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THE PANAM NAGAR GRAMMAR:  
A SHAPE GRAMMAR TO ANALYZE THE COLONIAL HOUSES  
AND URBAN SETTLEMENT AT PANAM NAGAR, BANGLADESH

A Thesis in

Architecture

by

Enam Rabbi Adnan

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The thesis of Enam Rabbi Adnan was reviewed and approved by the following:

**Heather Ligler**

Assistant Teaching Professor of Architecture  
Stuckeman Center for Design Computing  
Thesis Advisor

**Jose Duarte**

Professor of Architecture and Landscape Architecture  
Chair in Design Innovation  
Director, Stuckeman Center for Design Computing

**Madhuri Desai**

Associate Professor of Art History and Asian Studies  
Department of Art History

**Denise Costanzo**

Assistant Professor,  
Department of Architecture

**Rebecca Henn**

Associate Professor,  
Director of Graduate Studies,  
Department of Architecture

## ABSTRACT

Panam Nagar is an early nineteenth-century colonial settlement of Bangladesh. It was a famous trade center for clothes and crafts built by the merchants who presumably lived and worked there - and their colonial houses are the jewel of the site. Today, this settlement is dilapidated and needs preservation. The Government of Bangladesh has declared Panam Nagar a national heritage site, but budget constraints and other limitations have delayed conservation efforts. Before conservation or adaptive reuse, a thorough understanding of the site is necessary. Formal analysis provides a basis for successful historic preservation by contributing knowledge on the space and structure of the colonial houses and their role within the urban settlement. Previous research has dealt with ornamentation, documentation, and spatial understanding of Panam Nagar using space syntax. To develop a further spatial and morphological understanding of the settlement, this research will use the shape grammar formal methodology to study the inherent spatial quality of the consolidated type houses. More specifically, the Panam Nagar Grammar aims to shed new light on our understanding of the settlement by unpacking how the houses support a merchant lifestyle characterized by domestic and commercial functions. Shape grammars have been widely used to analyze different architectural precedents and bring understanding to their spatial character. Future research may incorporate the remaining houses to provide an over-arching preservation or rehabilitation plan by building on the Panam Nagar Grammar.

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## CHAPTER 01 – INTRODUCTION

Panam Nagar (Figure 1) is an early nineteenth-century settlement, situated at Sonargaon, presently located in Narayanganj, Bangladesh. It is located twenty-nine kilometers south of the capital, Dhaka. Due to its favorable location for trade, Sonargaon was the capital of the then Bengal Sultanate (regime) since 1338 (Table 1). The Mughals captured the sultanate in 1538. Later in 1608, they shifted the capital from Sonargaon to Dhaka, which was also an important trade route.



Figure 1: Aerial View of Panam Nagar showing the historic area (Source - Dipu Sarker, 2020)

Later, in the early nineteenth century, wealthy cotton merchants from Kolkata came back to Panam Nagar and established the settlement over their ancestral ruins (Shaikh & Mowla, 2009). The ‘Bengal Sultanate’ was famous for the Muslin

(Cotton) manufacturing and the merchants built their houses along a narrow pedestrian road. Nilufar (2015) claimed that the merchants who built the houses only visited the settlement once or twice yearly. Though there is no literary evidence of their lifestyles and living patterns, the houses have become a source of scholarly discourse based on their typologies and spatial organization. Previous research on the settlement of Panam Nagar (Figure 2) has explored the residential types (Ali, 1990; Hossain, 2013; Husain, 1997); spatial morphology of houses



Figure 2: The view from the street of Panam Nagar (Source - Author, 2020)

(Nilufar et al., 2015); courtyards (Murad & Hasan, 2016; Shaikh & Mowla, 2009); ornamentation (Nazneen, 2012; Shaikh & Mowla, 2009); and cultural significance (Akhter, 2005; Sharmin, 2019).

Currently, Panam Nagar is enlisted as a National Heritage site, in the custody of the Archeology Department, Ministry of Cultural Affairs, Government of

Bangladesh. In March 2003, the Government declared the site and its fifty-two buildings as an archeological site for conservation. But without adequate funds and conservation planning, the settlement is currently far from preservation and development (I. Ahmed, 2006). Today, forty-nine buildings remain on the site, dilapidated and in ruins. State of the art preservation management and scientific methods are necessary to revive the settlement so that the artifacts can be retained and celebrated for their significance in the architectural history of the country. However, before any methodical preservation work can proceed, a thorough understanding of the site or buildings is necessary. Formal analysis can pave the way for successful historic preservation, rehabilitation, and reuse by contributing knowledge on the space and structure of the houses.

To build a foundation for this analysis, this thesis will use the shape grammar methodology to study the spatial quality of the colonial houses at Panam Nagar. Understanding of the spatial quality can provide insight as to how the houses were organized and used. In this way, the formal study of the houses can also further our understanding of the lifestyle of the merchants who lived there. The goal is to develop new understanding of the formal structure of the houses that can contribute to ongoing preservation planning in the overall settlement.

## **Previous Research**

Previous research dealt with the possibilities of Panam Nagar to be a prospective historic landmark and advocated for an effective conservation management policy (I. Ahmed, 2006; Hossain, 2013; Shaikh & Mowla, 2009). Some researchers have

focused on architectural features and motifs to relate them with colonial architecture and European influences (Mowla, 2009; Murad, 2013; Shaikh, 2009). The facades of the houses of Panam Nagar contain various motifs and influences from the traditional, Mughal, and broader cultural influences. Nilufar and Eshika (2015) investigated the spatial configuration of the houses using space syntax to find the inherent genotypes of the buildings. As the buildings were built by influential Hindu merchants, the houses have similarities with the Kolkata palaces, so the research studied the morphological ties with Kolkata buildings as well as traditional Old Dhaka houses (Nilufar et al., 2015). The resemblances can be understood when the houses of Kolkata are compared with the houses of Panam Nagar (Sengupta, 2013). The findings hypothesized that the buildings were not residential, rather they had a commercial purpose which needs a more thorough study to explain their hybrid role. The formal and spatial analysis of the houses at Panam Nagar aims to address this gap to develop a greater understanding of the buildings. This work is envisioned as a first step in a more comprehensive use of formal methods and computation in the context of conservation work at Panam Nagar.

### **Shape Grammar Formalism**

To analyze and understand the morphology of the colonial houses, the shape grammar formalism is used in this research. Introduced by Stiny and Gips in the '70s, the formalism proposes a generative framework for specifying artifacts and interpreting the logic of designs with shapes (1972). More precisely, shape

grammars have been developed to analyze different precedents of arts, sculpture, and architecture (Duarte, 2001). Shape grammars are proposed here for their value in describing architectural precedents, assessing a broader urban context, and their potential for contributing to historic preservation strategies.

The formalism is widely used as an analytical method for understanding architectural precedents. Stiny and Mitchell (1978) first used shape grammars in an architectural context to understand the corpus of villas by Andrea Palladio. Since then, many researchers have used this rule-based framework to understand the fabric of houses designed by architects or built with distinct characters. For example, Frank Lloyd Wright's prairie houses were analyzed to understand their spatial arrangement by interpreting rules to derive them (Koning & Eizenberg, 1981). Another example in architecture is Duarte's research on Alvaro Siza's Malagueira patio houses, where rules are used to formalize the scheme of thirty-five houses and then, to allow for mass customization of new house designs (Duarte, 2001). In addition, analytical grammars have been used in previous studies to analyze Bungalow houses at Buffalo (Downing & Flemming, 1981); Queen Anne Houses (Flemming, 1987); Taiwanese traditional dwellings (Chiou & Krishnamurti, 1995); Bosnian Hayat houses (Colakoglu, 2005); and John Portman's Entelechy I (Ligler & Economou, 2018).



Shape grammars have also been influential in understanding the morphology and character of historic districts in an urban setting, relating housing patterns to the larger context of the city. For example, Duarte et al (2007) investigated the historic district of the Medina-Marrakech to interpret three grammars (Urban Grammar,

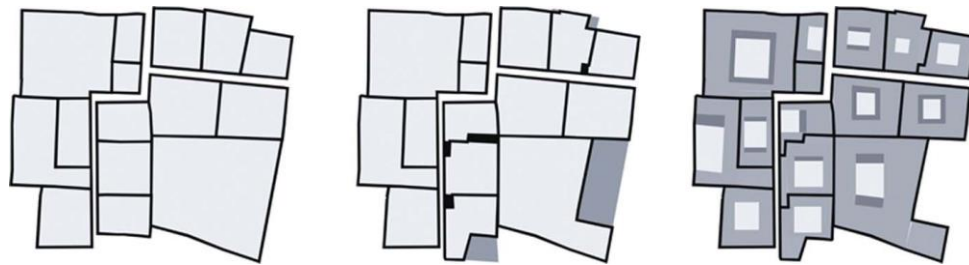


Figure 3: The shape grammars developed for the patio house of Medina-Marrakech: (left) urban grammar, (center) negotiation grammar, and (right) patio house grammar, (Source - Duarte et. al, 2007)

Negotiation Grammar, and Housing Grammar) inherent in the designs of the houses and surrounding urban fabric. In these grammars, the city is considered as an artifact to study the inherent pattern latent in the urban design. Though apparently chaotic from the aerial view, the grammars interpret a language of the formal organization that explains the settlement in an unprecedented way. Subsequently, the scholars assess the grammars to hypothesize the negotiation between the urban context and the housing context specific to Medina-Marrakech.

In addition, shape grammars have also informed strategies for historic preservation. Castro and Beirao (2019) used a shape grammar not only to derive the analytical corpus of the houses in the Moorish villages of Aljezur, Portugal, but also to create rules to safeguard the heritage. They selected some typical vernacular houses from the historic core of the city and first developed a

'vernacular grammar' based on the living areas, built areas, and their integration into the landscape. Then, they also developed a transformation grammar to create a foundation for preserving the vulnerable cultural and architectural artifacts by developing specific guidelines related to the formal study established in the rules of the grammars. Essentially, the researchers used the shape grammar formal structure to develop a basis for understanding the Moorish village site and then found ways to safeguard the basic corpus of the houses by discussing supportive planning motivated by their findings in the grammar (Castro & Beirao, 2019).

As the settlement of Panam Nagar has a significant architectural character containing different colonial influences and needs initiative for preservation, the use of shape grammar as an analytical tool is used in this research to understand the fabric and corpus of the architecture as well as the urban structure. Moreover, the research aims to understand the role of shape grammars in providing a formal foundation for preservation planning guidelines that can inform the future development of the historical context at the same time (Figure 4). The architectural conservation activists and researchers may find interest in the Panam Nagar grammar as the findings regarding spatial and syntactic organization aim to reveal unanswered questions about the living pattern and lifestyles of the inhabitants of the Panam Nagar houses in the colonial Bengal.

According to (Tyler et al., 2018), there are several steps in historic preservation. The steps start with listing, documentation, different degrees of implementing historic preservation at the site, and heritage management.

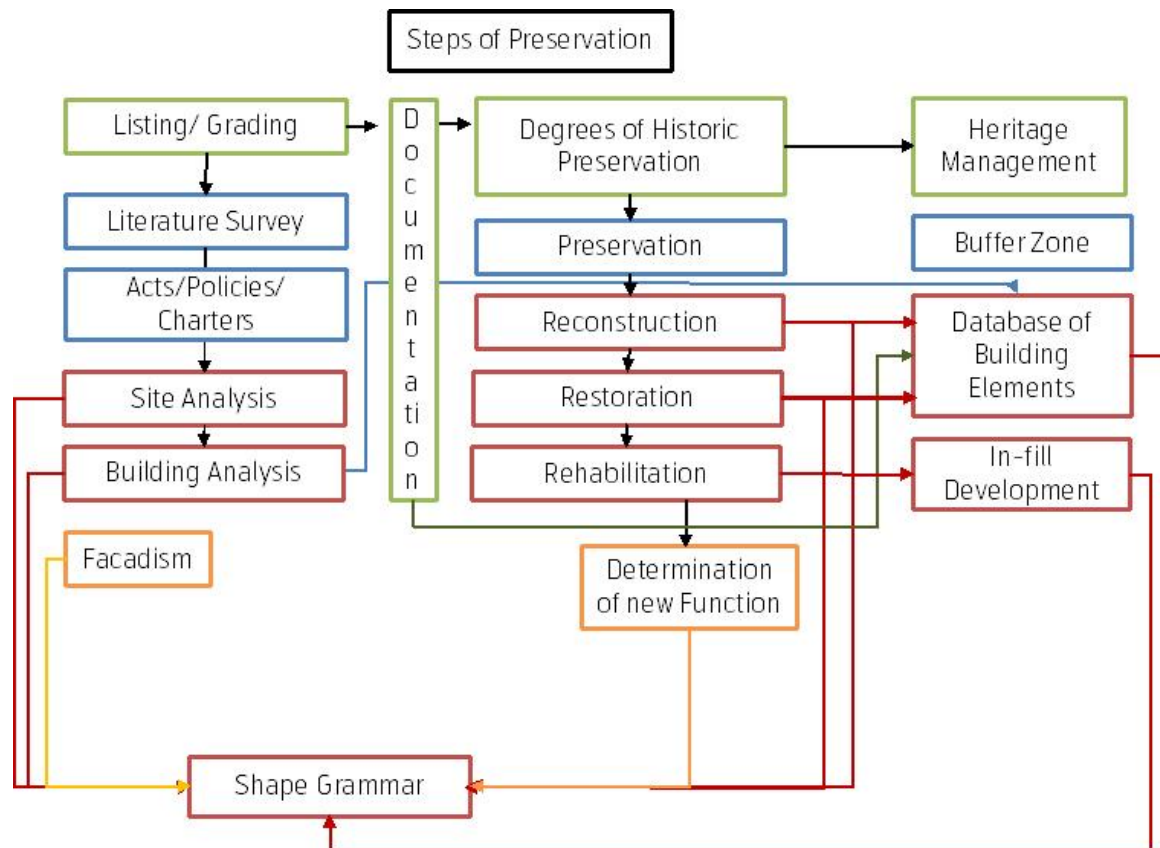


Figure 4: Shape Grammar in different steps of Historic Preservation,  
(Source - Author 2020)

From the analytical perspective of shape grammar, it is assumed that the formalism has potential to explain facades or have the capacity to develop new functions using the rules developed by shape grammars. In this research, the analytical ability of shape grammar has been used to understand the formal character of the Panam Nagar houses, specifically for the consolidated type houses.

## Research Objectives

Through this study, shape grammars have been used to analyze the spatial and formal organization of the Historic Colonial Houses at Panam Nagar, Bangladesh. This builds new knowledge and perspectives on how the houses' spatial and formal organization may reveal the living pattern and lifestyles of their inhabitants. Finally, the study enhances the understanding on the value of these buildings and the need for their preservation and rehabilitation through the formal and spatial analysis. The generative, visual description of the historic colonial houses at Panam Nagar provides a foundation for future preservation efforts and potential rehabilitation.

The goal of the research is to analyze the historic colonial houses of the Panam Nagar in Bangladesh using the shape grammar formalism as a theoretical/computational framework. The previous analysis using space syntax gave some clues about the genotype of the houses based on connectivity and links (Nilufar & Eshika, 2015), but shape grammar analysis can provide additional understanding of the spatial organization of the houses and their layouts. By studying a corpus of the houses to decode shared spatial relationships, a series of rules are developed that provide insight on specific functional adjacencies and urban relationships that further our understanding of how the houses might have been used within the larger context of the settlement. Criteria for studying these patterns foregrounds the functional zoning in the houses to further understand how the spaces are structured for duality in their street-level and internal composition as well as in their vertical growth to upper stories.

Future work may include developing a Preservation Planning Guideline that could apprehend some of the characteristics and features of the traditional building fabric and use it in planning contemporary guidelines. More specifically, these studies may include exploring the applicability of the Panam Nagar Grammar in developing subsequent rules to establish guidelines for preservation to retain the original characteristics of the settlement within a larger plan for rehabilitation or reuse.

## **Research Methodology**

This research aims to stand in between the history of a settlement and the future possibilities for it – viewing the site through the lens of a formal methodology. Thus, it starts with understanding the characteristics of the Panam Nagar Houses and the settlement through a Literature Review.

Then the methodology proceeds with the development of a shape grammar. More specifically, this process includes developing rules to analyze the existing houses at Panam Nagar spatially and formally to interpret their development, building elements, and structure. In this study, consolidated type residential buildings will be analyzed as the basis for a more comprehensive understanding of the site.

Based on the findings of the grammar, the study theorizes the living pattern of the past inhabitants of the settlement by providing a visual and generative description of the colonial houses at Panam Nagar to create a foundation for future rehabilitation or preservation process.

## **Organization of The Chapters**

This thesis is organized into five chapters, including this introductory chapter, which describes the background of the research, methodology, and overall outline of the research.

Chapter 2 discusses the site and historic context of Panam Nagar, the background of the settlement, and its current situation to highlight the necessity of preserving the settlement.

Chapter 3 describes the overall corpus of dwelling typologies and urban settlement at Panam Nagar. The typologies were based on their ornamentation, organization, morphology, and context.

Chapter 4 presents the shape grammar developed for the Panam Nagar consolidated type houses. It explains the rules and illustrates how the grammar is used to generate a novel understanding of the existing corpus.

Chapter 5 summarizes the findings, reflects on the project to date in a closing discussion and outlines the scope of future research.

## **CHAPTER 02 – SITE AND HISTORIC CONTEXT OF PANAM NAGAR**

Before any preservation or architectural intervention, the history of the site plays an important role. Without understanding the context, it is difficult to develop any theories or assumptions. To develop a better sense of the historic site of Panam Nagar, this research investigates the literary evidence describing historic Panam Nagar along with the site of Sonargaon as a broader context. Panam Nagar and Sonargaon were visited by many famous travelers in the Sultanate, Mughal and colonial periods who described their experience and observations of the site in different ages. A timeline covering significant historic events serves as a summary to conclude the chapter.

This chapter sheds light on those historic narratives and discusses the case of Panam Nagar as a colonial settlement to investigate its Indo-Saracenic character amongst the domain of domestic architecture within the rural-urban scenario. More specifically, the chapter discusses the history of the settlement from the thirteenth century to the present context, through the accounts of different travelers and historians.

## Background

Bengal has been always marked as a tumultuous place within history. From *Gangaridai*<sup>1</sup> to becoming a sovereign nation in 1971, Bengal has been transformed under various rulers. Panam Nagar is an ancient settlement of the early nineteenth century situated at Sonargaon, presently located in Narayanganj, Bangladesh. It is located twenty-nine kilometers south of the capital, Dhaka. Without discussing the context of Sonargaon, the history of Panam Nagar will remain incomplete.



Figure 5: Isa Khan, the leader of Baro Bhuiyans, a sketch by unknown artist (Source - Wikimedia).

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<sup>1</sup> According to Ptolemy, Gangaridai was the ancient region in Bengal



Panam Nagar has been grown on the debris of an earlier settlement, the earlier capital of Isa Khan (Figure 5)<sup>2</sup>, one of the famous *Baro Bhuiyans*<sup>3</sup> of Sonargaon. Due to its favorable location for trade, Sonargaon was the capital of the then Bengal *Sultanate* (regime) since 1338. Exact accounts before the thirteenth century cannot be found in scholarly discourse (Majumdar, 1943).

The name Sonargaon is derived from the name *Suvarnagrama*<sup>4</sup>, or 'Golden Town'. Before being captured by the Mughals, it was one of the three *Iqlims*<sup>5</sup> (Administrative Centre) of the Bengal. It is also situated near the historical Hindu Pilgrim Site of *Langalband* and *Panchami Ghat*. Under the Isa Khan rule of the Sultanate period, the Portuguese pirates constantly raided the Sonargaon Port

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<sup>2</sup> Under Sultan Taj Khan Karrani, Isa Khan, was the prime minister in the Sultan's court, gained an estate covering the area of Sonargaon. The Karrani dynasty was defeated by Mughal forces in western Bengal. Isa Khan gradually increased his strength and he was designated as the ruler of the whole Bhati region, with the title of Mansad-e-Ala.

<sup>3</sup> *Baro Bhuiyans* means Twelve Leaders. These leader fought against the Mughal rulers constantly. Isa Khan and a confederation of zamindars resisted Mughal expansion in eastern Bengal. The confederation is known as the Baro-Bhuiyans (Twelve Bhuiyans). The confederation included Bengali Muslim and Bengali Hindu zamindars, many of whom had Turkic and Rajput ancestry.

<sup>4</sup> 'Suvarnagrama' has been changed to Sonargaon which mean 'Golden Village' in English. As, the name had its origin in Sanskrit, Habiba Khatun demanded the town as Hindu originated. *Suvarnagrama* derived from the word *Suvar-Nigama*. Suvar means the Principality where Nigama was the Merchant Centre.

<sup>5</sup> Iqlim was the administrative unit in the Medieval Bengal ruled by the Shah Dynasty. The three Iqlims of that time is Lakhnauti, Satgaon and Sonargaon.

often and the golden days of Sonargaon were over when the Mughals shifted the capital from Sonargaon to Dhaka in 1608.

## **Accounts of the Travelers**

Ziauddin Barani, the famous Muslim Historian of Delhi mentioned Sonargaon as a territory ruled by Rai Danuj in the 14th century. In 1345, world-famous traveler Ibn Batutah visited the country in the Shahi Dynasty on the way to Java. He met many saints at Sonargaon which was then ruled by Fakhruddin Mubarak Shah. It was a mercantile center of the time and Batutah was amazed by the cheapness of the agricultural crops and abundance of fruits in Sonargaon which were exported to Java and other southeast Asian ports. Ma Huan, a Chinese Missionary who also visited Sonargaon in 1406, mentioned the walled city of Sonargaon and wondered about the quality of Muslin<sup>6</sup>, the famous cotton fabric of Bengal. Later, the English merchant Ralph Fitch visited the capital, Sonargaon, again in 1586. He noticed that the walled city had been turned into ruins. James Taylor in his book titled '*A sketch of the Topography and Statistics of Dacca*' wrote about the water bodies around the settlement in 1840. In his writing, he mentioned that the area was covered with a thick layer of trees including mango, tamarind, jackfruit trees, and bamboos. The settlement was almost invisible from outside. In the dry season, the place could be reached by narrow pathways. But in the rainy season, only small

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<sup>6</sup> Muslin is the finest cotton made in Bengal.

boats were required to visit this settlement. According to all accounts, Panam Nagar was a very wealthy center in its time (Taylor, 1840).

### **A Centre for Local Craft and Muslin**

Sonargaon is currently marked as a center for promoting Bengal folk and craft, due to its museum which promotes this heritage. Sonargaon was famous for its Muslin (Figure 6)- the finest cotton of Bengal. Ralph Fitch also mentioned the Muslin, along with the rice and other crops in his chronicles. In 1856, Muslin was crafted locally in Sonargaon and exported worldwide with other goods. A very large pond named Khasnagar was at Sonargaon. The water of the pond was used to wash Muslin clothes which helped to make the cotton extraordinarily white. It was mentioned in *Ain-i-Akbari*<sup>7</sup>, that the Khasnagar area was previously known as *Katare Sundar*. It was famous for the water which made the clothes exceptionally white. These accounts aid in understanding the importance of Muslin weaving in Sonargaon and the likelihood that weavers were an important part of the population in this area. Their industry was key to the exports and wealth of the merchants who lived at Panam Nagar. According to the chronicle of Ralph Fitch<sup>8</sup> written in 1585 -1586, on the way to Sonargaon from Sripur, he mentioned the best and the finest cotton of Muslin to be found here in Sonargaon. He also described the rule of Isa Khan as a friend of the Christians and he mentioned the people as

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<sup>7</sup> *Ain-i-Akbari* was written by Abul Fazl, one of the courtiers of Mughal Emperor Akbar

<sup>8</sup> Ralph Fitch came in Sonargaon in 1585, took a ship on his way to Pegu from Sripur.

wealthy traders who exported their rice and cotton clothes to India, Sri Lanka, Pegu, Melacca, and other places (Ryley, 1899).



Figure 6: A woman in Dhaka clad in fine Bengali muslin, 18th-century, painting titled 'Muslim lady reclining' by Francesco Renaldi (Source - Yale Center for British Art)

## **Panam Nagar in Mughal and Colonial Period**

During the Sultanate Period in Panam, the court was full of different merchants and people from different regions. Merchants visited the port to trade cotton and silk fabrics, the cheap agricultural products to Java, and various ports. The Ruler Ghiyas Uddin Azam Shah even sent an invitation to the Persian poet Hafiz. But after the Sultanate Period, the course reversed. The Bengal had its occasional clash with the Delhi Sultanate. The Mughals tried several times to conquer the vast

Bengal. To resist the continuous attacks, Isa Khan formed '*Baro Bhuiyans*' (Twelve landlords) and fought several battles valiantly with the Mughal army. Finally, Man Singh with the Mughal army attacked Bengal and conquered. The Mughals shifted the capital from Sonargaon to Dhaka (then it was named Dacca), another mercantile center near Sonargaon, and built several river forts along the Buriganga river. Later, in the British colonial period, the political change of Company rule in India transformed many significant modes of administration and trade. Bengal was very famous for its production of Muslin and many agricultural crops. It could serve other states of India after fulfilling their demands. The British rulers established cotton industries, and they primarily exported Muslin fabric.

The Muslin was exclusively exported to Arab, Middle East, Egypt, Turkey, and other European countries. But, in the middle of the nineteenth century, after the industrial revolution, the production of Muslin started to cease as the East India Company focused on establishing their trade and at the same time seized the business from local merchants and ethnic industries. At Panam Nagar, there is a *Kuthi-Bar*<sup>9</sup> (Office-House) which is an East India Company Office bearing the memory of the site as a vibrant business hub. After the formation and growth of the city Calcutta (Kolkata) as the capital of British Bengal and Due to the many temples and ritual structures of the Hindu religion found at Panam Nagar, it is assumed that one of these Hindu merchant groups founded the settlement (Nilufar

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<sup>9</sup> The Kuthi Bari, was only the buildings built by the British. The East India Company built this building in order to maintain their indigo business for the cotton industries.

& Eshika, 2015; Sharmin, 2019). They chose an already established trade zone and formed a township to enhance their business. Though there are approximately forty-nine buildings in the Panam Nagar now, in the late eighteenth and early nineteenth century there were approximately ninety buildings, varied from one to three stories in height. All the buildings had ornate decorations at their front facades which acted as the urban facade and the backyards were used as private collective spaces. Dr. James Wise has given a description of the settlement's social life and trades in his book 'Notes on the Races, Castes, and Trades of Eastern Bengal' (Wise, 1883).

A great trade in cotton, chiefly English piece goods, was carried out. The majority of the residents were prosperous merchants who make extensive purchases in Calcutta & Dhaka, which are disposed of in the villages around. At Panam, they made extensive trade in cotton fabrics and English piece goods. (Wise, 1883)

Panam Nagar was a sub-product of British Mercantile initiatives. The Archeological Survey of India also established the fact that the British East India Company discovered the place for its suitable geographic location. The Hindu merchants then helped to develop the area by creating a settlement following the steps and initiatives by the rulers at Kolkata. The Zamindars from Kolkata, Dhaka, and other places helped to develop the community as well.

### **Social Context of Panam Nagar**

Panam has a history of being a part of the Sultanate Dynasty, which is broadly a Muslim settlement. However, Colonial Panam Nagar was established by the Hindu

Merchants at the late eighteenth century and their temples are found in this settlement. Two buildings still have a temple that is private in nature on their roof. Evidence of one conventional public temple have been found at Panam Nagar, but significant remains of the structure do not survive. Even after being marked as a national heritage site in a predominantly Muslim country, many Hindu visitors come here to offer their prayers at the temples.

The north-eastern part of Sonargaon was mostly dominated by the Hindu community, and Panam Nagar is situated in that region. The inhabitants of Panam Nagar depended on the Pankhiraj canal and ponds for the water. These ponds have landing areas at their sides. The ponds were also elongated in the north-south direction, which is another proof for the assumption that they were shared among the same caste Hindu community due to their strong belief and inclination in the system. Wise noted that there was not a single Muslim inhabitant in the Panam Nagar in the 1880s. He also mentioned that the Hindu Wealthy Taluqdars<sup>10</sup> owned the houses and they used to pay direct taxes to the Dhaka Treasury. Other residents of Panam Nagar were businessmen, traders, and moneychangers (Wise, 1883).

The differences in the social context in different periods mark the early social context. The colonial period was not at all favorable for the inhabitants in Panam Nagar. Yet, when the potential of Panam Nagar as a trade hub was realized, the merchants invested there and developed their own settlement. Thus, the British

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<sup>10</sup> The Taluqdars means the people who have many lands.

East India Company stimulated the reincarnation of the Panam Nagar as a significant colonial settlement characterized by trade and commerce. Well into the twentieth century, Panam Nagar had a vibrant environment having festivals of Durga Puja and Rathe Jatra (Haque, 2016; Kabir et al., 2010). The community thrived until faced with the challenges of the great India-Pakistan Partition in 1947, when many of the inhabitants were compelled to leave their establishment (Sharmin, 2019). Still, a remnant of the settlement endured until Panam Nagar faced the second blow of fatal eviction. During the liberation war of 1971, the remaining Hindu families left Panam Nagar and took shelter in India. Thus, the settlement was encroached by local people, and they altered the houses based on their needs. Most of them are local Muslim people.

### **Current Context of Panam Nagar**

Panam Nagar covers almost 10 acres of land surrounded by water bodies in the north and south parts. At the north, Pankhiraj Canal (Figure 8) surrounds the settlement while there are several ponds and water bodies in the south. The waterbody has made the settlement seem like an island. It is assumed that the Pankhiraj Canal was the source of water supply for the inhabitants, it provided security, transportation, and sanitation to the site (Figure 8).

Around fifty buildings, from single story to three stories, are situated in dilapidated condition on the narrow and elongated plots. Around twenty-nine houses are on the north side and twenty-one houses on the south, standing very close. To create visual interest, each owner contributed an urban façade to the main street. These



ornate facades share patterns of symmetry, arched openings, decorated cornices, and more (Mowla, 2000).

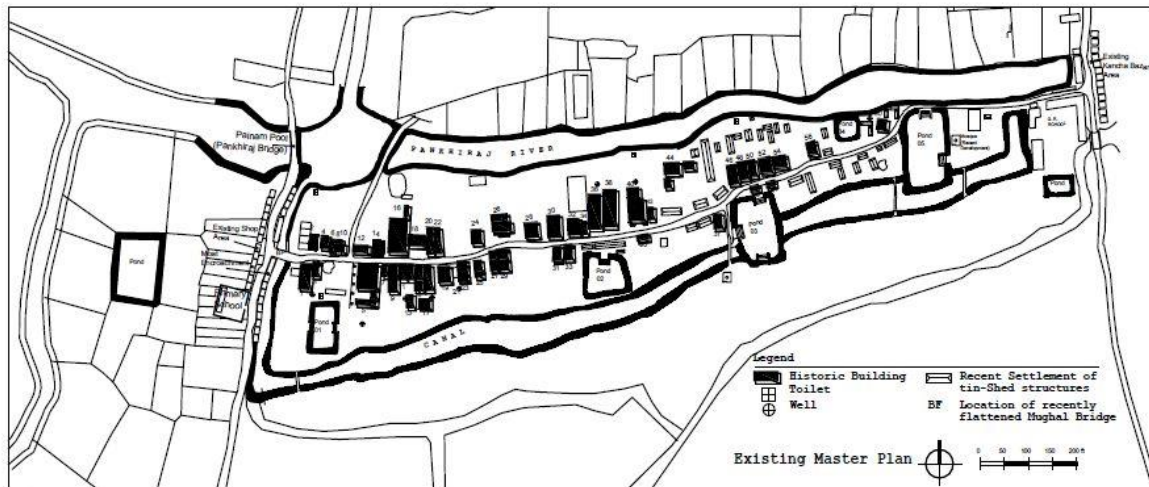


Figure 7: The Site Plan of Panam Nagar (Source - Shaikh, 2006)

The street ranges from four to six meters in width and is six hundred meters in length. Most of the houses are two-storied, only fourteen buildings are single-story. The site bears significant characters of Indo-Saracenic architectural styles identified in columns, arches, arcades, doorways, windows, pediments, gables, roof, and veranda railings. These characteristics are most prominently displayed in the street façades.

From the perspective of architectural history in the colonial Bengal, the buildings of Panam bear historic, architectural, and archeological values as well as rare evidence of the building technology and material of the time. Local people, being unaware of the heritage context, renovated and reorganized some of the old buildings in Panam. Lack of scientific and long-term planning considering the tropical weather, specifically the heavy rainfall of the Bengal, accelerates the decay in the buildings.



Figure 8: The Pankhiraj Canal at the Northern side of the Panam Street (Source - Author, 2020)

The government enlisted Panam Nagar as National Heritage in 2004 and evicted the illegal dwellers from the houses they were living in after the migration of a large Panam Nagar population in 2006. Currently, the buildings are under the jurisdiction of the Archeology department of Bangladesh, but there was no initiative taken by the government to revitalize the settlement. In 2020, the Archeology Department took an initiative to restore one building as a test case.

Apart from the street front houses at Panam Nagar, there remain some colonial palaces around the settlement. After the liberation war in 1973, Sonargaon Folk Museum was established and shifted to some houses at Panam Nagar. Then it was relocated to Baro Sardar Bari, another residential complex situated near the settlement of Panam Nagar. The table below shows the timeline of Sonargaon and Panam Nagar-

Table 1: The Timeline of Panam Nagar, Author 2021

<b>Panam Nagar Timeline</b>			
<b>Period</b>	<b>Century</b>	<b>Year</b>	<b>Events</b>
Sultanate/ Pre-Muslim	13th Century		Name Suvarna Nagar,
			Buddhist rulers shifted the capital from Bikrampur to Sonargaon
	14th Century	1338	Sonargaon becomes the capital of Isa Khan
			Sonargaon becomes a commercial hub
		1345	Ibn Batutah visited Sonargaon, ruled by Fakhruddin Mubarak Shah
			The first literary trace of Panam Nagar can be found
	15th Century		Sonargaon Flourished as a central commercial hub
		1406	Ma Huan visited the walled city of Sonargaon
		Houses were small and covered with thatches	

<b>Panam Nagar Timeline</b>			
<b>Period</b>	<b>Century</b>	<b>Year</b>	<b>Events</b>
			surrounded by moats for protection and sanitation purpose
Mughal	16th Century		Reached to the apex of its glory during Baro Bhuiyans
			Port was very active
			Rich Jain Merchants visited Panam Nagar
	1586	Ralph Fitch visited the walled city of Sonargaon but found ruins	
	17th Century	1608	Capital shifted from Sonargaon to Dhaka
		Sonargaon worked a commercial point, but Panam has lost its glory	
Early Colonial Period	18th Century		Panam turned into a village covered with jungle
Late Colonial Period	Early 19th -Late 20th century		The jungle has been cleared and settlement started to grow again
		1840	James Taylor mentioned Panam Nagar as a settlement covered by trees
			Sonargaon becomes a cloth manufacturing hub
			Wealthy Hindu merchants started to build residential and commercial buildings
		1883	James Wise mentioned Panam Nagar as a center of wealthy Taluqdars

<b>Panam Nagar Timeline</b>			
<b>Period</b>	<b>Century</b>	<b>Year</b>	<b>Events</b>
Pakistani Period		1947	End of British rule, many Hindu merchants left Bangladesh
		1963	Local riot upon Hindu owners
		1965	The houses of Panam Nagar become 'Enemy property'
		1968	Antiquities Act has been passed
Post Liberation of Bangladesh		1970-71	Liberation war of Bangladesh and many owners left again
		1973	Folk Museum established in Sonargaon, in some houses of Panam Nagar
		2004	Panam Nagar has been enlisted as National Heritage of Bangladesh
		2006	World Monument Fund enlisted Panam Nagar in their watchlist as a significant heritage (Source - <a href="https://www.wmf.org/project/sonargaon-panam-city">https://www.wmf.org/project/sonargaon-panam-city</a> )
		2015	Dept of Archeology took full custody of the Panam Nagar area
		2016	Baro Sardar Bari at Sonargaon renovated by public and private initiatives
		2020	Attempts have been taken to restore the number 13 building of Panam Nagar by the Dept. of Archeology

## **CHAPTER 03 – THE DWELLING TYPOLOGIES AT PANAM NAGAR**

This chapter discusses the core dwellings with the understanding of colonial influence and their translation on the spatial planning of the settlement in the Panam Nagar. It is also connected with the rise of a new Mercantile elite class at the beginning of the nineteenth century Bengal who built their houses imitating the European buildings or the Kolkata buildings which were also built with the influence of European Neo-classical Style. Though the settlement imitated the exterior façade following the Indo-Saracenic motifs, they followed the traditional spatial zones in the planning and layout of the house. In some cases, they followed the duality of exterior and interior to maintain the syntactic sequence like the other provincial administrative towns in nineteenth-century Bengal.

Among the buildings of Panam Nagar, researchers have assumed that they are residential, and they are commonly referred to as houses in the literature (Husain, 1997; Shaikh & Mowla, 2009). However, one of the aims of this study is to investigate the actual use of the so-called houses, as it is theorized that many of the buildings had commercial and mixed uses (Nilufar & Eshika, 2015). The architectural typologies were narrated based on their use, ornamentation, building style, materials, and building techniques.

The ornamentation of the buildings features local motifs blended with imitations of neo-classical details. Overall, these buildings convey an eclectic architecture metamorphosed by local and western ideas in domestic dwellings (Husain, 1997). In this way, the houses represent the prestige, richness, and affluence of their merchant owners. The buildings are rectangular in size, made of lime and brick, and elongated in the north-south direction on their plots. The narrow front facades are highly ornamented, with some buildings composed of distinct terracotta and *Chini-tikri* works (See Glossary).

In Panam Nagar, two main patterns of housing types are evident. The first is a bungalow-type consisting of a larger compound or courtyards. The term bungalow came from the origin of Bengal or Bangladesh (King, 1995). The bungalow type houses are situated at some significant places around Panam Nagar and Sonargaon. Among the bungalow type houses of Panam Nagar, Ananda Mohan Poddar House, Baro Sardar Bari and Kuthi-Bari is significant (A. S. M. Ahmed, 2016; Husain, 1997; Kabir et al., 2010). The second is a street front type consisting of a denser arrangement of spaces. The street front type houses at the Panam Nagar, and more precisely the consolidated subtype, are the focus of this research.

Panam Nagar street-front houses are generally rectangular in shape. The width of the front façade varies from 6 meters to 9 meters, with facades that are mostly symmetrical with an odd number of openings. This symmetry is constrained to composition of the façade and is not evident in the internal spatial organization of the houses. Openings usually have arches alternated by pilasters. Floor levels can be distinguished from the externally projected cornice. The raised patio (*verandah*)

and plinth work as a buffer from the exterior and interior. Husain (1997) in his book divided the street-front type houses into four categories. They are: 1) central hall type houses; 2) courtyard type houses; 3) consolidated type houses; and 4) compartment type houses.

### Central Hall Type

The Central Hall types (Figure 9) are characterized by double-height central covered halls that are generally colonnaded around the perimeter. These house types are usually larger than the other houses. The halls are typically a double-

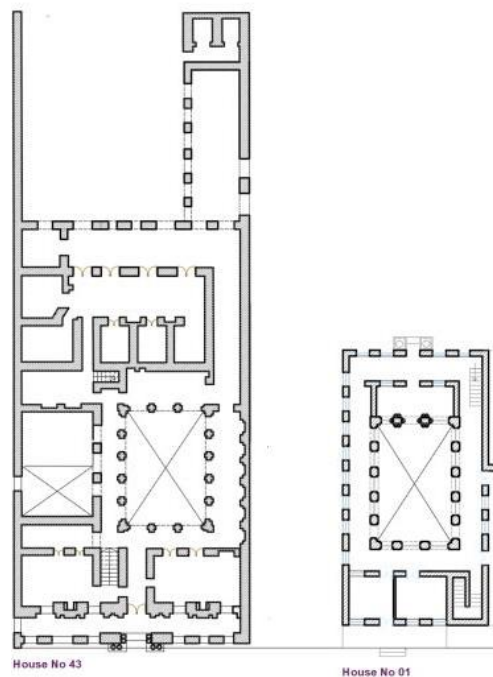


Figure 9: Central Hall Type Building (House No 01 and 43). (Source - Author, 2021)

height space. The halls function as the central organizer of the house plan, whether literally occupying the central space or not. The main activities of the house used



to take place in these halls situated on either the ground floor or first floor of the houses. The size of the hall varies but they are rectangular in shape. The hall was



Figure 10: The Central Hall Space at Panam Nagar Houses (Source - Author, 2020)

used for social gatherings and community occasions. The popular assumption about the use of the halls is as *Jalshaghar* (Dance Room). The halls are highly ornamented displaying the exquisite wealth and power of the merchant class (Figure 9). Exceptional cases of these houses even include colorful stained glass in their halls. Building numbers 1, 3, 8, 39, and 43 at Panam Nagar fall into this category (See Appendix / List of the Houses).

## Central Courtyard Type

Having a courtyard at the central location of a house or a group of houses is a very

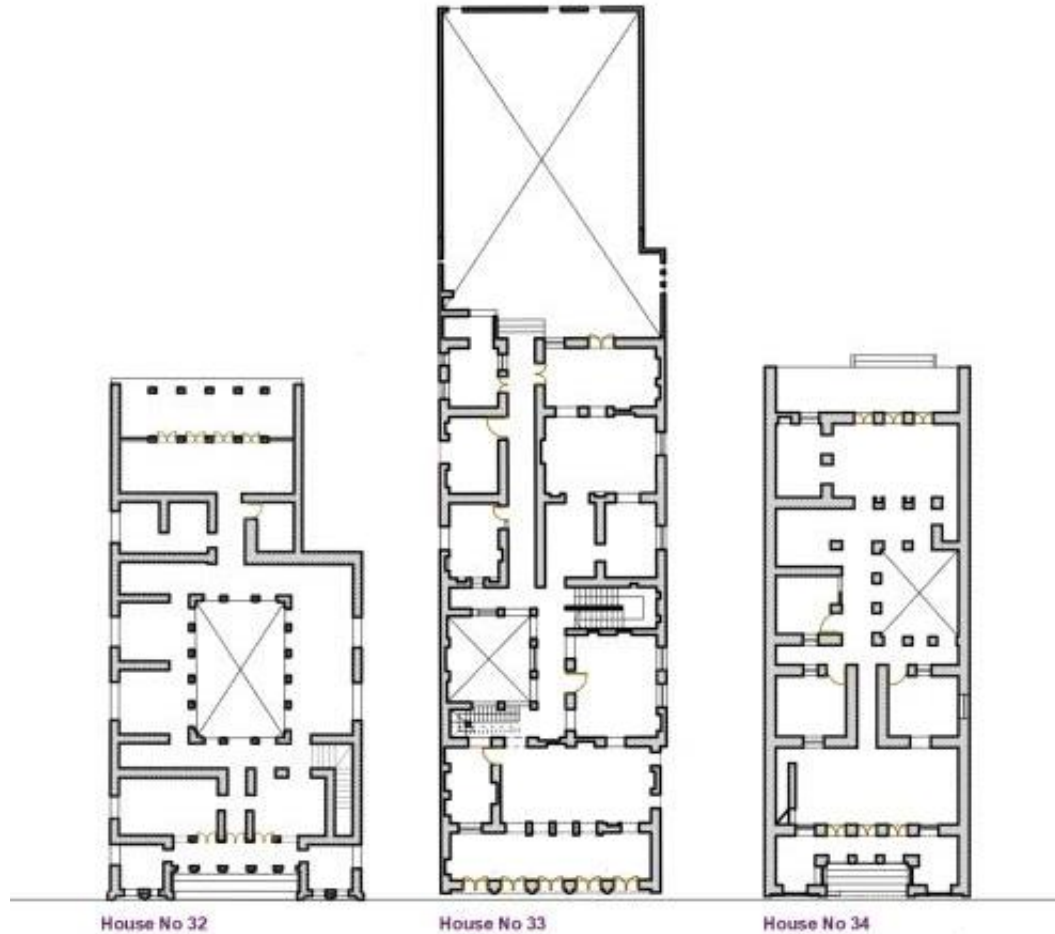


Figure 11: Central Courtyard Type Houses of Panam Nagar (Building Number 32, 33 and 34) (Source - Author, 2021)

common pattern of the traditional rural settlement of Bangladesh. The central courtyard houses (Figure 11) have rooms cloistered around a courtyard that serves as the source of natural ventilation, light, and daily activities. Unlike the central hall-type houses, these courtyards are not covered with a roof. The courtyards are generally open to the sky and paved with tiles. The verandahs around the

courtyard generally have ornamented pilasters, detailed in their base, shaft, and capitals. The parapets and cornice are also highly decorated. This house type is derived from traditional courtyard houses of rural Bengal, where activities are organized around the courtyards. The facades around the courtyards sometimes get treatment equal to the urban facades at the street front. Inspiration from Mughal architecture is traced in the ornamentation, such as the pointed arches and multiple cusps, for example. The building numbers 03, 32, 33, and 34 are examples of courtyard-type houses at Panam Nagar (See Appendix / List of the Houses). Building number 33 and 34 have a comparatively smaller courtyard on the ground floor and work as a lightwell, too. Though not situated at Panam Nagar, Baro Sarder Bari is an excellent example of the courtyard house of Sonargaon.

### Consolidated Type

In Panam Nagar, the consolidated-type house is the most frequent street front type house of the settlement. They do not have any courtyard or hall, but feature verandahs in front of the building which works as a threshold space between the exterior and the interior. The single-storied buildings mostly conform to this type.

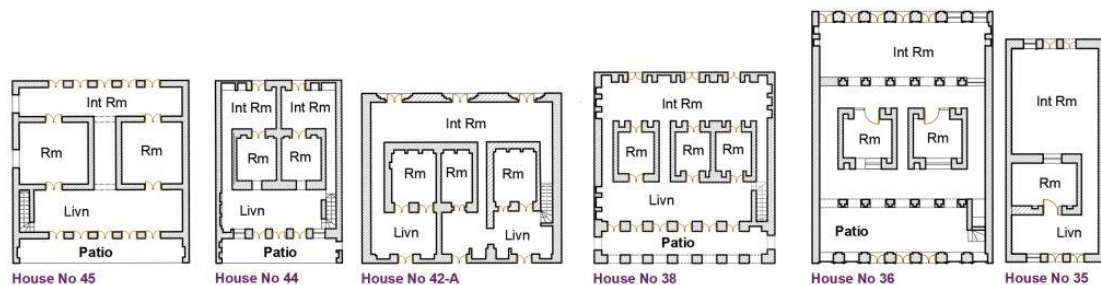


Figure 12: The consolidated Type Houses at Panam Nagar (House Number 45, 44, 42-A, 38, 36 and 35 from left to right. (Source - Author, 2020)

They either have an entrance portico, verandah, or high plinth as a transition from the street to the houses. In many cases, the base is difficult to distinguish from the street level as they have merged over time. Due to their frequency and prevalence at Panam Nagar, this research focuses on the street-front consolidated types of houses, which have a compact layer at their core like the central space of the temple (*Garvagriha*).

### **Compartment Type**

The compartment type house (Figure 13) consists of one or more compartments without internal correspondence. They usually have one or more rooms placed side by side. The stairs are usually placed adjacent to the rooms; it is assumed



Figure 13: the compartmental Type house at Panam Nagar  
(House number 31), (Source - Author, 2020)



that these houses were not used for residential purposes but rather for storage or miscellaneous functions (Nilufar & Eshika, 2015). They are typically located by the waterbodies, suggesting their use for storage. Building no 21, 22, and 31 at Panam Nagar fall into this category (See Appendix / List of the Houses)

## House-Temples

According to the account of Ralph Fitch, the small houses of Sonargaon were built with mud and thatched (Riley, 1899). It was hypothesized that the permanent construction material was only used in the case of religious buildings as many of them still survived in the greater Sonargaon. On the other hand, during the Mughal



Figure 14: The incorporated Temple at the House of Panam Nagar,  
(Source - Author, 2020)

rule, many secular buildings were considered prominent expressions of wealth. These were subsequently built with a permanent material. Thus, the Hindu merchants who built the houses at Panam Nagar constructed luxurious homes instead of making temples. In fact, they incorporated the temple into their own



Figure 15: The Shiva Temple at Panam Nagar in 1872, now demolished, photo taken by W. Brennand (Source – British Library)

houses, adapting the Bengal traditional roof pattern (Figure 14). Wise mentioned a Shiva Temple in 1872 (Figure 15), which is not standing at the site at present. He describes thirty houses of Brahmins, sixty-five of Shahas, five Bhumalis lived in the settlement, with no Muslim there. Others are barbers in nature (Wise, 1883). Later, after the great partition of India in 1947, the Merchants left the houses dilapidated due to their minority situation, local riots after the partition and liberation war of Bangladesh in 1971 (Mowla, 2008; Sharmin, 2019).

## **Cross-cultural Influences on Panam Nagar Houses**

The houses of Panam Nagar are mostly built with brick. Various shapes and sizes of bricks have been used in Panam houses for different parts of the buildings. In most cases, the outer surface is plastered with lime mortar to cover the bricks. Currently, the plaster is damaged due to negligence and lack of craftsmanship. The thickness of the wall varies from 50 cm to 70 cm (Sharmin, 2019).

### **Mughal Influence in the buildings**

In the Indian subcontinent, the Mughal regime began in 1526 and Bengal was under this regime during 1576-1765 till the British company rule. During the sixteenth and seventeenth centuries, the Mughal period was a very influential and powerful dynasty in the world.



Figure 16: The Mughal Bridge (Pool) on the Pankhiraj River at Panam Nagar, (Source – Author, 2020)



However, Mughal architecture as we know it today comprises many cross-cultural influences. Taking inspiration from the Islamic architecture in Iran, Turkey, Tajikistan, and Afghanistan, the Mughals enriched their architecture with geometric landscape design, formal gardens, and especially tombs and forts spread around the Indian sub-continent.

At the time of Mughal rule, many bridges and pools were built and constructed. The main bridge on the Pankhiraj river is also an excellent example of the Mughal Bridge. It consists of three pointed-arched openings having the bigger at the central position (Figure 16).



Figure 17: The multiple-cusped arches openings at Panam Nagar, having Mughal influences (Source – Author, 2020)

As Panam Nagar was established before the colonial period, the traces of the Mughal period can be found in the spatial organization and ornamentation of facades (Figure 17). One of the key components is using multiple-cusped molding over the openings, pointed ogee arches, and small niches with pointed arches



(Shaikh & Mowla, 2009). Another important feature of Mughal houses was that they were square in plan. From the field survey, Shaikh (2006) gave remarks that

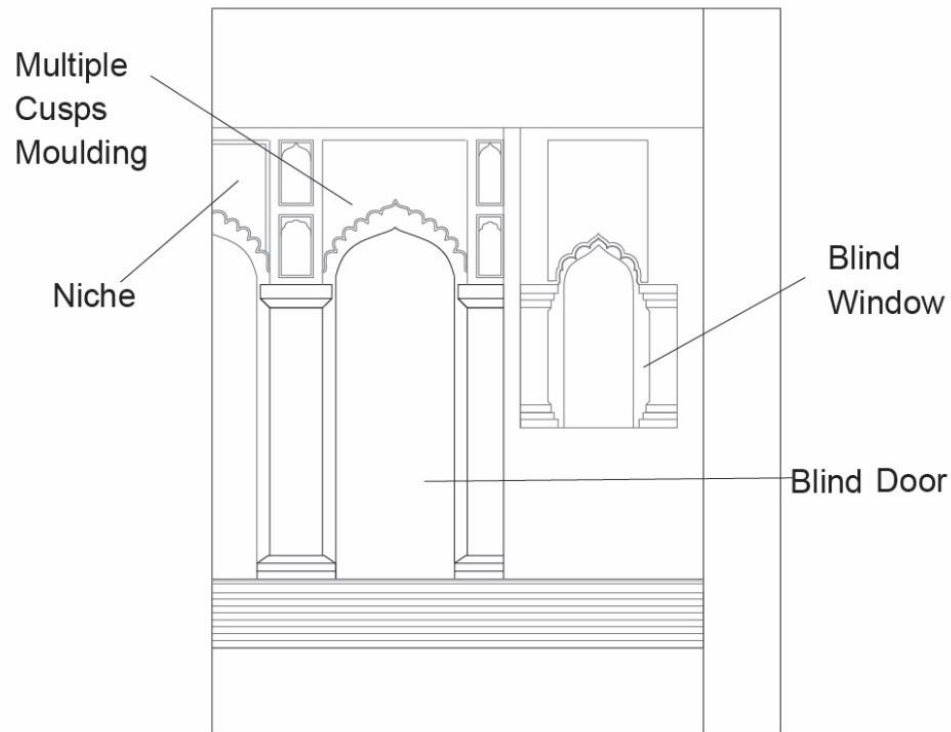


Figure 18: The Mughal Details at Building 48, (Source - Shaikh, 2009)

some current buildings were built on the ruins of older buildings. We can see that tendency in the bungalow-type houses in Sonargaon as well. Traces of four different periods of building within the same complex have been found at the famous Baro Sarder Bari of Sonargaon (A. S. M. Ahmed, 2016).

The construction of the roof depended on a wooden truss. Floral decoration was done on the lime plaster. Figure 18 shows the multiple cusped arches, niches, and blind windows and doors as Mughal ornamental motifs for facades.

### Mixed or Hybrid Influence in the buildings

Though they were built and flourished in the colonial period, Panam Nagar buildings accumulated significant features of Mughal style and colonial features. Many scholars identify this phenomenon as a hybrid or mixed influence. These styles came from the Mughal and Sultanate architecture elements like two centered arches, four centered arches, and multiple-cusped arches (Figure 19).

The colonial architecture elements like Doric or Ionic columns, compound piers,

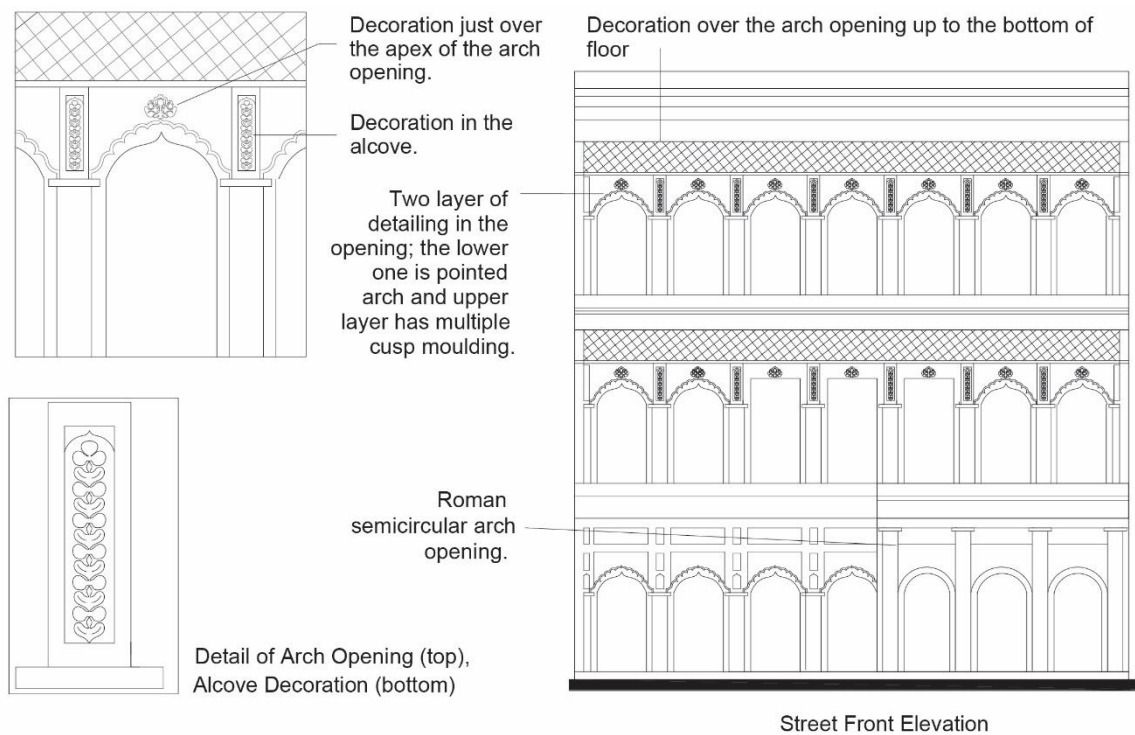


Figure 19: The Hybrid or Mixed use of Mughal and Colonial architectural elements, here Building number 09 is illustrated, (Source - Shaikh 2009)

entrance porticoes, pediments, cast-iron railings, and moldings are evident in some buildings. Some Mughal-style buildings later added colonial features to adapt to the surrounding buildings. Building numbers 4, 5, 7, 9, 13, and 17 at Panam Nagar falls into this category (See Appendix/ List of the Houses).

In this context, Panam Nagar bears significant influence from different cultural fusions. The mixed style is also evident due to the variety of brick sizes and roof elements. These phases of hybridization are a little bit difficult to determine. With the rise of neo-classical style in the late eighteenth and early nineteenth century, the fusion started to disappear, and the colonial style with local fusions emerged.

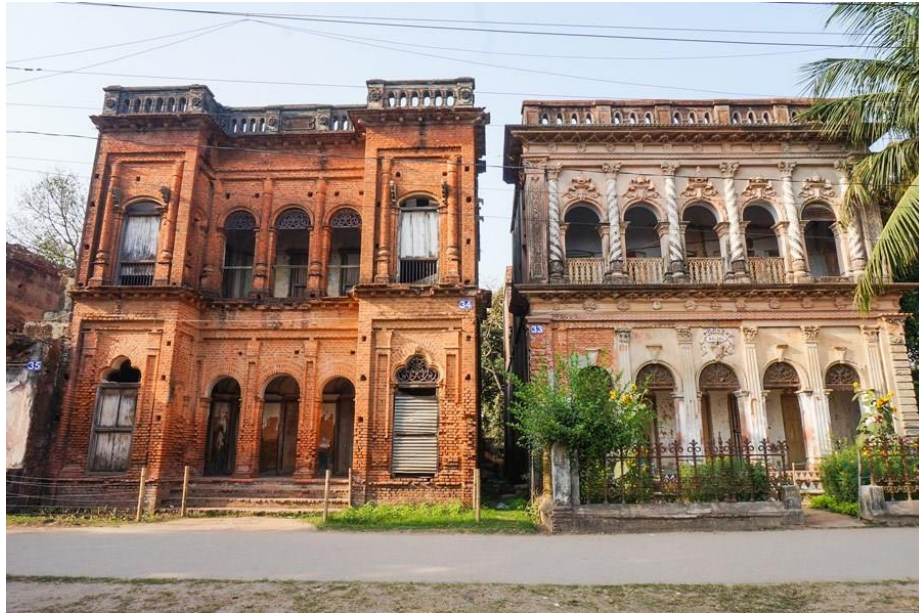


Figure 20: The colonial period houses of Panam Nagar, having semi-circular arches, chinni-tikri works and cast-iron railings at the front facades (Source - Author, 2020)

### **The Colonial Influence in the Buildings**

Most of the buildings in Panam Nagar were built in the colonial period starting from the late eighteenth and early nineteenth century (Figure 20). The buildings of Kolkata became an inspiration to the inhabitants of the settlement. They followed the Indo-Saracenic style in building these settlements.

Among the colonial-style buildings of Panam Nagar, some are less ornamented having simple plaster works. The later versions had the front façades decorated valiantly over the plaster. The ornamentations can still be found on the corners, pillars, walls, railings, and cornices of the buildings. These two types of colonial building, having high ornamentation and having no ornamentation, created high contrast helping us to identify the older and newer buildings. Semi-circular arches on the doors, multi-colored tiles, and *Chinni-tikri* ornamentation (See Glossary) were significant features of colonial period houses in Bengal (Sharmin, 2019).

Another remarkable feature of the colonial period house was the extensive use of Corinthian capitals in the facades, used for both load-bearing and ornamental purposes. Many influences and differences can be addressed through the column decorations. Moreover, cast iron floral decorated railings are also signs of the colonial period Bengal architecture.

The colonial buildings were usually raised on a higher plinth. Sometimes the entry is emphasized with an entrance portico. The Mughal buildings usually didn't have defined entries, but the colonial buildings usually have them. One of the key features of these buildings is Roman semi-circular arches that are highly decorated



with floral patterns around the openings. Some buildings were detailed further with colored glass at these openings. (Shaikh & Mowla, 2009)



Figure 21: An example of Colonial Building type in Panam Nagar, Building Number 02, (Source – Author, 2020)

In both exterior and interior, pointed niches were found in the houses (Figure 22). On the interior, the spatial connection between interiors is simpler and follows the duality of the public-private zone of the dwellings as most of the houses were used

as residence cum office (*Kutchery*). The houses maintained a proportion and scale representing the neo-classical European buildings.



Figure 22: The niche area inside of a Panam Nagar house, (Source – Author, 2020)

Panam Nagar has a large number of colonial buildings, as the settlement flourished in the Colonial period. Some of these buildings display evidence that their redevelopment occurred over the Mughal period structure. Building numbers 1, 2, 3, 6, 9, 11, 12, 16, 22, 32, 33, and 34 at Panam Nagar fall into this category of colonial architecture (See Appendix / List of the Houses).

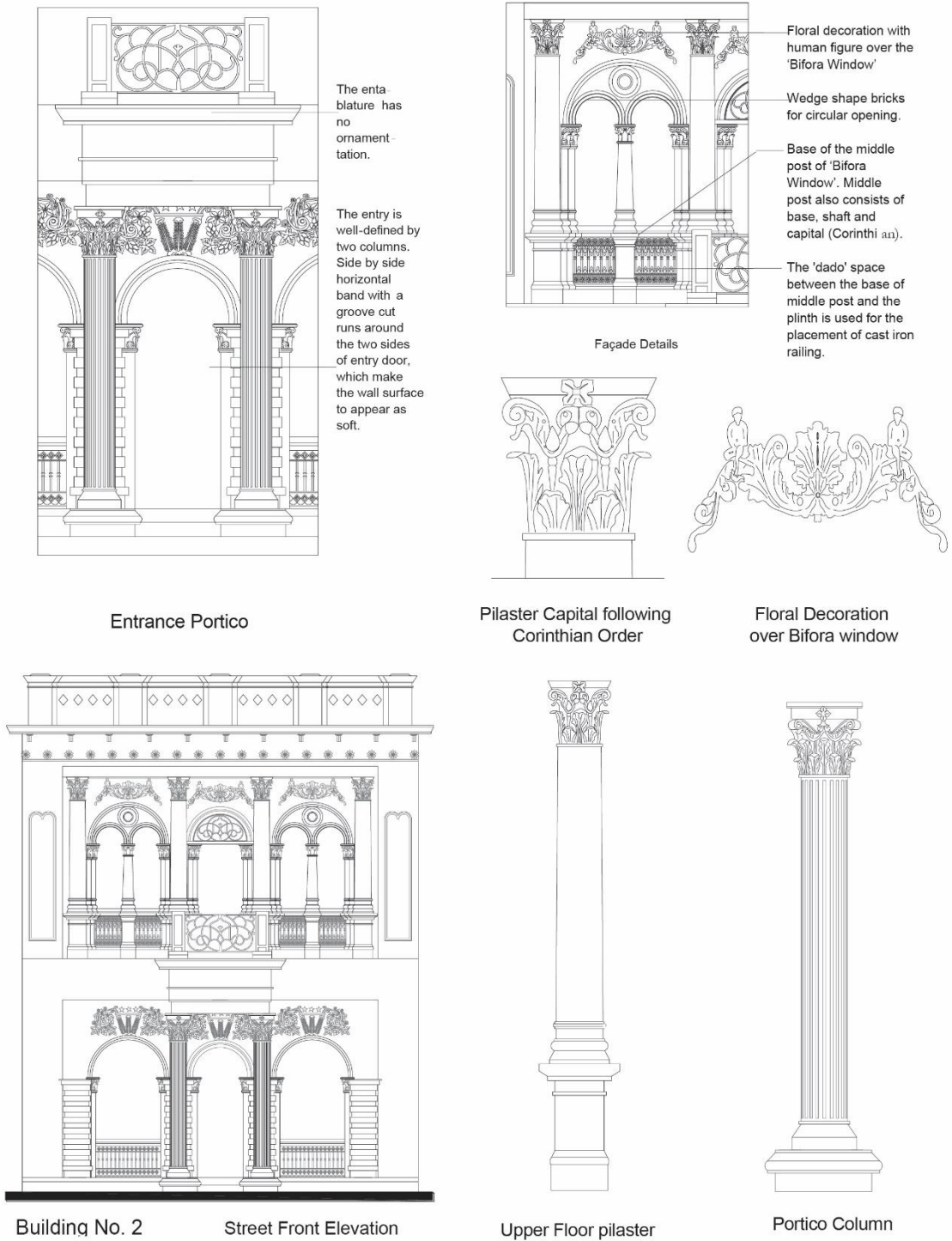


Figure 23: The features of colonial architecture in facades and building elements of the building number 02 at Panam Nagar, (Source - Shaikh, 2009)



## **Urban Context**

The urban scenario of Panam Nagar represents a harmonious combination of open and built spaces. The buildings share their backyards and waterbodies, including separate toilet facilities in this zone. The buildings and their exterior façades attained visual unity with their ornate craftworks, masonry, and the language of openings. These characteristics portray the communal lifestyle of the regional colonial Bengal of the nineteenth century. The inner courtyards and lavish ornamentation communicate forms consistent with the lifestyle of the wealthy merchant community. As all the Panam houses feature ornate street façades, they act like row houses and convey a dense, urban settlement.

## **Social Background of Panam Nagar Inhabitants**

The houses of Panam were built by the Merchants who most of the time lived in Calcutta, the central capital of India in the Colonial regime. Panam was a trade center, and the residents moved back and forth in between settlements and seasons. The inhabitants were mostly in local trading and cloth business and money lending as well (Kabir et al., 2010). Most of the inhabitants, known as Taluqdars were absentee landlords, visited Panam Nagar to celebrate 'Durga Puja' and 'Rathajatra' (Chariot Rally) Kabir et al., 2010 mentioned that usually the brahmins are considered elite in the social hierarchy, Shahas were known as traders and the other casts are usually considered lower castes. From Wise's description, Kabir assumed that the larger houses at Panam Nagar were owned by the Brahmins and Shahas (Kabir et al., 2010).



The houses were used by both single and multiple families. Thus, the houses served dual functions and fall within the realm of living, working, and leisure. The



Figure 24: The existing Shiva Temple at Panam Nagar  
(Source - Author, 2020)

front side of the houses is directly connected with the street which is the outer realm and much more connected with commerce. The inner courtyards work as a barrier or buffer for the interior and exterior of the house in different buildings.

The nature of the composite dwellings determined the functionality of the spaces and their social relationships. As an example, the very same space could be used as an office and living quarters, which can be expressed with the terminology '*Kutchery*' (office). The very same space could be used by young male relatives or guests for staying overnight or for several days. This flexibility facilitated the interchange of functions for daily or annual festive activities. Some spaces are

difficult to define functionally due to their temporal ability to change. These interior spaces also could adapt incrementally due to their spatial layout and common uses, according to (Sengupta, 2013).

Chattopadhyay mentioned the street front houses of Kolkata sought a public identity through the changes in the urban fabric. She wrote about the *Shovabazaar Rajbari* and other palatial houses of Kolkata with a courtyard of public space and events, creating permeability. The façades contained neo-classical motifs with grandeur in scale. The connectivity towards the hustle-bustle of streets in the 20<sup>th</sup> century Kolkata influenced many provincial buildings in the Colonial regime. The highly ornamented façade, elaborate openings, and high plinth at the ground quarters enhanced the interaction between the street and the houses. The urban façade had an impact on the people (Chattopadhyay, 2005). Following the same path, the merchants of Panam Nagar wanted to create colonial urbanity around their dwellings to create interactive spaces. The inner courtyards housed sleeping, cooking, and dining spaces. This urban frontage worked as an extension of the dwellings to the street and brought the lives of the street to dwellings.

Once a thriving center within the larger context of Sonargaon, Panam Nagar lost its importance due to shifting the capital from Sonargaon to Dhaka. Being a Hindu pilgrimage center, it turned into a Sultanate capital and a flourishing trade center of Medieval Bengal. As the dwellings of medieval Bengal do not have that many remnants left, only the religious buildings are left with their permanence. But, in the colonial period, the East India Company realized the importance of this trade center and revived it with the local newly elite Mercantile class who built the

township with the political patronage and Indo-Saracenic influences in their dwellings. The merchants consciously attributed the influences of British-built Kolkata dwellings in their houses- having neo-classical facades and incremental easy planning in the interior. The houses of Panam, with their colonial and Indo-Saracenic influences, require more formal study on the domestic duality in spatial zoning which may give a glimpse of the lifestyle of a newly formed and elite Merchant class who played a role as a media between colonial agencies and local inhabitants.

## **CHAPTER 04 – THE PANAM NAGAR GRAMMAR**

Revealing the common features of any design language – including art, sculpture, and architecture - lies in the scope of shape grammars (Stiny, 1980). The analytical aspect of shape grammars focuses on investigating designs to find a common spatial language defined in shape rules, based on which new designs can be implemented (Duarte, 2001). The formalism has been used for different technical issues and this theory has become one of the significant analytical tools in architectural research.

This chapter discusses the grammar of a particular house type existing in Panam Nagar based on their spatial zoning, incremental growth towards the axis from the street towards the backyard.

### **Computation and Conservation**

Accurate preservation needs a thorough knowledge of the context, technology, lifestyles, and architectural principles (Angelo et al., 2012). This chapter presents some of the cases of architectural precedents that were analyzed by shape grammar. Castro and Beirao (2019) have used shape grammar as a support instrument for heritage safeguard planning. Selecting a site at Portugal, they identified that tourism did significant harm to historic sites. Using the 'Prairie grammar' (Koning & Eizenberg, 1981) to develop their definition of the grammar and using the structure of Yingzao Fashi grammar (Li, 2005), they developed some

parallel grammars to preserve the town of Aljezur. In broader perspective, they developed a grammar that could describe the corpus of their buildings and can be incorporated for the development of the new vernacular houses. This can be one way to safeguard the heritage by introducing and implementing codes that are coherent to the rules of the houses described. While there is much debate on the ethics of preservation relative to any structure, these studies anticipate possibilities for computation and conservation to provide a formal basis for describing, interpreting, and evaluating heritage sites.

In Panam Nagar, the historic merchant houses are now dilapidated and in ruins. Moreover, the new development around the site is not coherent with the site because of the context, changing functions, and importantly, the scarcity of building technology. In addition, the fabric of the settlement is distinctively different from the surrounding context (Figure 1). To revive and preserve this architectural legacy, the knowledge on the buildings, their use, and technology is critical. Shape grammars provide a formal tool to understand the spatial arrangement and inherent architectural features of the buildings and urban settlement at Panam Nagar, which ultimately provides new perspectives on the original historic fabric.

In the case of Panam Grammar, the goal is to develop and describe the essence of the design, so that if new buildings can be created or the existing buildings need to be reused, the grammar can be useful. Though Panam Nagar street front type houses consist of four types, the grammar here is based on the consolidated type houses.

For the derivation of the grammar, this research collected data from the consolidated type houses. The consolidated type houses are the most common types of houses at Panam Street. Nilufar and Eshika sub-grouped the consolidated type houses into three categories. A single type, multiple-corridor-type and buildings without corridors (Nilufar & Eshika, 2015). One of their key findings was that the consolidated type houses are usually very shallow in-depth, with front and back rooms that are mostly connected from the streets, and backyards having very strong control. The front rooms work as a connector because of the connectivity to the upper floors having stairs. They have also questioned the use of the central spaces having just one connection. According to their understanding, the courtyard and central hall type houses have strong lineages that lie in the traditional house types of Dhaka. In addition, they felt the spaces are highly connected to the exterior from the streets and backyards.

### **Corpus of the consolidated house types**

One of the main aims of the grammar was to find out the origin and layers of the Panam Nagar houses and investigate the characteristics based on other types of houses at Panam Nagar. As consolidated house types are compact and most common in Panam Nagar, we started the research with these types of houses.

Among the remaining forty-nine houses, the corpus for our study started with the analysis of the plan of eighteen consolidated type buildings.

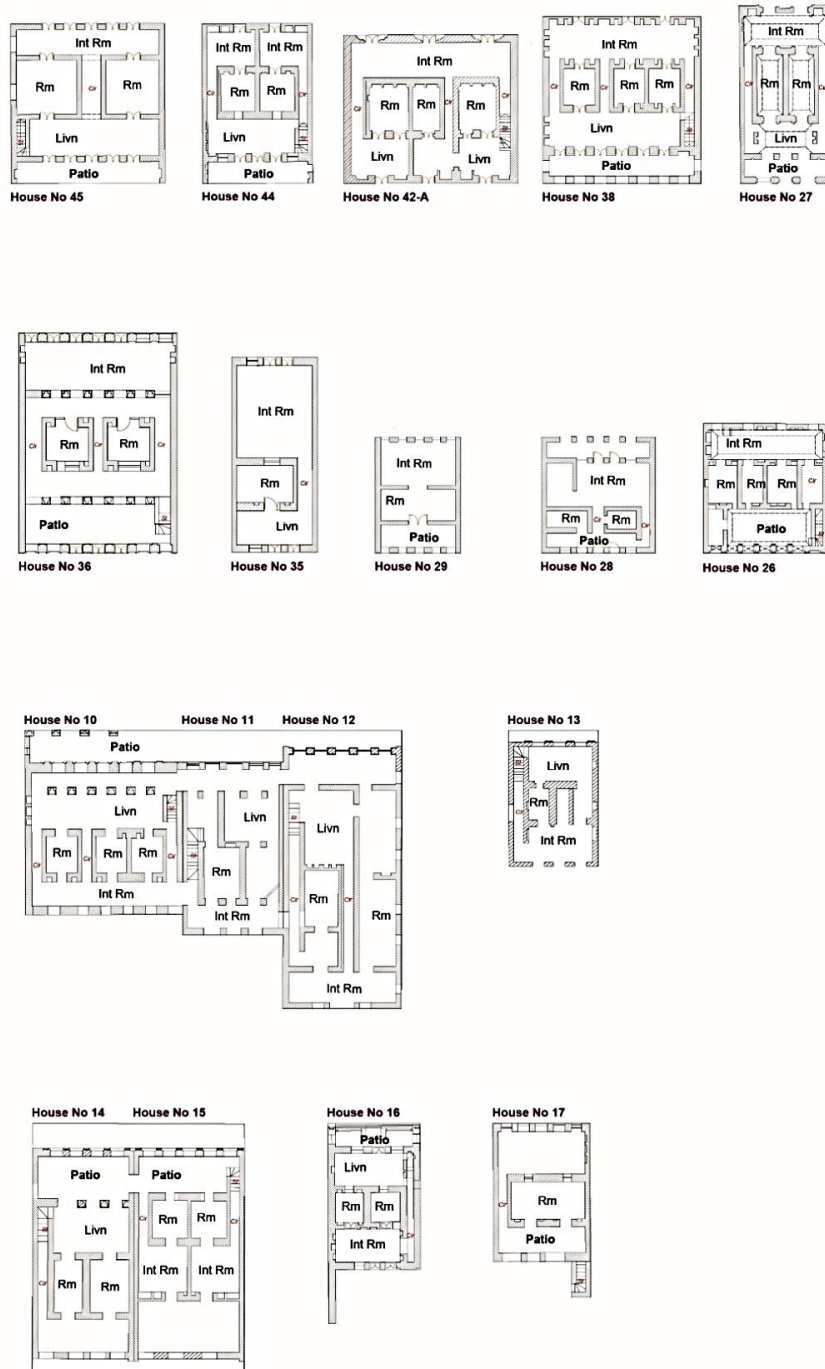


Figure 25: The corpus of the consolidated Houses (Selected) at Panam Nagar (Source - Author, 2021)

## Description of The Grammar

From observing the Palladian grammar (Stiny & Mitchell, 1978), Malaguiera Grammar (Duarte, 2001), and Yingzao Fashi Grammar (Li, 2005); the grammar presented here focuses on the development of rules for deriving the spatial zones in the consolidated house types of Panam Nagar. The current version of the grammar focuses on the description of the zoning at the ground floor.

To develop the rules, rectangles were used to illustrate the zones of the houses



Figure 26: The color codes of the zones used in the derivation and rules for Panam Grammar (Source – Author, 2021)

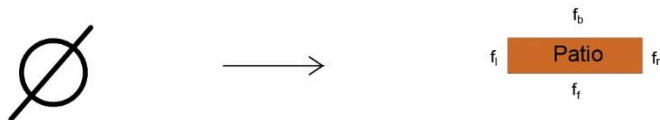
according to various functional uses and their relationships one to another. Each of these rectangles can be related to specific parameters of the existing houses to customize their proportions to actual site measurements, which can be calculated through the labels used in the rules. In addition, different colors have been used to denote those zones in the grammar as a visual labeling system for these functions. The grey color shows the street color, the brown represents the patio or verandah; the blue represents the zone of living and mixed public zones, the red represents



the sleeping or the central core area where sometimes different use or functions can happen. The orange color represents the back internal semi-public or semi-private area that opens up towards the backside of the houses, sometimes it opens up through another level of patio or Verandah (Figure 27).

To derive the spatial development of the houses, the rules are being applied in four steps. The first step begins the initial development of the rules. The second step develops the spatial zones incrementally one after another. The third step identifies the central area, then creates the rooms and spaces within it. Finally, step four locates the circulation zones and stairs. The steps of the rules are discussed in this chapter.

**Rule 01: Establish the Initial entry**



**Rule 02: Establish the Initial entry**

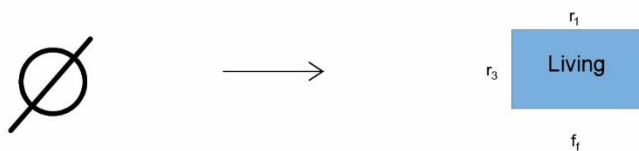


Figure 27: The initial rule to start the process, (Source - Author, 2021)

**Step 01: Initial Phase**

The initial shape starts from the street level of Panam, representing the entry of a house, often through a patio or verandah. In the consolidated type houses, the

initial house consists of a patio, living, and sleeping zone. The patio or verandah was raised on a plinth and marked the entrance of the house. Rule 01 and Rule 02 are the initial rules to add this primary layer. From the corpus of the consolidated houses (Figure 25), most of the buildings have a plinth, sometimes with steps.

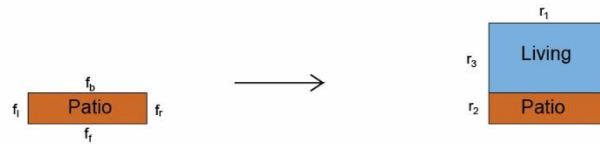
Rule 01 produces the starting plinth. On the other hand, some houses initially started with the living directly as provided for in Rule 02. In some particular consolidated type houses, the columns have been added to the patio or *verandah* as a structural element. The  $f_f$ ,  $f_b$ ,  $f_l$  and  $f_r$  labels used in the shape rules represent front width, back width, left and right length, respectively.

### **Step 02: Introduce the Interior Zones**

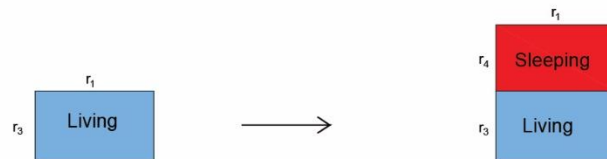
From the corpus of the consolidated type houses, the houses consist of a series of functional zones. They are - living or *Kutchery* zone, sleeping area, and Interior room area that opens towards the backyards or open area. Every house opens with a patio or a living room. Then the zone incrementally grows along an axis that extends through the house. Following Rule 03, the patio extends towards the Living or *Kutchery* zone and then extends towards the Sleeping zones using the Rule 04. Following the similar development of Rule 03 and 04, Panam houses grow incrementally adding another layer of interior rooms and backyards. (Figure 29) This growth usually remains perpendicular to the street from the street towards the backyards where the waterbody remains. The entrance creates symmetry at the front façade.

## ZONING LEVEL

### Rule 03: Adding the Living Area



### Rule 04: Adding the Sleeping Zone after living Area



### Rule 05: Adding the Sleeping Zone after Patio



### Rule 06: Adding the backyard Room Zone



### Rule 07: Adding the Patio



Figure 28: The rules to establish the zoning and area at the ground level,  
(Source - Author, 2021)

### **Step 03: Defining the Central Space of the Houses**

From the corpus of the consolidated house types, it is evident that the houses have a central location at the middle of the public street front living zone and semi-private backyard zones. In most cases, the rooms are divided, merged, and overlapped here and sometimes they become converted to circulation spaces.

Rule 08 - Rule 14 describe rules to create the zones within the central space of the houses (Figure 30). These rules of subdivision, changing, and merging functions generate the assignment of rooms from zones following the incremental growth. Rule 08 subdivides a space into three spaces, whereas rule 9 subdivides a space into two. Rule 10 combines two zones into one zone and rule 11 combines two functions into one. From Figure 31, Rule 11 changes the function of the room and rule 12 transforms the function.

Rule 13 redistributes the area of one larger function from another smaller one. Rule 14 deletes the label and related function of a space. These rules define the interior space or rooms from a broader sense of zoning.

**Rule 08:** Dividing the Zone into three areas



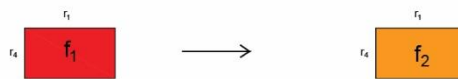
**Rule 09:** Dividing the Zone into two areas



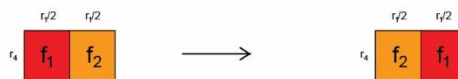
**Rule 10:** Combining two zones into one zone



**Rule 11:** Changing the function



**Rule 12:** Transforming the function



**Rule 13:** Enhancing the area of a function



**Rule 14:** Removing the label or the function

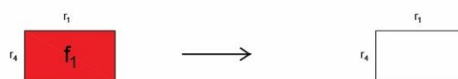


Figure 29: Rules 8-14 shows the ways of creating central area, the division of rooms and functions. (Source - Author, 2021)

#### **Step 04: Assign Circulation and Stair**

The circulation starts with the entrance to the house. Following the symmetrical pattern of the house, the circulation starts with the central axis and follows the pattern through the interior walls. As the houses are growing incrementally, the circulation follows through the doors which are situated at the central location of the interior walls. The circulation converts into a stair when a house extends to a second floor. Rule 16 adds the circulation strip at the west or east side of the house.

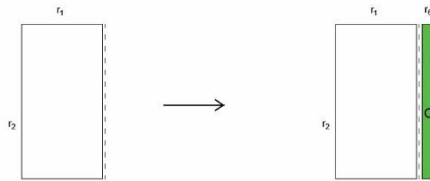
The circulation inside the house often creates a corridor like space between two public and semi-public zones of the house. Rule 18 shows that connection from living to the internal rooms. The circulation moves towards the backyard where the waterbody is and creates another circulation from the backyards which indicates the duality of the living pattern. Rule 19 shows the overlapping of patio zones over the circulation where sometimes we can see blind openings of the facades to create a harmony.

## CIRCULATION AND STAIRS

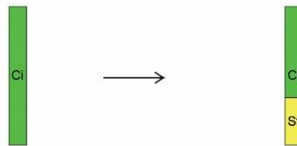
**Rule 15:** Adding the Circulation Zone adjacent to the sleeping zone



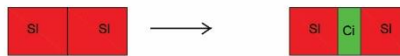
**Rule 16:** Adding the Circulation Zone adjacent to the label



**Rule 17:** Dividing the the Circulation into circulation and stair to the upper floor



**Rule 18:** Connection of the Interior Room with the living Zone



**Rule 19:** Overlapping of The Patio Zone on the circulation

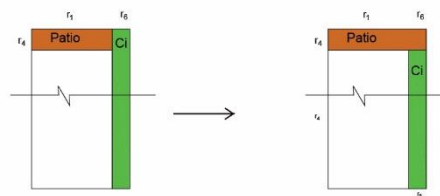


Figure 30: Rule 15, 16 and 17 showing circulation bands; Rule 18 and 19 showing the connectivity of the circulation area and corridors. (Source - Author, 2021)

### Consolidated Type Houses- a case in Panam Nagar

For the derivation of the Panam Grammar, we have selected the consolidated type houses at Panam Nagar, and developed rules based on the spatial organization of the spaces, then the rules were verified by their application through the derivation of the planning aspects on two cases. For the derivation, we have selected the house number thirteen (Figure 26) and house number thirty-eight to verify the description interpreted in the grammar.



Figure 31: The plans of number 13 building of Panam Nagar, plans are collected from the Archeology department of Bangladesh, (Source - Author, 2020)



House number 13 is a two-storied house situated on the southern side of the street. It has entries from the street side and openings at the backyards like the other street-front houses of Panam Nagar. Raised on a high plinth, the building has 10 feet by 16 feet space as a living room, the central spaces having three small rooms with narrow and elongated spaces and another layer of living spaces at the backside of the house. Additionally, another layer of circulation has been added to the west side of this house. It also contains the stair to the upper floor. The stair has access from the living room, and it is a narrow stair opened at the roof level. It is also an example of a Mughal style building as it has a *dochala*-roof temple on its first floor. The lime mortar has been used to imitate the Bengal roof (Figure 14).

#### **Derivation of the plan- House Number 13**

The derivation started with the street level, then Rule 1 helps to add the Patio or the *verandah* for the house's entry. Rule 3 then was applied to add the living area of the house, the next phase adds the sleeping core zone adjacent to the living area. Behind the living and sleeping zone, the plan axially grows to the next layer. Using the rule 6 of adding a semi-private internal room after the sleeping core, the house becomes fulfilled. However, at the backyard, using Rule 7, another layer of patio or verandah is added.

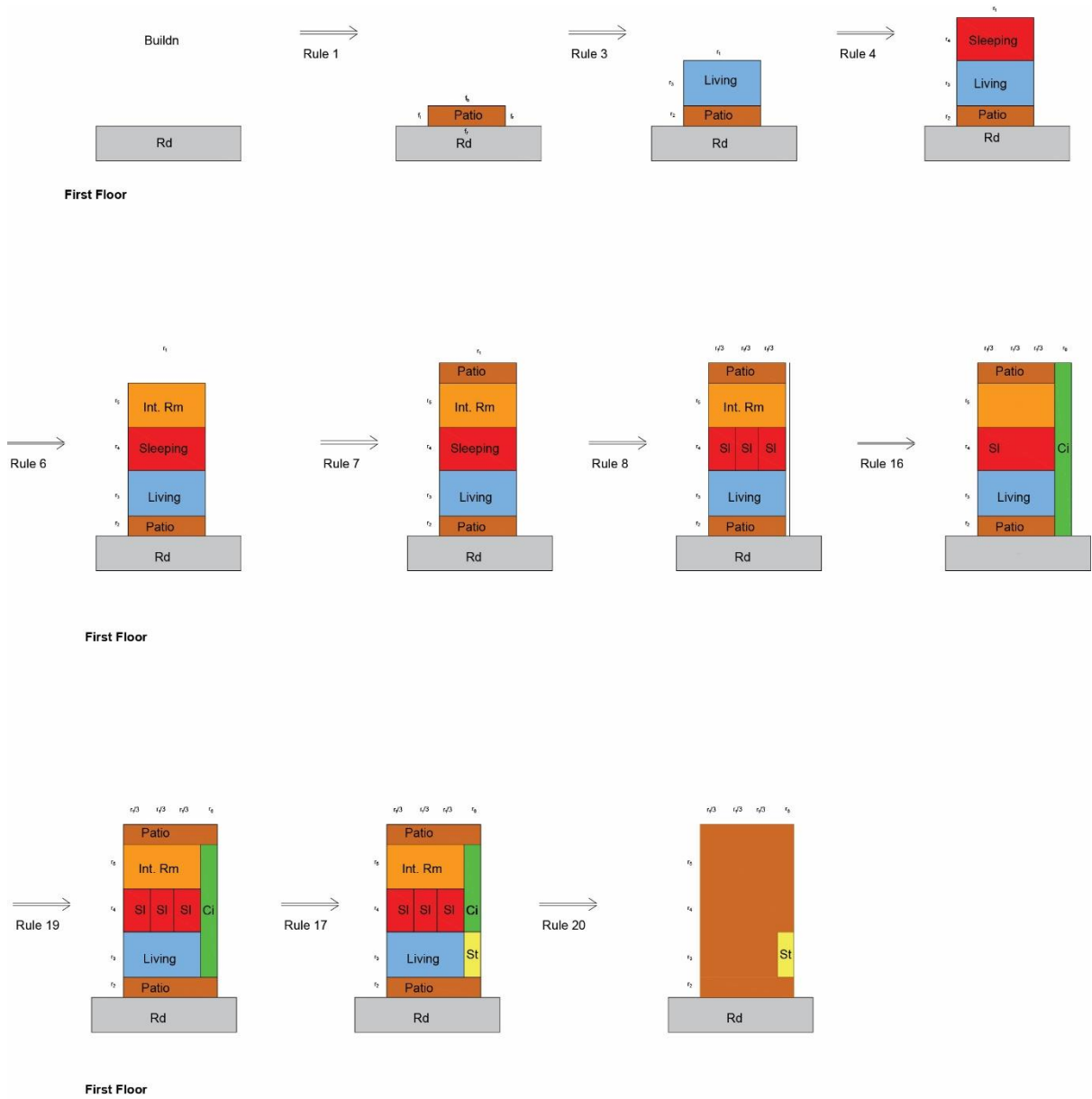


Figure 32: The derivation of the ground floor plan of the house number 13 using the rules (Source - Author, 2021)

Until now, the formulation of main layers are incrementally set up one after another. The next level would be crucial for creating internal rooms and zones. Using Rule 8 of dividing one zone into three zones, the sleeping area will be divided. Then, Rule 16 is used to add the circulation band at the labelled side of the house. Then Rule 19 has been used to overlap and extend the patio zone to create a balanced façade at the front and back sides of the house.

Using Rule 17, the stair has been created within the circulation band. The circulation band is colored in green and the stairs are colored as yellow. In the consolidated houses of Panam Nagar, the stairs have been added adjacent to the living area. The stair and circulation bands are the later addition as the house needs to be extended to the next floors and stories.

### **Derivation of the plan- House Number 38**

Our second building for the derivation of rules is building number 38. Unlike the building number 13, the building 38 (Figure 35) is situated at the north side of Panam Nagar. The house features colonial architecture characteristics with less ornamentation. However, it is a two-storied building but the second story is crumbling and already the roof is severely damaged. In these cases, the rules

developed through shape grammar can aid developing the floor plans for restoration or reuse purposes.

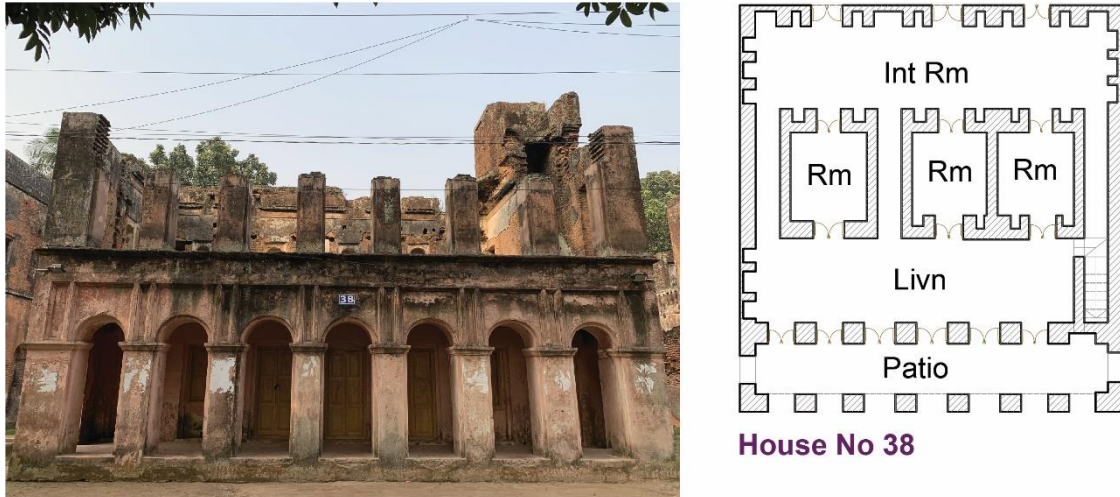


Figure 33: The plans of number 38 building of Panam Nagar, plans are collected from the Archeology department of Bangladesh, (Source - Author, 2020)

In the figure 36, the step-by-step derivation is shown. Derivation started with the Rule 01, where street is marked with grey color and patio has been added. Then using Rule 03, the living zone is has been added. Following the similar path of House 13, the Rule 4 established the Sleeping or the core zone. Then Rule 6 had been applied to add the last layer of the house -the internal room. Unlike house number 13, this house does not have a patio or verandah at the backside of the house. However, without having the patio, the semi-public zone is opened at the backside of the house ultimately to the backyards.

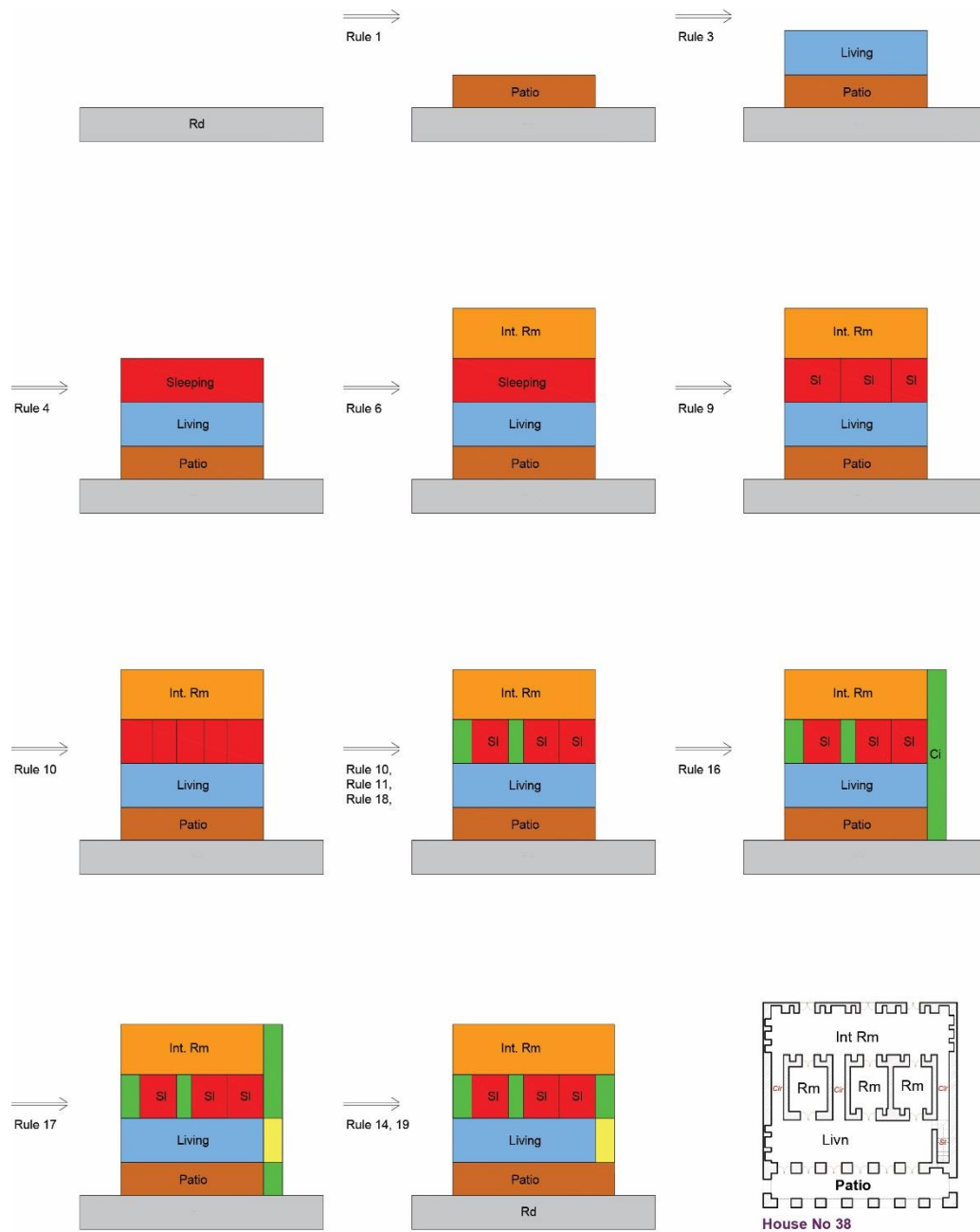


Figure 34: The derivation of the plan for the house number 38 using the rules.

(Source - Author, 2021)

Then the core or sleeping zone is developed by using the Rule 09 which divided the core into three zones. After that, using Rule 10, the spaces can be divided again. After that, using Rule 11 and 18 to change the function from sleeping to circulation from the sleeping to internal rooms. Then Rule 18 has been used to develop the circulation band to facilitate the circulation from the ground floor to the upper floors. Rule 17 then has been used to introduce the stair. Then Rule 14 and 19 helps to extend the patio and internal room to extend and overlap the the zones.

### **Discussion**

The grammar developed here sheds light on the concentrated core of the consolidated type houses that have yet to be thoroughly discussed in the existing literature. From the zoning of the house, it is evident that the ground floor had public activities at the street side and very different types of activities at the back yards where it was open to the courts and waterbodies. The living rooms are rather simple in the organization, usually placed after the ornamental patio or verandah at the street front side of these houses. The grammar clearly illustrates the incremental, layered growth of the houses from front-to-back and back-to-front. The figure 35 shows the incremental development. These layers of use meet at a

central, concentrated core, a space that interrupts the regularity of the layers and

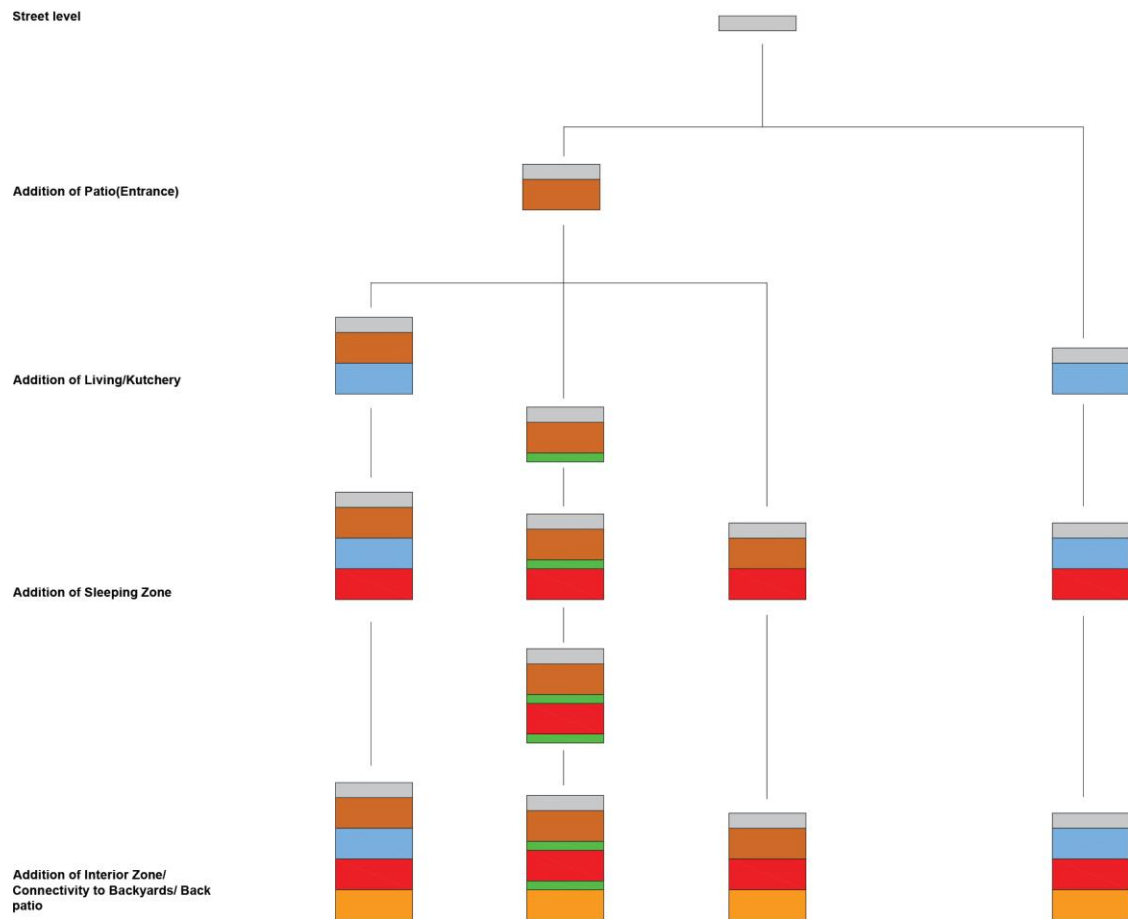


Figure 35: The development and incremental growth of the spaces (Source - Author, 2021)

suggests a unique functionality within the houses at Panam Nagar.

Many scholars have debated about the functionality of these central living areas of the houses at Panam Nagar (Nilufar & Eshika, 2015). It is assumed that they had multipurpose functions besides use as a formal living space. As the occupants were merchants, they used this space flexibly - as Kutchery or office spaces too. The central core, which effectively divides the spaces of the house with smaller rooms in the middle is a distinctive feature that is developed in rules 8-14 of the

grammar, the key rules for subdividing and proportioning these unique relations in the houses. Simply based on the scale and centrality of these rooms, it is imagined that sleeping or storage was likely the function of these zones.

Additionally, the internal or back rooms semi-public functions opened to the back yards, emphasizing the houses as two-faced, relying on both of their urban elevations equally. Being consolidated at the central zone with a core of support rooms provides an internal logic that serves both the ornamental public façade at the street front, which the houses are best known for, *and* the semi-public facades at the back yard, linked to the waterbody behind the houses. This duality in the houses, negotiated by the central core, supports the exchange of both residential and commercial uses, and reinforces the duality in the lifestyle of the merchants at Panam Nagar.



## **CHAPTER 05 – DISCUSSION AND CONCLUSION**

This chapter will summarize the research presented in the thesis, elaborate the findings and contributions of the study, limitations of the research and future direction for the study.

### **Summary**

Panam Nagar is a vibrant historic settlement of Bangladesh, retaining some of the fabric of the historic township in the colonial period of Bengal. This research focused on describing the consolidated type houses from the analytical viewpoints of the shape grammar formalism. The compartmental and courtyard-based houses will be discussed in future work to elaborate the scope of the grammar on a broader scale. This is an example of analytical grammar to describe the zoning of a housing type very dominant in Bengal in the colonial period. The study has focused on developing the shape grammar for the consolidated type houses with a larger focus on describing the other types of houses in the future and to investigate the cross-cultural influences of the site. It should be noted that the development of the shape grammar largely depended on describing the spatial development, formal organization, and sequence of development of the interior zones. The houses of Panam Nagar are significant due to its urban setting and context. The country, Bangladesh is a developing country and historic preservation is a neglected topic. In many cases, development hinders the process of historic preservation where

many historic buildings have already faced demolition and severe damage. Panam Nagar is not exceptional from that. This research started with the historic significance of the site and its growth and development since thirteenth century, a timeline projected the ups and downs of the township in several periods.

However, Panam Nagar survived through its last buildings with significant influence from the Mughal, Sultanate and Colonial period. Through some previous research, it is also assumed that the buildings were not totally residential. They have mixed use and different purposes. Previous studies highlighted the facades and openings to organize the typologies based on the ornamentation (Murad & Hasan, 2016; Nazneen, 2012; Shaikh & Mowla, 2009). The houses have also been divided based on their interior organization, mainly based on the criteria of having courts or not (Husain, 1997; Shaikh & Mowla, 2009). Uniquely, this study focused on the spatial configuration of the consolidated type houses to begin to unpack a more detailed formal understanding of the site.

This research is also motivated by the current preservation condition and trends in Bangladesh, which establishes some foundation for the necessity to preserve this settlement. As a melting pot of occidental and oriental cultural fusion (Nazneen, 2012), Panam Nagar bears not only some ornamental ideas, but also some building technologies that are considered very local, crafted by artisans in Bengal. For example, the technology of Chinni-Tikri, mixture of lime mortar and development of ornamental cast-iron railings. One of the objectives of the study was to create some analytical framework where shape grammar can be informative for the historic preservation of these details too. The Panam Nagar

grammar is a foundation for this future work, which aims to bridge conservation and computation to preserve the site through adaptive reuse or redevelopment around the area.

### Contribution

In this study, the necessity for the preservation of Panam Nagar is established through its historic and architectural contribution in the architectural history of Bangladesh. The study through shape grammar provided insight on some issues that need further investigation as well. It is well known that the Panam Nagar houses are important for their facades that are influenced from different cultural regions and for this reason, the street front is emphasized in the research to date. The Panam Nagar grammar initiates new conversations on the houses beyond the façade to address their spatial and formal organization. The contribution from this research is discussed below, emphasizing three key findings on the consolidated houses at Panam Nagar.



Figure 36: The back facades of the Panam Nagar houses played significant role in the day-to-day life of the inhabitants (Source - Author, 2021)

Firstly, this research through shape grammar shows the backyard façade was equally important. The back facades, which has a semi-public or semi-private character, plays important role in the day-to-day domestic life (Figure 36). The connectivity towards the waterbody and backyard made the semi-public internal room a place for the family itself. Different rituals of the Hindu religion also emphasized in the courtyards and especially the backyards played an important role in the urban context of Panam.

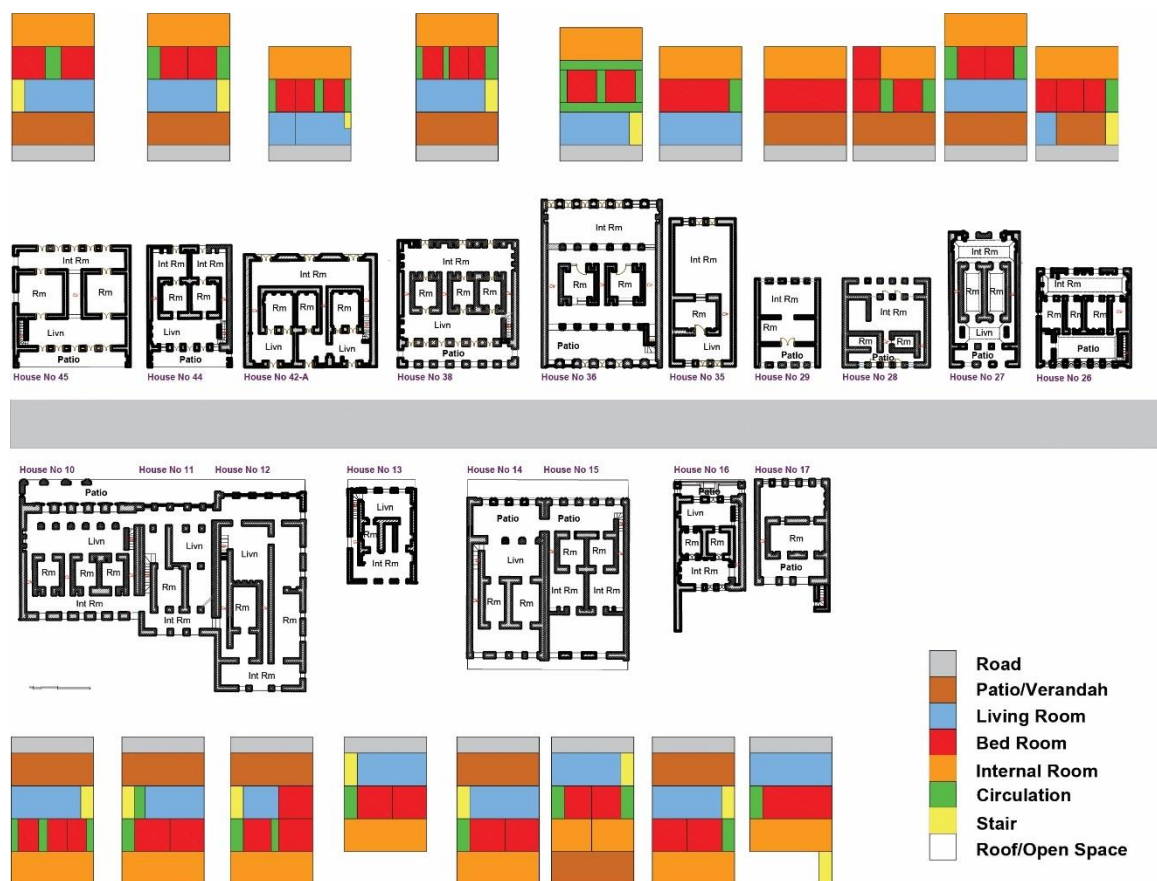


Figure 37: The corpus of the consolidated type houses with the derivation of the zonings using the Panam Grammar (Source - Author, 2021)

Secondly, through the discussion of the shape grammar of the consolidated houses, it is also evident that the houses have a multifaceted and concentrated

core at the middle part of these houses. The public living spaces at the front of the houses and semi-public internal rooms at the back are simple in the nature. The central core demanded separate rules, though simplified, to derive the spatial organization they have now.

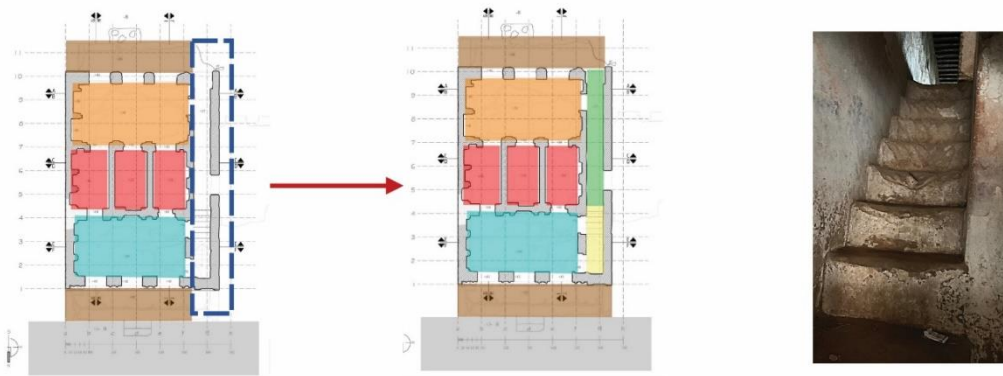


Figure 38: The addition of circulation band and stair at the sides of the houses to extend to further stories (Source -Author, 2021)

Thirdly, the grammar and study also pointed out that the circulation pattern modifies with the incremental growth of spaces and needs to move higher to the second story (Figure 38). This representation also gives us some idea of the duality of the character of the houses. On one side, a highly ornamented facade may have been added later and very simple fluid growth in spatial or planning level.

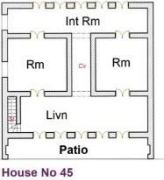
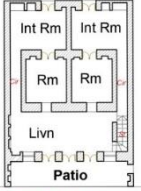

Though shape grammar has been used widely to analyze the architectural precedents, this study is a part of understanding the development of a particular traditional housing system that is not analyzed using the shape grammar formalism and aims to expand the grammar as a basis for a larger conservation effort at the site.

### **Future Direction**

The scope of the thesis is limited to the formal study of the consolidated type houses. The remaining houses at Panam Nagar, with more elaboration, featuring courtyards and halls need further investigation through shape grammar. The construction techniques, building technology, façade and structural systems might be included in the future studies to compare with the similar type of colonial houses existing in greater Bengal region (current Bangladesh and West Bengal, India) to find the origin and development of the house types. The overall planning and elaboration of urban context may be featured in future work.

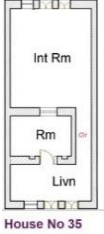
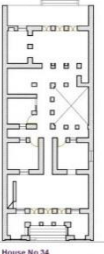

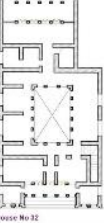
## Appendix

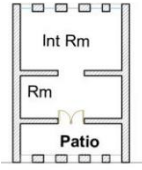

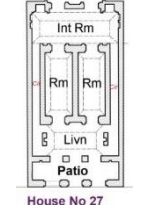

### List of Houses

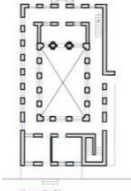
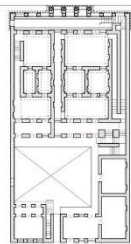
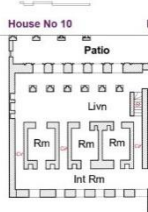
SI	House Number by Archeology Dept	Plans (If Any)	House Number by Asiatic Society	House Name	Location from the Street	Building Footprint (sft)	Stories	House Type	Ornamentation Style	Condition
1	49		2		North	-				
2	48		4		North	405				
3	47		6		North	576	2	Consolidated Type	Mughal	Very Bad
4	46-A		8		North	201	1	Consolidated Type		Bad
5	46		10		North	0.5	2	Consolidated Type		Bad
6	45		12		North	1224	1	Consolidated Type		Bad
7	44		14		North	831	2	Consolidated Type		Bad
8	43		16	Niharika	North	5962	2	Central Hall Type	Colonial	Bad

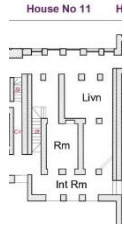
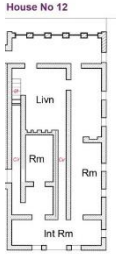
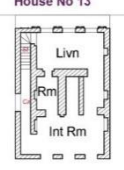
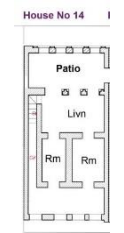
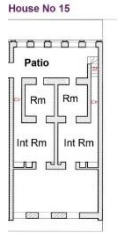
SI	House Number by Archeology Dept	Plans (If Any)	House Number by Asiatic Society	House Name	Location from the Street	Building Footprint (sft)	Stories	House Type	Ornamentation Style	Condition
9	42-A	 House No 42-A	18	Progressive Life Insurance Company	North	788	2	Consolidated Type		Medium
10	42		20		North	-	2	Consolidated Type	Mixed	Bad
11	41		22		North	0.8	1	Consolidated Type		Medium
12	40		24		North	0.7	2	Consolidated Type		Very Bad
13	39		26	Sonargao n G.R. Institute Teacher's Quarter	North	0.12	2	Central Hall Type		Good
14	38	 House No 38	28		North	-	2	Consolidated Type		Bad
15	37		30		North	0.9	2	Consolidated Type		Bad
16	36	 House No 36	32		North	-	2	Consolidated Type	Mughal	Bad

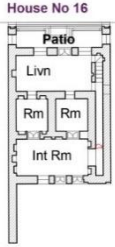
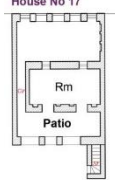


SI	House Number by Archeology Dept	Plans (If Any)	House Number by Asiatic Society	House Name	Location from the Street	Building Footprint (sft)	Stories	House Type	Ornamentation Style	Condition
17	35	 House No 35	34		North	-	2	Consolidated Type	Mughal	Medium
18	34	 House No 34	36	Art Gallery	North	0.11	2	Central Courtyard Type	Colonial	Good
19	33	 House No 33	38	Kashinath Bhaban	North	2446	2	Central Courtyard Type	Colonial	Good
20	32	 House No 32	40	Jubo Sangha	North	1827	2	Central Courtyard Type	Colonial	Good
21	31-A, 31		42	Thakur Bari	North	389	2	Consolidated Type	Mixed	Bad
22	30-A, 30-B, 30-C, 30-D		44	Thakur Bari	North	614	1	Consolidated Type		Very Bad

SI	House Number by Archeology Dept	Plans (If Any)	House Number by Asiatic Society	House Name	Location from the Street	Building Footprint (sft)	Stories	House Type	Ornamentation Style	Condition
23	29	 House No 29	46		North	1580	1	Consolidated Type		Bad
24	28	 House No 28	48		North	696	2	Consolidated Type		Bad
25	27	 House No 27	50		North		2	Consolidated Type		Bad
26	26	 House No 26	52		North		2	Consolidated Type	Mughal	Very Bad
27	26-A		54		North		1	Consolidated Type		Very Bad
28	25		56		North		1	Consolidated Type		Medium
29	24		58		North		1	Consolidated Type		Bad
30	23		60		North		1	Consolidated Type		Very Bad

SI	House Number by Archeology Dept	Plans (If Any)	House Number by Asiatic Society	House Name	Location from the Street	Building Footprint (sft)	Stories	House Type	Ornamentation Style	Condition
31	1		1		South		2	Central Hall Type	Colonial	Bad
32	2		3	Mamun Poultry farm	South		2	Consolidated Type	Colonial	Medium
33	3		5	Museum Quarter	South	4837	2	Central Hall Type	Colonial	Good
34	4		7		South	452	3	Consolidated Type	Mixed	Very Bad
35	5		9		South	2242	3	Central Courtyard Type	Mixed	Bad
36	6		11		South	792	2	Consolidated Type	Colonial	Bad
37	7		13	Rajia Manjil	South	742	2	Consolidated Type	Mixed	Good
38	8		15		South	1592	2	Central Hall Type		Bad
39	9		17	Panam Art Gallery	South		2	Consolidated Type	Mixed	Bad
40	10		19		South	871	3	Consolidated Type	Mixed	Bad

SI	House Number by Archeology Dept	Plans (If Any)	House Number by Asiatic Society	House Name	Location from the Street	Building Footprint (sft)	Stories	House Type	Ornamentation Style	Condition
41	11		21		South	397	2	Consolidated Type	Colonial	Medium
42	12		23		South	541	2	Consolidated Type	Colonial	Bad
43	13		25		South		2	Consolidated Type	Mixed	Bad
44	14		27		South	194	2	Consolidated Type	Mixed	Bad
45	15		29		South	185	2	Consolidated Type	Mixed	Bad

SI	House Number by Archeology Dept	Plans (If Any)	House Number by Asiatic Society	House Name	Location from the Street	Building Footprint (sft)	Stories	House Type	Ornamentation Style	Condition
46	16		31		South	0.6	2	Consolidated Type	Colonial	Medium
47	17		33		South	0.6	2		Mixed	Very Bad
48	18		35	Goura Nitai Akhra	South	296	1			Bad
49	20		37		South	487	1			Bad
50	21		39		South	-	1	Compartmental Type		Bad
51	22		41		South	346	1		Colonial	Medium

## Glossary

Chinni-Tikri Ornamentation:

Sonargaon, especially Panam Nagar, has many significant ornamentations like *Chinni Tikri*. The current entry building of the Baro Sardar Bari complex was adorned with a traditional ornamentation technique known as “*Chinni Tikri*”. This specific ornamentation style is a type of mosaic work on the surface of a building created by broken pieces of glazed chinaware and colored glasses (Khatun, 2006; Nazneen, 2012). Following the possibility of the architectural contour line of the elevations, colorful geometric and floral patterns are generally created in this “*Chinni Tikri*” work using daily-use objects (E. g. glazed dinner plates, vases) as well as with available colored glasses. Plates and glasses are generally broken randomly and sometimes in specific shapes as well, then pasted on the surface or



Figure 39: The process of developing Chinni tikri ornamentation from different pieces of broken china (Source - Author, 2021)

scattered in places where needed. This specific mosaic technique with chinaware can be traced back to the early British colonial period when such plates or vases

were imported from abroad in abundance (Adnan & Islam, 2018; A. S. M. Ahmed, 2016).

Cast iron railings.

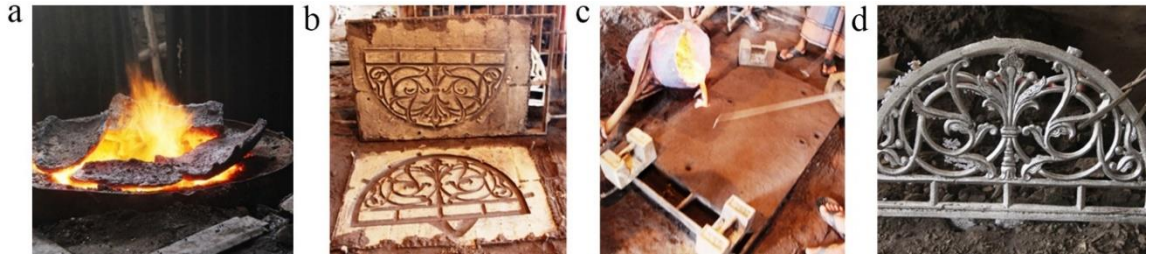


Figure 40: Different steps of creating sand-casting iron grill (a) the kiln, (b) the module of design; (c) pouring the metal onto the mold; and (d) the final product (Source - Author, 2021)

An iron railing is a fence made of iron, this may either be wrought iron or the cheaper cast iron. Cast iron may be used to construct ornate railings or can also produce complicated floral shapes that are created through the use of molds of compressed sand. Early uses of cast iron railings were at St Paul's Cathedral, Cambridge Senate House, and St Martin's-in-the-Fields in London in the early eighteenth century. In the mid-nineteenth century such cast-iron railing was introduced in Kolkata, India by the colonial builders or East India Company. From then techniques of cast iron were widely practiced in the whole Bengal by the wealthy Jaminders or Merchants.

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