View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Annali dell'Istituto Superiore di Sanità

Ann Ist Super Sanità 2016 | Vol. 52, No. 1: 88-97
DOI: 10.4415/ANN_16_01_15

MONOGRAPHIC SECTION

Healthcare for all in emerging countries: a preliminary investigation of facilities in Kolkata, India

Andrea Rebecchi[1], Marco Gola[1], Mrudula Kulkarni[2], Emanuele Lettieri[3], Ingrid Paoletti[1] and Stefano Capolongo[1]

[1]*Dipartimento di Architettura, Ingegneria delle Costruzioni e Ambiente Costruito (ABC), Politecnico di Milano, Milan, Italy*
[2]*Maharashtra Institute of Technology, Pune, India*
[3]*Dipartimento di Ingegneria Gestionale (DIG), Politecnico di Milano, Milan, Italy*

Abstract

Introduction. India is one of the five countries with the lowest public health spending levels: the private medical services are one of the most developed fields, meanwhile public health ones are totally inadequate with the most number of health facilities concentrated in cities, where only the 25% of the population lives. Public facilities are mainly made up of primary level and not well distributed on the territories, so they do not guarantee accessibility to a wide sample of population, who live in rural areas of India.

Methodology. Starting from the analysis of three different health care levels in the Indian context, the research team developed a meta-project that considers all the current criticisms and the Indian customs through a flexible layout that responds to the healthcare needs of population.

Result and Discussion. The research work is aimed to develop a meta-project that considers all the current criticisms and the Indian customs through flexible layouts that responds to the healthcare needs of population.

Conclusion. The innovation of the research work is to develop the hygienic aspects, the layout and the distribution, the sub-division of the medical functions through the Indian culture and the needs of the country.

The choice of lowly technologies permits to promote the usage of local materials, their maintenance and skills for creating a virtuous economic system.

Key words

- healthcare in Kolkata
- Institute for Indian Mother and Child
- low care hospital model
- self-built modules
- flexible layouts

INTRODUCTION

The Indian context

India, in South Asia, is one of the largest political state in the world. It is considered the seventh largest nation in terms of area with a population of more or less 1 150 000 000 inhabitants, therefore it is the second most populous nation after China. It is a country with its rich diverse cultural heritage and colourful history and people of various ethnicities living in harmonious collaboration [1].

Nowadays, this country presents a very complex economic and social scenario because, on one hand, it is among the states with an increasingly central role in the global economy and, on the other, the presence of different customs and traditions still pervade the social organization and the structure of some economic sectors. Moreover, in the past decades the country was subjected to an accelerated growth becoming in 2011, according to the data taken from the International Monetary Fund, the third force in world economy in terms of PPP (Purchasing Power Parity) and the tenth in nominal ones [2]. Indian economy is the 10th largest with a gross domestic product of US$ 1377.3 billion (2009), and it becomes one of the prime industrialized nations in the world, on the back of rapid technological advances over the past decade.

According to the World Bank data, nowadays, about 40% of India's population lives below the poverty line with the Human Development Index that ranks the country at 132 out of 169 in the world ranking. Otherwise, the 30% of people live below the poverty line and, starting from the statistic data, India is losing more than 6% of its GDP (Gross Domestic Product) annually due to premature deaths and preventable illnesses, according to World Bank report of 2010. Total expenditure on health is 4.2% of GDP, and current public expenditure

Address for correspondence: Andrea Rebecchi, Dipartimento di Architettura, Ingegneria delle Costruzioni e Ambiente Costruito (ABC), Politecnico di Milano, Via G. Ponzio 31, 20133 Milan, Italy. E-mail: andrea.rebecchi@polimi.it.

is only 1.1% of GDP. However, India remains among the five countries with the lowest public health spending levels in the world: in fact, the central government is responsible to define and supervise the teaching and healthcare services through the actions of each state (it means the health policies are delegated to the governments of individual state).

Speaking about the priorities of Indian Government, only 4.2% of public expenditure is devoted to Health, factor that places India among the ten countries with the lowest health investment in all the world. Spending per capita of Health issues increased from $ 21.00 in 2000 to $ 45.00 in 2009, nevertheless it does not improve the situation and it leaves India in a situation unchanged [3]. The total health expenditure invested by the Indian Government, as emerged, presents a huge gap between the public health (32.3%) and private one (67.6%).

Therefore, Indian healthcare industry has more private structures than public ones: about 68% of the existing hospitals (15 097) and 37% of the inpatient beds (623 819) in the country belong to health private sector and most of these are located in urban areas [3].

India has about 0.6 beds per 1000 inhabitants and this situation is worsened by the lack of facilities and management/support staff that leads to have 50% of beds in the public health sector and 30% in the private one not used. The situation is, however, slightly improved by the introduction of the National Rural Health Mission (NRHM), founded by 85% the Union and the remaining 15% by the states, which aims to bring its action in rural areas strategic, engaging more than 800 000 workers paid according to the performance [4].

Starting from the data analysis, in India the private medical services are one of the most developed fields, meanwhile public health ones are totally inadequate with the most number of health facilities concentrated in cities, where only the 25% of the population lives [5]. Moreover, the public infrastructures are not well distributed on the territories, in fact they are in the main urban centres and so it does not guarantee accessibility to a wide sample of population, who live in rural areas of India; it is possible to identify three different health care levels:

- **Primary health care level** is free and it is provided in public hospitals in the main cities, namely Urban Health Centre, and in primary health centres, namely Primary Health Care (PHC) in rural areas;
- **Secondary medical care level** is guaranteed by general hospitals at the district office and/or the *taluk*, namely administrative subdivision of the district;
- **Tertiary medical care level** is guaranteed by specialized hospitals and/or local universities.

The public health care is mainly made up of primary level, with differences between urban and rural areas; in urban areas there is a double level system: a Basic Health Post for few thousand inhabitants and a Health Centre Urban, or Urban Family Welfare Centre, for 100 000 people joined with a general hospital. Instead, in rural areas there is a triple level system: a Sub-Centre for 5000 inhabitants manage by two operators (a man and a woman); a Primary Health Care Centre for 30 000 people with medical and paramedical staff; a Primary Hospital with 30 beds per 100 000 inhabitants and some basic specializations [6]. The last ones include primary care services, which means that specialize mainly in vaccinations, prevention of malnutrition, pregnancies, postnatal care and treatment of common diseases. These activities are essential although not specialized because they guarantee basic health services in place that would otherwise be totally devoid.

However, a research work realized in 2010 revealed alarming data that demonstrate the poor conditions of these healthcare facilities: approximately 12.4% of Primary Health Care Centres and 27.8% of the Sub-Centres have regular procurement of drinking water; the 14.2% and 28.5%, respectively, do not have electricity; the 7.5% and 8.1% are hardly accessible; 54.3% and 47% are without phone or computer connection [6, 7]. Moreover, in addition to these factors, the lack of specialized facilities determinate to the patients, who need some more targeted treatments, to go to hospitals of secondary and/or tertiary levels, not already accessible to many users. One of the main problem is also the lack of equal access and balanced population in good health services. The economic policy of the public health system has various dimensions: multiple systems, several types of ownership and different infrastructure's typologies. All these aspects determinate several criticisms that make difficult hinders the development and organization of a system.

It is known that India is in the middle of a process of change and some of the present deficiencies that concern the improvement of the health systems, such as the insufficiency and inequality in the distribution of sanitary staff, privatization of main services and their efficiency, closer adaptation to the current needs and international standards, the progressive realization of the Millennium Developments Goals (United Nations Development Programme for India), especially fights against malnutrition and inequity between the genders, improvement of the epidemiological scenario that presents primarily attention on cardiovascular, cerebrovascular and metabolic diseases, cancer and mental illness (they correspond to two thirds of the total Burden of Disease (BoD) in the country, about 66.7%, and they are responsible of the 53% of deaths, with prevision that it increases up to 59% in 2015) and, subsequently, other diseases very frequent, such as Tuberculosis (TB), sexually transmitted diseases (AIDS) and diseases transmitted through water or poor sanitation. In synthesis, the principal diseases of the population can be subdivided into: 53% non-communicable diseases; 31% communicable diseases; 10% malnutrition and poor health conditions; 6% something else [8].

These consist of both final outcomes, through the improvement of the health levels and equity, protecting people against the catastrophic consequences of disease, improving responsiveness to people' expectations and achieving all of the above efficiently, and intermediate objectives improving access, quality, continuity and sustainability of the health structures [9, 10].

Starting from these concepts, a research work, funded by Fondazione Politecnico di Milano, developed on

new strategies for improving the healthcare services in the context of Kolkata through the collaboration of some NGOs that operate in the surroundings of this country. The goal of the multidisciplinary group, composed by architects, doctors, economists and hospital planners, is to define layouts of healthcare facilities that respond to the local health needs of the population in terms of quantities and modalities of affordable, efficiently networked and sustainable evidence based services and modernizing outdated structures.

Moreover, the research work aims to improve the way in which health service delivery institutions in the public and private sectors are managed with the introduction of professional decision-making for the resources, serving the customer and maximizing quality and productivity and to create public health communities [11].

The West Bengala context

Kolkata district occupies an area of 185 km^2 and it is divided into 141 areas, with a population of 4 486 679 inhabitants: subdivided into 2.36 million male and 2.14 million female, according to provisional results of the 2011 National Census. Population density is 24 252 per km^2.

Starting from the health and epidemiological reports, only a small part of households has guaranteed health coverage: in fact, about 1.5 million people (one-third of the population) live in 2011 registered slums and in 3500 unregistered squats. The authorized slums, that have access to basic services like water, latrines, trash removal by the Kolkata Municipal Corporation, can be broadly divided into two groups: Bustees, in which slum dwellers have some long term tenancy agreement with the landowners; Udbastu Colonies, settlements which have been leased to refugees by the present-day Bangladesh Government [12].

Vice-versa, the unauthorized slums, devoid of basic services provided by the municipality, are occupied by squatters who started to live mainly along canals, large drains, garbage dumps, railway lines and roads [13]. It is clear the conditions of the people in those shacks are the worst: in fact, they do not have proper access to any basic amenities such as sanitation services or water.

According to the National Family Health Survey in 2005, around 14% of the households in Kolkata are poor, while 33% live in slums, indicating a substantial proportion of households in slum areas were better off economically than the bottom quarter of urban households in terms of wealth status [12]. The slums present the worst conditions of health. Their deplorable environmental and economic circumstances result in malnutrition among children. Infant as well as maternal mortality rates were very high in the slums. Due to poor hygiene conditions people died of hepatitis, encephalitis, typhoid and rabies [14]. The incidence of respiratory diseases like fever, viral infection, tuberculosis, skin diseases, diseases of the kidney and urinal diseases were high in the slums. The most conspicuous and highest degrees of incidence could be noticed for some special diseases: the incidence of tuberculosis was ten times higher in the slums than in the city as a whole, viral infections were 2.5 times higher, skin diseases 2 times, respiratory diseases 1.4 times, heart and circulatory system about 10 times and allergic diseases 1.9 times higher. As the slums have no open spaces and playgrounds, children in the slums developed mental complexes and physical imbalances [15].

In general, the total fertility rate is 1.4 in Kolkata and 77% of married women use contraceptives, but the use of modern contraceptive methods is low; instead, the Infant mortality rate is 41 per 1000 live births and the mortality one for children under five is 49 per 1000 live births. Kolkata has a high percentage of children who have not received vaccinations as part of the program of Universal Immunization. Therefore, 57% of children between 0-71 months were taken to a central Anganwadi (kinder garden school) under the Integrated Child Development Services program [16].

Moreover, the percentage of malnourished, anaemic and underweight children in Kolkata is less in comparison with cities of the country. About 30 per cent of women and 18 per cent of men in Kolkata are obese.

Kolkata has the highest percentage of women with anaemia among the cities surveyed, while men are only the 20 per cent.

Large numbers of people suffer from diseases such as diabetes, asthma and other thyroid disorders. Tropical diseases such as malaria, dengue and chikungunya are prevalent in Kolkata, though their incidence is decreasing. For example, one of biggest goals in Kolkata is the reduction of Malaria cases between 2012 and 2012 (1379 suspected patients in 2011 against 766 in 2012) and confirmed cases were 719 against 78 like 1/10 in one year. As of 2011, the Health care system in Kolkata consists of 48 government hospitals, mostly under the Department of Health & Family Welfare, Government of West Bengal, and 366 private medical establishment, providing the city with 27 687 hospital beds [3].

For every 10 000 people in the city, there are only 61.7 hospital beds. Nine medical and dental colleges are located in the Kolkata and West Bengal areas which act as tertiary referral hospitals in the country. These facilities are inadequate to meet the healthcare needs of the citizens, so that more than 78% of inhabitants in Kolkata prefer the private medical sector over the public medical sector, due to the poor quality of care, the lack of a nearby facility and excessive waiting times at government facilities.

As emerged in the introduction, hospitals in urban contexts are healing centers that deal with everything and guarantee primary, secondary and tertiary services; instead, in rural one, health facilities are focused primarily on prevention and promotion activities, such as communicable disease control programs, immunization ones and family services. The health efficiency in rural areas is the weakest component of the Indian Health and, in the same time, it has also the highest request of need by population.

The limited public expenditure of the district and inadequate health insurance coverage hamper the effectiveness of the health system for the most vulnerable social groups, that ones incapable of supporting a private health expenditure. The total number of medical staff and its distribution on the territory was recently identi-

fied as a critical aspect for progress in area. According to the World Health Organization, standard of health staff should be of 25.4 health workers (doctors, nurses and midwives) per 10 000 people: while the data collection, according to an estimation of 2010, demonstrate 11.9 doctors and nurses with a qualification recognized by the Medical Council of India and in particular urban areas are better serve than rural areas: 1.3 against 12.39 of doctors; 4.2 against 1.18 of health workers; 1:59 0:41 against the nurses and midwifes [3].

METHODOLOGY

Starting from the Indian context, an analysis of the culture and the epidemiological data, the research team developed a meta-project that considers all the current criticisms and the Indian customs through a flexible layout that responds to the healthcare needs of population. For the development of the research work, the multidisciplinary team collaborated with the NGOs Project for People (P4P) and Institute for Indian Mother and Child (IIMC).

It was carried out a survey through the analysis and the relief of several healthcare facilities managed by IIMC, such as Thegaria Indoor, Chakberia Outdoor, Keyadah Outdoor, Hogolkuria Outdoor, Dhaki Outdoor and Indoor. As emerged by the analysis conducted, the sample presents outdoor and indoor structures: the first have a limited activity to specific days and times of the week, typology widespread in the territory and due to the category of sub-center; the indoor clinics, instead, are centers with constant activities and spaces dedicated to the inpatient wards.

Were made several technical tabs with the analysis of the design choices and the internal distribution, the dimension of the spaces and the function, the identification of the criticisms, such as the presence of particular degradations, and the definition of materials and technologies most commonly used. In addition, the planimetric relief of all the facilities allowed to quantify the spaces and to analyse the fluxes and internal paths.

In the analytical phase, were also conducted several interviews with operators and hospital staff about the services and possible problems related to the health processes. From these interviews, many suggestions emerged for improving the quality of service provided, on supplies and materials available to patients.

Studying the reports and financial statements was possible to create an analysis matrix *(Table 1)* that examines several sanitary activities carried out in those clinics, the space dimensions, opening days and hours and the number of medical staff.

Starting from the comparison, it is clearly visible the deep difference that persists between indoor and outdoor clinics, both for the kind of performances they deliver, primarily for paediatric and neonatal health activities, and for the number of yearly interventions carried out. The outdoor facilities commonly offer general activities related to health promotion, unlike the indoor ones that offer services that require user's hospitalization. It is common for each typology to find skin infections' ambulatories because skin fungus's infections mainly spread in rural areas; instead, only in Thegaria outdoor there are specialized activities such as homeopathy, dentistry, ophthalmology, etc. and in the indoor one there is a medical health assistance device open 24 hours on 24 due to the wide range of population referenced to the geographic area.

From a dimensional point of view, the larger structures are Thegaria outdoor and Dhaki indoor and, according to the analysis conducted, the ratio for health worker is around 20 m^2 per worker.

The efficiency of the structures can be attributed to the opening hours, very short and sporadic during the week, because the NGO has a little number of doctors and volunteers, who turn during the week in several facilities, and the reduced economic resources.

Starting from collected data, it was possible to realize several reasoning for obtaining quantitative data useful for the definition of the dimension of new healthcare facilities.

DISCUSSION

Starting from the data collected and the analysis conducted, the research work develops a meta-project that considers all the current criticisms and the Indian customs through flexible layouts that responds to the healthcare needs of population [17]. For developing a coherent design approach with the Indian culture, it is necessary to understand the traditional architecture and the settlement's types in the context. The settlements in those rural areas are linear, form thin strips that outline the territory following the interstices between agriculture fields. Along these villages the main single-family houses are the peasants or traders' ones.

Starting from the analysis, the modules have only a level: they are in fact composed by a central part body, the house itself, usually disposed parallel and perpendicularly to the road, whose sides are one or two warehouses and stables, the house is also equipped with a veranda. Traditionally the materials used for construction are mud brick or light walls of bamboo and thatched roofs, but nowadays they have been replaced by sheet metal, bricks and roof tiles.

In general, these buildings constitute a central permeable, but private, courtyard with the adjacent road. On the back, there are some tanks with large dimension useful for gathering water during the wet season, also for agriculture, cattle and raise fish. Another interesting aspect is the constant presence of trees along the roads, perhaps with the primary purpose of mitigating the heat of the sun.

The interesting aspect of this structure is the common dimension (3.50 m length, 2.10 m height, 9.00 m depth), even if the construction materials change. The houses can be realized with only one module or assembling some of them. The module is going to spread even in the rural areas, probably because it is easier to achieve with modern materials.

The building materials considered are modern, besides having the advantage of being more durable and require little maintenance (a mud house with a thatched roof has a life expectancy of 20 years old and it needs to be maintained every 3 or 5 years), represent a real status symbol, despite they offer a worse liveability of the

Table 1
Matrix analysis about data collection of Indian Institute for Mother and Child's healthcare structures

Characteristics		Clinics of Institute for Indian Mother and Child					
		Thegaria	Chakberia	Keyadah	Hogolkuria	Thegaria	Dhaki
Types of clinic		Outdoor	Subcenter	Outdoor	Subcenter	Indoor	Indoor
General activities	vaccines	x	x	x	x		
	nutrition programs	x	x	x	x		
	support to pregnant women	x	x	x	x		
	skin infections	x	x	x	x	x	x
	malnutrition					x	x
	burns					x	x
	viral fevers					x	x
	prenatal treatments						x
Specialized activities	pathological tests	x					
	homeopathy	x					
	dentist	x					
	oculist	x					
	basic diagnostics	x					
	cardiologist	x					
	medical center H.24					x	
Total patients per year	outdoor	75 235	15 715	7921	5074	-	-
	indoor	-	-	-	-	382	309
Year of construction		2002	2012	2000	1997	1996	2005
Surfaces (in square meters)	gross floor area	754.00	288.00	207.00	169.00	218.00	720.00
	sanitary functions	333.00	128.00	74.00	77.00	133.00	365.00
	support spaces	34.00	3.00	13.00	41.00	10.00	54.00
	vertical and horizontal connections	249.00	57.00	90.00	14.00	75.00	175.00
	semi-open spaces (arcades)	138.00	100.00	30.00	37.00	-	126.00
	community services and hospitality	-	-	-	-	-	-
Opening days		Monday and Thursday	Tuesday	Sunday	Friday	from Monday to Saturday	Wednesday and Saturday
Opening times		10:30 - 14:00	11:00 - 14:30	11:00 - 14:00	11:00 - 14:00	11:00 - 12:30 / 15:00 - 16:00	11:00 - 14:30
Management cost per year							
No. sanitary and medical staff	doctors	16	4	2	3	2	4
	nurses	10	3	1	1	3	5
	assistants	6	2	-	-	-	2
	receptionist	6	4	2	1	-	4
	operators in pharmacy	8	4	2	2	1	4
	volunteers	5	4	2	2	3	5
Beds		-	-	-	-	20	10
No. patients / day		900	400	200 / 250	150 / 200	-	-
No. floors		2	2	1	1	1	1
No. spaces	general diagnosis	5	2	1	2	2	4
	specialized diagnosis	5	1	0	2	0	2
	health treatment	1	1	1	1	1	1
Design parameters assessed according to the case studies' analyzed	No. annual patients	93 600	20 800	11 700	9100	-	-
	m^2 area indoor / beds of indoor clinics	-	-	-	-	10.90	72.00
	m^2 area / units of medical and care staff	15	14	23	19	24	30

living spaces due to the weak thermal insulation [18].

If in rural villages, the population carries the work within their own backyard; in traders' areas, the road is no longer functional passage, but it becomes a collective space in which there are commercial and social activities.

Starting from these notions, for permitting flexible layouts, the design module has a dimension 4×4 m which is compliant and useful to planning a different combination of medical units (it has a versatility that allows to respond several activities). The choice of this module depends on different necessities: at first, to formulate a proposal that is both flexible and adaptable in the current socio-economic climate to substitute the present "low care" model, then to create a minimum space requires a correct and detailed analysis of those medical intervention and assistance and to be adaptable to the features and requirements of its project area which can vary enormously due to the social and cultural complexity of India. This flexibility of the basic structure allows not only such an adaptability, to its immediate surroundings, but also the possibility of future internal modifications.

This strategy was developed for guaranteeing a local development of the population that can self-build the hospital with local technologies and building materials. Therefore, the analysis examines the current availability of the characteristic resources, meant not only as natural materials but also as local workforce, synergies between the population, the influences due to the cultural, climatic, productive and economic context, as well as giving attention to the users' needs [19-20].

The answer to these needs passes through merging conventional technologies (readily available, low cost and self-constructive) with the innovative ones, derived from research studies at all levels [21, 22].

The approach of using local technologies can determinate the growth of the community and to trigger such processes promoting development.

In the light of the studies carried on materials and commonly used were selected the following materials: bamboo, clay, straw, steel, linoleum and lime [23]; in particular, the steel appears to be a not conventional choice because internationally it is well-known expensive but in Indian context it results economical and practical for use (ease to be transported, dry working and fast construction time) [24].

Compared to the territorial demands of West Bengal, starting from the module that characterizes the healthcare facilities examined, it is necessary to consider:

- having a crawl space of 0.40 m, to prevent possible stagnation of humidity, but at the same time, to ensure easy access for maintenance;
- responding to the hot and humid climate, introducing of a ventilated roof so as to promote good ventilation inside the outpatient clinics, inclined to control the outflow of the precipitation for a possible reuse and for a better installation of solar thermal panels;
- providing open or covered zones along the surfaces of the building, so as to obtain a greater liveability both of the inner space, thanks to a more effective shielding, and external area [25].

Development of an architectural and typological meta-project for a new healthcare scenario

Therefore, the project is oriented towards a building complex with a predominantly horizontal development, through the aggregation of repeatable and flexible modules.

Starting from these considerations and for allowing lean processes, the planimetric development is determinated by a regular structure composed by primary and secondary pedestrian routes: the first are dedicated to the public paths and the others for the technical flows of medical and nursing staff and the distribution of goods [26, 27]. As *Figure 1* shows, this scheme creates a rational settlement, ordered by the linear paths, and the squares become welcoming, distribution and waiting areas. Each block is made up by four areas in which are localize several sanitary activities.

From the design point of view, the organization of the blocks presents several connections with the historical Indian cities, that characterized the urban morphology and which are distinguished by their density and for the close relationship between the open and closed spaces [28].

The design concept is supported by the aggregation of several sanitary and outpatient functions around the squares that can be considered as multi-functional spaces, such as waiting areas or even a garden bounded by an open porch that integrates the different sectors. Moreover the courtyard welcomes all public activities and acquires a receptive role and social value for the community. This approach is common in the architectures of the architect Charles Correa, in which the morphology settlement is composed by units positioned along the perimeter of the sites with large courtyards and open common areas in the middle of the block [29].

As happen in developed countries, the hospital attempt is to open the structure outside, making it accessible and familiar, eliminating the barriers of uncertainty and fear that could lead to a closed space. The meta-project highlights a typical progression from outside to inside of the hospital complex, related to the settlement's principle of the typical Indian village, in which in the center are localized the collective space: the users goes from public to private spaces inside the hospital itself, in semi-private patios or waiting areas characterized a large central common space (the ratio between built-up area and green ones are approximately one to one).

The facility will be managed directly by the inhabitants and will become a collective place; the current widespread conditions of poverty do not yet allow for the exclusive health and population plays an active and crucial role [30]. The hospital becomes a place of social life, where the cure is still a shared value and actively participated in the community.

The system is configured in which the final flexible model that allows the time to be expanded and transformed [31-33], as to be constituted by minimum units or modules of size 4×4 m to be able to operate alone or joined to other modules so as to create a system that meets the needs.

For the development of the meta-project, have been studied three different types of blocks, each one differ-

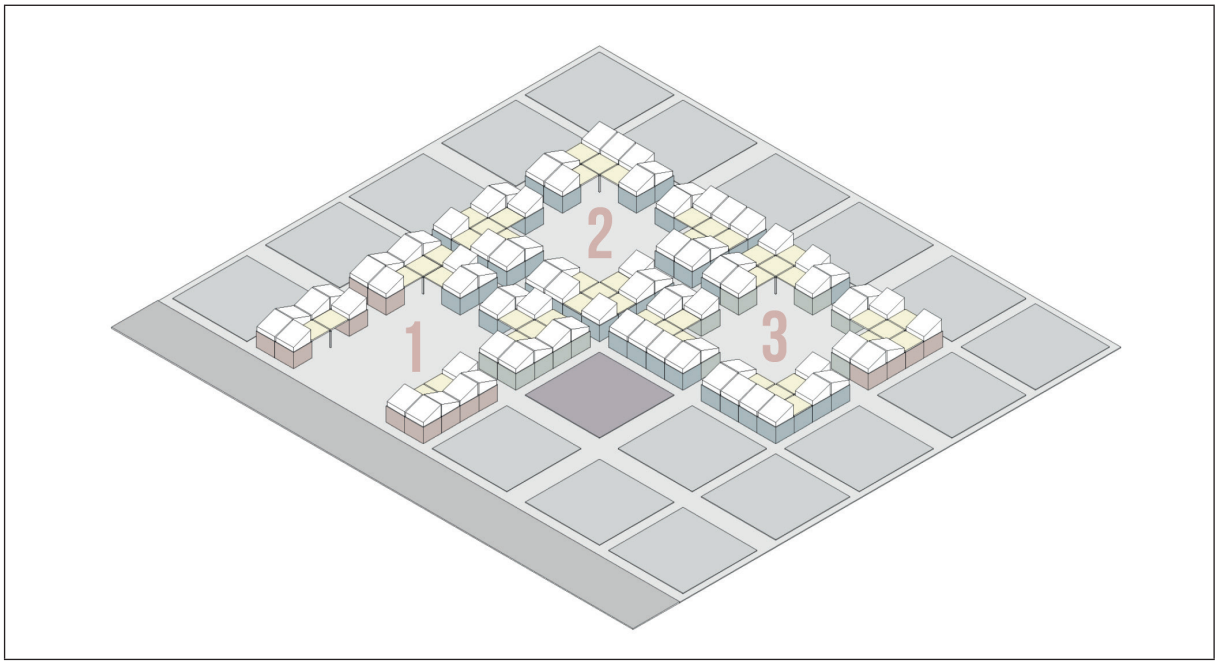

Figure 1
Planivolumetric view of the functional blocks.

ent from the others for its heterogeneity of the functions. They, aggregated gradually, make up different "levels of care" of which the first with a purely receptive, welcoming and acceptance aim, the second deputies to medical consultation and outdoor activities and the third which provides space completely reserved to hospitalization [34].

1. Urban / receptive block

The first block acquires the function of public area where there are all the no-care activities that can be easily accessed by the population of the surrounding. Here it is possible to find areas of catering, training and counselling, laundry, pharmacy and medical health assistance device open 24 hours on 24.

This nucleus has the function of main street for the users of the social-health complex in which the path for men and women are divided for respecting the privacy of the health services. Specifically, the access of the user is in correspondence of the restrooms where people can wash their hands, feet or other parts of the body as well as a strategy for promoting health campaigns and personal hygiene [35] *(Figure 2)*.

2. Outdoor sanitary block

The second block is an area dedicated to outdoor clinics in which all the specialized activities are located. This block is open only at certain times of the day or specific days of the week. Each clinic is organized by three modules and inside there are standard furniture in all the ambulatories, in addition to the specific instruments required for each specialty care.

According to the meta-project, in each functional unit is provided for a doctor and a nurse and, depending on specific medical requirements, there are additional storages for the materials and surgical areas. In this block, finally, there are some changing rooms for medical staff and storages for dirty (organic and inorganic waste, medical waste, etc.) and clean materials and they are linked through secondary paths, accessible only to medical staff *(Figure 3)*.

3. Indoor sanitary block

The third block acquires the function of indoor health activities' area where are localized all the inpatients

Figure 2
Layout of the urban block.

Figure 3
Layout of outdoor sanitary block.

Figure 4
Layout of indoor sanitary block.

wards, open every day with the presence of medical staff. The wards are organized as large shared rooms, [36] respecting the local culture which provides for the sharing of space. In each inpatient ward there are two areas for patients' toilets and, externally, there is a waiting room and meeting area in which patients can meet visitors and relatives.

The block is also characterized by an area for doctors and volunteers with sleeping and sanitary facilities and a working area and storages for materials and equipment *(Figure 4)*.

4. Energy community center

The meta-project provides for an "energy community center" or a service area unit for energy self-production on site. It consists of a tank for the recovery of rainwater and provides the collection point of the energy produced by solar and photovoltaic devices, localized on the roofs of the healthcare modules.

The localization of such center for the energy production is recommended in proximity of the functional areas that require high power levels such as kitchens, laundry, diagnostic area, etc. and it is desirable that over time this pole can become accessible to the entire community in the surroundings of the hospital complex.

CONCLUSIONS

The innovation of the research work is to develop the hygienic aspects, the layout and the distribution, the sub-division of the medical functions through the Indian culture and the needs of the country. The function of the module is to be easily built through local construction techniques and materials, with an emphasis on their budget, environmental impact and to create a micro-economy on the neighbourhood [37].

Moreover, the choice of lowly technologies permits to promote the usage of local materials, their maintenance and skills for creating a virtuous economic system: in fact, through the first block with urban and commercial functions that can easily be used by local people, such as restaurant, laundry, pharmacy, etc., it is possible to promote a local ecosystem-oriented to the progress.

The meta-model developed, managed either by NGOs or by the Indian health system, can permit to become an autonomous reality that can self-manage and sustain the local population [38]. For this reason, the hospital must be necessarily inspired to the flexibility's principles in order to promote efficiency, effectiveness and security of both the initial setup and during the development of the structure.

Therefore, the main challenge becomes the ability to provide a "management model" enabling various processes implemented as a combination of both material resources (buildings, technology, equipment, etc.) or intangible (knowledge, skills, etc.), to achieve the social, environmental and economic goals projected [39].

Nowadays, it is known not all the NGOs that operate in this area are interested in non-health services because it is not their primary objective for quantifying possible revenues and costs in a good structured business plan; although, on the basis of several existing studies, the introduction of such services can guarantee a great efficiency to a business model aimed to a long-term economic sustainability according to the present paradigm of social innovation.

Acknowledgements

The development of the research work was possible thanks to Fondazione Politecnico di Milano (Eugenio Gatti and Paola Esena) that funded the research project "PoliSocial Award" during 2012-2013.

Moreover, the research was supported by the NGOs Project for People (Andrea Subert, Anna Ciceri and Anna Doneda) and Institute for Indian Mother and

Child (Sujit Komar Brahmochary) who guaranteed to analyze and study several data of the healthcare services in Kolkata and to share the know-how on the Indian reality and culture.

Special thanks to Giovanna Tavecchi for reliefs and local analysis of the current context in the proximity and neighbourhood of Kolkata, Enrica Fugazzola for the data collection and the detailed analysis on the local NGOs' activities and ARCò – Architettura e Cooperazione, a group of young engineers and architects that operate in the world of International Cooperation in order to face and to solve architectural problems in emergency situations.

Conflict of interest statement

There are no potential conflicts of interest or any financial or personal relationships with other people or organizations that could inappropriately bias conduct and findings of this study.

Submitted on invitation.
Accepted on 18 December 2015.

REFERENCES

1. Husian M. *Geography of India*. New Delhi: Mc Graw Hill Education; 2014.
2. DeFrancis MP (Ed.). *Economic impacts of inadequate sanitation in India*. Water and Sanitation Program; 2011.
3. Gangolli LV, Duggal R, Shukla A. *Review of healthcare in India*. Mumbai Centre for Enquiry into Health and Allied Themes; 2005.
4. Beretta S, Targetti Lenti R. *L'India nel processo di integrazione internazionale: dal primo al secondo unbundling e la posizione dell'Italia*.). Pavia: Università degli Studi; 2010. (Quaderni del Dipartimento di economia pubblica e territoriale).
5. World Health Organization. *Country health profile – India: WHO statistical profile*. Country statistics and global health estimates by WHO and UN partners; 2015.
6. World Health Organization - Regional Office for South-East Asia (WHO - SEARO). *India's health and development challenges and responses in WHO India's new country cooperation strategy 2012-2017*. India: WHO; 2011.
7. Vlassoff C, Tanner M, Weiss M, Rao S. Putting people first. A primary health care success in rural India. *Indian J Commun Med* 2010;35(2):326-30. DOI:10.4103/0970-0218.66896
8. United Nations Development Programme. *Millenium Development Goals India Country Report 2014*. Social Statistics Division Ministry of Statistics and Programme Implementation Government of India, 2014.
9. Buffoli M, Gola M, Rostagno M, Capolongo S, Nachiero D. Making hospitals healthier: how to improve sustainability in healthcare facilities. *Ann Ig* 2014;26(5):418-25. DOI: 10.7416/ai.2014.2001
10. Buffoli M, Capolongo S, Bottero M, Cavagliato E, Speranza S, Volpatti L. Sustainable Healthcare: how to assess and improve healthcare structures' sustainability. *Ann Ig* 2013;25(5): 411-8. DOI: 10.7416/ai.2013.1942
11. Capolongo S, Battistella A, Buffoli M, Oppio A. Healthy design for sustainable communities. *Ann Ig* 2011;23(1):43-53.
12. National Family Health Survey. International Institute for Population Sciences, Deonar, Mumbai, 2005; Vol 1.
13. Kundu N. Understanding Slums: Case Studies for the Global Report on Human Settlements 2003: the case of Kolkata, India. Salt Lake Kolkata (INDIA): Institute of Wetland Management & Ecological Design; 2003.
14. Nath V. Social-organization in an Indian slum - Rao, RN. *Economic Political Weekly* 1993;28(45):2457-8.
15. Patel V, Chatterji S, Chisholm D, Ebrahim S, Gopalakrishna G, Mathers C, Mohan V, Prabhakaran D, Ravindran RD, Reddy KS. *Chronic diseases and injuries in India*. Lancet 2011;377(9763):413-28. DOI: 10.1016/S0140-6736(10)61188-9
16. Kilby P. *NGO in India: the challenges of women's empowerment and accountability*. New York: Routledge Contemporary South Asia Series; 2011.
17. Capolongo S, Bottero MC, Lettieri E, Buffoli M, Bellagarda A, Birocchi M, *et al.* Healthcare sustainability challenge. In: Capolongo S, Bottero MC, Buffoli M, Lettieri E (Eds). *Improving sustainability during hospital design and operation. A multidisciplinary evaluation tool*. Cham: Springer; 2015. p. 1-10. DOI: 10.1007/978-3-319-14036-0_1
18. Rössel S. *India: architettura contemporanea*. Milano: Motta architettura; 2009.
19. Buffoli M, Bellini E, Bellagarda A, di Noia M, Nickolova M, Capolongo S. Listening to people to cure people. The LpCp – tool, an instrument to evaluate hospital humanization. *Ann Ig* 2014; 26(5): 447-55. DOI: 10.7416/ai.2014.2004
20. Capolongo S, Bellini E, Nachiero D, Rebecchi A, Buffoli M. Soft qualities in healthcare method and tools for soft qualities design in hospitals' built environments. *Ann Ig* 2014;26(4):391-9. DOI:10.7416/ai.2014.1998
21. Capolongo S, Buffoli M, Riva M G, Tognolo C, Oppio A. Hygiene and emergency: considerations and proposals for improving hygiene and health features of Advanced Medical Post. *Ann Ig* 2012 S;24(5):389-96.
22. Capolongo S, Buffoli M, Oppio A, Rizzitiello S. Measuring hygiene and health performance of buildings: a multidimensional approach. *Ann Ig* 2013;25(2):151-7. DOI: 10.7416/ai.2013.1917
23. Capolongo S, Daglio L, Oberti I. *Edificio, Salute, Ambiente: tecnologie sostenibili per l'igiene edilizia e ambientale*. Milano: Hoepli Editore; 2007.
24. Capolongo S, Buffoli M, Oppio A, Nachiero D, Barletta M.G. Healthy indoor environments: how to assess health performances of construction projects. *Environm Engin Manag J* 2013;12(S11):209-12.
25. Signorelli C, D'Alessandro D, Capolongo C. *Igiene edilizia e ambientale*. Roma: Società Editrice Universo; 2001.
26. Capolongo S. *Edilizia ospedaliera*. Milano: Hoepli; 2006.
27. Capolongo S, Buffoli M, di Noia M, Gola M, Rostagno M. Current scenario analysis. In: Capolongo S,· Bottero MC, Buffoli M, Lettieri E (Eds). *Improving sustainability during hospital design and operation. A multidisciplinary evaluation tool*. Cham: Springer; 2015. DOI: 10.1007/978-3-319-14036-0_2
28. Capolongo S, Buffoli M, Oppio A. How to assess the effects of urban plans on environment and health. *Territorio* 2015;(73):145-51.
29. Rossi S. *I luoghi dell'abitare. Identità della residenza contemporanea*. Facoltà di Architettura "Aldo Rossi" LSF 09-10.
30. D'Alessandro D, Buffoli M, Capasso L, Fara GM, Rebecchi A, Capolongo S. Green areas and public health:

improving wellbeing and physical activity in the urban context. *Epidemiol Prev* 2015;39(5): 8-13.
31. Buffoli M, Nachiero D, Capolongo S. Flexible healthcare structures: analysis and evaluation of possible strategies and technologies. *Ann Ig* 2012;24(6):543-552.
32. Capolongo S. *Architecture for flexibility in healthcare*. Milano: Franco Angeli; 2012.
33. Astley P, Capolongo S, Gola M, Tartaglia A. Operative and design adaptability in healthcare facilities. *Techne* 2015;9:162-70. DOI: 10.13128/Techne-16118
34. Bottero MC, Buffoli M, Capolongo S, Cavagliato E, di Noia M, Gola M, *et al*. A multidisciplinary sustainability evaluation system for operative and in-design hospitals. In: Capolongo S, Bottero MC, Buffoli M, Lettieri M (Eds). Improving sustainability during hospital design and operation. A multidisciplinary evaluation tool. Cham: Springer; 2015. p. 31-114. DOI: 10.1007/978-3-319-14036-0_4
35. Alfonsi E, Capolongo S, Buffoli M. Evidence based design and healthcare: an unconventional approach to hospital design. *Ann Ig* 2014; 26(2):137-43. DOI: 10.7416/ai.2014.1968
36. Origgi L, Buffoli M, Capolongo S, Signorelli C. Light wellbeing in hospital: research, development and indications. *Ann Ig* 2011;23(1):55-62.
37. Del Pero C, Butera FM, Buffoli M, Piegari L, Capolongo L, Fattore M. *Feasibility study of a solar photovoltaic adaptable refrigeration kit for remote areas in developing countries*. International Conference on Clean Electrical Power (ICCEP), IEEE, 2015. p. 701-8.
38. Golini R, Landoni P. International development projects by non-governmental organizations: an evaluation of the need for specific project management and appraisal tools. *Impact Assess Proj Appraisal* 2014;32(2):121-35. DOI: 10.1080/14615517.2014.894088
39. Radaelli G, Dal Molin M, Lettieri E, Masella C. Promoting a new practice in hospitals. A qualitative comparative analysis of alternative designs. *Intern J Publ Administr* 2014;37(6):376-87. DOI: 10.1080/01900692.2013.858352