Urban Slum Upgrading: A Model for Expeditious Estimation of the Cost of Interventions

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Abstract. More than a billion people around the world live in slums in undignified and precarious living conditions. These are places of high poverty characterized by overcrowding, poor housing facilities and inadequate access to basic services such as clean water, electricity and sanitation. Slums today testify to the two main challenges to human settlement development in this millennium: rapid urbanization and the urbanization of poverty. Slums, in fact, are the increasingly common solution of providing housing for low income-to people. Therefore, the phenomenon of slums is an important contemporary challenge that requires well-structured intervention programs aimed at poverty reduction and urban transformation. In light of the above and in line with the goals mentioned in both the Sustainable Development Goals (SDGs) and the New Urban Agenda (NUA), urban slum redevelopment interventions would make it possible to improve the quality of existing settlements, and reverse their decline, by transforming and making the spaces better, safer and more sustainable places where everyone can live and work. In this sense, the purpose of the work is to define possible intervention scenarios and characterize a model for the expeditious estimation of related construction costs. The model, which is based on a synthetic-comparative procedure, makes it possible to provide an economic reference that is useful in determining the amount of resources to be allocated for the urban upgrading of slums, a symbol of profound social inequality.

Keywords: Slum · Appraisal Issues · Cost-Approach

1 Introduction

According to the *World Cities Report* [1], there are about 1.6 billion people living in inadequate housing, nearly 20 percent of the world's population. Of these, 1 billion reside in slums and informal settlements. In the next 30 years, in the absence of appropriate intervention measures, this number could even double. Indeed, current urbanization trends indicate that an additional three billion people will live in cities by 2050, increasing the urban share of the world's population to two-thirds [2].

The challenge of housing and slums, therefore, remains a critical factor in the persistence of poverty in the world: millions of urban residents are continually deprived of

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their right to an adequate standard of living and housing. In such a scenario, the 2030 Agenda's goal of eradicating poverty in all its forms looks a long way off.

Rapid population growth, mass migration from rural to urban areas, and the inability of the market and government to meet the huge demand for decent and affordable housing are the main factors contributing to the development of slums [3]. In addition, there are poor government investments in infrastructure, ineffective urban planning systems and misguided regulatory systems that still do not consider slum neighborhoods as an integral part of cities [4, 5].

Slums are, therefore, the most manifest expression of poverty and social and economic inequality on the Planet, and although spread globally, most of them are located in the large urban areas of Southeast Asia, sub-Saharan Africa and South America [6].

Often covering very large areas equal to entire towns or villages, however, slums are not recognized by the state and their informal existence almost always results in the absence of minimum essential services, such as water and sanitation, and adequate security measures.

They are overcrowded, unsanitary, illegally built urban spaces with unsuitable materials, located in areas exposed to environmental hazards and lacking public spaces and services. For low-income people, however, slums are still the only means of providing an answer, albeit partial, to their needs.

The slum phenomenon is, therefore, one of the main contemporary challenges facing the world and requires well-structured intervention programs, whose economic aspect is currently still poorly investigated.

In this sense, the work is aimed at characterizing a model for expeditious estimation of the construction costs of possible intervention scenarios aimed at the redevelopment of slums; this is with the purpose of providing an economic reference useful for estimating the amount of resources to be allocated.

The study is structured as follows. Paragraph 2 defines the slum phenomenon and its specific characteristics. Paragraph 3 outlines the different policy and intervention approaches adopted over the years to address the slum issue. Paragraph 4 characterizes a model for expeditious estimation of intervention costs for slum upgrading; this model is made explicit for different intervention scenarios. The paper concludes with reflections on the limitations and potential of the proposed estimation approach.

2 Definition and Characteristics of a Slum

The term "slum" was first used in 1812 by J.H Vaux as a synonym for "racket" or "criminal traffic," indicating, rather than a place, a deprived social condition [7, 8]. It was in the late 19th century that the term began to have a spatial connotation. In 1895, in *The Slum of the Great Cities*, the word "slum" becomes a metaphor for the degradation, moral and civil, of "an area of dirty back streets inhabited by a sordid and criminal population" [9, 10].

In 2002, at the UN conference in Nairobi, the definition of a slum was officially adopted as a densely populated emerged informally, characterized by dilapidated buildings and living conditions below minimum survival standards [11].

Furthermore, according to UN-Habitat (2003), a slum household is defined as a group of individuals living under one roof in an urban area who lack one or more of the following:

1. access to water, i.e., access to a sufficient amount of potable water for family use and at an affordable price;
2. access to sanitation, meaning access to a private bathroom or a public bathroom shared with a reasonable number of people;
3. sufficient living space, implying the presence of less than three people per room of a minimum of 4 square meters;
4. quality/duration of housing, i.e., the presence of adequate and permanent structures built in non-hazardous locations;
5. guarantees of possession conditional on the existence of documentation proving possession status or the existence of protection against possible eviction.

In light of the physical and legal characteristics dictated by the UN-Habitat, in fact, one of the main problems of slums around the world is the absence of essential services: we refer to sanitation facilities and sources of drinking water, as well as effective waste collection systems, electricity supply, rainwater drainage, etc. This results in unhealthy living conditions that, combined with malnutrition, feed the spread of diseases such as malaria, tuberculosis, etc.

Moreover, most of the houses are overcrowded, occupied by five or more people, from the same or different families, sharing a single apartment or even a single room intended for all functions. The latter is almost always built with substandard materials unsuitable for housing, given the local climatic and location conditions. Slum houses are, in fact, mostly made of sheet metal, sacks, wood, mud and reed walls and are located in dangerous areas or land unsuitable for settlement, as they are at risk of flooding or landslides, or near industrial plants and railway lines [12, 13].

Slum inhabitants also live in precarious conditions, in squatted housing since they lack a formal document to protect them against arbitrary illegal eviction by the state, harassment and any other threats. Often, in the absence of a legal address, people do not even have the ability to access social services such as subsidized health care or education.

These factors of social destabilization are often combined with the risk of high levels of crime: high poverty rates induce violence, abuse and underworld crime.

Economic subsistence also lacks, in most cases, a formal framework and any form of security [14]: the so-called *informal economy*, consisting of generally small-scale industries and businesses, is often the source of survival for the majority of the inhabitants and compensates for much of the formal sector's inability to provide goods and services [15–17]. In the informal sector, in fact, activities persist and even grow faster than large-scale enterprises in the formal sector. Informal jobs, however, are unskilled, pay very little, and provide no guarantees; in fact, they generate a subsistence economy that allows residents to survive but not to advance far enough to improve their living conditions.

3 Urban Redevelopment of Slums

In response to the sensitive and complex issue of slums, different policy approaches have been attempted in recent decades, evolving over time and in relation to the uniqueness of the needs to be met. This evolution was well outlined in *The Challenge of Slums* (2003), a global report by UN-Habitat [11].

As highlighted in the report, the 1970s were characterized by a general attitude of denial of the reality of slums and the rights of their communities. This induced an approach of "negligence" toward these settlements that were considered an inevitable but temporary problem to be addressed simply by aiming for greater economic development, both of urban and rural areas.

This solution proved to be unsuccessful and prompted more "repressive" policies that dealt with the problem by demolishing entire slums and evicting the inhabitants in mass, often without offering viable alternative solutions and without any compensation payments. This approach did not solve the problem of slums, which, in practice, were simply located toward the outskirts of cities, where access to land was easier and planning control was inexistent [18, 19].

In the late 1970s, slums were recognized as an enduring structural phenomenon, thus to be addressed by appropriate interventions recognized in a new approach of "Self-help and in situ upgrading." In the light of a new awareness of the right to housing and the protection of citizens against forced evictions, there are three main lines of action: (i) the provision of basic urban services; (ii) securing housing possession and implementing innovative land access practices; and (iii) innovative access to credit, adapted to the economic profile, needs and requirements of slum residents and communities [20].

The in situ redevelopment approach saw further evolution during the late 1980s–1990s, in which greater emphasis was placed on community involvement in decision-making, design and implementation of the regeneration of their own settlements; this allows for the implementation of interventions and transformations that are more appropriate and close to the cultural needs of citizens [21].

The scope of redevelopment, however, can vary from small-scale sectoral projects, such as street resurfacing or street lighting, to comprehensive housing and infrastructure projects, to integrated projects that combine building and environmental interventions with social and political empowerment programs [22–24].

Urban slum upgrading is in line with the current *Sustainable Development Goals* (SDG) Goal 11 – Sustainable Cities and Communities – which aims to make cities and human settlements inclusive, safe, resilient and sustainable. In detail, it also aims to redevelop slums by ensuring access to adequate, safe and affordable housing and basic services for all.

Also the *New Urban Agenda* (NUA), whose goals are closely related to those of the 2030 Agenda, promotes the improvement of living conditions for all against the persistence of multiple forms of poverty, inequality and environmental degradation, the main obstacles to sustainable development worldwide.

In recent years, many agencies, local governments, and Non-Governmental Organizations (NGO) have been involved in major slum upgrades in all regions of the world.

Examples of participatory slum redevelopment programs include the Empower Shack, an interdisciplinary housing development project directed by the Urban Think Tank (ETHZ) and the NGO Ikhayalami, in collaboration with the BT-Section community and local and international partners. The goal of the project is the redevelopment of informal settlements through an innovative and inclusive methodology based on four key components: (i) a prototype of two-level, innovative, affordable and sustainable housing; (ii) a participatory land-use planning process; (iii) integrated urban systems; and (iv) economic solutions to support the local community. The first intervention was implemented on the outskirts of Cape Town, South Africa, in the Khayelitsha district, a 4 km2 area where 400,000 people live. In 2015, the pilot project saw the construction of the first four houses, which were accompanied by new houses of different prototypes as well in the following years. Occupying a smaller portion than usual, the houses are developed on two levels, with basic local materials and relatively simple construction techniques: the supporting structure is made of wood and is covered with sheet metal, also designed to be self-built. In fact, community members had access to a microcredit system and were fully involved in the project as the driving force behind the reconstruction of their own homes with materials familiar to them.

Another good example of redevelopment is Slum Networking, an innovative approach to urban development in India. The brainchild of engineer Himanshu Parikh, the holistic approach has won numerous awards, including the Dubai Award the World Habitat Award 1994 and the Aga Khan Award for Architecture [25].

Slum Networking was first pioneered in 1997 in Indore, India, and is now being applied elsewhere. It mainly involves interventions to upgrade the sanitation system of an entire city using the network of slum settlements as a starting point.

In Indore, engineer Parikh implemented interventions aimed at connecting individual houses to the water and sewerage network, establishing a public lighting system, and resurfacing roads and common areas. These interventions, however, were designed as part of a broader strategy that included the "networking" of multiple slums, which in turn were connected to the already stable and functioning cities [26, 27]; this allowed for an overall improvement of the entire infrastructure network that was no longer weakened by the presence of discontinuity areas not served by infrastructure [28]. All of this has been achieved at a fraction of the cost of conventional approaches. Although not a housing program, the improved infrastructure results in a significant increase in the quality of housing and health standards in the slum. The intervention in Indore, moreover, was the result of intensive collaboration, including financial, of local government agencies, private companies, NGOs and local residents. According to Parikh, in fact, the approach can only work with the cooperation and active participation of slum residents: their direct involvement increases the willingness on the part of the community to care for and support what has been achieved, thus avoiding the lack of assistance that has proven in the past to be one of the main obstacles to slum improvement programs [27, 29].

4 Model for Expeditious Estimation of Intervention Costs

Today, one of the main issues negatively affecting the improvement of living conditions in slum communities is the lack of real political will to address this complex problem in a structured, sustainable and large-scale way [30].

In fact, with the increased demand for health, education, transportation and all other kinds of services, administrations fail to secure appropriate solutions. The lack of resources has contributed to the imbalances between cities as most investments are made only in the capital. For this reason, in smaller cities, the projects implemented are almost always possible thanks to foreign funding, particularly from NGOs. The latter, however, contribute to the deresponsibility of the national government by going to act where the state is absent by verifying, in addition, its proper use of international assistance money, which is often wrongly used.

The economic aspect related to slum upgrading interventions is still little investigated. In light of the poverty, environmental degradation, and unhealthy conditions in which slum communities live, only a few useful interventions would suffice to meet the minimum requirements set by UN-Habitat (Paragraph 2) to ensure at least decent living conditions for citizens.

However, it is clear that urban redevelopment interventions alone cannot improve the overall quality of life of slum residents unless their economic and social conditions also change. For slum inhabitants to improve their standard of living, it is necessary to provide them with opportunities to be able to increase their incomes [31].

Three possible reference scenarios are presented.

a) **Minimum level of intervention**, which is the implementation of actions such that meet the minimum requirements set by UN-Habitat (Paragraph 2). The reference is to the implementation of actions that ensure:

   – a good level of structural quality and sufficient living space;
   – access to drinking water through the implementation of water distribution and collection systems;
   – access to improved sanitation through the construction of a sewerage system.

b) **Barely satisfactory level of intervention,** which includes upgrading works aimed at improving the level of livability of the slum. In detail, the interventions included in the minimum level are added to those required for the:

   – remediation of polluted areas;
   – waste management;
   – implementation of road networks;
   – implementation of drainage networks;
   – implementation of green infrastructure.

c) **Fully satisfactory level of intervention** which involves socio-economic improvements aimed at generating employment and business activities in light of the severe poverty and lack of income that characterize the slums. Useful initiatives could include: the creation of workshops for the development of professional and entrepreneurial skills; advice to aspiring entrepreneurs on registering, setting up and managing their businesses; technical education scholarships to promising students;

the activation of funds to secure interest-free loans for raw materials, machinery and institution [32].

In order to provide an economic reference useful for determining the amount of resources to be allocated for urban slum upgrading interventions, having identified possible intervention scenarios, it is possible to structure a model for the expeditious estimation of the related construction costs [33–35]. This cost estimate comes in useful, even in the absence of a final design, for feasibility assessments of a project and for budget decisions.

The cost approach is a methodology recognized by international standards and the scientific bibliography of Estimate. It involves determining the economic value that would be placed on the building today if it were destroyed or needed to be completely replaced [36, 37].

Construction Cost CC is sum of Construction Technical Cost CTC, General Expenses SG and Constructor's Technical Profit UTC:

$$CC = TCC + GC + CTP \tag{1}$$

$$TCC = MT + L + FT \tag{2}$$

In detail, the TCC item represents the technical cost of construction whose rate is composed of the direct variable costs that depend in a directly proportional form on the work to be performed: these are the costs related to materials (MT), labor (L) and freight and transportation (FT). This technical cost TCC greatly affects the overall construction cost since it is to it that the other cost items are linked.

GC expresses the general costs composed of indirect, variable, and fixed costs. In detail, the variable indirect costs do not depend on the work produced but simply on the opening of the construction site (costs concerning the setting up of the construction site itself, personnel, safety costs). Fixed costs, instead, are the general site costs that are independent of site activity (personnel employed, financial charges, etc.).

CTP represents Constructor's Technical Profit, i.e., remuneration for the organization of construction production and work phases, in addition to any risks associated with increased input costs, sanctions for delays or problems in the work.

In line with the previously outlined intervention scenarios, formulation (1) and formulation (2) can be made explicit as follows:

$$CC_{(a)} = TCC_{(a)} + GC + CTP \tag{3}$$

$$TCC_{(a)} = (TC_d + TCC_h) \times S_h + (TCC_w + TCC_{ww}) \times L_s \tag{4}$$

$$CC_{(b)} = TC_{(b)} + GC + CTP \tag{5}$$

$$TCC_{(b)} = TCC_{(a)} + TCC_g \times S_h + TCC_{dr} \times L_s + TCC_s \times S_s \tag{6}$$

Respectively for the minimum level (a) and the barely satisfactory level (b), each cost item represents:

- TC_d – Technical cost of demolition, usually expressed per square meter or cubic meter;

- TCC_h – Technical cost of housing construction, per square meter
- TCC_w – Technical cost of water network construction, expressed in linear meters;
- TCC_{ww} – Technical cost of construction of wastewater collection network, in linear meters;
- TCC_g – Technical cost of green infrastructure construction expressed in square meters;
- TCC_{dr} – Technical cost of drainage network, in linear meters;
- TCC_s – Technical cost of construction of road networks measured in square meters.

The cost items are multiplied by: the surface area to be allocated to housing (S_h); the surface area to be allocated to road networks (S_s); and the surface area to be allocated to water, drainage and wastewater collection networks (L_s).

Regarding the fully satisfactory level (c), no particular construction works are planned, rather actions to improve the socio-economic network of the slums. For this reason, there is no explicit formula concerning construction costs.

For the purpose of estimating the construction cost, in light of the information needs, processing time and the degree of reliability required by the forecast, two procedures can be used: (i) analytical; (ii) synthetic-comparative.

The analytical procedure (i) focuses on the analysis of the production process of construction and, therefore, on the identification and quantification of all the production factors involved in it. This procedure, therefore, provides for the preparation of an estimated metric calculation that guarantees an accurate amount of the resources needed to carry out an intervention but, at the same time, requires the preparation of a final or executive project to which reference must be made. It is easy to deduce the difficulty that would be encountered in applying the analytical procedure to a large area such as slums, where a metric calculation would have to be processed for each civil work to be carried out.

Definitely more expeditious, and suitable for preliminary cost estimation of slum upgrading interventions, is the synthetic-comparative procedure (ii). The latter estimates construction costs through comparison with known costs of similar works already carried out. The procedure involves:

– a first step of finding data on cost prices, expressed through unit parameters, of construction or urbanization works similar to those to be estimated;
– a second step of choosing a technical parameter that measures consistency on which to base the comparison with the sample work (for residential buildings, for example, a parameter might be volume, area or number of rooms);
– a final step in which the amount of the previous technical parameter is to be multiplied by the appropriately discounted unit cost, so as to obtain the total reconstruction cost.

Operating in an informal context such as slums, the synthetic-comparative approach (ii) has limitations in the first step of finding data on the cost prices of sample works. Official price lists are often dated and difficult to find. Moreover, the cost items do not always reflect the official ones, as the economic-political environment is highly unstable.

Figure 1 summarizes the steps of the estimation model.

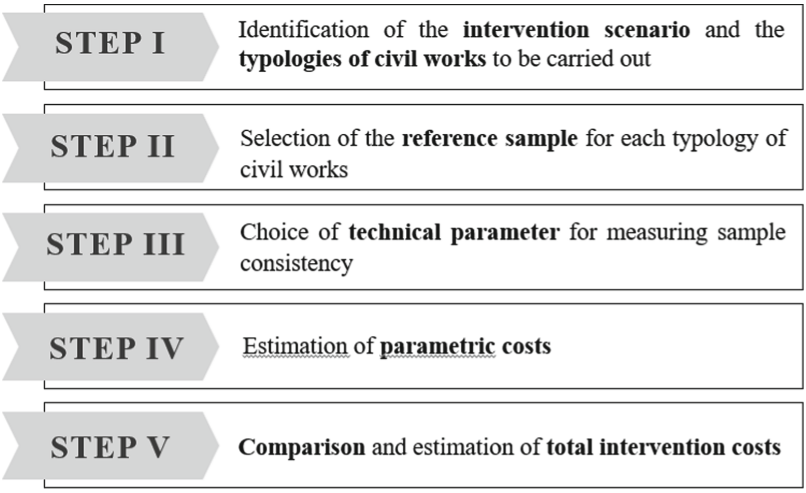

Fig. 1. Steps of the estimation model.

5 Conclusion

Slums are a global phenomenon affecting one billion people around the world, particularly in developing countries. Currently, one in eight people worldwide live in slums or in housing environments with similar conditions; in the next 15 years, it is estimated that more than three billion people will be in need of adequate housing.

Rapid urbanization, migration from rural to urban areas and limited housing options for low-income families are the main causes of slums.

For years, attempts were made to solve the problem by first demolishing most of the slums and later trying to hide them in the suburbs. To date, however, many governments and international organizations have recognized the importance of addressing the slum phenomenon and are implementing policies and programs to provide a future for this substantial part of humanity [38].

Urban redevelopment interventions are a possible solution to improve the living conditions of people living in these areas; however, they can be complex and costly and require careful planning and a multidisciplinary approach involving different stakeholders [39]. Indeed, it is important to make sure that interventions are actually responsive to the needs and requirements of the local communities living in the slums, which is why people are made increasingly involved in decision-making and construction processes.

The economic aspect related to the slum issue is still poorly investigated. The intervention costs for urban redevelopment in these areas can vary depending on the size of the area to be redeveloped, the pre-existing conditions, and the goals to be achieved. Importantly, initial costs, while high, can generate long-term benefits for slum communities and their economic and social development [40].

As a result of the above, the purpose of the work is to define possible intervention scenarios and to characterize a model for the expeditious estimation, through a

synthetic-comparative procedure, of the related construction costs. This makes it possible to provide an economic reference useful in determining the amount of resources to be allocated for urban slum upgrading.

This model has limitations related to the context in which it intervenes.

Slums are characterized by high economic instability resulting from several factors, including lack of job opportunities, low quality of available jobs, lack of access to credit, poor financial services, unstable prices of goods and services, and lack of long-term financial security.

Along with economic instability comes political instability: slums often lack stable and accountable governance structures, and organized crime can play a predominant role [41]. Slum inhabitants often find themselves in situations of social and economic degradation, which can lead to high levels of unemployment, poverty, resource scarcity, and lack of access to public services. This can result in the emergence of criminal groups or paramilitary organizations that seek to control the area and exploit the local population.

The data required to conduct the expeditious estimation of construction costs reflect the instability of the context from which they come and, in addition, are often lacking or difficult to find and require the use of market surveys.

Research prospects involve the application of the estimation model to case studies; this is with reference to the three possible intervention scenarios proposed in Sect. 4: (a) minimal level; (b) barely satisfactory level; and (c) fully satisfactory level. In this sense, the model can also be examined with respect to estimating the costs required to secure socio-economic improvements for communities.

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