so or be offered a financial incentive should they equal or exceed a key performance indicator associated with a deliverable. The target price that is developed for each work package takes into account these requirements.

This approach of addressing the social and economic agenda is very flexible and, unlike most other delivery models, allows the client to change the deliverables over time in response to emerging needs and changing circumstances. This is of particular value where the contracts extend over a few years.

Current public sector realities

Currently, most public sector clients don't have internal design staff and outsource the design to consultants. Projects are either delivered as a single contract or are commonly broken down into small contracts to provide access to local contractors and to encourage labour-based technologies, the theory being that smaller contractors are best able to implement employment-intensive works. This delivery model, however, results in a consultant-driven, stop/start mode of delivery, often with disappointing outcomes.

TABLE 2: Standard social and economic deliverables

THEME	DELIVERABLE #	DESCRIPTION
EMPLOYMENT OF LOCAL RESOURCES	A1	PROVIDE EMPLOYMENT OPPORTUNITIES TO TARGETED LABOUR
	A2	Utilise local resources
Employment opportunities in labour-intensive works	B1	Provide employment and skills development opportunities to targeted labour
Business opportunities	C1	Provide business opportunities for targeted enterprises
	C2	Procure subcontractors for defined portions of the contract in terms of specified procedures
Enterprise support and development programmes	D1	Provide third-party management support services to targeted contractors
	D2	Procure or manage (or both) mentoring services for targeted contractors
	D3	Execute the contract in joint venture with a targeted partner
Skills development	E1	Provide experiential work opportunities towards a specified professional registration for designated persons
	E2	Provide work learning opportunities towards a specified degree, diploma or certificate for designated persons
	E3	Provide experiential work opportunities towards a SAQA-registered qualification or certificate for designated persons
	E4	Procure and manage a training provider to provide specific training for designated persons
HIV/Aids	F1	Promote HIV/Aids awareness

Lawless (2005) found that there are no civil engineers, technologists or technicians employed in 34% of South Africa's local municipalities and 9% of district municipalities. Only one civil technician was employed in 18% of the local municipalities and 9% of district municipalities while 16% of local municipalities and 13% of district municipalities employed only technologists and technicians under the age of 35. Only 19% of local municipalities and 53% of district municipalities have at least one civil engineer in their employ.

A rough comparison of the distribution of engineers and technologists in South Africa in 1967 and 2005 can be made by comparing the figures published by Terblanche (1971) and Lawless (2005) (see table 3). What is evident from table 3 is that there has been a major flow of technologists and engineers from the public sector to the consulting sector over time. The cidb (2006) attributed the infrastructure-delivery capacity problem within government to:

- the project approach, where for each and every project, consultants are appointed, briefed, directed and overseen by a gradually disappearing cadre of skilled staff
- unbundling strategies aimed at reducing the size of contracts to target small or local enterprises to satisfy social and economic imperatives that place increased demands on the client's resources to manage and oversee these small contracts.

It may be also be argued that capacity constraints exist owing to the continued use of a delivery approach that no longer matches the capabilities and capacities of the client to oversee its implementation effectively, ignores the capabilities of the private sector and fails to accommodate current delivery imperatives.

There are two distinctly different strategies to address the current lack of service delivery and poor project outcomes. The first seeks to

TABLE 3: Change in distribution of technologists and engineers in South Africa over time (according to Terblanche (1971) and Lawless (2005)

EMPLOYER	PERCENTAGE DISTRIBUTION (%)	
	1967	2005
State-owned enterprises	12	6
National and provincial government	12	4
Local government	15	10
Consultants	31	51
Industry or business	28	23
Academia	2	6

increase the numbers of built environment professionals significantly within government to manage and oversee the current approach to delivery effectively and efficiently. The second harnesses the capability and capacity of the built environment professionals located within the private sector to deliver infrastructure using a radically different delivery process.

A strategic approach to procurement

A strategic approach to procurement can be undertaken should a construction procurement strategy be developed for a portfolio of projects. Procurement strategy, according to ISO 10845-1, is the "selected packaging, contracting, pricing and targeting strategy, and procurement procedure for a particular procurement". It is the selection of a combination of the delivery-management strategy and associated contracting-and-procurement arrangements. It necessitates that a number of choices be made from the available options (see figure 8).

A procurement strategy can be developed for a single project, a programme of projects or a portfolio of projects to identify the best way of achieving objectives and value for money, while taking into account risks and constraints. The procurement strategy can be used to translate a portfolio of projects identified in an infrastructure plan into a series of packages for delivery under a single contract or a package order issued in terms of a framework agreement. It documents the choices made in the development of a delivery management strategy and the determination of the contracting and procurement arrangements.

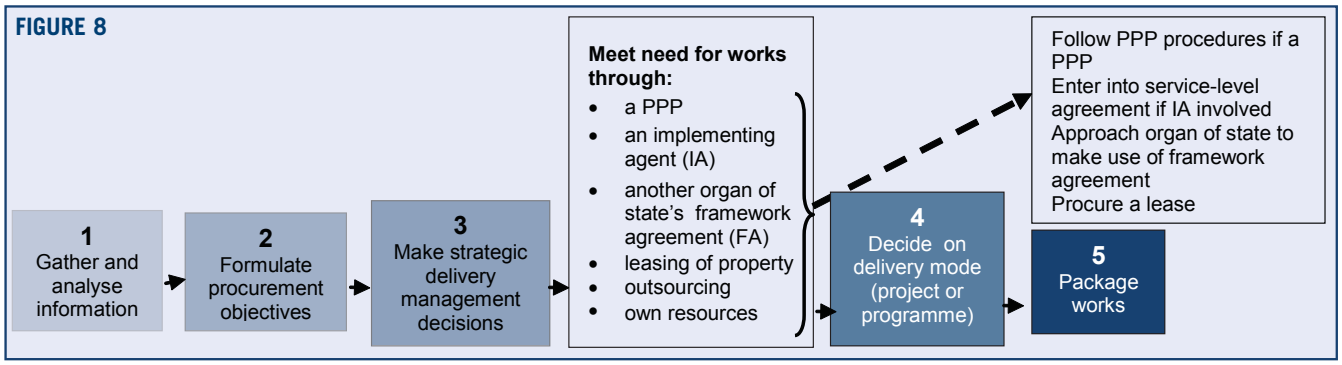
The client as a driver of change

A culture change is needed to improve performance in the delivery of infrastructure. Clients are the drivers of change and need to 'call

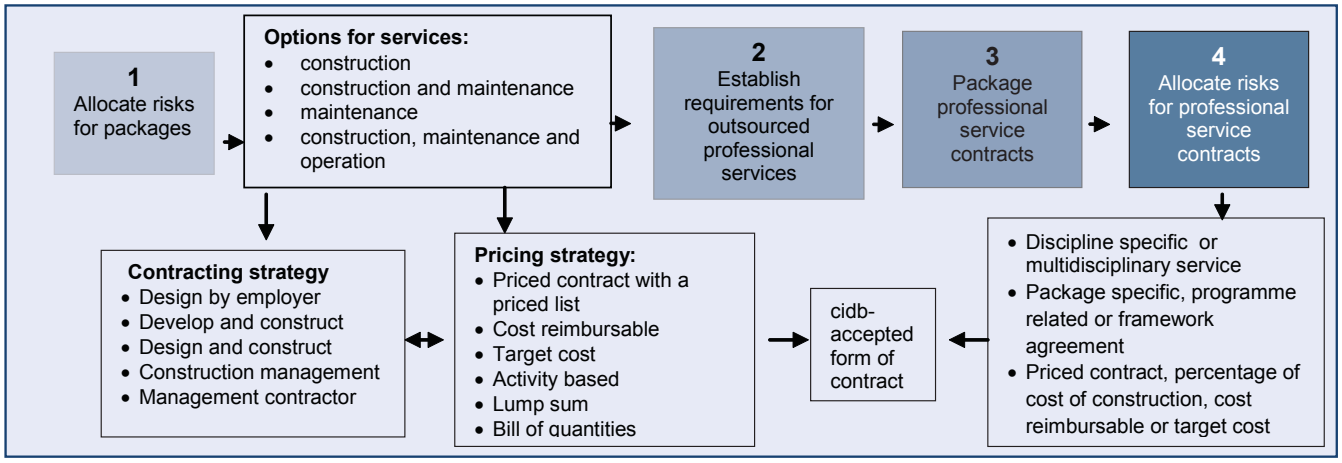
TABLE 4: The culture change need to improve performance (ICE, 2010)

CHANGE FROM	CHANGE TO
Master-servant relationship of adversity	Collaboration between two experts
Fragmentation of design and construction	Integration of design and construction
Allowing risks to take their course or extreme and inappropriate risk avoidance or risk transfer	Active, collaborative risk management and mitigation
Meetings focused on the past – what has been done, who is responsible, claims, etc.	Meetings focused on: "How can we finish projects within time and available budget?"
Develop project in response to a stakeholder wish list	Deliver the optimal project within the available budget
'Pay-as-you-go' delivery culture	Discipline of continuous budget control
Constructability and cost model determined by design team and cost consultant **only**	Constructability and cost model developed with contractor's insights
Short-term 'hit-and-run' relationships focused on one-sided gain	Long-term relationships focused on maximising efficiency and shared value
Procurement strategy focused on selection of form of contract	Selected packaging, contracting, pricing and targeting strategy and procurement procedure aligned with project objectives
Project management focused on contract administration	Decisions converge on the achievement of the client's objectives
Training is in classrooms, unconnected with work experience	Capability building is integrated within infrastructure delivery

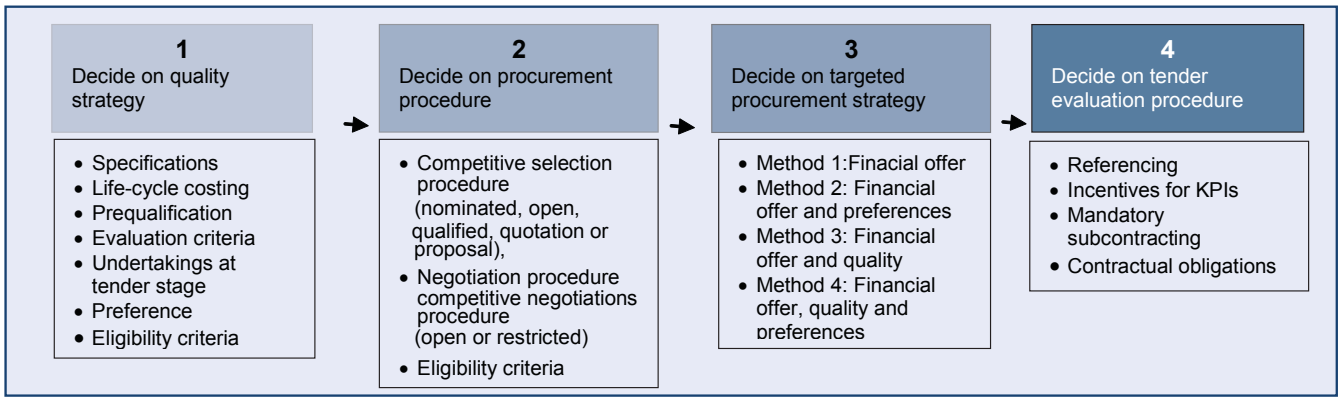
FIGURE 8



Part 1: Developing a delivery management strategy



Part 2: Deciding on the contracting arrangements



Part 3: Deciding on the procurement arrangements

the shots'. It's all about setting objectives, taking a strategic approach to procurement, making appropriate choices, and tightly managing a well-defined process within available resources. Performance in the delivery of infrastructure needs to improve and optimal outcomes need to be delivered within available budgets. This necessitates the culture changes set out in table 4.

A change in culture and approaches in delivery has the potential to address:

- the severely stressed departmental and municipal oversight resources
- a crisis-management culture, which cuts corners in the planning processes
- the fragmentation of design and construction with aspects such as constructability and cost-modelling determined by the design team and cost consultant only
- tasks being allowed to take their course or extreme and inappropriate risk avoidance or risk transfer
- a 'pay-as-you-go' culture, where significant cost overruns are the order of the day
- consultant-driven projects frequently with perverse incentives, for example fee rates as a percentage of the value of the works
- a history of under-expenditure and poor service delivery, particularly by weaker rural municipalities.

The choice of the contracting system can facilitate or frustrate performance. The NEC3 family of contracts integrates risk and project management processes, provides a wide range of contracting strategies, including priced-based, cost-reimbursable, target cost-and-management contract. This family of contracts is accordingly well placed to support the required culture change and broader project objectives.

The cidb Standard for Uniformity in Construction Procurement permits all the alternative delivery models described in this article to be implemented within the current legislative framework. The question is: "Will clients initiate change?" 35