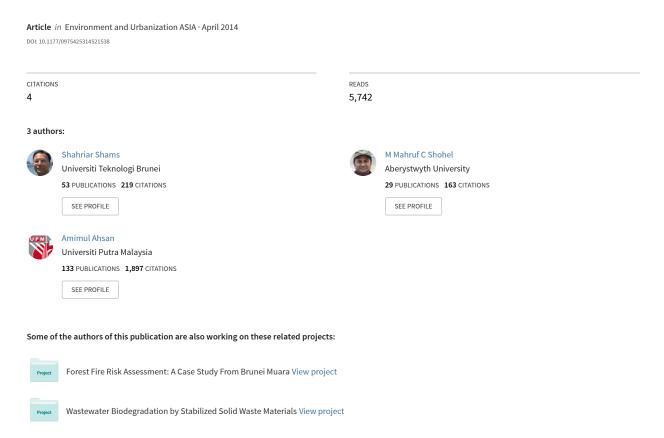
# Housing Problems for Middle and Low Income People in Bangladesh: Challenges of Dhaka Megacity



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#### **Abstract**

In Bangladesh, 30 per cent of its total population is living in urban areas and by 2030 the rate of urbanization will be more than 40 per cent. There is a tremendous pressure of influx of people in Dhaka city. Current trend of urban migration is driven by rural poverty, river erosion and natural calamities forcing them to migrate to Dhaka city in search of better livelihoods. These newcomers floating people in the city end up sleeping in public places such as street corners, railway and bus stations as well as other available places including abandoned buildings. The existing infrastructure facilities developed in Dhaka megacity cannot cope with the minimum living requirements of this poor working class floating population. The Dhaka city is exposed to an array of urban problems that could not be discussed in one paper. This article explores the nature and pattern of housing developed under public sector and the policies and strategies that the Government of Bangladesh is pursuing particularly for the middle and poor class who are living permanently in Dhaka city in temporary shelters or on floating basis.

#### 孟加拉国中低收入居民住房问题: 达卡大都市区的挑战

在孟加拉国,其总人口的30%居住在城市地区,到2030年孟加拉国的城市化率将超过40%。人口汇集给达卡市带来了巨大的压力。目前人口向城市迁移的推力主要来自农村的贫困、河流侵蚀和自然灾害,这些因素迫使他们迁移到达卡市以寻求更好的生活。这些新流动人口在城市里睡在公共场所,如街头、火车站和汽车站,以及包括废弃建筑物的其他可用的地方。达卡大都市区目前已有的基础设施无法满足这些贫穷的工人阶级流动人口的最低生活需求。达卡市面临的城市问题不可能在一篇文章中讨论完全。本文探讨的是公共部门管理下住房发展的性质和模式,以及针对永久居住在达卡市的临时庇护所或流动地点的贫困阶层,孟加拉国政府正在推行什么样的政策和战略。

#### Keywords

Housing, urbanization, urban migration, slums, policy

#### Introduction

In developing countries, high population growth followed by increased migration towards cities has resulted in rapid decline of urban land raising the house price beyond the reach of middle and low

income people (Brennan and Harry, 1989; Dunkerley, 1983). Urbanization in Bangladesh is taking place due to rapid growth of urban population and rural—urban migration. The capital city-centric development strategies have led to an explosion of Dhaka city's size, without corresponding expansion of the infrastructure. The city expanded in all directions including over the low-lying areas on the eastern side and western side (Chowdhury and Faruqui, 1998). The population increased to 3 million within one decade of the independence of the country (Uddin, 2006) and reached to 14.5 million in 2011 (BBS, 2011). New residential, administrative, business and commercial areas start to emerge at the cost of swaps and wetlands. Numerous slums and unplanned low-income residential areas also started to boom up creating environmental and social problem.

The cities become sources of economic development and national savings, and urban productivity becomes crucial to national development (Harris, 1992). The continuous migration of rural people in Dhaka city has added significant pressure to its already overstretched infrastructure. As migrants pour into the city, they often settle in illegal settlements on marginal pieces of land which pose significant environmental concerns. Urban dwellers constitute 26 per cent of the total population and their contribution to GDP is more than 45 per cent (UNDP, 2007). Dhaka is the 10th largest urban agglomeration in the world with the second fastest rate of population growth and has become one of the megacities of the world (UN-Habitat, 2006). Since 1991, Dhaka's population has been experiencing growth rate of 4.3 per cent compared to a national average of 3.2 per cent (BBS, 2001, 2005). Migrations are the combined effect of both push and pull factors and it is often difficult to separate the role of the two (Lee, 1966). Within the push–pull model, push factors (at rural end) may be identified as: landlessness and poverty, frequent natural calamities (particularly river bank erosion, tidal surge), lack of social and cultural opportunities (applicable for rural rich). The *pull factors* are operative at the urban destination end such as perceived job opportunities and higher wages, rural-urban disparities in accessing civic services. The concept of sustainable urbanization is a dynamic, multi-dimensional process and it embraces relationships amongst all human settlements. It is projected that by 2030 the level of urbanization will be more than 40 per cent (UNFPA, 2005). Of the 30 million urban dwellers in Bangladesh, 10 million reside in Dhaka and the rest in other urban sites across the country (Ahmed, 2007).

Housing is one of the basic needs, which provides a sense of belonging and security. Good housing is the pre-requisite for good health and mental comfort. Bangladesh, like many other developing countries, faces an acute shortage of affordable housing particularly in the urban areas. There is an acute shortage of housing for the low-income households (HHs) in developing countries (Sivam, 2003). Housing is treated as a basic right in the constitution of Bangladesh. Therefore, the government should provide housing facility to its citizens.

# What is Megacity?

Megacities are a new form of human settlement and developed in different physical locations of different countries with different growth rates and socio-economic and cultural histories. 'New dimension of large high density concentrations of populations with immerse sprawl and a serious increase in infrastructural, socio-economic and ecological overload' (Kraas et al., 2005). Most urban plans and regulatory regimes in the developing world have been incapable of preventing the conversion of rural land to urban use in city peripheries, as a result, the reclassification of settlements from 'rural' to 'urban' has become the second most

significant determinant of urban population growth and expansion in the developing world giving birth of megacities (UN-Habitat, 2012). Megacities are more vulnerable for the populations living in slums due to poor quality of infrastructure and public services (Satterthwaite et al., 2007). Urbanization in the developing world, particularly since 1970, has spawned the rapid growth of megacities as shown in Table 1.

City	1950 (Million)	2010 (Million)	Increase
Dhaka	0.34	14.65	×43
Delhi	1.37	22.16	×16
Karachi	1.05	13.13	×I2
Lagos	0.33	10.58	×32
Sao Paulo	2.33	20.26	×9

Table 1. Growth of Selected Megacities from 1950 to 2010 (Millions) (UN-Habitat, 2012)

# Profile of Dhaka Megacity

Dhaka, the capital city of Bangladesh, covers an area of 154 sq km and is situated between latitudes 23°42′ and 23°54′N as well as longitudes 90°20′ and 90°28′E. The city is bounded by the rivers Buriganga to the south, Turag to the west, Balu to the east and Tongi Khal to the north. Dhaka emerged as an important strategic and business centre along the river Buriganga at the beginning of Muslim rule in the thirteenth century. Dhaka city grew from a rural settlement to become a megacity without much planning effort (Huq and Alam, 2003; Nilufar, 2010). Since independence, capital city Dhaka has been accommodating major share of urban population. The inner core of Dhaka city reveals a tendency towards high density built form because of close proximity between place of residence and place of work. Transport sector failed to keep pace with the growth of the cities and its population size; there is insufficient provision of appropriate transport modes and inadequate infrastructure (Zaman and Lau, 2000). The evidence suggests that if there are no major decisions in terms of its pattern of development, congestion could reach intolerable levels in the near future (Kabir and Parolin, 2011). Dhaka city refers to the area under the jurisdiction of the Dhaka City Corporation (DCC). It is predicted by United Nations that Dhaka would be the second largest megacity of the world by the year 2015 (Islam, 2005).

Dhaka has emerged as one of the fast growing megacities of the developing countries in recent times. Compared to the enumerated population in 2001, about 1.8 million people were added, which represent a 14.4 per cent increase and a 1.34 per cent average annual growth rate. There is no city in the world, which has experienced such a high growth rate in population during this period. By the year 2015, almost 1.9 million people will have to find their house (CPD, 2006).

# **Housing Problems**

Bangladesh has an agriculture-based economy and most of its rural population is dependent on agriculture. There is a huge surplus of labour in the rural areas as only farming cannot support all the rural population. As a result, they remain unemployed or underemployed for most of the year. These populations

along with the millions affected by frequent natural calamities such as river erosion and tidal surge migrated to the cities in search of jobs and a better life. Most of them started squatting on the government owned vacant land such as the road reserve; railway stations, sides of railway tracks, launch terminals and market places. These poor people lived in appalling conditions in slums, totally unfit for human habitation without the presence of any sanitary or utility facilities. As a result, an unhealthy living condition was created causing serious threat to the public health and the overall environment of the Dhaka city. The challenge of affordability is not new to Bangladesh, but the need for instituting a supportive institutional framework to increase the supply of affordable land and housing is still a daunting task. Housing market in Bangladesh is characterized by a surplus of upper-income group housing stock and shortage of affordable housing for the great majority of middle and lower-income population groups.

# Urban Formal and Informal Housing

Formal housing is constructed following the building codes and standards enforced by the national housing authorities, whereas informal housing is built defying minimum standards of housing regulations. Lack of tenure security is a key characteristic of informal settlements. According to UN-Habitat (2007), the total urban population in the world exceeded the rural population, indicating that we have passed a significant threshold into an 'urban age'. However, the future growth of the urban population continues to be mainly located in developing countries, or more precisely in their slums. It is estimated that by 2020 the world slum population will reach 1.4 billion (UN-Habitat, 2006, 2007). An estimated 20–40 per cent of all urban HHs in developing countries are living on land to which neither they nor their landlords have legal title (Malpezzi, 1990). Due to such tenure problem, property transactions are slow or stalled; incentives for new construction and upgrading are depressed; lenders are unwilling to extend credit for property holders without clear title; and property taxation is impeded. These are one of the reasons why the lands occupied by slums are not easy to be upgraded. Many cities have master plans prescribing directions of urban growth, but these plans rarely are realized and languish in metropolitan planning office as irrelevant document (Brennan and Harry, 1989). The problem with these rules is that their implementation is time-consuming and gives opportunities for corruption.

Large disparities have emerged as poverty has urbanized. Over 200 million people live in poverty in Asian cities and many more are vulnerable to economic and environmental shocks (Lindfield, 2010). According to Pugh (2000), developing countries have three types of housing development systems; formal, informal and organic. Formal developments have the legal basis of the planning agency. These are developed within the structure of government rules, controls and regulations. Informal housing development is illegal and consisted of unauthorized 'colonies and squatter settlements'. These types of developments happen mostly because of unaffordability or sometimes unavailability of housing in legal housing market. The significant characteristics of informal development are insecurity of tenure and low standard of facilities and infrastructure. Natural gas and electric connection for HH use (90 per cent) in slums possess potential fire hazards (6.1 per cent) and each year over hundreds of people in slums are dislodged by fires (Centre for Urban Studies, 2006). These slums often become a safe heaven for criminals and results in violence centering from uses of drugs. Dhaka's rapid growth, large size, topography, environmental conditions and problems of governance exacerbate already complex land and housing issues for

the disadvantaged poor. The number of slum dwellers is projected to grow to 8 million over the next decade. With this growth, policymakers including central and local government officials will need to address land and housing as a top priority.

### Housing Shortage in Dhaka

The ever-increasing urban migration and industrial expansion including garments factories within the Dhaka city has created a serious housing shortage. The imbalance between the total number of HHs and the total housing stock is often referred to as the great housing shortage in Dhaka. The growth of dwelling stock was inadequate to cope with the increasing population and the intensifying housing need in Dhaka. The Bangladesh Bureau of Statistics (BBS) has categorized urban housing types into cement/brick, corrugated iron/metal sheet, mud/unburnt brick, straw/bamboo. Eightynine per cent of poor HHs in Dhaka live in one-roomed homes of the latter types. In the densely populated slums of Dhaka, the floor area per person is as small as 1.2 m<sup>2</sup>. This high price of land in Dhaka acts as a prohibitive factor in the supply of housing to all but the highest-income groups. On account of high price of land, lower middle-class HHs, who are actually majority in cities, are virtually kept out of the land market. The public sector's contribution is too insignificant and government's policy is to act as an enabler in order to increase access to land and other supporting facilities especially for low and middle-income groups. Therefore, the construction of housing will generally be left to the private sector and the people themselves. The private housing market is dominated by small scale, self built housing. In the absence of well-established formal land and housing markets in Dhaka city, informal sector has been playing the major role to cater the housing needs. Small-scale builders and developers, owner-builders operating in the informal private sector are the largest suppliers of land and shelters in Dhaka. The informal sector holds the role of largest housing supplier in Dhaka, both in the rental and ownership sector. Existing housing finance system including fast growing private banking sector is also not supportive to access housing loan.

Private developers are the active housing provider in Dhaka city. But no more than 5 per cent of the city dwellers are getting access to these housing due to poor affordability. Two major constraints for the housing development in Dhaka's are: scarcity of land and high construction cost. The rise in construction cost with the building height is prominent where construction is labour-intensive. The inclusion of the costs of developed land, render such housing solutions inaccessible even for HHs well above the median income.

The Government of Bangladesh cannot cater to the housing needs of its citizens alone due to paltry fiscal capacity. Thus, the formal private developers and entrepreneurs are being popular to the upper and middle class as housing provider and growing rapidly.

High land prices have excluded the poor from ownership of land and housing. Residential land values in prime locations of Dhaka range between US \$30 and \$60 per sq ft, similar to prices reported in other regional cities such as Hyderabad, Kuala Lumpur or New Delhi. Nevertheless, land prices are high compared to those found in developed countries. For example, areas in the US where land prices exceed \$60 per sq ft are rare.

These prices make it impossible for the poor to purchase land in the open market within the DCC area. The cheapest ready-to-build plot within the DCC is priced at Tk. 700,000 per katha (i.e., 720 sq ft lot) or US \$12 per sq ft. Normally RAJUK¹ (Capital Development Authority) does not grant building permission on lots smaller than 1,050 sq ft. This would cost Tk. 1,000,000 (US \$12,600), which is equivalent

to nearly 20 years of income for an average poor HH (Tk. 3,000 per month). The cost of housing would be additional. In any case, such small lots are hardly available in the open market and only rarely supplied by the government in a subsidized market. Consequently, it is estimated that 97 per cent of the urban poor in the city do not own any land.

# New Housing and Rent Levels

With regard to the types of new housing produced, formal sector private developers generally serve only the upper and middle income groups. The low and middle-income families are in need of low cost flats or plots and the high and upper middle-income families are complaining that the cost of a decent plot or a decent flat is going beyond their means (Seraj, 2001). Even 'lower cost' housing products sell for approximately Tk. 1.36 million (US \$17,000). With a 50 per cent down-payment and under current credit conditions, the unit can be repaid with monthly payments of Tk. 5,000. Under an already high payment-to-income ceiling of one-third, the required minimum income of the HH would be of Tk. 15,000, which means that only those in the top 30 per cent of the distribution of income in Dhaka could afford to purchase new housing.

In private slums and 'mess' units the disadvantaged poor pay regular rent to a landlord or homeowner. In the case of squatter settlements, occupants generally have to pay 'tolls' to mastaans (musclemen) and agents of employees of the land owning authorities. Rents in the private slums are reported to be high. Islam (1985) found that slums dwellers in Dhaka City were paying higher rent per m² than non-slum HHs, even though the latter usually benefited from a much better physical environment and level of services. A survey carried out in 2012 reveals that rents today would be around Tk. 800 for a single person, Tk. 1,200 to Tk. 1,800 for a family. Many poor HHs pay up to Tk. 3,400 (US \$40) for a small two-room unit in slums with utilities of water, electricity, gas and access to latrine. This spending accounts for approximately 25 per cent of the HH budget of the urban poor. This figure is considerably higher than that observed in large Indian cities where the average urban HH spends 7 per cent of their income on housing, even in high cost locations such as the state of Maharasthra where Mumbai is located. As a consequence of tight budget constraints and relatively high rents, the poor in Dhaka usually live in very small accommodations (2 or 3 m² per person similar to the situation in Mumbai).

# The Role of Microfinance Institutions in Promoting Housing for Urban Poor

Microfinance institutions have been impressively present in rural Bangladesh for at least two decades and have achieved international recognition as pro-poor effective and transparent institutions. Some of them, such as Grameen Bank, BRAC have devoted significant resources to housing programmes. Grameen has made more than 600,000 housing loans in rural areas in Bangladesh. However, most NGOs are confined by their charters to work in rural areas. Others work in urban areas, but have prioritized income generating activities as a main focus. The very high land prices in Dhaka are cited as a main reason for this limited involvement. Recently, BRAC formed a Housing Fund called 'Grihayan Tahabeel' of Tk. 100 million for building hostels for 2,500 women workers of garment factories in Uttara, Dhaka with 1 per cent interest, repayable in 20 years.

#### Recommendations

Bangladesh needs reforms in the field of housing finance to cope with the growing demand. Reforms should improve regulatory enforcement and property registration, prudential norms customized to housing finance, legal framework for safeguarding customers, improved availability of housing and mortgage information. In addition, policy interventions are needed as shown in Figure 1:

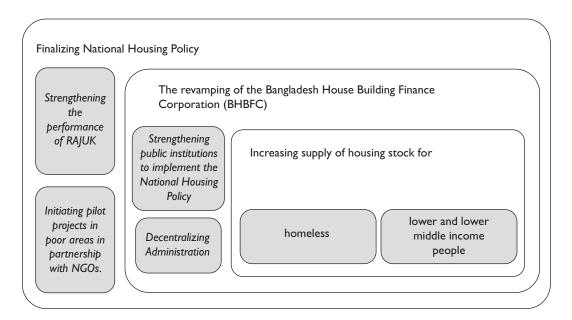


Figure 1. Policy Interventions for Finalizing National Housing

#### Strengthening Public Institutions and Implementing the National Housing Policy

This is a priority for any sustainable improvements for the urban poor. Destruction of squatter settlements should be limited to necessary actions of redevelopment or infrastructure building and should be accompanied by relocation plans for evicted squatters. If the National Housing Authority continues to be the overseer of the National Housing Strategy, it would be more effective if they focus on a policy and regulatory role rather than implementing housing projects. The promotion of long-term financing facility and a national savings scheme for housing should be introduced.

# **Decentralizing Administration**

There should be a coordination between DCC, RAJUK—the planning authority, concerned ministries and utility agencies in urban projects, while administrative procedures should be decentralized to ensure

transparency in the implementation of the housing projects. Private sector should be given responsibility to construct housing units for medium or high income HHs while low-income housing projects could be done by a specific entity, as RAJUK failed to focus on the housing for the poor.

#### Initiating Pilot Projects in Poor Areas in Partnership with NGOs

NGOs have not been active in the housing sector in urban areas. It would be useful to foster the piloting of additional programmes aimed at improving land and housing conditions for the poor with careful monitoring and evaluation so they can be scaled up over time. NGOs can play an important role to promote urban farming on rooftop of a house and provide food and income for many poor HHs.

#### Conclusion

Both the government and private sector have failed to address the housing problem for middle and low income people. As housing is one of the basic needs and right of individuals living in a country, therefore, disadvantaged low income and displaced people need support to secure a decent housing through public—private partnership (PPP). To solve the chaotic living condition in Dhaka city, policymakers have huge responsibility to develop a legal framework and strategic planning for reducing shortage of housing and for providing secure healthy urban living environment in the Dhaka megacity.

#### Note

RAJUK is the sole authority for the approval of planning and designing of buildings within an area of an approved
master plan and enforce rules and regulations under the Bangladesh National Building Codes (BNCC) within the
RAJUK jurisdiction area.

#### References

Ahmed, K.I. (2007). *Urban poor housing in Bangladesh and potential role of ACHR*. Bangkok, Thailand: Asian Coalition for Housing Rights (ACHR).

BBS. (2001). Bangladesh bureau of statistics report. BBS.

. (2005). Bangladesh bureau of statistics report. BBS.

. (2011). Bangladesh bureau of statistics report. BBS.

Brennan, E.M., & Harry, W.R. (1989). Asian megacity characteristics, problems, and policies. *International Regional Science Review*, 12(2), 117–129.

Center for Policy Dialogue (CPD). (2006, October 10). Strengthening the role of private sector housing in Bangladesh economy: The policy challenges. Report No. 64, 2003.

Centre for Urban Studies (CUS). (2006). National Institute of Population Research and Training and Measure Evaluation, *Slums in Urban Bangladesh: Mapping and Census*, Dhaka and Chapel Hill, USA.

Chowdhury, A.M., & Faruqui, S. (1998). Dhaka—A study in urban history and development. In S. Ahmed (Ed.), *Dhaka: Past present future* (pp. 43–63). Dhaka, Bangladesh: The Asiatic Society of Bangladesh,.

Dunkerley, H.B. (1983). Urban land policy: Issues and opportunities. New York: Ford University Press.

Harris, N. (1992). Cities in the 1990s: The challenge for developing countries. London: UCL Press.

- Huq, S., & Alam, M. (2003). Flood management and vulnerability of Dhaka. In Alcira Kreimer, Margaret Arnold, & Anne Carlin (Eds), Building safer cities: The future of disaster risk (pp. 121–136), Part II: Environment, Climate Variability, and Adaptation. Washington: The World Bank.
- Islam, N. (1985). Rural—urban migration in Asia: Its patterns, impact and policy implications. HSD Working Paper no. 14, Human Settlements Division Asian Institute of Technology, Bangkok, Thailand.
- . (2005). Dhaka now: Contemporary urban development. Dhaka: Bangladesh Geographical Society (BGS).
- Kabir, A., & Parolin, B. (2011). Dhaka megacity: Growth, congestion, environment and planning for a sustainable future. Presented in the conference of Asian Planning School Association, 19–22 September 2011, Tokyo University, Tokyo.
- Kraas, F., Aggarwal, S., Coy, M., Heiken, G., Mulder, E., Marker, B., et al. (2005). Megacities—Our global urban future, planet earth. Leiden, The Netherlands: Earth Sciences for Society Foundation. Retrieved 14 February 2013, from http://yearofplanetearth.org/content/downloads/Megacities.pdf
- Lee, E.S. (1966). A theory of migration. *Demography*, 3(1), 47–57.
- Lindfield, M. (2010). Cities: A global threat and a missed opportunity for climate change. *Environment and Urbanization Asia*, 1(2), 105–129.
- Malpezzi, S. (1990). Urban housing and financial markets: Some international comparisons. *Urban Studies*, 27(6), 971–1022.
- National Housing Authority. (2004). Report.
- Nilufar, F. (2010). Urban morphology of Dhaka city: Spatial dynamics of growing city and the urban core. Presented in the International Seminar on the Celebration of 400 Years of the Capital Dhaka, Asiatic Society, February 2010, Dhaka.
- Pugh, C. (2000). Squatter settlements: Their sustainability, architectural contributions, and socio-economic roles. Cities, 17(5), 325–337.
- Satterthwaite, D., Huq, S., Pelling, M., Reid, H., & Lankao, P.R. (2007). *Adapting to climate change in urban areas:*The possibilities and constraints in low and middle income nations. Discussion Paper Series, Climate Change and Cities 1, IIED, London. Retrieved 15 September 2008, from www.iied.org
- Seraj, T. M. (2001). Real estate, housing and construction industry in Bangladesh in 2001 and beyond: Scope and prospects. In S.U. Ahmed (Ed.), *Dhaka: Past present future*. Bangkok, Thailand: The Asiatic Society of Bangladesh, pp. 23–31.
- Sivam, A. (2003). Housing supply in Delhi. Cities, 20(2), 135–141.
- Uddin, M.N. (2006). The relationship between urban forestry and poverty alleviation—Dhaka as a case study. Master's Thesis submitted to Dept. of Landscape Management & Horticultural Technology, Swedish University of Agricultural Sciences, Alnarp, Sweden. Retrieved 2 August 2013, from http://www.fao.org/uploads/media/The relationship between Urban forestry and poverty alleviation Dhaka case study.pdf
- UNDP. (2007). Towards a National Urban Policy, N. Islam, Policy Dialogue Series.
- UN-Habitat. (2006). State of the world's cities 2006/7: The millennium development goals and urban sustainability: 30 years of shaping the habitat agenda. London: Earthscan.
- ——. (2007). Global report on human settlements 2007: Enhancing urban safety and security. London: Earthscan.
- ——. (2012). State of the world's cities report 2012/2013: Prosperity of cities. United Nations Human Settlements Programme (UN-HABITAT).
- UNFPA (2005). State of World Population 2005, The Promise of Equality: Gender Equity, Reproductive Health and the Millennium Development Goals. UNFPA.
- Zaman, Q.M.M., & Lau, S.S.Y. (2000). City expansion policy versus compact city demand: The case of Dhaka. In M. Jenks, & R. Burgess (Eds), Compact cities: Sustainable urban forms for developing countries (pp. 141–152). London: Spon Press.

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