CASE STUDY

Fast track approach to delivery 2016 facilities for the two new universities

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Introduction

The Department of Higher Education and Training (DHET) entered into an agreement with the University of the Witwatersrand, Johannesburg (Wits), during November 2011 to project manage and resource the spatial and physical planning and development for two new universities located in the Northern Cape and Mpumalanga Provinces. Wits appointed the DHET New Universities Project Management Team to do so on its behalf i.e. a core team comprising the Wits Director Campus Planning and Development and contracted resources in the form of a delivery manager, a programme / project manager, a spatial and architectural design specialist and a procurement specialist, all of whom had worked together in delivering Wits' capital programme since 2008. This team was supported by a small team of built environment professionals and administrative staff mostly in the employ of some of the members of the team. The DHET subsequently extended the agreement with Wits to manage the work required for the launch of the two New Universities and the 2014 start-up for the first intake of student and thereafter to proceed with the provision of physical infrastructure to accommodate the student intakes for the 2015 and 2016 start-ups.

Budget allocations of R 50.0 m, R 81.3 m, R 117.1 m, R 383.0 m and R 1.32 b where made available in respect of the 2011/2012; 2012/2013, 2013/14, 2014/15, and 2015/16 financial years, respectively.

Work commenced on the infrastructure for these two new universities before the establishment of their respective councils. The interim councils were announced by the president of the Republic on South Africa on 25 July 2013. The fully constituted Council of both universities were inaugurated during August 2014.

The challenge

The student numbers which needed to be accommodated at the Sol Plaatje University and the University of Mpumalanga were as indicated in Table 1. The 2014 and 2015 intakes were accommodated in existing buildings on these university campuses, which were refurbished by a management contractor under the NEC3 Engineering and Construction Contract (Option F: Management Contract). The 2016 and 2017 student population required additional buildings as indicated in Table 2.

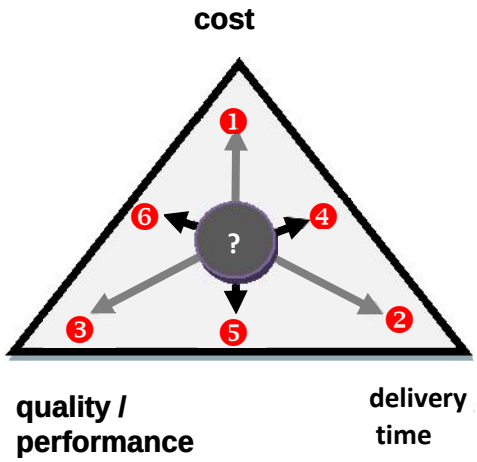
Table 1: Student population for 2014, 2015 and 2016 academic years.

University	Total student population for academic year		
	2014	2015	2016
Sol Plaatje University	127	337	700
University of Mpumalanga	169	828	1255

The consequence of not having facilities available at the start of an academic year was that the intake would have to be cancelled. Accordingly time became the dominant projective objective, possibly at the expense of quality and cost (see value proposition 2 in Figure 1).

Table 2: Facilities for the 2016 / 2017 intakes

Work package	Required facilities	Approximate gross building area (m2)
Sol Plaatje University		
C001	The building comprises 342 beds located on floors 1 to 4 with large residential common rooms, lounges and games rooms located on the ground floor facing onto a semi-private square shared with Building C002.	12 747
C002	The building is a multiuse building comprising a dining hall and kitchen, ground floor retail space and a residence comprising 122 single rooms, 48 double rooms, TV rooms, games rooms and meeting rooms. There is also a large flat floor teaching venue, lecture rooms, seminar rooms and meeting rooms	13 532
C003	Building comprises ground floor and three floors above, laid around a central open to sky courtyard. Ground floor - retail area, raked lecture halls, class rooms, health and wellness and open amphitheatre, First floor – lecture halls and flexible classrooms. Second floor – academic meeting rooms, offices and gymnasium. Third floor – sports centre, student SRC, Union and clubs	9 624
CX01	The works comprise the construction of bulk on site infrastructure for the new buildings (C001, C002, C003 and C004) for all the services outside of the footprint of the buildings being constructed including services and associated works to connect all infrastructure to existing municipal infrastructure.	-
University of Mpumalanga		
L001	Building L001 is predominantly a student residence comprising 6 distinct buildings integrated into the existing residential precinct. Residence seminar rooms, student centre, games rooms and laundries also form part of the complex.	6 153
L004	L004 is a distinct new building comprising a range of various size lecture venues, auditorium and study spaces as well as seminar rooms and offices	2 123
L006	Building L006 comprises: J 3 distinct new building portions (a dean's office comprising office and office facilities with a lift, a student resource centre, study centre and study service with a lift and a 250 seat auditorium comprising classroom and classroom services); J a combination of refurbishment and new construction which includes a range of various size lecture venues, auditorium, laboratories, student life centre and study spaces The facilities associated with building 6 include seminar rooms, staff offices, facilities for postgraduates and tutors, recreational spaces, IT resources, facility and library. They also include a Student Life Centre which contains retail facilities for the students such as specialist bookshop, coffee shop and food outlet.	7 536



Value proposition	Dominant project objective	Trade offs
❶	Cost	Clients may sacrifice quality and delivery to achieve cost objectives
❷	Delivery	Clients may pay higher costs or accept a lower quality if delivery is guaranteed
❸	Quality	Client may trade higher costs and later delivery for an agreed quality
❹	Cost and delivery are equal	Client forgoes some quality objectives to satisfy delivery and cost imperatives
❺	Quality and delivery are equal	Client accepts higher costs to guarantee certain levels of quality and a timely completion
❻	Cost and quality are equal	Client opts for later delivery if it lowers costs

Figure 1: Different value propositions and trade offs

Procurement arrangements for delivering the 2016 facilities

Approach

Use was made of the Wits University's *Construction procurement policy, processes, procedures, methods and delegations*. This university document is almost a carbon copy of the draft National Treasury's Standard for a Construction Procurement System which was published in November 2012 for public comment. The professional services contracts were structured around the draft Standard for an Infrastructure Delivery Management System which was also released for public comment during November 2012.

The primary procurement objectives for the New Universities project were as follows:

- Deliver the universities within a control budget.
- Ensure that expenditure is within the amounts allocated in each financial year of the MTEF period and is capable of being accelerated should additional funding become available.
- Ensure that teaching spaces are capable of being occupied at the start of the required academic year.
- Provide works that are capable of being readily maintained.
- Make use of expertise within universities to ensure that the designs of the teaching spaces are aligned with current and future best practice.
- The quality of facilities is such that maintenance costs are minimised.

A decision was taken to conduct a design competition to identify a small group of architects (not more than 5 for each campus) to design these new campuses so that they would not only be responsive to spatial requirements but also result in architectural landmarks symbolic of intellectual aspiration. The decision to appoint a small group of architects to lead the design of the campus had a major impact upon the procurement strategy that was adopted and the number and nature of consultants that needed to be appointed. These appointed architects needed to be supported by a team of discipline specific consultants, led by a project manager to develop each package. Accordingly a design by employer contracting strategy was adopted.

A decision was also taken to enter into framework agreements (Watermeyer, 2013) wherever it made sense to do so. This approach not only fitted in with the team's philosophy of developing long-term relationships focused on maximising efficiency and shared value but also allowed more time to develop the scope of the required services in an incremental manner and enabled early contractor involvement in the project before the designs were complete (Laryea and Watermeyer, 2016). Wits accordingly entered into the following three year framework contracts to establish the capacity necessary to deliver the 2016 and further intakes:

- 9 framework contracts for architectural services (NEC3 Professional services contract (Option G: term contract));
- 39 contracts for engineering design, cost planning and control, project management and specialist support services (NEC3 Professional services contract (Option G: term contract)); and
- 5 engineering and construction contracts (NEC3 Engineering and Construction Contract (Option C: Target contract with activity schedule).

Contracting arrangements for the construction contract

A target price in a target contract, based on activity schedules, 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) throughout the contract to arrive at a final 'cost'

to keep the target equitable. The contractor is paid his costs (people, materials, plant, equipment, site overheads, subcontractors etc.) at open market or competitively tendered rates plus their tendered fee percentage to cover items such as profit, company overheads, finance changes, insurances and performance bonds on a monthly basis as the work proceeds. 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 (see Figure 2) (Watermeyer,2009 and 2015).

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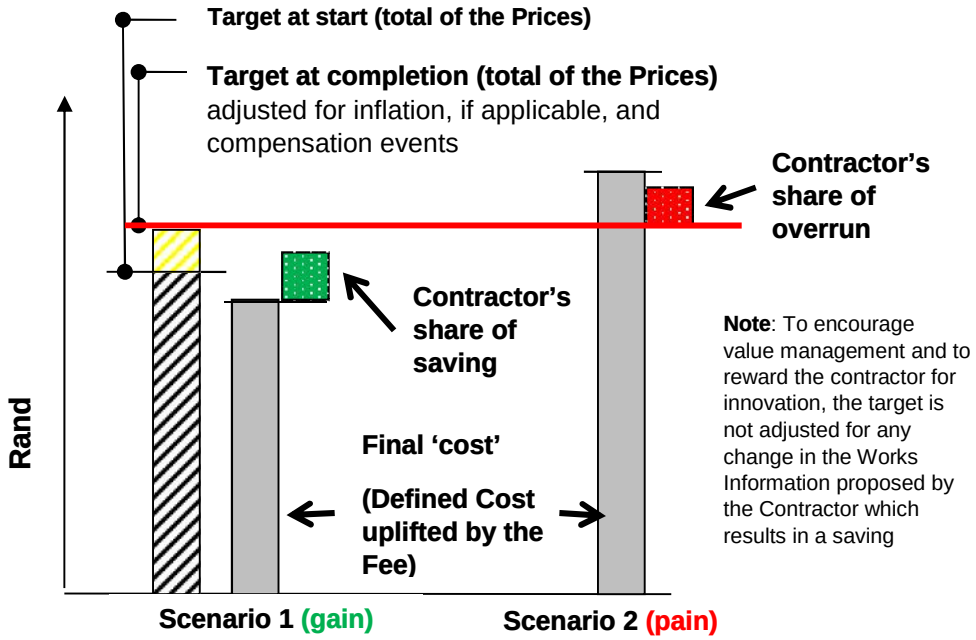

Figure 2: Target contract concept as provided for in the NEC3 ECC

The NEC3 ECC was converted into a framework contract by simply introducing a Z clause modelled along the lines of secondary option X17 (Task Order) contained in the NEC3 Term Services Contract. The Contract Data that is entered into using an NEC3 ECC can then make reference to Package Orders which are to be issued in terms of the aforementioned Z clause during the term of the contract. Package Orders can in this manner be issued through the standard NEC3 ECC. Accordingly the NEC3 ECC becomes a framework contract which sets out the generic terms, conditions and Works Information for the "call offs" over the term and the Package Orders contain the Package specific data and information. The "contract" for a Work Package is therefore the Package Order read together with the NEC3 ECC contract that is entered into (Watermeyer, 2013).

Tender processes

The tender process for the architectural services for the Sol Plaatje University and the University of Mpumalanga was completed during September and October 2013, respectively. The tender processes for the remaining professional services (design, cost planning and control, specialist investigations and project management) were completed for both campuses between March 2014 and May 2014.

Tenders were invited for the construction of buildings within the university precincts of both universities during 2014 in terms of a restricted competitive negotiations procedure. This process was completed during August 2014 (Watermeyer, Jacquet and Prinsloo, 2016).

Cost norms for university facilities

Current norms

The DHET's *Space and Cost Norms for buildings and other land improvements at Higher Education Institutions* (2009) establishes the need norm, the area norm and the cost norm which are necessary for DHET to establish a budget allocation for higher education facilities. This publication as such describes and enables the following parameters to be evaluated:

- Full time equivalent student numbers (FTE) for a facility to be established. The FTE is a weighted number derived from student enrolments with the weightings based on the nature of curriculum programmes and qualifications. A FTE value is calculated by assigning to each course a fraction representing the weighting it has in the curriculum of a qualification, and by multiplying the headcount enrolment of that course by this fraction.

- Space norms which, as necessary, take into account factors such as circulation space, annual utilisation hours, contact hours, the nature of furniture and equipment etc. and are expressed in terms of assignable square metres (ASM) per FTE. The spaces for which ASM values are provided relate to:

    - classroom facilities, class /open laboratory facilities and office facilities associated with the Classification of Educational Subject Matter (CESM) categories;
    - research and academic support facilities;
    - student services;
    - institutional support;
    - operation and maintenance of plant; and
    - auxiliary enterprises.

- Building cost units (BCU) are representative of the all-inclusive estimate of building cost units to provide one ASM building facilities space within a particular space use category. Such costs include air conditioning where necessary, a 2% allowance for possible adverse physical conditions on the building site and a 1% allowance for site improvement in the immediate vicinity of the building. These costs include VAT, professional fees and all other costs directly attributable to the building project. Building costs units exclude streets, roads, bridges, landscaping, open air parking areas, open-air recreational areas and utility distribution systems.

The ASM multiplied by the FTE represents the area within the gross building area required for higher education purposes. It does not include all the spaces required to provide functional facilities. For example it does not include toilets, corridors, stairwells and the like. ASM multiplied by the FTE and divided by the gross building area represents the efficiency of the design of a building. The linking of the BCU to ASM rather than to the gross building area encourages efficient design. An efficiency of 70% is considered to be achievable. Efficiencies of 70 to 75% are targeted in design.

The BCU is defined annually as the current Rand equivalent of R 3 065 on June 1995, the latter amount being escalated by the BER Building Cost Index Report on Building Costs published quarterly by the Bureau for Economic Research (BER), University of Stellenbosch. A 13% allowance for the total cost units for new buildings is provided for the associated land improvement other than buildings

Recent revalidation of cost norms

The University of the Witwatersrand on behalf of DHET, recently commissioned a project to revalidate the Building Cost Unit (BCU) applied to Buildings at Higher Education Institutions. The motivation for this project was that the latest published values of the DHET Basic Cost Unit may no longer reflect the accurate Rand Value of the cost unit for two reasons, namely the current values represent the compounded escalated value of the 1995 base cost, and changes in use, technology, teaching methods and building standards are not reflected in the Rand value of the cost unit.

Elemental cost analyses of five buildings were prepared (two office blocks, two teaching blocks and one laboratory), based on the final or latest projected quantities. A basket of common rates applicable to Gauteng in March 2017 were compiled and agreed upon by the project quantity surveyors. These rates were then utilised to price the elemental analyses on a common basis. The average cost per square meter, based on the gross building area, was calculated which was then reduced to a BCU based on the number of ASM cost units in the buildings and a 70% efficiency.

The values for the two office blocks excluding land improvement other than buildings, professional fees and VAT, fell within the range of values contained in AECOM's authoritative publication *The Africa Property and Construction Cost Guide 2016*. One of the values fell at the lower end of the AECOM range and the other at the higher end. An analysis of these two building indicated the reasons for the

differences in costs. The office block which fell into the lower range of the AECOM cost norms compared favourably with the BCU derived from the other buildings that were included in the study. The office block yielding an approximately 25% higher BCU was therefore removed from the analysis.

The four remaining buildings were found to have a BCU of R 19 957 with a standard deviation of ± R 180. This close correlation in values between buildings with very different ASM spaces confirms the validity of the space norms and the reasonableness of the current methodology in arriving at ASM values. (Had the relationship between the different types of spaces for which ASM values are assigned changed over time, there would have been a scatter in values.)

The DHET BCU published in April 2009 including VAT, escalated with the published BER indices, resulted in a BCU value of R18 352 for June 2017. The June 2017 BCU, based on the average of the four buildings, was found to be R20 712.59. This difference can be attributed to changing requirements in security (access control and CCTV), IT provision and green building design, including adequate sun shading, low E glass, etc. A revised BCU of R 20 500 for June 2017 was recommended by the project team to DHET.

Regional impact on building costs

The DHET's current approach is to have a single BCU which is universally applicable across South Africa. The Bureau for Economic Research and Medium Term Forecasting Associates reports different building costs for each province which take into account factors such as materials costs (.e.g. transport costs from Gauteng manufacturers of construction materials and the existence of oligopolies or regional monopolies in the supplies of sand, stone, steel, cement, etc.), labour costs; composition of labour, building methods (e.g. cavity wall construction, corrosion protection of window and door frames etc. in certain coastal regions), market competitiveness (e.g. differences in workloads), and productivity (e.g. that caused by adverse weather conditions). These rates are the average of project information received for a province irrespective of building type or location and may underestimate the adjustment for rural areas and overestimate the adjustment for urban areas.

A location factor for each university site was developed as part of the review to enable university specific adjustments to be made on an equitable basis, taking into account the following (see Table 3):

- Regional differences in the cost of construction. Rates relevant to each university location were obtained and inserted into a calculator which applied quantities for the office block (grouped into building elements and reduced to quantities per m² of gross building area) to these rates to generate a cost per m² which could then be used to compare costs across all universities on a comparable basis. This allowed an adjustment factor to be applied to the Gauteng rate.

- Differences in construction requirements for coastal versus inland conditions. Typically coastal regions require cavity wall construction, corrosion protection of window and door frames, roof sheeting and the like. A 1% difference is allowed to accommodate coastal versus inland conditions which translates into a coastal factor of 1.01 whereas the inland factor is 1.0.

- Differences in climatic regions required to provide comfortable buildings using an optimal combination of passive design strategies such as passive solar heating, thermal mass, direct evaporative cooling, indirect evaporative cooling and natural ventilation. The location of the universities was plotted on maps, which identify the number of hours per year in which cooling and heating is required for different locations and based on the latest research outputs obtained from the CSIR. This process allowed an adjustment factor to be determined.

Approach to delivering the 2016 facilities

Establishment and adjustments of control budgets

A control budget is by definition the amount of money which is allocated to deliver a work package, including site costs, professional fees, applicable taxes, risk allowances (contingencies) and provision for price adjustment for inflation. Separate control budgets were set for each work package with the objective that the delivery of the facilities would be within a budget derived from the cost norms.

Accordingly whenever a control budget was set, such a budget was benchmarked against the budget derived from the costs norms in order to test design efficiency. A conscious decision was made to exceed the budget derived by the cost norms when the nature of the site available for a building precluded efficient design.

An allowance of 8% of the cost of the buildings was made for furniture.

Table 3: Proposed adjustment factors and their make up

University	Province	Location rate factor (A)	Coastal factor (B)	Climatic factor (C)	Adjustment factor (A)x(B)x(C)
Nelson Mandela Metropolitan University	Eastern Cape	1.060	1.01	1.00	1.071
Rhodes University		1.084	1.00	1.00	1.084
University of Fort Hare		1.114	1.00	1.00	1.114
Walter Sisulu University		1.088	1.01	1.00	1.099
Central University of Technology Free State University of the Free State	Free state	1.069	1.00	1.00	1.069
Safeco Makgatho Health Science University University of Johannesburg University of Pretoria University of South Africa University of the Witwatersrand Tshwane University of Technology	Gauteng	1.000	1.00	1.00	1.000
Vaal University of Technology		1.015	1.00	1.00	1.015
Durban Institute of Technology Mangosuthu University of Technology University of KwaZulu-Natal	KwaZulu Natal	1.034	1.01	1.05	1.097
University of Zululand		1.119	1.00	1.05	1.175
University of Limpopo	Limpopo	1.071	1.00	1.00	1.071
University of Venda		1.156	1.00	1.05	1.214
University of Mpumalanga	Mpumalanga	1.071	1,00	1,05	1.125
Sol Plaatjie University	Northern Cape	1.107	1.00	1.03	1.140
North-West University	North West	1.000	1.03	1.03	1.030
Cape Peninsula University of Technology University of Cape Town University of the Western Cape	Western Cape	1.072	1.01	1.00	1.083
University of Stellenbosch		1.080	1.00	1.05	1.134

The full professional team was appointed only after the completion of the strategic brief and concept reports. As a result, it was not possible to establish a control budget to guide the planning of the buildings. The architectural design was nevertheless informed by the efficiency of the building (ratio of ASM / gross building area) and a set of architectural guidelines issued by the DHET Project Management Team.

Fast tracking construction through early contractor involvement

The scope of work (Works Information) for a package needs in a perfect world to be complete in order to develop and price an Activity Schedule. This is not always possible due to time constraints, particularly where the project is driven by schedule considerations. As a result, certain pricing assumptions needed to be made regarding allowances for items or budgetary items. When the

production information for such items is complete, the Works Information can be changed in accordance with the provisions of the contract. A change in Works Information triggers a compensation event which then allows the total of the Prices, the time for Completion and Key Dates to be changed in accordance with the provisions of the contract (see Figure 2).

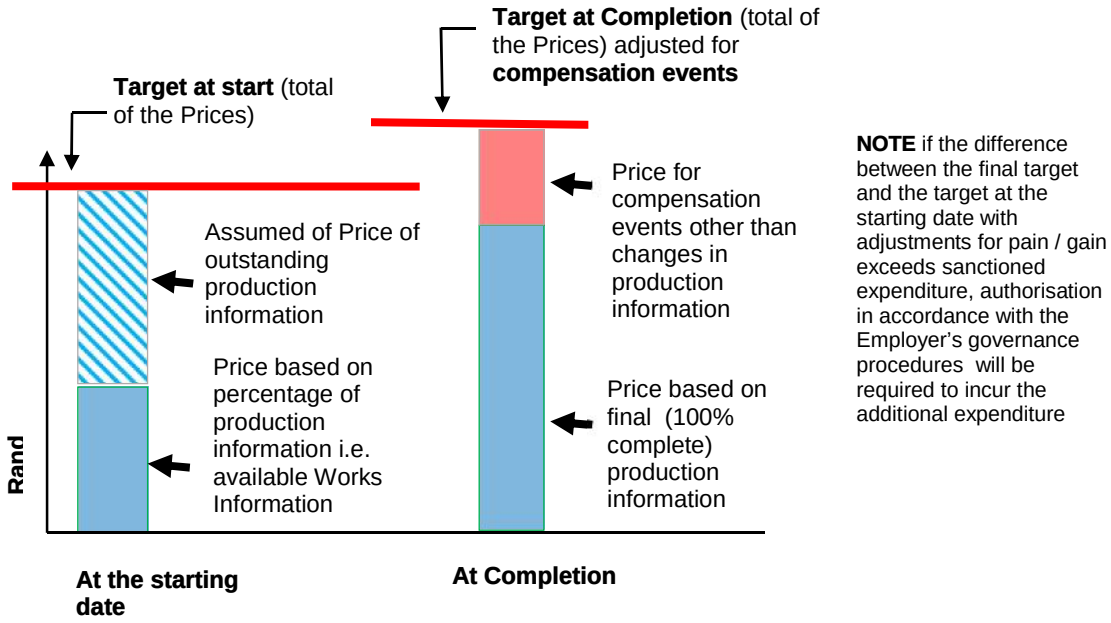

Figure 2: Setting and adjusting incremental targets to "fast track" construction

Accordingly, a contractor can be provided with a description for the whole of the works which he is ultimately to provide. He can prior to commencing the works be required to programme the whole of the works and to only price a portion of the works where the production information is complete. An assumption can then be made as to what allowance should be made for the balance of the works for which production information is not yet available. These assumptions can be revisited as and when new production information is available and adjustments to the target, the date for Completion and Key Dates can be made. The accuracy of the assumptions made can be improved upon should they be developed with contractor insights (Watermeyer, 2015). This is the approach that was used on both campuses.

Outcomes in delivering the 2016 facilities

Financial performance in terms of control budgets and cost norms

The shifts in control budget at various stages in the delivery process are indicated in Table 4. All the buildings at Sol Plaatje University fell within the DHET cost norms while the construction of bulk on site infrastructure for the new buildings fell within 13% of the sum of the costs based on the DHET ASMs for the buildings which were serviced. One of the buildings at the University of Mpumalanga which had an awkward footprint exceeded the cost norm.

The DHET Project Management Team in April 2015 derived a June 2016 Building Cost Unit. The published 2015 BCU value of R 20 328 was used as the base value. This was escalated, using the MFA/BER First Quarter 2015 BER Indices, to a value of R 21 975 (average index of 8,1% forecasted escalation for 2016). What was not realised at the time was that the 2015 published value of R 20 328 overestimated the BCU. The correct procedure should have been to calculate the actual increase from the 15th June 1995 Rand equivalent value of R 3 494 including VAT using actual indices and applying a forecasted index only for one year in advance. During the revalidation exercise it was discovered that from 2009 the forecasted indices had not been replaced with actual indices so that the increase was overestimated. The actual 2016 value calculated in 2017 should have been R 17 239. The recalibration exercise indicated that the June 2016 BCU based on Gauteng rates should have been R 19 256; the difference being attributed to changing requirements in security (access control and CCTV), IT provision and green building design, including adequate sun shading, low E glass, etc. If however, the adjustment

factors (location rate factor x coastal factor x climatic factor (see Table 3)) is taken into account, the 2016 BCU will be R 21 953 and R 21 664 for the Sol Plaatje University and the University of Mpumalanga, respectively.

The final cost expressed as a percentage of the different BCUs (cost norms) which could be used to establish a benchmark are indicated in Table 5. The design efficiencies that were achieved with the assignable spaces in relation to the gross building areas are indicated in Table 6.

Table 4: Changes in control budgets as the work packages were developed

Work package (see Table 2)	**Control budget (including VAT)**		**Final account (including VAT and professional fees)[3]**	**Cost based on DHET ASM of completed building including professional fees and VAT[4]**
	Based on elemental cost analysis prior to contractor pricing the order[1]	**Based on agreed target price at the time that the order was issued[2]**		
Sol Plaatje University (SPU)				
C001	235 409 325	217 870 833	209 650 271	227 542 314
C002	248 472 064	243 958 078	232 145 660	245 227 872
C003	187 391 695	174 421 800	172 072 166	177 137 214
CX01	83 480 485	89 773 571	81 895 017	84 487 962[6]
Total			695 763 114	734 395 362
University of Mpumalanga (UMP)[7]				
L001	121 079 793	100 117 037	91 605 442	114 361 048
L004[5]	47 224 073	47 621 235	47 070 781	31 797 058
L006	202 436 746	184 023 243	180 106 624	185 734 436
Total			320 468 897	331 892 542

Notes

1 Includes estimate of construction based on limited information, a provision for price adjustment for inflation, a contingency of 5% and professional fees at 17% (UMP) and 19% (SPU).

2 Includes construction cost, a provision for price adjustment for inflation, a contingency amount of 5%, and a professional fee estimate based on the tendered fees.

3 Based on actual costs.

4 Based on a BCU of R 21 975.00 including VAT (2016) and ASM calculated from record drawings.

5 Estimated costs exceeded the ASM value due to the awkward nature of the site, expensive foundations and the small footprint of the building with high wall to floor ratio.

6 Value derived from 13 percent of the sum of the DHET ASM values for buildings C001, C002 and C003.

7 The electrical, civil and bulk infrastructure control budget amounted to R 87 482 995. The final account amounted to R 76 692 025. This equates to 24% percent of the ASM costs for L001, L004 and L006. However, this infrastructure is able to service the next phase of buildings and will reduce as a percentage when all the buildings which are serviced are taken into account.

Table 5: Efficiency of final cost in relation to different ASM benchmarks

University	**Efficiency against cost based on cost norm (final account / ASM x BCU) x100 (percent)**			
	R 21 975 (value used as a benchmark)	R 17 239 (correct current DHET value)	R 19 256 (proposed value de-escalated to June 2016)	R 19 256 multiplied by proposed Table 3 adjustments[1]
Sol Plaatje University	94.7	120.7	108.1	94.8
University of Mpumalanga	96.6	123.1	110.2	97.9

[1] R 21 953 and R 21 664 for the Sol Plaatje University and the University of Mpumalanga, respectively

The buildings that were delivered at the Sol Plaatje University and the University of Mpumalanga were on average 5,6 percent and 3,4 % below the DHET cost norm that was used as a benchmark, respectively. On the other hand, the Sol Plaatje University and the University of Mpumalanga buildings

had an average efficiency (ASM / gross building area) of 66% and 73%, respectively, compared to a targeted value of 70%.

Table 6: Design efficiencies

Work package (see Table 2)	**ASM (m^2)**	**Gross building area (m^2)**	**Efficiency (ASM / gross building area)**
Sol Plaatje University			
C001	8 474	12 747	66%
C002	9 235	13 532	68%
C003	5 887	9 624	62%
Average			**66%**
University of Mpumalanga			
L001	4388	6153	**71%**
L004	1 281	2 123	60%
L006	5 899	7 536	78%
Average			**73%**

Cost and time performance

Table 7 sets out the assumptions that were made in the Pricing Assumptions including the amount of work not priced at the time that the Package Orders were issued in order to allow contractors to commence with the works before the design had advanced to a stage where all the works could be accurately priced. The Sol Plaatje buildings had uncertainty in the pricing of the three buildings of between 69 and 74% of the target price included in the Package Orders issued to contractors. This uncertainty in the University of Mpumalanga buildings was between 23 and 44%.

The percentages in Table 7 provides an indication of the state of the design development when the target price for each Package Order was agreed, based on elemental cost estimates. The design team were tasked to complete the outstanding work as far as possible within the target prices for a Package Order. Where design solutions resulted in cost increases, savings or trades offs were sought elsewhere to bring the total of the prices back to within the agreed target price.

Table 8 indicates the number of days between the starting date for a Package Orders and planned and actual Completion Dates. The schedule for Completion was always optimistic given that there were in several instances two December / January industry shut downs and a late start to construction following the procurement processes. Acceleration was paid for on building C002 to advance the Completion Date on the academic facilities. All academic teaching spaces were capable of being used at the start of the term despite the Package Orders not achieving the original Completion Dates. The office spaces on Building C002 were completed late due to a design error arising from the failure to connect a beam in a stairwell to a column. This resulted in excessive deflection of a floor slab and damage to the staircases in the stairwell. Remedial works were required to jack up the floor slab, connect the beam to the column, demolish and rebuild a portion of the stairs and to install hangers to tie the floor slab that sagged to the floor above to reduce deflections – a delay of 2,5 months. No delay damages for late completion were applied as the Completion Dates that were revised in accordance with the contracts were achieved.

Table 9 indicates the shifts in the costs from the initial agreed target price to the final cost to client. The contract made provision for price adjustment for inflation. The contract price adjustment is calculated in accordance with the provisions of the contract on the progress payments which are based on “today’s cost” plus the Fee (Price for Work Done to Date) and is added to the target price. Accordingly, the “today’s cost” plus the Fee needs to be de-escalated to the starting date before calculating the adjustment to the target price. An allowance for price adjustment for inflation needs to be made in the initial target price so that the growth in target price arising from compensation events (events for which

the contractor is not at risk) can be compared to the final cost plus the Fee and the target price at Completion.

Table 7: Assumptions relating to work not priced in the Package Orders

Work package (see Table 2)	**Assumptions excl VAT included in the target price**	**Value of assumptions as a percentage of the Target Price**
Sol Plaatje University		
C001	⁾ all the work excluding the concrete structure and embedded services is R 109 388 176 including the Fee ⁾ allowance or earthworks subcontractor's P & Gs of R0,26 m ⁾ soft and hard rock and earthworks quantities, quantities for mass concrete under bases, concrete reinforcement quantities and uncertainties in structure of building ⁾ allowances for items embedded in and associated with the structure for R 2.9m	**69%**
C002	⁾ all the work excluding the concrete structure and embedded services is R 116 559 784.50 including the Fee ⁾ uncertainties in structure of building, soft and hard rock and earthworks quantities and concrete reinforcement quantities	69%
C003	⁾ all the work excluding the concrete structure and embedded services is R 90 549 866 including the Fee ⁾ allowances for printing, soft and hard rock of R0,7 m. permanent formwork for the auditorium seating of R1,7m and concrete reinforcement quantities ⁾ diesel rate for generator	74%
CX01	⁾ allowance for breaking up concrete and provision of additional pipes for R0,45 m ⁾ uncertainties in information ⁾ allowance for thermally activated building systems (TABS) for R5,95m, wet services for R5,4m, fibre optic installation of R 2.1 m, fire services of R1,6m, emergency generator of R1,65 m and miscellaneous items of R2.74m	25%
University of Mpumalanga		
L001	⁾ civil works, foundations, structural frame, roof, external works, internal plumbing etc – R37.4 m	44%
L004	⁾ electrical, HVAC and lift - R4.70 m, piling – R1,63 m and other – R2.43 m ⁾ hard and soft rock and reinforcement quantities.	23%
L006	⁾ civil works, foundations, structural frame, roof, internal plumbing etc – R34,2m ⁾ provisional sums - R20,7 m ⁾ hard and soft rock and reinforcement / steel quantities.	36%

Table 8: Planned and actual Completion

Work package (see Table 2)	**Starting date for order**	**Completion Date**		**Planned calendar days**	**Actual calendar days**	**Percent variance**
		When order issued	**When order completed**			
Sol Plaatje University						
C001	13 October 2014	15 January 2016	2 March 2016	460	508	+10,4%
C002	13 October 2014	15 January 2016	5 July 2016	460	602	+30,9%
C003	13 October 2014	15 January 2016	8 April 2016	460	544	+18.3%
CX01	27 April 2015	15 January 2016	20 May 2016	264	390	+47,8%
University of Mpumalanga						
L001	1 November 2014	15 December 2015	5 February 2016	410	462	+13%
L004	27 June 2014	18 February 2016	24 March 2016	237	272	+15%
L006	27 October 2014	17 November 2015	2 February 2016	387	464	+20%

Table 9: Shifts in the total of the prices in the construction works contract

Work package (see Table 2)	**Target price at the start**	**Target price at the start with allowance for inflation[1]**	**Final target price[2]**	**Price for Work Done to Date at Completion[4]**	**Client gain (+) / pain (-)**	**Cost to client**
Sol Plaatje University (SPU)						
C001	178 336 429	184 703 040	184 543 260	181 652 357	+ 1 445 452	183 097 809
C002	191 776 818	198 623 250	208 263 636[3]	198 036 334	+ 5 208 489	203 055 148
C003	140 366 859	145 377 956	149 129 474	154 303 411	-2 586 969	151 716 443
CX01	76 109 401	77 920 805	78 443 843	73 980 895	+ 2 297 733	75 405 110[5]
Totals		606 625 051	620 380 213	607 972 998	+ 6 364 705	613 274 510
University of Mpumalanga (UMP)						
L001	79 392 515	82 171 599	79 802 745	78 685 387	+ 558 679	79 244 067
L004	38 749 003	40 234 912	38 945 512	42 768 205	-1 529 076	40 474 589
L006	152 222 456	158 570 132	156 082 984	155 720 087	+ 181 448	155 901 536
Totals		280 976 643	274 831 241	277 173 679	-788 949	275 620 192

Notes

[1] The escalation allowances (estimates) were calculated using the MFA/BER indices.

[2] Includes compensation events and price adjustment for inflation calculated in accordance with the provisions of the contract.

[3] Includes R 5,1 m for compensation event associated with the failure by a structural engineer to connect a beam to a column in a stairwell and an acceleration cost of R 2,1 m.

[4] Audited value for Defined Cost plus the Fee less Disallowed Costs

[5] Includes a low performance damage deduction of R 741 000 for failure to attain development targets

It can be seen from Table 9 that, despite the assumptions regarding the work not capable of being priced (see Table 7) and significant changes in the Completion Dates being made (between 10 and 48% in the case of the Sol Plaatje University and between 13 and 20% in the case of the University of Mpumalanga) the average difference between what was planned (initial target price with an allowance for price adjustment for inflation) and the final amount paid to contractors was on average plus 1% in the case of the Sol Plaatje University where the uncertainty at the start was greatest and -1% in the case of the University of Mpumalanga.

A “gain” was achieved on 5 of the 7 Package Orders that were issued. The average “gain” made by the employer at the Sol Plaatje University (see Table 9) was approximately 1% of the total of the Prices for Work Done to Date at Completion whereas the “pain” incurred at the University of Mpumalanga was approximately 0.3%.

Professional fees

Table 10 provides a breakdown of the direct costs associated with a package. A breakdown of professional fees for the six buildings is shown in Table 11. These fees are significantly lower than the recommended tariffs published by the various built environment councils. This is due to the competitive tender process that was followed in procuring consulting services. A comparison of the professional fees for the three buildings for the Sol Plaatje University to that which would have been paid had the recommended tariff being used indicated a saving of just over 20%.

Table 10: Direct costs professional fees and construction costs associated with each package

Work package (see Table 2)	Final account for the package (Rand)	Final construction cost to client (see Table 9)	Final professional fees	Percentage of construction cost (%)
Sol Plaatje University				
C001	209 650 271	183 097 809	26 552 462	14.50
C002	232 145 660	203 055 148	29 090 512	14.31
C003	172 072 166	151 716 443	20 355 723	14.42
CX01	81 895 017	75 405 110	6 489 907	8.61
University of Mpumalanga				
L001	91 605 442	79 244 067	12 361 375	15.60
L004	47 070 781	40 474 589	6 596 192	16.30
L006	180 106 624	155 901 536	24 205 088	15.53

Table 11: Breakdown of professional fees

Professional service	Sol Plaatje University Work Packages[1]			University of Mpumalanga Work Packages[1]		
	C001	C002	C003	L001	L004	L006
Project management consultant[2]	2.38	2.27	2.44	2.71	2.93	2.69
Architectural consultant	5.50	5.56	4.12	5.14	5.78	6.30
Cost control consultant	2.63	2.48	2.03	3.23	3.44	2.91
Structural engineering consultant	1.93	1.88	1.88	2.17	1.59	1.74
Electrical engineering consultant	0.37	0.36	0.80	0.79	0.54	0.39
Mechanical engineering consultant	0.46	0.50	0.74	0.26	0.68	0.65
Wet services consultant	0.36	0.39	0.27	0.30	0.25	0.17
Traffic engineering consultant	-	-	-	0.14	-	-
Geotechnical engineering consultant	0.06	0.06	0.08	-	0.06	0.02
Civil engineering consultant	-	-	-	-	0.16	-
Health and safety consultant	0.14	0.12	0.17	0.12	0.11	0.11
Acoustic engineering consultant	0.04	0.08	0.18	0.10	0.24	0.16
Environmental control officer	0.06	0.06	0.08	0.06	0.06	0.06
Environmental sustainability Consultant	0.23	0.20	0.25	0.22	0.20	0.20
Fire engineering consultant	0.23	0.22	0.21	0.25	0.26	0.16
Audio visual consultant	0.12	0.10	0.16	-	-	-
Total	**14.50**	**14.31**	**13.42**	**15.60**	**16.30**	**15.53**

[1] Based on final construction cost to client (see Table 9)

[2] The project management fees relate to contract management (NEC3 Project Manager) and project leader (non- technical leading of planning and design stages) functions. It excludes the collective management costs of the all projects (i.e. those that were under construction and those being planning and designed). These values should be increased by about 33% to account for such management. Accordingly, the above fees underestimate the professional fees by between 0.7 and 1 percentage points.

Quality of buildings

Quality can be defined as the totality of features and characteristics of a product or service that bears

on the ability of the product or service to satisfy stated or implied needs. The satisfying of stated needs can be viewed as compliance with requirements or specified performance whereas compliance with implied requirements can be viewed as the degree of excellence. Quality includes, aesthetics, durability, maintainability and environmental sustainability.

The buildings were delivered in accordance with the specifications of the professional team. There were, however, due to the "fast track" nature of the project, some of the work fell short of excellence in some areas within the Sol Plaatje University precincts. A decision was taken to spend R 10,3 million to enhance the completed works on this precinct i.e. 1,5% of the cost of the 4 Work Packages. Nevertheless, Building C002 on the Sol Plaatje University campus was entered in a number of design competitions. The execution of the sun-shading solution in the form of wind driven louvres and bespoke multi-coloured vertical louvres was listed among 7 finalist in the Commercial Architectural Category of the 2016 Southern African institute of Steel Construction Awards. It has also been shortlisted as a finalist in the Higher Education and Research and the Best Use of Colour categories at the 2017 World Architectural Festival.

Furniture, fittings and equipment

Table 12 indicates the original allowance for furniture, fittings and equipment and expenditure incurred in this regard. Expenditure was well within budget.

University	Original allowance (percent)	Expenditure (percent)
Sol Plaatje	8%	5.84%
University of Mpumalanga	8%	6.68%

Conclusions

Clients need to define the priorities for the trade-offs between cost, time and quality at the outset of a project. Fixing the time variable frequently impacts negatively on cost and quality as illustrated in Figure 3. Time was fixed on these projects as academic facilities were required at the start of the 2016 academic year. This necessitated that the works commence before the designs were complete and assumptions be made on the value of the work (25 to 74%) not capable of being accurately priced when work was instructed.

The project outcomes in terms of time cost and quality can be summarised as follows:

- **time:** although the Package Orders were not completed within the optimistic initial time frames which straddled in some instances two industry shutdown periods, agreed to at the start of such orders and the actual time for completion exceeded the planned time for completion between 10 and 48%, all academic facilities were opened at the start of the 2016 academic year;

- **cost:** the buildings were delivered slightly below the DHET cost norms for university facilities while the Work Packages were delivered within 1% of the target price (with an allowance for price adjustment for inflation) agreed to when the orders were issued, despite extensions of time being granted and the designs being incomplete when the works commenced;

- **quality**: the works were in accordance with the specifications.

Accordingly, the adopted procurement and delivery management strategy, which revolved around collaborative long term relationships, mitigated the risks associated with fast track construction. The client the schedule, budget and quality objects set for the project.

The World Bank Procurement Regulations for IFP Borrowers (2016) suggests that value for money is the "*effective, efficient, and economic use of resources."* The National Treasury Standard for Infrastructure Procurement and Delivery Management (2015) defines value for money as "*the optimum use of resources to achieve intended outcomes*".

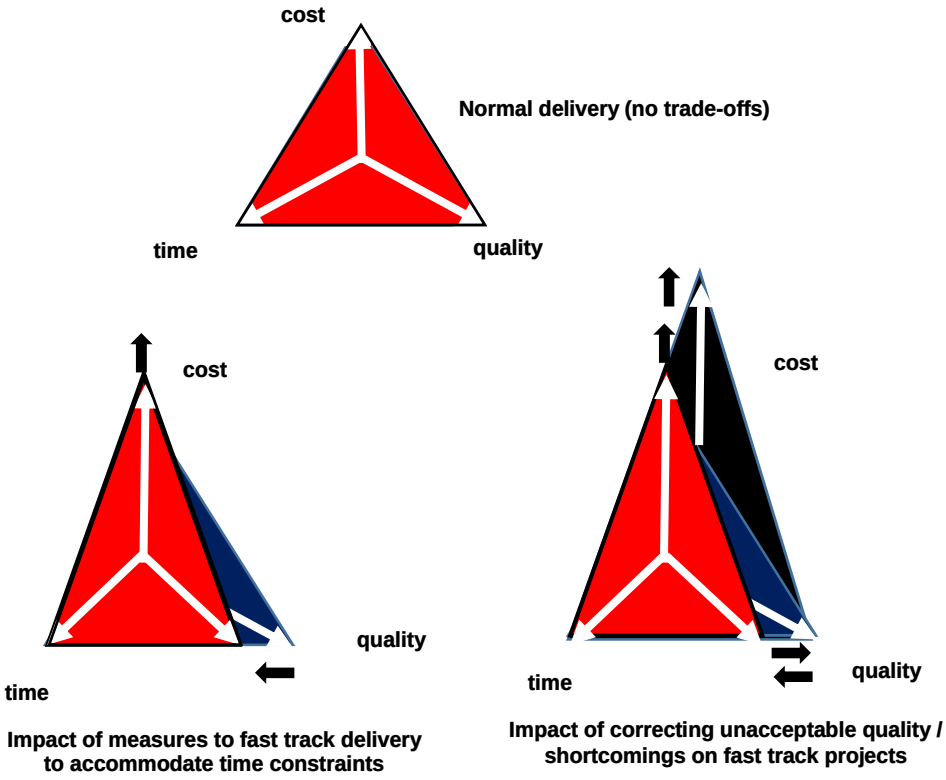

Figure 3: Common trade-offs between cost and quality where time is fixed

Underlying value for money is an explicit commitment to ensure that the best results possible are obtained from the money spent, or maximum benefit is derived from the resources available. It is about striking the balance between the three "E's", namely, economy, efficiency and effectiveness. The critical starting point in delivering value for money through infrastructure projects is, in the first instance, to align such projects with strategic objectives, priorities, budgets and plans, and thereafter, during the planning phase, to clearly define objectives and expected outcomes, as well as parameters such as the timelines, cost and levels of uncertainty. This frames the value-for-money proposition that needs to be implemented at the point in time that a decision is taken to proceed with a project, i.e. it establishes "economy". The end point is to compare the projected outcomes against the actual outcomes, i.e. to confirm the "effectiveness" of the project in delivering value for money.

Implementation sits between "economy" and "effectiveness" in the results chain framework. It needs to be executed "efficiently" in order to minimise time delays, scope creep and unproductive costs, and to mitigate the effects of uncertainty on objectives so as to maintain the value-for-money proposition formulated at the outset of the project. This necessitates that those who implement infrastructure projects exercise due care and reasonableness during implementation. Failure to do so may result in substandard or unacceptable performance, which results in a gap between intended and achieved outcomes. This gap puts value for money for a project at risk.

Given that the gap between what was planned and what was achieved is very close, it may be concluded that value for money was achieved in delivering the 2016 facilities for the two new universities.

The outputs of the team responsible for the delivery of the facilities for the 2016 academic year at the Sol Plaatje University and the University of Mpumalanga confirms that South Africa has the skills, the people and the tools to deliver challenging fast track projects without compromising budget and quality imperatives. It also indicates what is possible in the public sector when a client has an awareness of the delivery options that are available and possesses the necessary leadership and determination to implement an appropriate option.

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