BASIC COSTS OF SLUM UPGRADING IN BRAZIL

Alex Abiko, Luiz Reynaldo de Azevedo Cardoso, Ricardo Rinaldelli, and Heitor Cesar Riogi Haga

Slum areas in Brazil have expanded greatly, and particularly in the last two decades.

The initiatives taken by the government in relation to this issue have evolved from superficial actions and measures aimed at minimizing infrastructure deficiencies to broader interventions seeking to consolidate newly upgraded slum areas as part of the city. This requires more far-reaching construction work and involves at least some restructuring of the road system, relocating and/or re-housing when necessary, and doing construction work that often affects areas surrounding slums.

So, the aim of this paper is to assist in planning and examining strategic concepts for interventions in informal urban areas by compiling basic costs and technical data associated with understanding these items.

Conclusions and recommendations are listed in relation to general guidelines for interventions, to upgrading costs, to the data obtained and to strategies and technologies for minimizing costs or raising the cost-to-benefit ratio of interventions.

1. Introduction

This article is based on the project *Infrastructure Engineering in Informal Urban Areas* prepared for the World Bank by researchers at the Civil Engineering Department of the Escola Politécnica of the University of São Paulo.

The aim is to assist in planning and examining strategic concepts for interventions in informal urban areas by compiling basic costs and technical data associated with understanding these items. Although a very important aspect of these programs, detailed analysis of costs at the design execution level does not lie within the scope of this study.

Several slum upgrading programs and projects in Brazil have been innovative in administrative and technological terms, but our knowledge of the cost-related aspects of these interventions tends to be fragmented and rather unsystematic.

A recent study analyzing slum upgrading costs has pointed to the difficulty of obtaining reliable data on examining costs for the Low-Income Population Sanitation Program (local acronym PROSANEAR), which extended water supply and sewerage systems to urban low-income populations settled in precarious situations, e.g. slums and/or subdivisions in high-risk areas such as hillsides, flood-prone riverside areas, etc. After painstakingly retrieving cost data for this program, there was great variation across the eleven cases studied and in many of them this was due to the different criteria used for appropriating these costs (Abiko, 2003)

Major differences emerge when we compare methods used for appropriating costs of buildings with those used for infrastructure projects. Very little is known in relation to infrastructure costs, even for formal sectors in cities. One reason is that these costs involve a number of different agencies and utility licensees using a wide range of costing methods and approaches in their work

When there is a need to estimate the cost of upgrading slums or rehabilitating degraded settlements, the difficulties are even greater for a number of reasons: a) these types of intervention involve specific kinds of technical solutions; b) they are located in high-risk areas with steep slopes or flood-prone areas; c) inhabitants remain in the location during construction work; d) executive designs are almost never available before construction work begins; e) the numerous agents intervening include financing agents, public bodies and utility licensees.

These were some of the difficulties we met with in undertaking the present study. In view of these features and the scarcity and unsystematic nature of the available data, we took the approach itemized below:

a) we initially examined previous work on urban infrastructure costing issues for both formal and informal sector urban experiences and attempted to identify the variables affecting these costs;

b) we compiled costs and statistical treatment for three slum upgrading programs: Guarapiranga in São Paulo, Favela-Bairro in Rio de Janeiro and Ribeira Azul in Salvador;

c) we compared the three programs between themselves and in relation to costs studied in item a);

d) we compiled tables showing costs for different urban infrastructure projects in the informal sector in urban areas and their typologies.

2. Slum Upgrading in Brazil

2.1 Approaches to intervention in slums

Initially, public policies sought to eradicate slums and relocate residents to housing projects on the outskirts of the city, and this is still the approach in many areas (Silva, 1994). This policy proved ineffective over time as relocated residents often left their new homes and moved back to new slums. Moreover slum areas have grown considerably, so generalized re-housing was no longer feasible.

The current approach is to upgrade slum areas, attempt to keep the community in the same location by building infrastructure, and seek to regularize property titles. Whether the community stays on the same site or not will also depend on the risks involved; relocation may be required when sites are near waste landfills, under overpasses, or are endangered by mud slides or frequent floods in riverside areas.

Slum upgrading projects may be divided into four basic stages following Abiko (1995).

a) Preliminary study: this stage is crucial for deciding the technical, physical, and legal feasibility of implementing an upgrading project in a certain area. This stage will include initial contacts with residents;

b) Registration: Once an upgrading project is seen as feasible, residents should be registered. To avoid swelling the numbers benefiting from upgrading, it is advisable to have the local population assist with the registration procedure and decide which families will benefit;

c) Project design: The area selected will be subdivided to accommodate the largest number of registered families in the best manner possible, with each family's lot supplied with water, electricity, internal thoroughfares and drainage, telephone and sewerage facilities, and spaces required for utilities to install these systems. This means designing the project in the way that meets needs most efficiently;

d) Execution: construction time will depend on the terrain, the availability of finance and community involvement. Flat terrain and an easily accessed site will speed construction and vice-versa. Execution time may vary from several months to years.

Rehabilitating degraded settlements poses a challenge for specialists and institutions involved, be they municipal governments, national government agencies, state companies, or non-government organizations. There have been innumerable cases of attempts to rehabilitate settlements of this type in Brazil, but little is known in relation to the outcome of these interventions.

Some sectoral initiatives have been implemented with solutions specifically designed for slums. Water and sewerage utilities have used condominium sewerage (Melo, 1994) or 32 mm HDPE, High Density Polyethylene, which is more malleable than rigid PVC. Electricity utilities have used smaller metal posts with mains switchboxes and metering for several households.

However, sector initiatives in slums may often be consolidating an urban structure that is densely occupied, unhealthy and inadequate, and at risk geo-technically. Installing water supplies in a slum means higher sewage volumes that will require drainage. So when installing piped water in a slum, there has to be a new sewerage system too. Drains for rainwater must be installed, otherwise this water will flow into sewers. There has to be garbage collection to complement water supplies, sewage and rainwater drainage — in order to avoid solid waste blocking drains and sewers. There must be a suitable road system for garbage collection to be carried out properly.

So there is obviously a need to integrate interdependent initiatives relating to degraded settlement rehabilitation. This is no easy task since the different technical specialties involved are associated with institutions that have their own particular characteristics at different levels of government.

Providing environmental education along with these initiatives is crucial to the process of rehabilitating degraded settlements and helping ensure sustainability for upgraded slums. Experience has shown that rehabilitated urban environments are at risk of deteriorating again if there is no community involvement in the process of maintaining a new habitat.

Another extremely important issue is the cost of these interventions. The state has to respond to a wide range of demands from society, so public policy makers must pose the question: what are the costs and benefits of slum upgrading projects? Is upgrading the most appropriate approach to the slum problem?

Finally, in terms of mobilizing financial resources, the traditional focus fails to make use of more innovative financing strategies such as: a) strategies for involving the private sector through partnerships that do not rely exclusively on public financial resources; b) clear and transparent subsidy strategies; c) family-based credit for construction, extensions or improvements to housing units; d) strategies for recovering costs of investments in building and infrastructure.

IBAM (2002b) recently studied twelve municipal slum upgrading or property-title regularization programs and found that the main sources of financing were a) municipal own funds (38.9%), including those from Municipal Housing Funds; (b) transfers from federal budget (6.3%), including funds under the Habitar-BID program; c) loans from the official employee severance fund (local acronym FGTS) and employee assistance fund (local acronym FAT) (5.4%); d) foreign sources of loans (46.8%), in particular the Inter-American Development Bank (IDB) loan to Rio de Janeiro; e) donations from bilateral and multilateral cooperation agencies (1.2%).

2.2 Characterization of current slum area interventions

Werna et al. (2001) reported that slum upgrading programs led to better quality housing standards in relation to the structure found in informal settlements. These upgrading programs are based on specific projects or, in some cases, are part of the process of general physical planning in urban areas in Brazil (Sallen, 1983, in Werna et al, 2001)

Three programs were analyzed in this study: a) the Urban Recovery Program of the Environmental Recovery Program for the Guarapiranga Basin in São Paulo; b) the Favela-Bairro program in Rio de Janeiro; c) the Viver Melhor program in Salvador.

2.2.1 The Urban Recovery Program of the Environmental Recovery Program for the Guarapiranga Basin

The Environmental Recovery Program for the Guarapiranga Basin, supported by the World Bank, was formulated by a group of social actors (representatives of the state, municipal districts and civil society), to tackle the different problems related to the urban environment of the city of São Paulo. It sought to mitigate the negative consequences of occupation and use of land in the basin area, and define and deploy procedures for re-ordering urban occupation.

The Guarapiranga reservoir can hold approximately 180 million cubic meters of water. The State of São Paulo Water Supply and Sanitation Company (local acronym SABESP) draws off 12 million cubic meters water per second to meet the needs of approximately 3 million people, corresponding to 20% of the provisioning of the São Paulo Metropolitan Region. It is the second largest water resource supplying the Greater São Paulo area.

In 1991, approximately 18% of the population living around the basin were living in slums. The portion belonging to the municipality of São Paulo contained more than 180 clusters of slums. In 1992, informal subdivisions documented in legal actions in São Paulo's municipal administration in this area totaled 119.

As one of the subprograms of the Environmental Recovery Program, the Urban Recovery Subprogram initially covered slum upgrading activities (25,000 families), adaptation of road infrastructure and drainage in low-income subdivisions usually located near slum areas (76,000 families on an area of 10 square kilometers). In relation to slum upgrading, there were also plans for resettling a small fraction of the population (3,700 families) to include new housing projects in well-equipped areas well served by public transport.

In technological terms, the conventional solutions used were not very flexible bearing in mind the requirements posed by this type of intervention. An example of this was the fact that condominium sewerage arrangements were accepted only in very special situations in relation to access to the sewerage system.

2.2.2 The Favela-Bairro program

The municipality of Rio de Janeiro is the center of Brazil's second largest metropolitan region. Like most Brazilian metropolises, the municipality is subject to the consequences of the phenomena of ‘peripherization’ and informal urban expansion.

As a result of demographic pressure, aggravated by growing urban poverty and the absence of suitable alternatives for settlements and housing poor families, the city has a long history of illegal occupations of public and private land and thus the multiplication and expansion of informal settlements (IBAM, 2002a).

Most of Rio's slums are on steep hillsides and subject to collapse, falling stones or rocks, and/or landslides. The others are in flood-prone areas. According to recent data, more than one million people are living in slums in Rio.

The Favela-Bairro program was conceived as an urban policy intervention rather than just a public initiative to help solve the slum problem in the city of Rio de Janeiro. In this respect it featured two basic principles: a) upgrading as the main public policy for slums; b) housing as an urban issue, and so situated in a broader context.

Note that the Favela-Bairro program is an integral part of a larger program known as PROAP-RIO, which involves upgrading of slums and informal and irregular subdivisions.

The Favela-Bairro program covers 158 slums and benefits 130,000 families or 500,000 people. This amounts to slightly less than half the number of residents in informal areas of the city. The initial portion of the program was known as the Low-income Settlements Urbanization Program (local acronym PROAP I) and covered 90 slums classed as medium scale, i.e. from 500 to 2,500 households.

This program supported by IDB was introduced in 1994, and aims to upgrade slums, make them into neighborhoods and promote their inclusion in what is called the 'formal' sector of the city, after an initial physical and urban planning upgrade. This upgrade includes physical reorganization, provision of public services, infrastructure and community equipment.

The infrastructure installed followed the parameters and technical standards of the utility services licensees because utility licensees were to take over maintenance and operation once construction work was executed. In particular the State Water and Sewage Company (local acronym CEDAE) does not accept technological alternatives for water supply or sewage drainage systems.

The Favela-Bairro program does not generally plan on building housing units except in cases of relocation when no other solution negotiated with families involved is feasible.

In short, the program is characterized by intervention in terms of provision of urban infrastructure and services. There is no emphasis on the problem of property-title regularization.

2.2.3 Ribeira Azul program

Salvador has a population of 2,443,107 and almost all live in the urban area (99.96%), while 875,033 people (35.83% of the urban population) live in informal settlements. There are 380 slums and 171 informal subdivisions in Salvador, according to the Urban Development Company of the State of Bahia (local acronym CONDER). Some 208,342 housing units are located in informal settlements corresponding to 32% of the total number of homes (IBAM, 2002a).

The stated aim of the Ribeira Azul project is to mitigate poverty in the area of Baía de Todos os Santos. Among its other aims, priority is posed for actions of a social or environmental nature.

Preliminary studies were begun in 1992, and work started in 1995 on 20 slums housing 40,000 families. The lower income families mostly occupied “palafittes” — that is, shacks built on stilts above marshy areas.

The project is managed by CONDER, with participation from the World Bank, Salvador municipal government, and NGOs such as the Italian AVSI.

Its main components are defining the external limit of the bays, by landfills and shore side paths used as dykes to impede the spread of more stilt housing over the mangrove area; providing basic infrastructure and social equipment for the settlements; producing more housing units to relocate families affected by the process of landfilling areas occupied by stilt housing, and financing housing improvements for surrounding communities.

The project seeks to adopt an integrated conception promoting environmental, housing, urban planning, and social and economic improvements, and by working with the participation of the community and in partnership with social organizations.

There is a varied typology of housing solutions depending on the needs and financial possibilities of the families assisted by the project; a) very basic core units to house families relocated from stilt housing; b) housing improvements for units located in landfill and consolidated areas; c) improvement or construction of sanitary units.

In infrastructure terms conventional solutions are adopted, and the only feature of note was the use of condominium sewerage as an alternative technology. Basic environmental education was provided but the community did not take responsibility for maintaining the sewerage network, and the latter is an important aspect of this technology.

3. Cost of Slum Upgrading

This section will look at the issue of slum upgrading costs from a more conceptual point of view, in the sense of identifying variables that influence the behavior of these costs.

This will initially mean examining the issue of infrastructure costs in general, in relation to formal urban areas, in an attempt to identify the main factors underlying their behavior. On the basis of this initial examination, we shall then look at the costs of slum urbanization.

The sources used to analyze both urban infrastructure costs in general and slum costs were mainly bibliographical research and the Guarapiranga program in São Paulo. Information and data from professionals specializing in budgeting and/or with experience in slum urbanization were incorporated, as were experiences and reflections noted by the members of team that compiled this study.

3.1. Factors affecting infrastructure costs in formal areas

For the initial analysis, a literature search brought in studies on infrastructure costs from Mascaró (1979 and 1987). Although the amounts of these costs are now outdated, they do provide an understanding of how infrastructure costs may be affected by urban planning and physical factors.

The database for these studies consisted of cost surveys for several Brazilian medium-sized cities in varying locations. The urban areas considered are in the formal sector, i.e. they are regularized both technically and legally in terms of urbanism. The technologies involved in executing the budgets used as the basis for the analyses are the conventional ones, and therefore follow Brazilian standards in force at the time.

These studies analyzed the costs of global supply systems for water, electricity and street lighting, sewerage, drainage, paving and gas. In view of the scope of the present study, we analyzed only the costs of infrastructure networks and so excluded treatment stations, generating stations, etc. The networks covered were water, sewerage, drainage, paving, electricity, and street lighting.

On the basis of the above studies, we analyzed cost variations per urbanized area and per house for these networks, in relation to variations in the following factors:

- type of layout of the network, basically depending on the design of the road system and to a lesser extent the layout of the network itself;[1]
- size of urbanized greenfield site;
- shape of field;
- density of field;
- slope of field.

We proceed to present a summary of the influences of the factors mentioned on network costs per urbanized area and per house.

TABLE 1 - Urban infrastructure networks - costs per urbanized area and factors influencing them

Network	Type of network layout	Size of field	Shape of field	Density of field	Slope of field
Water	A (1)	B (2)	(-)	C	(-)
Sewerage	A (3)	C	(-)	(-)	B (4)
Drainage	(-)	A	B (5)	(-)	B (6)
Paving	A	(-)	(-)	(-)	A (7)
Electricity and lighting	A	C	(-)	(-)	(-)

Source: Adapted from Mascaró (1979 and 1987)
Legend: A - High influence; B - Medium influence; C - Low influence; (-) insignificant / not detected / not studied / inconclusive.
Notes: (1) the larger the extension of the plan, the higher the cost of the network for the same population.
(2) Costs rise quickly for large fields (over 400 ha) and moderately for smaller fields.
(3) The smaller the block, the more the network costs.
(4) Costs rise when a slope is less than 1% or over 7%.
(5) The longer the basin, the higher the cost.
(6) Up to a 4% slope, costs decrease; from 4 to 6%. they remain constant; and, at 8% or more, they begin to increase.
(7) Costs tend to rise with the slope, but they may also - within certain limits - decrease, depending on the conditions of soil, traffic and the available technological alternatives.

TABLE 2 - Urban infrastructure networks – costs per house and factors influencing them

Network	Type of network layout	Size of field	Shape of field	Density of field	Slope of field
Water	A	B	C	A	(-)
Sewerage	A	C	(-)	A	B
Drainage	(-)	A	B	A	B
Paving	A	(-)	(-)	A	A
Electricity and lighting	A	C	(-)	A	(-)

Source: Adapted from Mascaró (1979 and 1987)
Legend: A - High influence; B - Medium influence; C - Low influence; (-) insignificant / not detected / not studied / inconclusive.

The tables show that the most important factors affecting costs is type of network layout, and in this respect road system design – which imposes a certain layout - tends to be the predominant factor. Alternative layouts for the same road system, when possible, may affect costs, but are less important. In this respect, the author notes that the conventional urban "grid" design makes networks more expensive by requiring greater lengths for the same number of houses served. "Normal" plans with a hierarchical road layout (main road and secondary cul-de-sacs feeding into it), are less costly because they require less extensive networks and involve greater optimization of capacities such as paving.

Once the urban design is determined, the other important factor is density. Whatever the network type, the rule is the greater the density, the lower cost per house unit served.

This is due to the fact that additional population served in the same area requires smaller increments in the overall network cost. The cost of a network for 500 inhabitants, for instance, is not much more than one for 50 inhabitants in the same area.

Following the same author, we also show the costs breakdown for each network.

TABLE 3 - Composition of cost of infrastructure networks

Network	Incidence on costs (%)
Water	4.1
Sewerage	20.2
Drainage	16.5
Paving	47.1
Electricity and lighting	12.1
Total	100

Source: Adapted from Mascaró (1979 and 2003)

As the table shows, the cost of drainage plus paving accounts for more than 60% of the total costs of infrastructure networks, and paving alone accounts for almost 50%. In this respect we once again see the importance of urban design for infrastructure costs, since it is the design of the road system that decides the extension and areas of paving, as well as the hierarchical layout of the latter.

The characteristics of slum areas, which are typically densely populated with a nested road system plan and smaller in area relative to a conventional subdivision, might suggest that network costs per unit served would be less than for a normal urban area, but this is not the case, as we shall show below.

3.2. Factors affecting infrastructure costs in formal areas – benchmarks

The costs from which the data shown above were extracted are in the above mentioned studies by Mascaró. However, the base date for the latter is 1975 with inflation-adjustment using the US dollar rate for 1979 and we believe that using the present value on this basis is not feasible after such a long period.

There are very few specialized publications or updated studies on this theme in Brazil that could provide updated benchmarks for infrastructure costs.

One of the few existing sources is derived from the study conducted by engineers Hélio de Caires and Guilherme Martins, as part of a method for evaluating urbanizable fields. Costs obtained using the methodology posed by these authors are inflation-adjusted and published in specialized magazines; they may be used as benchmarks in the absence of other costing data obtained from budgets or executed public works.

The table below shows a summary of the main infrastructure costs as published in the magazine Construção Mercado (2003) Note that this methodology uses certain parameters and hypotheses to simplify the issues and it is also old, so it does not cover technological innovations or design criteria introduced over recent years that have probably reduced these costs, such as the use of PEAD for water networks, the use of simplified sewerage networks, etc.

TABLE 4 – Infrastructure cost for urbanizable fields (R$[2] – May 2003)

Network	Cost per 1,000 square meter floor area	Cost per square meter raw field	Cost per 125 square meter lot	%
Water	2,554.19	2.21	319.27	11
Sewerage	4,767.25	4.12	595.91	20
Drainage	2,398.33	2.07	299.79	10
Paving	11,296.84	9.77	1,412.11	47
Electricity and lighting	847.70	0.76	373.15	12
Total	21,891.31	18.93	3,000.23	100

Source: adapted from the table "Evaluation of urbanization field-cost" (Construção Mercado, 2003).

Notes: The original table was altered as follows: average earthmoving taken as paving cost, as well as curbs and gutters. Project and administrative fees were eliminated and a rate of 33% included as project (3%) and IDB (30%). Cost of electricity and lighting was calculated at 12% of total cost.

One should note that the cost weightings for networks are relatively similar to those in the tables shown previously. The biggest differences are for water and electricity, and this may be explained by the fact that Guilherme Martins' cost included only street lighting.

Another cost benchmark that may be used as a basis for infrastructure cost is the incidence of this cost in relation to the total cost of construction (house plus infrastructure), for housing projects or condominiums (gated communities).

Data from Cardoso (1993) point to benchmark urbanization costs for low-income housing projects built in the Metropolitan Region of São Paulo, with weightings varying from 11 to 28% of total cost of construction (infrastructure plus houses). Professional cost estimators work with 15% of cost of infrastructure networks in relation to total cost of construction (infrastructure plus houses), for medium or large housing projects (over 300 units).

Taking 15% of infrastructure cost as our base number, for a low-income standard unit with 50 square meters built area, and a unit cost of R$ 500 per square meter, the average total cost of infrastructure networks per unit may be estimated at approximately R$ 4,500 on a preliminary basis.

3.3. Factors affecting infrastructure costs in formal-sector areas

Slum upgrading costs obtained from the literature and from surveys conducted for this study appear to be quite high in comparison with the references noted. Averages from the Guarapiranga program, the main source for this study, are around R$ 10,000 or more per family. Therefore we should analyze the composition of costs and their nature in order to understand variations in the same way as we approach infrastructure costs in formal-sector areas This involves an examination, however cursory, of the main characteristics of slum upgrading work.

3.3.1. General characterization of slum upgrading work

Slums have specific characteristics making them quite distinct from formal-sector urban areas since they are usually located in areas that have not been subdivided, perhaps valley floors, or steep hillsides, and are not suitable for residential construction (COBRAPE, 2000). The situation is aggravated by disorderly and extremely dense occupation hindering work on access roads or water, sewerage, and drainage networks. In the absence of these networks, inhabitants may leave effluent and waste on the ground, thus aggravating soil instability and accentuating sanitary problems.

As we have seen in the initial section of this study, the first government interventions in these areas in the 1980s sought to mitigate the worst aspects. When possible, basic services such as piped water and electricity were installed and sometimes sewerage and drainage and retaining structures were installed too. However they did plan for interventions of a more structural nature. Obviously the costs of the interventions executed were quite low, perhaps even lower than in normal areas.

This study has taken the Guarapiranga Program executed in the São Paulo Metropolitan Region during the first half of the 1990s as a benchmark for actions currently being undertaken in the ambit of slum upgrading programs that are of a different nature. They aim to consolidate these areas as urban centers that are social and functionally part of the city, and ensure that certain minimum standards of environmental and sanitary quality are upheld. Therefore, the interventions demand a wider scope of construction work, involving a certain minimum restructuring of the road system, reorganizing and/or relocating homes when necessary, as well as doing construction work that also oftentimes involves the area surrounding the slum

The scope of these interventions, in general terms, and using the Guarapiranga program as a basis, usually includes the following points:

- building water supply and sanitary sewerage networks to serve all housing units following roads used by pedestrian and vehicle traffic;
- a road system to facilitate house-to-house collection of garbage and access to homes;
- a drainage system, including straightening and covering over streams when necessary;
- construction work of a geotechnical nature, such as retaining structures on hillsides;
- installing electricity network and street lighting;
- providing garbage collection services;
- treatment of common and collective spaces compatible with the availability of areas internally or adjacent to the center;
- building the least number of new housing units in different locations, and examining the possibility of creating new settlement areas and relocating homes within the slum area itself;
- building new housing units outside the slum area, to assist families relocated or re-housed to different locations;
- social assistance follow-up for the benefited communities in order to encourage participation at every stage in the program.

Although the project incorporated simplified criteria[3] and more flexible features in relation to the usual approach, the aim was for slum networks to meet the same performance standards as those in normal areas. One example of this in the Guarapiranga program was the sewerage system, which required a minimum diameter of 200 mm, allowing condominium networks only in exceptional cases, not exceeding 3% of the total of the network and having 150mm minimum diameters.

3.3.2. Factors influencing costs

Studies of upgrading slum costs that we consulted showed that they are more complex in nature than infrastructure costs in normal areas, and this often impedes a modeling of their approach.

Rocha et al (2002) studied a number of upgraded slums in the Guarapiranga Program and detected quite a large variation in their upgrading costs. They obtained an average of R$ 7,962.10 per family (base date August 1995), with a variation of approximately 30% around the average.

The causes of this variation were ascribed to a number of factors: different services executed in the different slums, varying unit costs of the same service from one slum to another; and application of different urban planning standards. The study does not provide a detailed exploration of all possible factors having a bearing on costs, but it does proposes a simplified model for estimating slum upgrading costs on the basis of three components.

The first was infrastructure costs (drainage, cleaning or covering rivers or streams, paving, sewage drains). In the slums analyzed, a linear correlation between these costs and the area of the road system, modeled following a linear expression. Therefore by estimating the area of the road system planned, it would be possible to estimate the cost of this item. What was not so clear was how the area of the road system would be estimated.

The second is the cost of superstructure (relocating or re-housing). Relocation involves building homes in the slum itself, which corresponds to 20% of the cost of superstructure, in the cases we analyzed. The unit cost for relocation was estimated at R$ 12,684.61, with a coefficient of variation of 37.8%. By estimating in advance, on the basis of the diagnosis, the number of relocations to be made, the cost could be calculated directly. The weighting for relocating involving building new units in a different location may be calculated in the same way, i.e. taking the number of families to be relocated and multiplying by the unit cost of R$ 25,307.78 (August 1995), an amount that seemed to us be rather high, since if adjusted by the CUB index[4] through May 2003, the result would be approximately R$ 46,000.[5]

The third and last cost component is related to operational activities (executive project, management and maintenance of construction work, technical consulting services and social assistance). Data obtained from the slums analyzed showed this cost being estimated at 30% of the total for infrastructure and superstructure combined. We thought this rather high as a criterion and no details of how the index was composed were provided.[6]

Notwithstanding the above points, we applied this model to the slum (Parque Amélia), which was used as benchmark for the Guarapiranga program because it seemed closest to the actual costs. On this basis, our estimated cost was R$ 8,404.50 per family (August 1995), which came very close to the actual cost (R$ 7,603.90 per family, according to the data obtained).[7]

Another important source we consulted was Ancona & Lareu (2002), which analyzes a series of 32 slums upgraded as part of the Guarapiranga program to arrive at a total cost of R$ 10,623.94 per family on the base date of December 2000. Of this amount, R$ 9,701.47 (91.3%) related to infrastructure work (drainage, water, sewerage, paving), retaining structures and preliminary services (site, demolition, temporary buildings). The difference was related to the cost of relocation, which was not analyzed in the study. However, the cost of R$ 9,701.47 was the average of a range that varied from R$ 4,099.86 to R$ 30,793.02. The study looked at possible explanations and related costs to the following factors: slope, number of families, area of slum, density and duration of construction work. This latter factor had a major impact on the cost of preliminary services, including monthly cost items such as site maintenance. However, they did not find a correlation that could explain variations on the basis of the factors considered.

Note also that costs were inflation-adjusted for the date December 2000 using the wholesale prices index (IGP-M), which in our opinion does not accurately reflect variations in this activity, basically civil engineering and building work. Table 5 shows a number of price indices and their increases for the period August 1995 - June 2003; building costs in São Paulo rose between 74.36% and 101.30%, whereas the IGP-M rose by 135.64%.

Figure 1 shows indexes for the 1994-2003 period.

TABLE 5 – Price indices – August 1995 – June 2003 (%)

Indices	Construction Industry							Economy	
Period	**SINAPI** SP	**CUB** SP	**ICC** SP	**FIPE** SP	**FIELD** SP	**INCC** BR	**IPCE** SP	**IGP-M**	**US$**
August 1995 - June 2003	74.36[(1)]	81.18[(2)]	88.38[(2)]	92.20[(2)]	93.07[(3)]	94.10[(2)]	101.30[(2)]	135.64[(4)]	206.07[(4)]

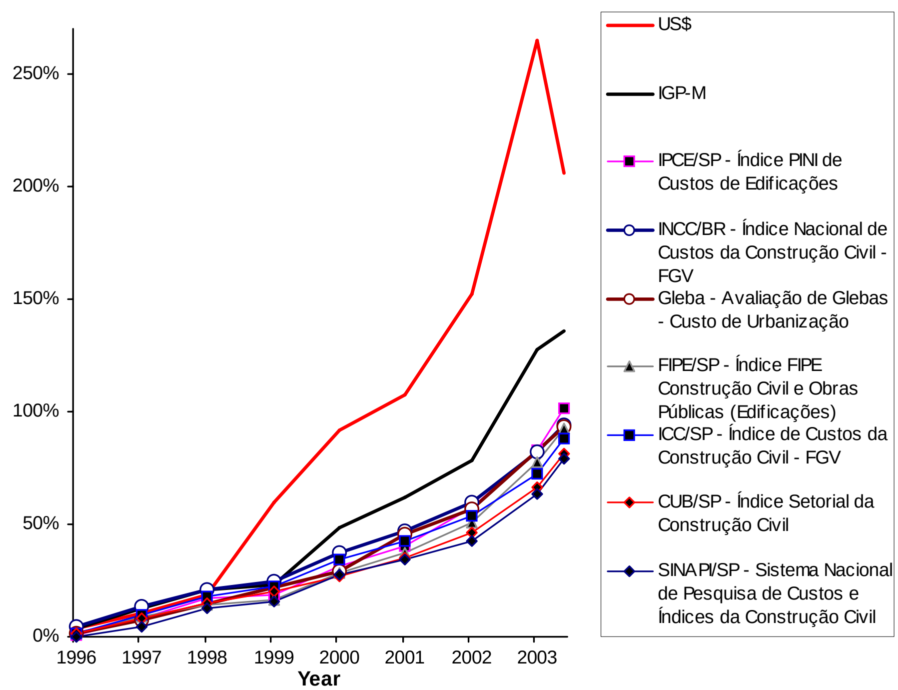
Notes: [(1)] Calculated on the basis of IBGE data;
[(2)] Calculated on the basis of data from the magazine Construção Mercado;
[(3)] Calculation considering average composition of infrastructure costs, following the methodology of Fernando Guilherme Martins and values published in the table "Evaluation of Field-Cost for Urbanization" (Construção Mercado 2003).
[(4)] Calculated on the basis of data from FGV, Fundação Getulio Vargas.

The third study we examined was a report on slum upgrading compiled by COBRAPE, the management company for the Guarapiranga program.

Weighted average[8] costs of the program for slum upgrading projects coordinated by PMSP and CDHU were reportedly R$ 10,623.94 and R$ 10,323.30 respectively (averaging R$ 10,473.62) The base date is not explicitly stated in the report but according to the authors' of the study previously mentioned, which used the same base date as the report, costs were adjusted using the IGP-M index through December 2000. The report examines the varying costs for different slums and poses a number of points to explain this variation.

The first point is that costs of services were higher than initially estimated. The cost initially planned was US$ 1,300 per family, which corresponds to R$ 3,900 per family today, which is similar to the benchmarks presented previously for urbanization of normal areas.

FIGURE 1 – Price indices over the period



NB: accumulated variation as of the base date of August 1995.

Some of the reasons for exceeding the initial estimate are mentioned. One was that scope was broadened - only sewerage and paving was planned initially and water was supposed to be installed by SABESP. Estimates erred in not taking into account the need for earth moving work to cover distances of over 1 km[9].

The Report also analyzed variations in the costs of services and slums that were much higher than average, and posed the following factors in explain these variations:

a) Paving

The key factors for costs were the situation of the surrounding area, its topography and the structure of the center of the slum. Slums located longitudinally along streams tend to involve higher costs, which is in line with the cost analyses posed at the beginning of this section. Very uneven terrain and deficiencies in the urban structure of surrounding area also tend to raise costs.

b) Water

The main factor is the situation of surrounding area. Costs increase when there is a need to extend networks to connect to the slum and decrease when there is a pre-existing supply network, although partially.

c) Sewerage

Costs related to conditions in the surrounding area - lack of infrastructure - and larger numbers of families require more network installation. This contradicts the analysis posed at the beginning of the section in which higher density reduced the length of network required per family

d) Drainage

Costs are higher for slums containing small numbers of families where rivers or stream shave been covered and where there is no paved road infrastructure around the area.

e) Retaining structures for hillsides

Costs depended on topography; the more uneven the terrain, the higher the cost. It was also found that amounts were higher than average in small slums (less than 100 families).

f) Relocating or building new housing units

This item basically depends on the size of the slum. Those containing less than 100 families generally do not involve relocations. In medium-sized slums (100 - 300 families) less than 8.5% need relocating. In large slums (over 300 families) more than 8.5% and as much as 28% may need relocating.

The report also points to difficulties in construction work due to the characteristics of the slums (high density and unhealthy settlements, precarious buildings, difficulties in access, problems with floods and low load-bearing capacity of the soil), that also drive up costs, although these items were not measured. From this angle, the relevant points were:

- difficulties involved in using equipment, requiring its vertical transport, manual excavation of ditches and drains;
- construction work when families remain in the same location, requiring special tasks and techniques to ensure residents' safety, such as retaining structures and lowering the water level to allow excavation;
- need for continuous revision of projects, given the extreme mobility of the families, their constant extensions or new buildings, and the need for temporary lodging to accommodate families whose houses are affected in the course of the work or found to be in imminent- risk situations.

The larger the slum, and the more densely it is occupied, the more these factors seem to be accentuated.

In view of the above data, we may summarize factors influencing costs in table form, as we did for infrastructure in formal areas, as follows.

TABLE 6 – Slums upgrading costs per family and factors affecting them

Network	Size of slum (number of families)	Topography	Situation surrounding area	Layout and location (along streams)
Water	(-)	(-)	A	(-)
Sewerage	A	(-)	A	(-)
Drainage	B	(-)	A	A
Paving	C	A	A	A
Retaining structures	C	A	(-)	(-)
New housing units and relocations	A	(-)	(-)	(-)

Legend: A - High influence; B - Medium influence; C - Low influence; (-) insignificant / not detected / not studied / inconclusive.

We see that one of the main factors affecting costs is the size of the slum, i.e. number of families. Apparently, the more families living in the slum, the higher the cost per family, although this does not apply to all services. This factor, we believe, calls for further research, since there is no clear characterization and the data contradict the points made at the beginning of the section.

Another key factor is the situation of the surrounding area, and here there can be no doubts as to its importance. The more precarious the infrastructure of the surrounding area, or the more distant the slum is from urbanized areas, the greater the cost involved and vice-versa

According to the COBRAPE report, costs for 30% of the slums analyzed were higher than the weighted average most of them were in areas with no infrastructure, so there are no doubts as to the major influence of this factor.

On a different level we have factors related to the physical conditions of the slum, its topography (the more uneven the terrain the greater the cost) its layout and location; slums laid out longitudinally along streams are more expensive to urbanize.

From the data obtained, it was not possible to detect a relation between the two main factors, in other words whether the larger slums tend to be located in worse or better situations in relation to surroundings. It is possible that the larger slums are located in or near areas that have better infrastructure, which would favor their cost in this respect. Small slums may tend to be located in more distant locations with less urban equipment, which would make them more expensive to urbanize. On the other hand, large slums tend to be more densely populated and involve more difficulties for construction work and more cases requiring relocation. These aspects too require further research in our opinion.

3.3.3. Cost per service

Based on the factors listed above and costs incurred, the COBRAPE report classifies slums in two groupings. One comprises 'average' slums, in which the quantities of services and costs required correspond to an average frequency interval of 70%. In other words, this grouping accounts for about 70% of the slums for which requirements of services and weighted average costs were calculated. The other set comprises complex slums, for which services requirements and costs significantly exceeded the weighted average, as shown below.

TABLE 7 – **Services (quantified) and average costs for normal and complex slums**

	Weighted averages – normal slums	Weighted averages – complex slums	Weighted average costs – normal slums		Weighted average costs – complex slums	
			R$ per family - December 2000	%	R$ per family - December 2000	%
Water meters per family	3.40	8.83	328	5.73	1,267	7.53
Sewerage meters per family	4.55	9.54	1,321	23.07	3,025	18.00
Drainage meters per family	1.56	9.20	1,528	26.69	5,064	30.13
Paving Sq. meters per family	13.44	39.90	1,069	18.67	3,150	18.72
Retaining structures Sq. meters per family	6.00	19.64	508	8.87	4,311	25.62
New housing units and relocation % of total families	6%	Over 8.5%(1)	972	16.98	(2)	(2)
Totals			5,726.00	100	16,817.00	100

Source: adapted from COBRAPE (2000)
Notes: (1) estimate
(2) not available

3.3.4. Summary of global costs

The table below shows summaries of global costs obtained from the studies mentioned above (COBRAPE, 2000) for the Guarapiranga program. Data are divided for areas covered by PMSP (local acronym for the municipality of São Paulo) and those under the CDHU (local acronym for the São Paulo State Housing Company), i.e. the municipalities of Embu, Embu-Guaçú and Itapecerica da Serra. There is also an estimate of costs for Guarapiranga based on Rocha et al (2002). The Ancona & Laureu (2002) data are not included in this summary, since their overall costs are the same as those in COBRAPE (2000)

Adaptations were made, supplements added and amounts inflation-adjusted in accordance with the following criteria.

For Guarapiranga PMSP and CDHU cost data, obtained from the above-mentioned works (COBRAPE, 2000), data were grouped under three items (infrastructure, superstructure and social work / casuals / project / administration); for project and administration we estimated a cost of 8% of the total cost of the other items. Costs were inflation-adjusted using the CUB-SP index for December 2000 as base date for the costs shown through June 2003.

For the estimate based on the study of Rocha et al (2002), the urbanization standard used was located between alternatives 2 and 3 described therein. Costs were inflation-adjusted using the CUB-SP index for August 1995 as base date for costs shown through June 2003.

Note that the totals are quite similar, but there are significant differences between the three groups in their incidence.

TABLE 8 – Overall slum upgrading costs summarized – Guarapiranga program

	Guarapiranga PMSP (1)			Guarapiranga CDHU (1)			Estimate Guarapiranga (2)		
	R$ Dec 2000	R$ June 2003	%	R$ Dec 2000	R$ June 2003	%	R$ Aug 1995	R$ June 2003	%
Infrastructure (3)	8,824.24	11,849.79	76.91	7,737.31	10,390.19	69.40	2,351.61	3,157.90	28.45
Superstructure (4)	1,674.33	2,248.40	14.59	1,661.02	2,230.53	14.90	4,013.18	5,389.17	48.55
Social work / Project/ Administration	975.28	1,309.67	8.50	1,750.83	2,351.13	15.70	1,902.06	2,554.22	23.01
Total	11,473.86	15,407.86	100	11,149.16	14,971.85	100	8,269.84	11,101.29	100

Notes and sources: (1) Adapted from COBRAPE (2000);
(2) Adapted from Rocha et al (2002);
(3) Infrastructure, water, sewerage, drainage, retaining works and paving;
(4) Superstructure: housing units, construction or repair.

3.3.5 Strategies for reducing costs and improving cost / benefit ratios for interventions

For the identification of certain key cost factors, we recommend using strategies for reducing costs and/or improving the cost / benefit ratio for interventions, also making use of contributions in COBRAPE (2000):

- undertaking careful diagnostic analysis covering conditions in the slum and especially the situation of surrounding area and way in which the slum relates to the latter, in order to estimate possible costs and on that basis decide the main lines of the intervention;
- revaluating the upgrading of small slum areas distant from the urban fabric (often the case of water-resource or spring areas), since intervention involves high costs and encourages irregular occupation in adjacent areas;
- analyzing as special cases slums located along streams or in very adverse sites (topography, stability, soil type, etc), since these factors will require large amounts of resources;
- evaluating the possibility of designing the executive project on the construction site itself, in order to efficiently match the dynamics of the slums and minimize problems arising from exceeding initial costs due to modifications. The executive project would follow the general guidelines and project criteria defined in the basic project. According to information obtained by the team, this procedure is being used in Rio de Janeiro;
- considering the use of network technologies using materials that can be transported manually, minimizing connections and improving sealing properties, such as plastic systems;
- including home facilities in the interventions, using prefabricated or pre-assembled components, such as installation kits and depending on the location, prefabricated bathrooms;
- evaluating the possibility of using concrete blocks interlocking or paving stone instead of asphalt paving, since they are suitable for slopes, are more permeable and may be installed manually;
- organizing systematic sanitary and environmental education campaigns (after interventions) to improve conservation of equipment and discourage further occupation. Assistance for

communities would include - in addition to urbanization aspects - social involvement, employment and income generation, etc.

4. Slum Upgrading Cost Data

This section presents summaries of cost data obtained from slum upgrading programs in three Brazilian state capitals: São Paulo, Rio de Janeiro and Salvador.

The three were seen as quite positive experiences, which encouraged further study and research (including dissertations and thesis), and thus provided data for this study.

4.1 Comparative analysis of three programs: Guarapiranga, Favela-Bairro and Ribeira Azul

Tables 9 and 10 and Figures 3 and 4 below summarize bibliographical data from section 3 and data obtained from the three programs:

TABLE 9 – Slums upgrading costs – JUNE/2003

Programs	Guarapiranga/ SP								Favela-Bairro/ RJ		Ribeira Azul/ BA	
Sources	BIBLIOGRAPHY				CASE-STUDIES							
	PMSP		CDHU									
Price indices	CUB/SP		CUB/SP		CUB/SP		SINAPI/SP		SINAPI/RJ		SINAPI/BA	
Services	R$	%	R$	%	R$	%	R$	%	R$	%	R$	%
INFRASTRUCTURE	11,849.79	76.91	10,390.19	69.40	9,501.73	56.84	9,252.21	57.13	6,499.86	74.94	4,608.40	42.34
Water	-	-	-	-	478.02	2.86	460.03	2.84	425.39	4.90	436.37	4.01
Sewerage	-	-	-	-	2,120.54	12.69	2,040.76	12.60	790.68	9.12	768.62	7.06
Drainage	-	-	-	-	3,051.05	18.25	2,936.27	18.13	805.46	9.29	177.48	1.63
Paving	-	-	-	-	2,382.54	14.25	2,292.90	14.16	2,576.59	29.71	2,981.07	27.39
Retaining structures	-	-	-	-	919.99	5.50	885.38	5.47	945.31	10.90	-	-
Electricity	-	-	-	-	389.02	2.33	472.54	2.92	-	-	122.43	1.12
Lighting	-	-	-	-	38.90	0.23	47.25	0.29	188.47	2.17	122.43	1.12
Garbage	-	-	-	-	-	-	-	-	40.69	0.47	-	-
Landscape	-	-	-	-	121.67	0.73	117.09	0.72	727.27	8.38	-	-
SUPERSTRUCTURE	2,248.40	14.59	2,230.53	14.90	4,745.80	28.39	4,567.26	28.20	1,358.72	15.66	5,392.70	49.54
Construction and relocation	-	-	-	-	2,214.11	13.24	2,130.82	13.16	1,358.72	15.66	5,392.70	49.54
Preliminary services	-	-	-	-	2,531.69	15.14	2,436.43	15.04	-	-	-	-
SOCIAL AS., DES. AND ADM.	1,309.67	8.50	2,351.13	15.70	2,469.06	14.77	2,376.17	14.67	815.14	9.40	883.43	8.12
Social Assistance	-	-	-	-	-	-	-	-	-	-	326.47	3.00
Design	-	-	-	-	589.13	3.52	566.97	3.50	815.14	9.40	230.42	2.12
Administration	-	-	-	-	1,879.93	11.25	1,809.20	11.17	-	-	326.54	3.00
TOTAL	15,407.86	100	14,971.85	100	16,716.59	100	16,195.64	100	8,673.72	100	10,884.53	100

TABLE 10 – Slums infrastructure costs – JUNE/2003

Programs	Guarapiranga/ SP								Favela-Bairro/ RJ		Ribeira Azul/ BA		Formal urbanized lot	
Sources	BIBLIOGRAPHY				CASE-STUDIES								BIBLIOGRAPHY	
	NORMAL SLUMS		COMPLEX SLUMS											
Price indices	CUB/SP		CUB/SP		CUB/SP		SINAPI/SP		SINAPI/RJ		SINAPI/BA			
Services	R$	%	R$	%	R$	%	R$	%	R$	%	R$	%	R$	%
INFRASTRUCTURE	6,798.28	100	22,962.70	100	9,501.73	100	9,252.21	100	6,499.86	100	5,369.30	100	3,000.23	100
Water	439.52	6.47	1,697.78	7.39	478.02	5.03	460.03	4.97	425.39	6.54	436.36	8.13	319.27	10.64
Sewerage	1,770.14	26.04	4,053.50	17.65	2,120.54	22.32	2,040.76	22.06	790.68	12.16	768.61	14.31	595.91	19.86
Drainage	2,047.52	30.12	6,785.76	29.55	3,051.05	32.11	2,936.27	31.74	805.46	12.39	177.07	3.30	299.79	9.99
Paving	1,432.46	21.07	4,221.00	18.38	2,382.54	25.07	2,292.90	24.78	2,576.59	39.64	2,981.06	55.52	1,412.11	47.07
Retaining structures	680.72	10.01	5,776.74	25.16	919.99	9.68	885.38	9.57	945.31	14.54	-	-	-	-
Electricity	389.02	5.72	389.02	1.69	389.02	4.09	472.54	5.11	-	-	503.10	9.37	109.34	3.64
Lighting	38.90	0.57	38.90	0.17	38.90	0.41	47.25	0.51	188.47	2.90	503.10	9.37	263.81	8.79
Garbage	-	-	-	-	-	-	-	-	40.69	0.63	-	-	-	-
Landscape	-	-	-	-	121.67	1.28	117.09	1.27	727.27	11.19	-	-	-	-

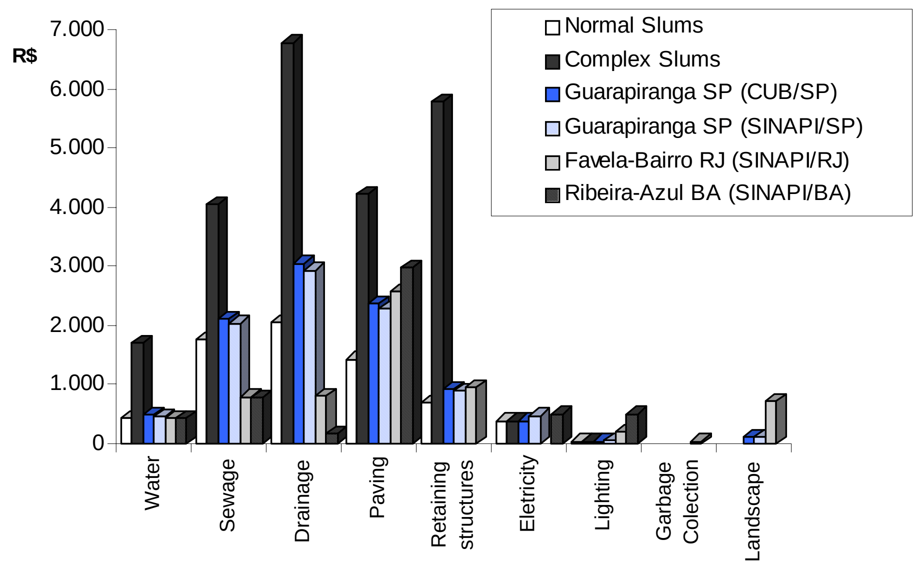


FIGURE 3 – Breakdown of costs of infrastructure services

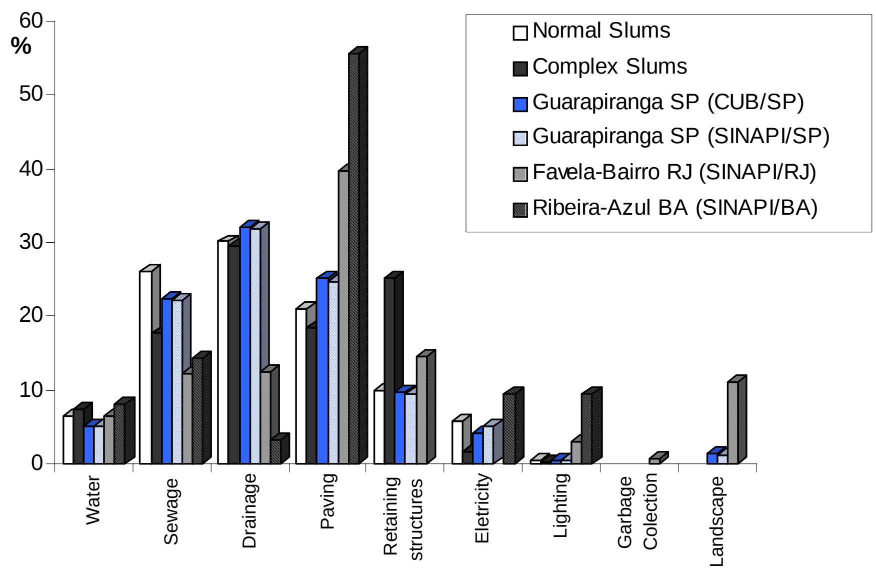


FIGURE 4 – Breakdown of infrastructure services

Data obtained from the three programs prompted the following observations:

- Total cost for the Guarapiranga program is similar to that obtained in studies shown in Section 3;
- Costs in São Paulo were highest;
- Costs were higher in Bahia than in Rio de Janeiro, and both were lower than São Paulo. The most costly item in Bahia was superstructure, but the reason for this was not identified;
- Paving and retaining structures in Rio de Janeiro were highly weighted (more than others). In Bahia, according to our reports, there are few sloping sites, but we were unable to asses the impact of this fact on costs as a whole;
- Data for all costs in the scope of the study were obtained. Electricity network costs for Rio de Janeiro were not obtained, but Rio was the only city to supply data on garbage collection;
- In relation to infrastructure costs, water supply costs are quite uniform across all programs; sewerage, drainage and paving costs varied more. Some costs, such as paving items were lower in São Paulo;
- No correlations were found for different typologies and costs, except for São Paulo, where data obtained correlated infrastructure costs for medium and complex slums, which are very different.

5. Conclusions and Recommendations

5.1 In relation to general guidelines for interventions

Slum areas in Brazil have expanded greatly, and particularly in the last two decades.

The initiatives taken by the government in relation to this issue have evolved from superficial actions and measures aimed at minimizing infrastructure deficiencies to broader interventions seeking to consolidate newly upgraded slum areas as part of the city. This requires more far-reaching construction work and involves at least some restructuring of the road system, relocating and/or re-housing when necessary, and doing construction work that often affects areas surrounding slums.

The three slum upgrading programs analyzed in this study were the Guarapiranga program in São Paulo; the Favela-Bairro program in Rio de Janeiro; and the Ribeira Azul program in Salvador.

In all these cases, we saw that the scope of the work is framed within the characteristics described above. The cost components of the programs include a varied spectrum of actions that may be grouped under three main headings:

- infrastructure, water supply and sewerage networks, road systems, paving and drainage, retaining walls or structures for hillsides, electricity and street lighting networks and garbage collection;
- superstructure: building houses and relocating in the slum area itself and/or building new housing units in different areas, treatment of shared areas and collective equipment;
- social assistance for the benefited communities, design and administration.

We found that certain initiatives were not implemented with the same intensity as others, even though they were in the guidelines for the programs; this is the case for property-title regularization and post-occupancy social work assistance.

It was also found the option of providing an urbanized lot for families relocated from slums has not been used as an alternative to providing finished housing units.

5.2 In relation to upgrading costs

The conclusion is that slum upgrading costs are not similar to formal-sector costs and this relates to three aspects.

One is that urbanization costs in formal-sector areas are restricted to infrastructure networks, whereas for slums the networks constitute a component of overall costs, although one with a heavy weighting (70 to 75% in São Paulo and Rio de Janeiro and 50% in Salvador). There are also programs not examined here, such as the Cingapura program, in which urbanization has still less importance within the global scope.

Another is that slums have specific features, so upgrading costs are of a different nature in relation to formal-sector areas where the cost factors are road system design and density of occupation. In slums the data obtained for cases in São Paulo show that the factors weighing most on costs are: firstly, the size of the slum, in terms of number of families, and the situation of the surrounding area — larger slums and those with more precarious infrastructure are more expensive to upgrade; secondly the physical conditions of slums (topography, geotechnical conditions and locations alongside streams or rivers). It was also found that very densely occupied slums in critical situations physically drive up the costs of building due to the increased number of construction tasks and services and the need to use special techniques or manual labor for jobs that could be done mechanically, such as excavations.

In this respect, the costs of slum upgrading are higher than those for formal-sector areas.

Based on the theoretical costs of slum upgrading infrastructure (following the studies we consulted) for São Paulo's Guarapiranga Program, inflation-adjusted through June 2003 — approximately R$ 11,000 per family on average, and the costs of the same program obtained by our own team of R$ 9,502 per family — we see that these costs are two to three times the theoretical costs of urbanizing a formal-sector subdivision. The costs obtained as benchmarks for an urbanized formal-sector lot, as shown in Section 3, are approximately R$ 3,000 and R$ 4,500.

On the other hand, we found that the costs of slum upgrading infrastructure amount to approximately one third the cost of a completed low-income standard home, which is estimated at around R$ 30,000.

The third characteristic aspect of upgrading costs is that, factors vary greatly from one slum to another so there is a wide range of costs across different slums. The analysis made by our team using data from the Guarapiranga program the weighted average cost was R$ 16,716.59 per family, but the costs ranged from R$ 7,320.53 to R$ 45,898.11, so the coefficient of deviation was 57.07%.

For the other locations analyzed in Rio de Janeiro and Salvador, although there are some issues in relation to the data obtained, we saw that the comparable costs are also high, although less than in São Paulo (lower than São Paulo by 46% and 33% respectively) and coefficients of deviation between slums are also over 50% in both locations.

We believe that this conclusion poses the need for planning initiatives to make advance estimates of the magnitude of costs involved in upgrading the areas in question and using the data as criterion when deciding slums to be covered.

Other conclusions related to cost analyses made were:

- there is a need for updated and in-depth data that covers upgrading costs, with benchmarks for costing studies and estimates, as is the case for normal housing projects. In this respect, the suggestion is to create a national index of urbanization costs for formal and informal areas, similar to the SINAPI index for formal housing projects;

- there is a need for more in-depth analysis of factors affecting slum upgrading costs since those identified refer only to slums in São Paulo; they are qualitative and are not well characterized in some cases; in this respect we would suggest that related studies use more powerful statistical instruments to build quantitative models for the behavior of costs in São Paulo and other locations;
- we found that inflation-adjusting for costs varied across and among studies and works consulted and the agencies that supplied the information. This problem was aggravated by the fact that certain data — those for São Paulo — date back to August 1995. In this respect, we suggest conducting studies to update costs through actual current prices rather than using indices.

We also concluded that when there is a need for inflation-adjustment indices, the ones that best reflect variations in slum upgrading costs are the construction industry indices for each location. We would emphasize the suggestion of creating an index for urbanization costs that could also be used as a parameter for inflation-adjustment.

5.3 In relation to the data obtained

The data obtained for São Paulo, Rio de Janeiro and Salvador comprise samples that may be taken as representative since they refer to some 45% of the slums covered by the Guarapiranga program in São Paulo, 40% of the population assisted by the Favela-Bairro program in Rio de Janeiro and 15% of the families assisted by Salvador's Ribeira Azul program.

Costing data were obtained for all items falling within the scope of this study, as listed at the beginning of this section. Note that only Rio de Janeiro provided data for garbage collection. We therefore suggest that future studies should research the costs of this item. For items relating to project and administration costs, no data were obtained from Salvador and there are dubious aspects in relation to those from Rio de Janeiro. Future research should undertake more in-depth study of the latter.

Our study of the Guarapiranga program in São Paulo was much more in-depth than that of the other locations due to its proximity. Research in São Paulo involved not only collecting numerical data, but also interviewing professionals who participated in the program, visiting the locations upgraded, and consulting a relatively large amount of material made available by the agents responsible. For the other cities, contacts were made by telephone and e-mail and data obtained in the same way. Not much information obtained for the physical characteristics of the slums in these locations, so we were unable to correlate costs and those characteristics, as we had done for São Paulo, although only in part. There were issues and lacunae in the data from Rio de Janeiro and Salvador and they could not be solved in time for this study. Therefore the data for São Paulo may be generalized to the Metropolitan Region of São Paulo, but not to other locations. For Rio de Janeiro and Salvador, the data could be used as an initial benchmark, but they should not be generalized to these locations unless there is more in-depth analysis of the latter.

In this respect, we strongly recommended that this research be continued.

5.4 In relation to strategies and technologies

Section 3 concludes with several recommendations relating to strategies and technologies for minimizing costs or raising the cost-to-benefit ratio of interventions:

- post-occupation performance and evaluation for upgraded slums, in the sense of updating project criteria, technologies and basic guidelines for the interventions, which could assist in compiling a technical project manual for slum urbanization;
- operational and maintenance costs for equipment and services related to slum upgrading, in the sense of covering the overall costs of these interventions;

- monitoring costs of projects using a cost-tracking spreadsheet and systematic and continuous collection of life cycle data (conception, execution, maintenance and post-occupation).

Alex Abiko *is a Professor of Civil Engineering and former Head of the Department of Civil Engineering at the Polytechnic School of the University of São Paulo in Brazil.* ***Luiz Reynaldo de Azevedo Cardoso*** *is a Professor of Civil Engineering at the Polytechnic School of the University of Sao Paulo in Brazil.* ***Ricardo Rinaldelli*** *is an architect and civil engineer teaching at the Polytechnic School of the University of Sao Paulo in Brazil.* ***Heitor Cesar Riogi Haga*** *is a civil engineer who teaches at the Polytechic School of the University of Sao Paulo in Brazil.*

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[1] Networks may vary in layout depending on the road system design - grids (conventional blocks) or the normal type with secondary cul-de-sacs off (perpendicular to or at an angle to) a main road. For the block-type design, the length and cost of networks for the same road design may vary with the size of the block and possible layout options for the network itself. These varying layouts were analyzed in relation to their repercussions on network cost and are shown in the tables.

[2] The exchange value of 1 real varied was 3.0 per US dollar in June 1993 at the time the bulk of calculations for this paper were performed..

[3] COBRAPE (2000) shows all the project criteria used.

[4] CUB index is one of the price index in Brazil, most commonly used by the construction sector.

[5] A home built under the PAR program, for instance, costs about R$ 27,000.00.

[6] Current practice in major enterprises place benchmark estimates for project and administrative costs at 5% and 3% of total costs respectively. Other costs are included in operational activities, so we believe it is important to have a breakdown of this index if it is used as a general criterion.

[7] This slum was taken as benchmark because it is relatively isolated and according to our information has no unique feature that might raise or lower costs excessively.

[8] Weighting reflected the number of families in each slum and the cost of each slum.

[9] We were told that environmental agencies would not allow material to be dumped near water sources (springs) so transport distances jumped to 10 - 35 km.

6. References

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