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An evaluation of projects within Soweto's contractor development programme

Synopsis

Projects within Soweto's Contractor Development Programme, which has been in operation since 1988, are evaluated in terms of certain project evaluation criteria. Parameters that may be used to measure the increase in employment and entrepreneurial opportunities generated by preferring certain technologies and construction practices over others are developed and evaluated. A project index that may be calculated by means of a simple formula is presented to evaluate both projects within a programme and the programme itself. This index may also be used to compare the effectiveness of different projects in meeting certain developmental objectives. The implications of the method of evaluation are discussed in terms of the Reconstruction and Development Programme and the NEF's proposed Public Works Programme, and its usefulness as a decision-making tool for implementing innovative technologies and evaluating current and historic initiatives is examined.

Afrikaanse samevatting op volgende bladsy.

Introduction

Soweto's Contractor Development Programme (CDP) is a unique programme that embraces labour-intensive methods and labour-based technologies. It furthermore encourages and trains the community to participate in the managerial, commercial and administrative aspects of construction. The programme, by its very structure, increases the labour-content of a construction project and, at the same time, trains local entrepreneurs in labour-based construction methods of installing services. In this way, technical, commercial, managerial and administrative skills are developed within the community with a concomitant increase in earning capacity. At the same time, the community retains and cycles a significant proportion of the money spent on a project. Local entrepreneurs who are from the outset employers in the community can, with sufficient technical and financial support and instruction, become fully fledged contractors and, as such, provide greater earning opportunities for others in the community. Thus the project may be described as a job creation programme with the potential for sustainability through entrepreneurial development.

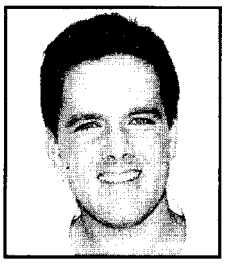
The programme objectives of the CDP may be described as being to *structure and to execute construction projects* using labour-based technologies and labour-intensive methods in such a manner that through the construction process:

- Employment and entrepreneurial opportunities are created for members of the community
- Skills and competencies in technical, commercial, managerial and administrative areas are transferred to participants
- The percentage of the construction cost retained by the community is maximized

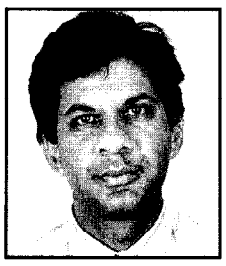
Project objectives, on the other hand, may be described as being to have the works constructed to specification within a specified period and a given budget using community-based contractors and labour-based construction practices in such a manner that:

- Opportunities for employment and training are created for the local community
- As much of the project expenditure as possible is retained by the community

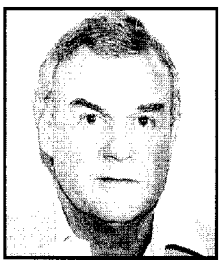
Ron Watermeyer *graduated as a civil engineer from the University of the Witwatersrand in 1978. Since 1988 he has been directly involved in the implementation of civil engineering labour-based/community-based projects and the creation of a contractor development programme in Soweto. He has been responsible for the development of contract documentation and standardised specifications and co-ordinates the development team responsible for managing and training local contractors. He is a director of Soderlund and Schutte Inc and currently serves on the joint ISE/Structural Division Committee.*



Graham Nevin *graduated as a civil engineer from the University of Cape Town in 1983 and obtained a BCom through Unisa in 1991. While in the employ of BKS Inc and a member of the project team appointed by the CWRSC to assist in the management of projects in Soweto, he in 1991 became directly involved in Soweto's labour-based/community-based programme. Since 1992 as an employee of Johannesburg City Council seconded to the Projects Branch of Soweto City Council, he has continued to play an integral part in the management of the labour-based projects and the development of the programme as a whole.*



Sam Amod *is a graduate of the University of Durban-Westville (BEng 1984) and the University of the Witwatersrand (MSc (Eng) 1994). His experience ranges from the design and construction of major industrial installations to the development of small-scale enterprises. He is currently involved with a variety of community upliftment projects, including the procurement and management of materials for the construction of roads, services and housing using labour-based methods. He is a senior project manager at Project Management Techniques (Pty) Ltd.*



Dick Hallett *graduated as a civil engineer from the Brighton College of Technology in 1966. He worked for the contracting firm Cementation Construction and gained his Chartered Engineer status prior to emigrating to South Africa in 1976. Following nearly 12 years in the road planning and traffic engineering section of the Johannesburg City Council, he joined the Soweto City Council's Engineers' Department. He has been involved in the Contractor Development Programme since its inception in 1988 and has been responsible for the promotion of the programme in Soweto. He currently holds the position of City Engineer.*

- Community-based contractors (local entrepreneurs) are developed from within the community
- A sense of participation is fostered within the community
- Members of the local community are, as far as practicable, employed by the construction and materials managers to assist them in the execution of their duties (Soderlund and Schutte Inc, 1994)

The Executive Director of the United Nations Commission on Human Settlements (UNCHS) suggests that 'there is need for empirical research on the scale of benefits likely to accrue from particular levels and types of employment generated by adopting labour-based methods for public works provisions, and the likely number of jobs which will result from particular policy choices ... Issues which need to be examined include the effects on labour costs and efficiency of large-scale use of labour-based methods in public works provision and ways in which the exploitative component of low wages can be minimized through bonuses, training, etc ... given that both employment-creation and having people unemployed have costs, the research should assess real and marginal costs and benefits of employment creation within labour-based technologies in both formal and informal sectors in public works in developing countries. This would be directed towards making informed decisions and encouraging shelter and infrastructure investments in competition with other sectors, the advisability of reducing capital costs at the expense of (or in order to achieve) labour inputs for maintenance, and other policy issues in the choice of labour-based technologies' (Commission on Human Settlements, 1992).

Soweto's CDP has been in operation since 1988. Approximately R50 million was spent in the programme between July 1988 and June 1994. In excess of 215 km of secondary water mains were laid, 19 500 erven were replumbed and 30 000 m² of roads were surfaced during this period. It was considered that there was sufficient data available and that it was highly desirable to evaluate the project along the lines suggested by UNCHS.

Project evaluation criteria

Appropriate project evaluation criteria are required to examine the degree to which the various projects within the programme address the project and programme developmental objectives.

Historically, projects involving the creation of assets using public funds have been evaluated in terms of:

- Providing value for money
- Creating useful and appropriate assets
- Being auditable
- Clearly assigning accountability

Accordingly projects can be evaluated in terms of the project evaluation diamond shown in Fig 1. All activities should fall within the boundaries of this diamond. Any activity falling outside the boundaries of this diamond should be seriously reconsidered or rejected. The removal of any one of the boundaries can have a negative impact on a project (Watermeyer and Band, 1994).

The 'accountability' and being 'auditable' criteria are well established and as such are well entrenched in the various financial regulations, contractual procedures, management plans, etc of local, regional and national public bodies and state departments. The boundaries relating to 'value for money' and 'creation of appropriate and useful assets' will, however, have to be redefined in terms of the objectives of specific projects to address the current social and economic concerns. For example, 'value for money' has traditionally meant awarding a contract to the lowest tenderer. Currently, 'value for money' can mean structuring the contract to provide the most employment opportunities per unit of expenditure. Likewise, the creation of 'useful and appropriate' assets has traditionally been interpreted to be the construction of tangible assets such as services, houses and buildings. Currently, however, the 'creation of useful and appropriate assets' must be broadened to include elements such as the development of human resources, empowerment of communities through skills training, etc (Watermeyer and Band, 1994).

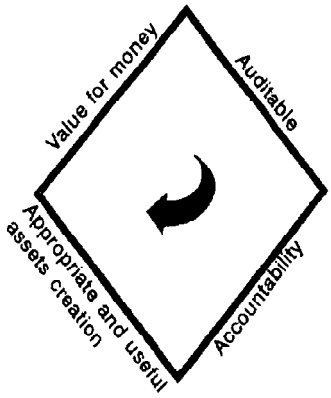


Fig 1: Project evaluation diamond

The boundaries relating to 'accountability' and 'auditable' are addressed in the documentation developed for Soweto's CDP, ie model forms of agreement, advisory notes, contract documentation, etc (Soderlund and Schutte Inc, 1994) and the CWRSC's project management plan. The boundary relating to the 'creation of useful and appropriate assets' on the other hand is defined by the developmental objects of the project. However, to ensure that standards are not unduly compromised by the technologies and the approach to construction that is adopted, the quality of the end product must be compared with that produced using conventional construction methods. At the same time, parameters need to be established to measure the effectiveness and efficiency of the choice of technologies and construction practices on the stated development objectives relating to human resources.

To establish the boundary representing 'value for money' it is necessary to develop parameters to evaluate the benefits accruing to the recipients against the cost of these assets. In particular, the parameters should identify the cost premium to be borne for preferring certain technologies and construction practices over others. Once these parameters are established, the boundary relating to 'value for money' may be set on a project-specific basis.

An approach to evaluating projects

Philips et al (1994) recently developed a choice of technique analysis (COTA) system as an analytical tool to assist funding bodies to manage the complex process of increasing the labour intensity of construction techniques. COTA is divided into three parts. The first part (P1) covers the part of the decision-making process that involves the elimination, on technical grounds, of possibilities for using labour-intensive techniques for individual construction activities. The second part (P2) covers the part of the decision-making that involves making cost comparisons. The third part (P3) covers the part of the decision-making process that involves monitoring and evaluation or, in other words, the feedback mechanism.

In essence this approach seeks to examine the implications of and to provide a means of justifying a decision taken with respect to increasing the labour-intensive components on projects at the expense of machine-intensive components. In terms of this approach, the construction cost of the most labour-intensive set of construction techniques that is technically feasible is compared with the direct construction cost of conventional machine-intensive construction. Firstly, financial life cycle costs are calculated for the two designs. Thereafter 'economic' costs are calculated by making adjustments for 'market distortions' to both labour-intensive and machine-intensive costs. In addition, there is a further step of calculating 'social costs' by making adjustments for the benefits resulting from employment creation (such as increasing the equity of income distributed and related benefits) that are not taken into account by purely financial cost comparisons. The cost calculations therefore result in comparative financial, economic and social costs for labour-intensive and conventional machine-intensive construction.

To date, COTA has been developed in theory only, and requires further development through practical application and empirical evaluation.

Watermeyer and Band (1994) in their report commissioned by the National Housing Forum (NHF), on the other hand, suggest that there are a

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Projekte wat binne die bestek van die Soweto-kontrakteursontwikkelingsprogram sedert 1988 uitgevoer is, word in terme van bepaalde projekevalueringskriteria beoordeel. Parameters wat gebruik kan word om die toename in werkverskaffing en ondernemingsgeleenthede te bepaal wat geskep word deur bepaalde tegnologieë en konstruksiepraktyke bó ander te kies, word ontwikkel en geëvalueer. 'n Projekindeks wat deur middel van 'n eenvoudige formule bereken word, word aangebied ten einde 'n projek binne 'n program, asook die program self, te evalueer. Die indeks kan ook benut word om die doeltreffendheid van verskeie projekte ten opsigte van die behaling van bepaalde ontwikkelingsdoelwitte te vergelyk. Die implikasies van die evalueringsmetode word in terme van die Heropbou- en Ontwikkelingsprogram asook die NEF se Openbare Werkeprogram bespreek, en die bruikbaarheid van die metode as 'n besluitnemingsmiddel om vindingryke tegnologieë te implementeer en om huidige en historiese inisiatiewe te evalueer, word ondersoek.

number of ways in which employment opportunities in the provision of housing can be maximized. These relate to:

- Forms of construction
- Construction methods
- Manufacturing methods

To achieve the goal of maximizing employment opportunities, quantitative information needs to be made available to developers, architects, engineers and the like as to which technologies, construction methods, materials, etc, are likely to produce high employment opportunities. The quality and nature of this information must be such that the aforementioned parties can rapidly relate these options to their given set of circumstances and evaluate the cost associated with employment-intensive solutions. At the same time, a labour index needs to be established to measure the efficiency and effectiveness of such solutions. Should a labour-index be established, this can be used as the basis to adjudicate the benefits if certain policies are implemented.

Employment opportunities in the construction of the built environment, ie houses, amenities and infrastructure, were examined in some detail in this NHF study. Manufacturers and producers of a wide range of construction materials were approached to provide information regarding the number of manhours required to produce a unit of their product. It was suggested that this figure should include all the time spent on obtaining raw materials, the manufacture of the item and the stockpiling of the item prior to distribution and could be based on the total number of manhours worked in the industry (management, administrative staff, workers, etc) and the annual quantity of the item produced. The results of this survey are summarized in Table 1. Watermeyer and Band, using the CSIR Division of Building Technology's Housing Delivery Systems Analysis (HDSA) database, were able to estimate the number of manhours required to construct a masonry house for any given floor plan. In this manner, they were able to compare the total number of manhours required to construct houses using different forms of construction (see Table 2). They suggested that employment opportunities should be linked to cost to ensure that sector effectiveness and efficiency are not impaired. Table 3 illustrates the cost implications and compares the cost of the manhours generated in the different forms of house construction presented in Table 2.

Watermeyer and Band demonstrated how similar statistics can be generated for the provision of township services. Table 4 presents such statistics for the servicing of stands in a specific low-cost housing development (typical electrification costs are included for comparative purposes). Manhours associated with the excavation of trenches using labour-based construction methods, based on statistics derived from Soweto's CDP, were then substituted for that associated with plant-based construction.

Table 1: Approximate number of manhours required to manufacture various building and construction materials (Watermeyer and Band, 1994)

Item	*Description*	*Unit*	*Man-hours per unit*
Aggregate	Sands for mortar, plaster and subbase material	ton	0,12
	Sands for concrete	ton	0,15
	Stone for concrete, aggregate for waterbound macadam; crushed stone for road base courses	ton	0,27
	Transport (20 km haul)	ton	0,13
Asbestos		ton	41,5
Bitumen	Road grade	ton	0,7
Cement	OPC	ton	1,1
Clay sewer pipes	150 m dia	100 m	68,2
	100 m dia	100 m	46,1
	150 x 150 junction	No	0,9
	100 mm dia 90 degree bend	No	0,3
Clay masonry units	106 x 212 x 73 (hightech plant)	1 000	3
	106 x 212 x 73 (normal plant)	1 000	9-9,5
Concrete masonry units	140 mm hollow (plant manufacture)	10 m²	5,6-8,2
	140 mm solid (plant manufacture)	10 m²	6,2-8,8
	140 mm hollow (hand manufacture)	10 m²	22,4
Concrete paving units	65 mm thick (plant manufacture)	10 m²	3,6-4,1
Concrete pipes	450 mm dia (stormwater)	100 m	100
	600 mm dia (stormwater)	100 m	125
	900 mm dia (stormwater)	100 m	200
	1 350 mm dia (stormwater)	100 m	335
	450 mm dia (sewer)	100 m	104
	600 mm dia (sewer)	100 m	132
	900 mm dia (sewer)	100 m	210
	1 350 mm dia (sewer)	100 m	350
Concrete roof tile		10 m²	0,9
Door frames	Standard pressed metal	No	0,5
FC roof sheeting		10 m²	4,1
FC ceiling board		10 m²	1,9
FC sewer pipe	150 mm dia	100 m	23
Gate valve	80/90 mm dia RSV	No	2,0
Glass	3 mm float	100 m²	4,2
Gypsum ceiling		10 m²	3,3
HDPE pipe	600 mm spiral wound	100 m	185
	32 mm dia (water)	100 m	3
Hyson cells		100 m²	0,03
Paint	PVA	100 litre	5
Polyethylene	Pipe grade	ton	3,3
Polypropylene	Pipe grade	ton	5,2
Precast concrete products	Average		7,8
Steel roof sheeting	0,6 mm galvanized	ton	21,1
Steel sections	Commercial grade angles, channels and IPEs	ton	10,1
Timber	Structural grade	m³	19,6
uPVC pipes	160 mm dia (sewer, HD)	100 m	30
Window frames	90 mm dia (class 12)	100 m	32
	ND54	No	1,3
	NC1	No	0,8
	NC2	No	0,9
Zinc		ton	25,4

Table 2: Comparison of the number of manhours required to construct non-masonry and masonry houses (Watermeyer and Band, 1994)

Construction type	*Number of manhours (hours) (non-masonry)*			*Number of manhours for equivalent masonry houses (hours)*		
	Materials	*Site labour*	*Total*	*Materials*	*Site labour*	*Total*
Timber (SALMA)	300	1 180	1 480	200	1 700	1 900
Precast concrete panels and posts (Blitz)	150	210	360	120	1 120	1 240
Steel frame with 100 mm brick infill panels (Belaton)	330	880	1 210	160	1 400	1 560

Table 3: Evaluation of non-masonry house types (Watermeyer and Band, 1994)

Construction type	*Estimated costs 1994*		*Cost/manhour (rand/manhour)*	
	Non-masonry	*Masonry equivalent*	*Non-masonry*	*Masonry equivalent*
Timber (SALMA)	47 200	46 100	32	24
Precast concrete panels and posts (Blitz)	16 000	20 300	44	16
Steel frame with 110 mm brick infill panels (Belaton)	28 400	30 800	23	20

Table 4: Manhours required in the provision of infrastructure for a low-cost township using conventional construction methods (Watermeyer and Band, 1994)

Service	*Estimated manhours (%)*		*Estimated total number of manhours/ erf*	*Cost/manhour (rand/ manhour) (March 1992)*
	Materials	*Site labour*		
Water	13	87	39	20
Sewerage	16	84	43	14
Roads (low standard)	14	86	21	36
Stormwater	8	92	26	16
Electricity	70	30	117	20

The implications of these practices are reflected in Table 5. At the same time, Watermeyer and Band generated plant-based and labour-based statistics, with assistance from Mr Emery of Stellenbosch University, in order to determine the manhours associated with different road designs using labour-based and plant-based construction practices. Tables 6, 7 and 8 present some of these statistics.

Evaluation criteria

The evaluation proposals put forward by Philips et al (1994) and those of Watermeyer and Band (1994) were reviewed. Those put forward by Philips et al were considered to be more relevant to the evaluation of a single project rather than a programme comprising a number of projects as they appear to present no measurables that could be used to compare the merits of one project against another. COTA, at the same time, is geared to evaluating alternatives within a specific project or sequence of activities where the potential exists for increasing the labour content by substituting men for machines, eg surfaced roads. In practice, this means that projects that do not involve the use of plant, eg plumbing, traditional masonry house construction, etc, cannot be evaluated. The proposals put forward by Watermeyer and Band, on the other hand, were more generally based and could be further developed to provide an effective means of evaluating projects within a programme and the programme itself.

It was therefore decided to examine and evaluate the following items in order to evaluate the boundaries relating to 'value for money' and some of those relating to 'creation of useful and appropriate assets':

- The multiplier in employment opportunities
- Expenditure per unit of employment generated
- The amount of the construction cost retained by the community
- The cost of the proposed construction compared with that of conventional construction practices
- The quality of the end product compared with that produced using conventional construction techniques

Multiplier in employment opportunities

The multiplier in employment opportunities may be defined as the ratio of the average total number of manhours generated in the construction of a specified structure or service using labour-based technologies to that using plant-based technologies. This ratio should include the number of manhours involved in the manufacture of materials, but exclude that associated with preliminary and general items. This multiplier in effect gives an indication of the increase in the total employment opportunities generated by the selection of specific technologies. As such, this multiplier can be assessed by examining a specified sample length, area or unit, as appropriate, of the structure or service under consideration.

This item in essence examines employment opportunities generated in specific activities or sequences of activities. Should an analysis be performed to undertake a series of activities using fully labour-based technologies, the ratio of the mix of labour-based and plant-based activities to fully labour-based activities would give a measure of the degree to which employment opportunities have been maximized.

This statistic can, however, be somewhat subjective, since the number of manhours generated on labour-based construction projects is dependent on productivity, which is in turn dependent, inter alia, on the following (Watermeyer and Band, 1994):

- Skill of management
- Skill of labourers
- Wage levels
- Method of payment
- Climatic conditions
- Health of the labour force
- Supply of quality hand tools
- Physical conditions such as ground conditions, depth of excavations
- Work ethic of labourers

Table 9 illustrates the variability in respect of excavation rates in pickable materials on different projects (Watermeyer and Band, 1994). Thus the multiplier in employment opportunities can at best provide only an indication of the chosen labour-based technology's performance with respect to employment creation when compared with conventional methods. To be meaningful, it must be examined in conjunction with the cost implication of the increasing employment opportunities.

Expenditure per unit of employment generated

The expenditure per unit of employment generated should be based

Table 5: Provision of water and sewer reticulation in a housing development using labour-based methods of construction (Watermeyer and Band, 1994)

Service	*Labour/ manhours/ erf*		*Cost/manhour (rand/manhour) (March 1992)*	
	Plant-based	*Labour-based*	*Plant-based*	*Labour-based*
Water	39	58	20	14
Sewerage	43	72	14	9

Table 6: Manhours associated with roadwork layers (Watermeyer and Band, 1994)

Layer	*Thickness*	*Manhours to produce and construct (manhours/m²)*	
		Plant-based	*Labour-based*
Road bed preparation (R and R)		0,033	0,350
Gravel wearing course (G5)	125	0,160	1,000
Gravel wearing course (G4)	150	0,192	1,200
Base course (G4)	150	0,192	1,200
Base course (G3)	125	0,165	–
Subbase (G6)	150	0,192	1,200
Waterbound macadam base course	100	1,040	1,370

Table 7: Manhours required to surface roads (Watermeyer and Band, 1994)

Surfacing		*Manhours in respect of materials and construction (manhours/m²)*	
Type	*Thickness (mm)*	*Plant-based*	*Labour-based*
Slurry	15	0,110	2,011
Asphalt	25	0,140	1,170
Concrete blocks	60	0,930	2,120

Table 8: Manhours required to provide and construct 5 m wide surfaced Class D roads (Watermeyer and Band, 1994)

Road	*Construction technology*	*Width (m)*	*Manhours/ m²*	*Manhours/ km*	*Labour-based to plant-based ratio*
Slurry with gravel base	Plant-based	5	1,18	5 885	
	Labour-based	5	7,54	37 705	6,4
Slurry with WBM base	Plant-based	5	1,95	9 765	
	Labour-based	5	7,13	35 655	3,7
Asphalt with G3 base	Plant-based	5	1,19	5 950	
	Labour-based	5	5,72	28 575	4,8
Asphalt with WBM base	Plant-based	5	1,99	9 965	
	Labour-based	5	6,33	31 650	3,2
Concrete block	Plant-based	5	1,77	8 825	
	Labour-based	5	6,02	30 100	3,4

Table 9: Trends in excavation rates for pickable material in various projects (Watermeyer and Band, 1994)

Project/Programme	*Production rates for excavation in pickable material*
Soweto's Contractor Development Programme	2,8 to 3,2 m²/six-hour task
Kenya Rural Roads Programme	3,0 m³/man day
KwaZulu road construction	0,7 to 1,0 m³/man day
Kwa Zulu road construction	0,3 to 1,1 m³/man day
Gazankulu and Venda	1,0 m³/person day
Ciskei	0,6 to 0,8 m³/man day
Ilinge	2,3 m³/man/day
Ibhayi	6,0 m³/man/day
Siviele Konstruksie	5 to 12 m³/man/day
SAFCEC – up to 1,0 m deep	2,5 to 5,0 m³/man/day
– up to 1,5 m deep	1,1 to 4,0 m³/man/day
World Bank standard	3,0 to 4,0 m³/man/day

on the total employment opportunities generated in the construction of a structure or service and the total construction cost excluding VAT but including any management fees directly related to construction activities. Employment opportunities should, therefore, be expressed in manhours and include all the hours associated with preliminary and general items, the manufacture of materials and construction activities. These statistics provide some indication of the cost-effectiveness of the employment generated by the adopted technology.

The statistic obtained in this manner indirectly takes cognisance of a host of factors relating to productivity and wage levels. At the same time, any premiums paid in respect of extended contract duration for the construction of a service using labour-based methods of construction are also taken into account as preliminary and general costs are included in the construction cost, as is the cost of highly paid managerial and supervisory personnel.

This statistic, in essence, provides a measure of the effectiveness and efficiency of the employment generated on a project. Projects that have high construction costs and low productivities will perform poorly in terms of this statistic. Projects having a high management cost will likewise fare poorly. This statistic can also be used to evaluate projects that are labour-intensive by nature, eg plumbing, traditional house construction etc, as well as conventional plant-based projects.

Amount of the construction cost retained by the community

The development of employment opportunities, skills, entrepreneurship and small-scale enterprises in construction can, if certain strategies are in place, lead to economic empowerment. These four development areas form the boundaries of an economic empowerment diamond as shown in Fig 2. The removal of one of these boundaries, ie the omission of a development area on a project, will drastically reduce the potential for economic empowerment (Watermeyer and Band, 1994). Development projects should operate within the confines of this diamond.

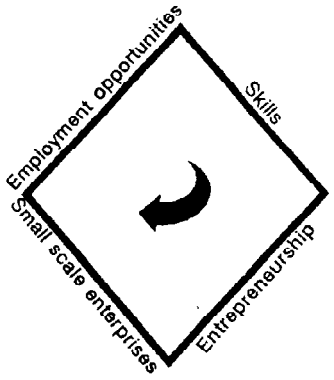

Fig 2: Economic empowerment diamond

The amount of the construction cost that is retained by the community gives an indication of the degree to which entrepreneurship and small-scale enterprises are promoted in the community and is as such one direct measure of economic empowerment within a community.

Cost of construction compared with that of plant-based construction

The cost of construction should exclude VAT but include all costs pertaining to construction, including any management and on-the-job training support costs provided for emerging contractors. Conventional professional fees relating to design and contract administration should, however, be excluded from such costs. This comparison should give an indication of the premium, if any, to be paid for the social benefits that result from the technologies and methods selected.

It should be borne in mind that cost comparisons between labour-based and conventional construction are coloured by the prevailing economic climate. During recessionary periods, plant is frequently priced at unrealistically low rates.

The data that is currently available is accordingly influenced by the present recession. In a free market system where supply and demand dictate prices, the provision of infrastructure on a large scale will cause a boom in the civil engineering industry and drive plant-based prices upwards. Labour rates, however, will be relatively unaffected by such a boom. Consequently, future comparisons may well show that plant-based construction practices are significantly more expensive (Watermeyer and Band, 1994).

Quality of end product compared with that produced using plant-based construction

This comparison should simply highlight the differences in specified standards and the associated impact on the end products. This should be undertaken with due regard to the appropriateness of the specified quality. 'Higher quality' can be subjective and not necessarily cost-effective.

Appraisal of current projects

In Soweto, the development team approach (Soderlund and Schutte Inc, 1994; Watermeyer, 1992; Watermeyer and Band, 1994) is used to implement the various construction projects in the CDP. In terms of this approach, a construction manager prepares a preconstruction stage report prior to the award of contracts that, inter alia, sets out the following (Soderlund and Schutte Inc, 1994):

- Proposed organizational structure
- Estimated requirements for plant, tools and equipment, materials, specialist contractors, transport and site establishment
- Proposed programme of work covering each construction activity
- Estimated cost of the works
- Materials requirements

At the same time, the construction manager prepares an estimate (shadow price) to protect tenderers from tendering unrealistically low prices and to enable tenders to be adjudicated. This estimate is based on an agreed profit margin, average productivity rates and the prevailing minimum wage and statutory obligations.

The City Engineers' Department has issued a directive that the prevailing minimum wage be used to determine of such estimates. Note that the legal provisions of the minimum wage do not apply to an employer who does not employ more than 20 employees at all times and whose annual turnover in any 12-month period does not exceed R1 million.

Reasonably accurate data can be obtained to evaluate projects using the above sources of information. This data can be readily compared with previously completed projects or be confirmed upon completion of a project, since construction managers are required to produce post-construction stage reports that set out the following, among other things (Soderlund and Schutte Inc, 1994):

- Final costs of the works
- Unit costs
- Expenditure on provisional sums
- Actual versus programmed completion dates
- Training received by contractors
- Projected versus actual expenditure
- Materials usage

Pilot projects can also be used to provide statistics for evaluation parameters. In this regard, it is interesting to note that the productivity rates for various roadwork activities that were established on a pilot project conducted late in 1991 (Watermeyer, 1992) are still, in the main, considered to be representative in 1994.

Multiplier in employment opportunities

Tables 10 and 11 present the estimated manhours associated with each

Table 10: 5 m wide waterbound macadam asphalt surfaced road

Layer	*Type*	*Manhours required to construct a square metre of road*		
		Plant-based	*Labour-based*	*Soweto's CDP*
Surfacing	20 mm	0,12	0,99	0,12
Basecourse	125 G2/ WMB	0,17	1,72	1,72
Subbase	125 G6	0,13	0,60	0,60
Boxcut		*0,20*	*1,85*	*1,85*
Rip and recompact subgrade		0,03	0,35	0,35
Kerbing	Mountable	0,44	0,59	0,44
Total		1,09	6,10	5,08

Table 11: 5 m wide concrete block paved road

Layer	*Type*	*Manhours required to construct a square metre of road*		
		Plant-based	*Labour-based*	*Soweto's CDP*
Surfacing	80 mm concrete block	0,93	2,12	0,93
Subbase	150 G6	0,16	0,70	0,70
Box cut		0,17	1,56	1,56
Rip and recompact subgrade		0,03	0,35	0,35
Kerbing	Mountable	0,44	0,59	0,44
Total		1,73	5,32	3,98

activity in Soweto's roads programme. These estimates are based on actual statistics derived from previous contracts. These figures include the manhours associated with the manufacture and transportation of materials to the site, but exclude those associated with preliminary and general items or management. Figures associated with plant-based and fully labour-based construction are provided for comparative purposes. The projects in question realise 75 per cent of the potential employment opportunities available in respect of the waterbound macadam roads and 83 per cent in respect of concrete block paved roads. This is due to Soweto's requirements for asphalt surfacing by conventional means and no on-site manufacture of materials.

A similar study was performed by Watermeyer and Band (1994) in respect of township water reticulations using productivity rates from Soweto's CDP. They found that the multiplier was about 1,9 in respect of earthwork activities and 1,4 where pipelaying activities were combined with earthwork activities.

The multiplier in employment opportunities in construction activities using Soweto's CDP work methods may be summarized as follows:

- Excavate and backfill trenches for water reticulation 1,9
- Excavate, lay pipes and backfill water reticulation 1,4
- Construct waterbound macadam roads 4,7
- Construct concrete block paved roads 2,3
- House connections (plumbing) 1,0

It should be noted that plumbing work cannot be performed by machine, hence a value of unity is recorded. These statistics confirm that the construction technologies employed in Soweto are of a labour-intensive nature.

Expenditure per unit of employment generated

The estimated total number of manhours generated in respect of materials, site labour and management for the various projects in Soweto is presented in Table 12, while Table 13 presents the expenditure per unit of employment generated.

It can be seen from Tables 10 and 11 that the number of manhours involved in road layerworks is significant and has considerable influence on construction costs. Reductions in layer thicknesses will probably marginally increase the cost per manhour given in Table 13.

The amount of the construction cost retained by the community

The percentage of the construction cost retained by the community is presented in Table 14 and summarized in Table 15. It should be noted that the community is involved not only in the construction contract, but also in the transport of materials from the store to the site and in the development support provided by the construction and materials managers. The percentage of the management fee retained by the community varies considerably between construction managers and ranges from 25 to 45 per cent of the total construction fee, inclusive of site staff charges, establishment costs and disbursements. The percentage retained in respect of materials management costs is approximately 25 per cent.

Table 12: Estimated number of manhours generated in Soweto's CDP

Type of construction	*Unit*	*Estimated number of manhours/ unit (hours/unit)*			
		Materials	*Site labour*	*Management*	*Total*
Road construction (waterbound macadam + stormwater)	m^2	0,5	6,8	1,8	9,1
Road construction (concrete block paving + stormwater)	m^2	0,7	8,0	1,8	10,5
Secondary water mains	m	0,4	5,9	0,9	8,2
House connection	erf	0,6	31,4	6,0	38,0

Table 13: Expenditure per unit of employment generated in Soweto's CDP

Type of construction	*Unit*	*Estimated expenditure/ manhour (rand)*
Road construction (waterbound macadam)	m^2	17,9
Road construction (concrete block paving)	m^2	18,4
Secondary water mains	m	17,4
House connections	erf	17,1

Table 14: Percentage of construction cost retained by the community in Soweto's CDP

Description	*Road construction*	*Secondary water mains*	*House connections (plumbing)*
Labour contract	26	22	33
Transport	2	8	9
Materials management	2	3	2
Construction management	7	6	6
Total	37	39	50

Table 15: Summary of percentage of construction costs retained by the community in Soweto's CDP

Type of construction	*Percentage expressed in terms of*		*Ratio of columns 2 and 3*
	Construction costs (%)	*Construction costs less materials (%)*	
Road construction	37	49	1,3
Secondary water mains	39	59	1,5
House connections	50	68	1,4

It should be noted that amounts paid to specialist contractors eg for reinstatement of paving, local materials supplies and vendors of dieseline are not included in these figures. A significant percentage of these costs, however, remain in the community. The statistics presented in Tables 14 and 15 may therefore be regarded as being conservative.

In Soweto, no materials are manufactured within the community. As a result, a more relevant statistic is the cost of construction less material costs retained by the community. This is presented in the middle column of Table 15.

The cost of the proposed construction compared with that of conventional construction

Table 16 presents in a tabular form the estimated costs in respect of the proposed community-based and equivalent conventional construction projects. Data relating to costs of conventional projects were extracted from miscellaneous letters and reports prepared by the project co-ordinators, Soderlund and Schutte Inc. No cost comparisons have to date been undertaken in respect of house connections, as data for conventional contracts is not available.

Table 16: Cost comparisons between projects using proposed and conventional construction practices

Type of construction	*Unit*	*Estimated costs (rand/unit)*	
		Community-based	*Conventional*
Road construction	m^2	R174	R147-R165
Secondary water mains	m	R145	R188-R209
House connections	erf	R670	none available

Generally, the cost of secondary water mains has been found to be approximately 30 per cent less expensive than that of conventional construction, whilst that of road construction is approximately 15 per cent more expensive. The cost of community-based road construction is, however, very sensitive to the thickness of the layerworks.

Quality of end product compared with that using plant-based construction

Soderlund and Schutte's S 100 standardized specifications for community-based construction are used on all projects (Soderlund and Schutte Inc, 1994). These specifications are based on the principles contained in SABS 0120 (1980) and provide the community-based equivalent specifications to SABS 1200 A, D, DB, DM, GA, L, LB, LE, LF, ME, MF, MJ and MK.

All materials specified on the community-based projects in Soweto either comply with relevant SABS standards or have JASWIC acceptance. Details pertaining to differences in tolerances between the S 100 standardized specification for community-based construction and the conventional SABS 1200 standardized specifications are summarized in the accompanying appendix. Compaction where hand stampers are used is specified as being 95 per cent of the maximum Proctor density. Depending on the material type, this equates to not less than about 87 per cent of mod AASHTO density. Hand compaction is not permitted in roadworks

or in trenches that cross roads. Conventional plant is used in such circumstances and mod AASHTO densities consistent with SABS 1200 specifications are specified.

The performance of the services constructed using the proposed construction methods are therefore not expected to be significantly different from that of conventional construction.

An evaluation procedure

Baseline or benchmark values for each of the aforementioned items are required to evaluate projects. Should the aforementioned data and corresponding benchmark values be used in the computation of a project index (PI), individual projects can be readily evaluated and compared as follows:

Assuming that:

$$PI = f_1 \frac{TEE}{EEE} + f_2 \frac{PCR}{100} + f_3 \frac{ECC}{EPC} \quad (1)$$

where TEE= target expenditure per unit of employment generated, EEE = estimated expenditure per unit of employment generated, PCR= percentage of construction cost retained by the community, ECC= estimated cost of conventional construction, EPC= estimated project construction costs, and f = a weighting factor.

Tables 3, 4 and 13 provide values of the estimated expenditure per unit of employment generated for a range of construction activities. An examination of these tables indicates that R20/manhour would provide a reasonable and appropriate target value in respect of expenditure per unit of employment generated. (It should be noted in this regard that the average cost of employment generated per unit of expenditure in the civil engineering industry, as a whole, obtained from statistics published in the January 1994 edition of the *Civil Engineering Contractor*, adjusted for employment generated in respect of materials manufacture using Watermeyer and Band's (1994) site labour to materials manufacture ratios, was approximately R27,50, R31,00 and R33,50 for the calendar years 1991, 1992 and 1993 respectively.) This value, however, should relate to a specific point in time, say July 1994. Thus all project EECs should be either escalated or de-escalated to this base month to provide equitable comparisons.

The values in respect of EPC should include any necessary adjustments to reflect increases and/or decreases in maintenance costs, life cycle costs, salary values, etc, to enable equitable comparisons to be made against the value of the ECC. This will in effect enable compromises made in terms of standards, if any, to be taken into account. Values for the EPC and ECC should have a common base month. It is furthermore suggested that the PI should not be increased where the EPC is less than the ECC, so as not to distort the index and to promote labour-based construction for the wrong motives.

The proportion of the cost retained by the community is extremely important, as this parameter provides some indication regarding aspects such as community involvement, affirmative action, redistribution of wealth, entrepreneurship, development, economic empowerment, etc. Accordingly this item should receive the highest weighting. At the same time, an additional weighting should be added to provide an incentive for the local manufacture of materials.

Thus if $f_1 = 1,0$, $f_2 = 1,25 \times 1,4 = 1,75$ (25 per cent weighting and factor of 1,4 (see Table 15) to transform percentage construction costs retained to percentage construction costs less materials retained), and $f_3 = 1,0$, Eqn 1 becomes:

$$PI = \frac{20}{EEE} + 1,75 \frac{PCR}{100} + \frac{ECC}{EPC} \quad (2)$$

where $\frac{ECC}{EPC} \leq 1,0$ (3)

A 'threshold' PI can then be established should certain assumptions be made. Projects having a PI lower than this value should then be rejected. Assuming that values of 20, 25, 1 and 1,15 (15 per cent premium paid for labour-based construction) are assigned to EEE, PCR, ECC and EPC respectively, the threshold PI would be 2,3. Alternatively, should a project produce employment for a cost of R20/manhour with no cost premium and 17 per cent of the construction cost is retained by the community, the PI will just meet the threshold criteria.

By way of comparison, a plant-based project for secondary watermains would probably have values of 23, 15, 1 and 1 in respect of EEE, PCR, ECC and EPC. In this case, the PI would amount to 2,1, a value below the threshold value of 2,3. The average EEE for the civil engineering industry, on the other hand, on the basis of information presented by Watermeyer and Band and statistics presented in the January 1994 edition of the *Civil Engineering Contractor*, may be estimated at R37,50/manhour. Information contained in the latter publication suggests that wages and salaries account for approximately 19 per cent of the turnover in the industry. Should all the wages and salaries be retained by the community, the PI for conventional construction practices would be in the region of 1,9.

At the other end of the scale, the maximum probable PI, assuming that 100 per cent of costs are retained by the community and employment opportunities are created with no cost premium at R20/manhour, will be in the region of 4,0; if all costs with the exception of those associated with materials are retained, this figure will be in the region of 3,5.

Programme evaluation

The PI calculated in terms of Eqn 2 does not, however, reflect the 'loss in physical assets' resulting from a cost premium relating to developmental and employment creation aspects. To address this aspect, it is proposed that where elements (ie individual projects and contracts) have a cost premium of 10 per cent or greater, the programme as a whole be examined to ensure it has a positive or acceptable delivery.

For a programme to have a positive delivery:

$$\Sigma \frac{ECC}{EPC} PP > PRP \quad (4)$$

where PP= project provision and PRP= programme provision.

Should a programme have a negative delivery, the statistic obtained from Eqn 4 can be used to quantify the loss of physical assets in terms of the programme's delivery capacity and to evaluate the acceptability of the programme as a whole. Specific projects that have excessive cost premiums may have to be scaled down or removed from the programme to achieve an acceptable delivery status. Such projects can always be reviewed in subsequent financial years and be incorporated into the programme or have increased provision should the cost premium reduce.

Evaluating Soweto's CDP

PIs for the various current projects in Soweto's CDP, in terms of Eqn 2, are as follows:

- Roadworks (waterbound macadam) 2,6
- Roadworks (concrete block paving) 2,6
- Secondary watermains 2,8
- House connections 3,1

The provision in terms of the current CWRSC/DBSA loan agreement in respect of the following projects is:

- Secondary watermains R9,0 million
- House connections R4,0 million
- Road construction R5,0 million

On these projects, the roadworks costs are in the region of 15 per cent more expensive than conventional construction, whereas the secondary watermain costs are about 30 per cent less expensive. Thus, in effect, the monetary value of 'physical assets' constructed in terms of the programme when compared with conventional construction methods would equal 9 x 1,30 + 4 x 1,0 + 5,0 x 1,15 = 20,0 million, a figure in excess of the allocated project amount of R18 million. Thus the programme has a positive delivery and the amounts allocated to each element are reasonable. If, however, R4 million and R10 million were allocated to the secondary watermains and road projects respectively, the value of 'physical assets' would have amounted to R17,9 million and the programme would have yielded a negative delivery. In this instance, the allocations would have had to be revised.

The projects within the CDP all have PIs above the threshold value, the programme as a whole enjoys a positive delivery and the allocation of the provision favours those projects with the greatest PIs. The PI of the programme as a whole amounts to 2,8.

Applying the project index to other projects

Watermeyer and Band (1994) in their NHF report provide figures for the estimated number of manhours required to construct township services using conventional plant-based methods of construction. According to Power (Watermeyer and Band, 1994), the labourer wage bill on projects of this nature is approximately 12 per cent. Should the labourer wage bill be regarded as the upper limit of construction cost retained by

the community, it can be shown that, based on the statistics above, the construction of township services using plant-based construction methods will have PIs with values below 2,0.

Projects in the Western Cape that are currently operating in terms of the Framework Agreement can also be evaluated and compared with projects in Soweto. On the basis of information received from those engaged in these projects, Watermeyer and Band (1994) report that targeted labour receives approximately 12 per cent of project costs, while the cost premium is between 10 and 15 per cent. Assuming that the cost/manhour of employment generated is R20 and the cost premium is 12 per cent, the PI, in terms of Eqn 3, amounts to 2,1, a figure below the proposed threshold of 2,3.

On a community-based project in Marlboro Gardens in Sandton involving the installation of the water and sewer reticulation for 40 houses at a total construction cost of R195 000, the cost/manhour of employment generated amounted to R15 and the percentage of construction cost retained by the community was 34 per cent. No cost premium was attracted by this project (Ralph, 1994). The PI in this instance is therefore 2,9, a figure well above the proposed threshold of 2,3.

The project index and the parameters used in its determination can also be used on a project to evaluate different construction techniques and options. For example, on a specific project in Soweto, involving the construction of residential roads, cast-in-situ concrete block road pavements (Hyson cell roads) were examined as an alternative option to the waterbound macadam/asphalt roads and concrete block paved roads. Table 17 presents the number of manhours required to construct a square metre of road using cast-in-situ concrete blocks.

Table 17: 5 m wide cast in-situ concrete block pavement

Layer	*Type*	*Manhours required to construct a square metre of road*	
		Labour-based	*Soweto's CDP*
Surfacing	75 mm	0,83	0,83
Subbase	150 G6	0,72	0,72
Boxcut		1,70	1,70
Rip and recompact subgrade		0,35	0,35
Kerbing	Mountable	0,59	0,44
Total		4,19	4,04

These figures may be compared directly with those presented in Tables 10 and 11 in respect of waterbound macadam/asphalt and concrete block paved roads. The difference in construction cost between each of the road types was found to be insignificant, while PIs for all three methods of road construction were found to be of the same order, viz 2,6. Thus the PI and its associated parameters showed that none of the systems offered a developmental advantage over the other methods for the project in question. (On other projects, where the in situ CBRs are higher and different layerworks are required, this may not necessarily be the case). Thus the choice of technique, in this instance, is not influenced by employment creation or financial and economic empowerment considerations, but rather by technical factors and community considerations.

The implications of the project index

The Reconstruction and Development Programme

The Reconstruction and Development Programme (RDP) (African National Congress, 1994) suggest that one of the first priorities in meeting basic needs is to provide jobs (cl 1.4.2). In regard to construction, it suggests that 'our people must be involved in these programmes by being made part of the decision-making on where infrastructure is located, by being employed in its construction and by being empowered to manage and administer these large-scale programmes' (cl 1.4.3) and that 'infrastructural programmes must take into account the implications for micro enterprises' (cl 4.4.7.10).

The RDP makes specific reference to public works and states that programmes of this nature should:

- Involve communities in the process so that they are empowered (cl 2.3.6)
- Create assets that are technically sound (cl 2.3.6)
- Not abuse labour standards (cl 2.3.9)
- Give priority to job creation and training (2.3.9)
- Encourage and support self-employment through small and medium enterprise creation to ensure sustainability of skills (cl 2.3.9)

The RDP in terms of housing suggests that a housing programme should:

- Incorporate the development of small, medium-sized and micro enterprises owned and run by black people (cl 2.5.6)
- Introduce support mechanisms in order to maximize the use of local materials (cl 2.5.19)
- Encourage community-controlled building material suppliers (cl 2.5.19)
- Involve beneficiary communities at all levels of decision-making and in the implementation of their projects (cl 2.5.21)
- Benefit the beneficiary community in matters such as employment, training and the award of contracts (cl 2.5.21)

The project and programme of objectives of Soweto's CDP are not dissimilar to the requirements of the RDP. Although they were developed before the formulation of the RDP, they are in harmony with the RDP. Accordingly, the project index developed to evaluate Soweto's CDP can equally be utilized to evaluate RDP construction-related projects, eg housing projects and public works programmes, to ensure that such projects do in fact meet the requirements of the RDP to an acceptable degree.

Evaluation of NEF Public Works Programme proposals

The key objectives of the National Economic Forum's proposed Public Works Programme are to:

- Increase the income flows to the poorest sections of the community while simultaneously creating useful public assets
- Enable participants to acquire skills
- Strengthen the decision-making capacity of poor communities and their ability to control their own environment

The National Economic Forum commissioned an investigation into the shape of a future National Public Works Programme (NPWP). The report of the Technical Focus Group (National Economic Forum, 1994) presents a technical model for an NPWP in order to examine the potential employment creation in each sector. This model groups various construction activities into five sector groups in terms of their levels of skills requirements and level of development of labour-intensive methods for each of the sector groups (see Table 18). The Technical Focus Group also estimated the potential increase in the proportion of the project costs that go to targeted labour in each sector on the basis of actual experience in South African projects and published data and by calculation. The sectors in which the potential increase in labour intensity was examined are shown in Table 19.

Table 19 also shows the current spending in South Africa on targeted labour, ie the spending on target labour expressed as a percentage of the sum of the costs of all labour, plant and materials.

The technical model proposed time scales for the various sectors to change their spending patterns by using labour-intensive techniques to that proposed in terms of maximum spending. Where projects are structured to involve labour from a specific area as low skill workers on a project and the targeted community has little or no involvement in the

Table 18: Sector groups and their characteristics in the NPWP (National Economic Forum, 1994)

Group	*Sector*	*Skills requirements*	*Labour-intensity*
1	Simple projects (eg some environmental projects and some maintenance projects)	Low	High
2	Small-scale agriculture-related infrastructure Low-cost housing	Low-medium	High
3	Community buildings (eg schools, clinics and community halls)	High	High
4	Water Stormwater Sanitation Roads Dams Electrification	Medium-high	Low, but starting to increase
5	Forestry Railways	Medium-high	Low

Table 19: Spending on targeted labour as percentage of spending on labour, plant and materials (National Economic Forum, 1994)

Sector	*Current spending*	*Maximum spending*
Simple projects	60%-80%	60%-80%
Low-cost housing	25%-35%	30%-40%
Social buildings	20%-30%	25%-35%
Water reticulation	5%-15%	25%-35%
Stormwater	5%-15%	40%-50%
Sanitation	5%-15%	25%-35%
Roads	5%-15%	30%-80%
Dams	10%-20%	50%-80%
Railways	5%-20%	20%-30%
Forestry	25%-35%	35%-45%
Electrification	10%-15%	12%-17%
Small-scale agriculture-related infrastructure	40%-80%	40%-80%

commercial, managerial and administrative aspects of construction projects, the spending on targeted labour may be regarded as the cost of construction retained by the community. Assuming that the estimated expenditure per unit of employment generated is R20/manhour and the cost premiums for the various sectors are as reflected in Table 19, the PIs for projects, in respect of each sector, calculated in accordance with Eqns 2 and 3 will eventually reach the ranges shown in Table 20.

The project index can in this instance be used to monitor and measure the change in spending patterns on projects as current levels of spending on targeted labour increase. The index can also contribute to an acceleration of the process of reaching targeted spending levels in a cost-effective manner. This can be achieved if the value of the PI for a given sector is used in the determination of the allocation of funding. Engineers will in this manner be encouraged and challenged to restructure projects and develop innovative technologies so as to reduce the cost of employment generated while increasing the amount of the construction cost retained by targeted labour.

Table 20: Maximum spending levels in an NPWP measured in terms of the project index

Sector	*Assumed cost premium at maximum spending level (%)*	*PI based on maximum spending levels and EEE = R20/manhour*
Simple projects	0	3,1-3,4
Low-cost housing	0	2,5-2,7
Social buildings	0	2,5-2,6
Water reticulation	0	2,5-2,6
Stormwater	10	2,6-2,8
Sanitation	0	2,4-2,6
Roads	15	2,4-3,3
Dams	15	2,8-3,3
Railways	15	2,2-2,4
Forestry	15	2,6-2,8
Electrification	0	2,2-2,3
Small-scale agriculture-related infrastructure	0	2,5-3,4

Affirmative action

Don Mkhwanazi, who is regarded as the 'father' of affirmative action in South Africa, at the Built Environment Action Movements (BEAM) conference held in Durban in August 1994, defined affirmative action as 'black economic empowerment'. The PI in its formulation is sensitive to the percentage of construction cost retained by the community, ie economic empowerment. Thus the PI provides a measure of affirmative action or economic empowerment potential on construction projects.

Evaluation of training in the programme

The project index does not, however, measure the effectiveness and efficiency of the training provided in the programme. Watermeyer and Band (1994) in the NHF report suggest that a Training Structure Plan is required to direct development within a programme and to ensure that the required development takes place. They suggest that such plans are required in developmental programmes in order to:

- Review and revise the respective training programmes and objectives
- Ensure that sufficient skills are developed in participants
- Establish selection criteria at each and every level or stage within the programme
- Prepare guidelines for the staffing of support structures
- Define competency objectives for exit points to various levels and stages, as appropriate
- Identify problems and opportunities
- Identify time limits and associated constraints for participants

A proposal regarding the appointment of a training manager has been submitted to the funding body to prepare a Training Structure Plan and to evaluate the effectiveness of training received.

Conclusions

Soweto's Contractor Development Programme is a programme that:

- Embraces most of the goals set in the RDP pertaining to the construction industry in a pragmatic manner
- Utilizes labour-based technologies that yield significant increases in employment opportunities over conventional plant-based construction practices, to promote both job creation and the emergence of local contractors
- Produces employment opportunities at a cost of about R18/manhour or at approximately 50 per cent of the average cost of employment for the civil engineering industry as it is currently structured
- Comprises some projects that are more cost-effective than conventionally structured projects would have been and others that attract a cost premium in the region of 15 per cent; however, current allocation of funds to the individual projects ensures that on average more assets per unit of expenditure are created than would have been the case for equivalent plant-based construction practices
- Has the potential to produce end products whose quality is no different from that achieved by means of conventional construction practices

In arriving at these conclusions, a procedure for evaluating projects has been developed that may be used to establish developmental opportunities within projects outside of Soweto. This procedure examines two different types of opportunities in the following manner:

Employment opportunities

A1) Establish the cost of construction and the estimated total number of manhours generated using conventional construction technologies, methods and practices.

A2) Explore possible multipliers in employment opportunities within elements of the project or specific activities that may arise from the employment of alternative construction technologies and methods.

A3) Establish the cost of construction, the estimated total number of manhours generated and the expenditure per unit of employment generated using the technologies and methods contemplated in A2.

A4) Minimize any cost premium and maximize the employment opportunities associated with different combinations of technologies and methods.

A5) Select the construction practice that comprises methods and technologies that attract low-cost premiums and generate employment opportunities in the most cost-effective manner.

A6) Evaluate the quality of the end product provided by the construction practice selected and compare it with that using conventional construction practices. If acceptable, utilize the chosen construction practice.

Community opportunities

B1) Examine the construction process and identify which aspects of the project may be undertaken by the targeted community.

B2) Establish the resources of the targeted community.

B3) Explore the construction options, eg conventional contractor approach, managing contractor approach and development team approach, contractor team approach and joint ventures (Watermeyer and Band 1994), and estimate the associated construction costs and the percentage of construction expenditure that may be retained by the community associated with each option, taking full cognisance of the resources of the community.

B4) Select the construction option that maximizes the percentage of the construction cost retained by the community.

Employment and community opportunities cannot be examined in isolation, as they are not mutually exclusive. Construction costs, for example, are dependent on construction options, while aspects of the project that

may be undertaken by the targeted community is a function of the construction technologies and methods selected. At the same time, certain options and selections may well necessitate the development of skills and competencies, which in turn have cost implications.

The project index developed in this paper may be used to evaluate a project's contribution in respect of employment and community opportunities and to compare one project with another, irrespective of whether or not such projects incorporate labour-intensive methods of construction. Projects that have a high project index present more development opportunities to a targeted community than those with low indexes.

The project index for projects within Soweto's CDP ranges from 2,6 to 3,1. Conventional civil engineering construction projects, on the other hand, have PIs in the region of 1,9. The PIs in Soweto's CDP are significantly higher than appears to be the case in the Framework Agreement projects currently being implemented in the Western Cape and are comparable with most of the projects contemplated by the National Public Works Programme only when the maximum level of spending on targeted labour is achieved, ie in the long-term projections.

Soweto's CDP has objectives that are not dissimilar to those of the RDP. For this reason, it is considered that, with further research into employment opportunities provided in the construction industry, the project evaluation approach outlined in the paper may make a meaningful contribution to measuring the success or otherwise of projects that seek to embrace the RDP.

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Appendix: Differences in tolerances and testing between S 100 and SABS 1200 specifications

S 100 D: Earthworks

- S 100 D caters for a permissible deviation having Degree of Accuracy II with respect to dimensions.
- S 100 D does not provide tolerances for 'slopes of top surfaces'.
- S 100 D caters for Degree of Accuracy II with respect to moisture content and density.
- S 100 D makes provision for supplementary DCP and RCDP testing.

S 100 DB: Pipe trenches

- Nil.

S 100 DMR: Earthworks (Roadworks)

- S 100 DMR has many small differences as this specification combines aspects of SABS 1200 DM and ME.
- S 100 DMR is more stringent in certain aspects as it has smaller lot sizes and does not permit three tests per lot.
- S 100 DMR makes provision for supplementary DCP and RCDP testing.

S 100 G: Concrete (Minor works)

- S 100 G generally caters for only Degree of Accuracy III. However, with respect to abrupt changes in a continuous surface, Degree of Accuracy II is specified.
- S 100 G does not give details of test procedures and states that the engineer shall specify these.

S 100 L: Medium-pressure pipelines

- Nil.

S 100 LB: Bedding

- S 100 LB caters for only Degree of Accuracy III with respect to optimum moisture content.

S 100 LC: Cable ducts

Nil.

S 100 LD: Sewers

- S 100 LD makes no provision for a water test.

S 100 LE: Stormwater drainage

- Nil.

S 100 LF: Erf connections

- Nil.

S 100 MFW: Base waterbound macadam

- S 100 MFW specifies density in terms of apparent density.
- S 100 MFW increases smoothness and thickness tolerance increases from 10 mm to 15 mm.
- S 100 MFW does not provide minimum deviations from grade and has some minor differences with respect to level tolerances.

S 100 MJ: Segmented block paving

- S 100 MJ has minor variations with respect to 'vertical deviations from 3 m straight line'.

S 100 MKK: Kerbing

- Nil.