

Parametric Architectural Solution to River Front Developments: Restoring River Ravi Lahore

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Abstract

The major intention of this research is to present a catalogue for the development of river Ravi by using the potentials of digital tools to resolve issues related to heritage connection and preservation for development of tourism, awareness and economic development for the people living near Ravi River. This paper aims to contribute to this intention by examining the current situation near river Ravi through remodelling of the site using parametric architectural solutions. The scope of the study includes exploring the concepts of parametric architecture, digital architectural tools, and study of river Ravi area for its sustainable economic growth, heritage preservation and tourism development. The research is significant with reference to current situation where process of urban redevelopment proposals by government authorities are underway, so this research can contribute towards some aspect it. In this paper, we have explored some proposals that are undertaken in the fourth-year design studio in Department of Architecture, University of Engineering and Technology, Lahore to familiarize the students about the current situation of River Ravi urban development and to think about parametric architectural solutions for it.

Key Words: Architectural heritage, River Ravi urban development, parametric architecture tools, digital architecture education

1. Introduction

In contemporary times, digital tools have been widely used, not only to develop architectural forms but also to explore urban issues and bring out new possibilities of structures and concepts. Parametric architecture uses these digital tools to explore numerous possibilities that can be controlled by varying the parameters. It is rapidly replacing the traditional methods of designing and is retooling the architectural discipline by adopting the contemporary needs of digital age. [1] we are living in times where we cannot have same methods of architectural solutions as earlier. In contemporary times, urban and architectural design practices are rapidly being transformed and digitised. We are relying on technology in almost every field, so is the case with architecture.

In this research, we have introduced parametric architecture in fourth year design studio where Parametric architectural tools have been used to develop architectural solutions for river Ravi urban development. The major emphasis was to introduce the students with actual site and tried to link it with parametric architecture. They have developed their concepts based on the issue they have picked up from the site and developed a component that is later populated for project development.

2. Objectives of research

Primarily, the objective of the research is to develop a studio methodology for parametric architecture design and to link it actual site issues. Secondly, to develop some innovative at the same time practical design solutions for Ravi River front development using parametric architecture. For this, we need to study the history, context, and existing situation of urban river front area. We must learn the elements that are the major reason for the threat to river health, including the factors essential for the good healthy river front and healthy development of natural ecosystems.

3. Description of the Case Study Area

Ravi is smallest of all five rivers of Indus river systems. It is a trans-boundary river crossing Eastern Pakistan and Northwestern India. Over the years, it has remained the center of attraction for the tourists and has plenty of activities like fishing, boating, water skiing, river camping and water rafting. The number of tourists on river Ravi have always been on a higher side throughout the year.

Ravi is no longer a river, but a sludge carrier. The annual water flow in river Ravi has

been decreased from 5MAF to 1.1MAF due Indus water treaty as the rights of using water of Ravi has been assigned to India. The river side is filling with waste disposal and contamination. Besides, through storm water outfalls and dumping of industrial waste posed a major health and environmental hazard. The riverbank settlements are deficient in essential infrastructure facilities.[2]

After years of neglect and abuse, urban areas are now reviving their rivers. This trend is now very common all around the world after realizing that this is a precious economic and community asset. Rivers sites have a strong potential for creating recreational facilities and generate a lot of economic power for the community and neighbourhood.[3] Similar situation is prevailed in and around the river Ravi that is in the historic city of Lahore and encompasses major historic and heritage sites of Mughal imperial tombs in its neighbourhood and Mughal period Baradari in the centre. 'This monument is a reminder of river s' celebrated past that is no longer left and water in river has run dry now. Humayun s' stepbrother Kamran built this beautiful summer pavilion and is one of the oldest Mughal period structures standing in the middle of the river Ravi.'[4] it was once located in the middle of the river ravi. It was actually built on the bank of the river ravi but river had changed its course over the period of time. So now its been located in the center of the river as an island while the gardens that once sorrounded it, are no more on surface. The original pavilion was designed on two floors with twelve columns of vaulted balconies. [5]. Besides, Lahore fort, Badshahi Masjid and Jahangirs' tomb are also located in close vicinity.

Despite having strong potential site for tourism, river Ravi has faced strong exploitation and ignorance over the period from the neighbour and authorities. Primarily, the reasons for the neglect might be the water level is continuously depleting with every passing year, because of that it has been neglected by the authorities. Secondly, the water pollution continuously destroying the water quality in river Ravi. Water pollution is highest in river Ravi compared to other rivers in Pakistan. So, the two major challenges of the site are clean water, waste management. 'Today industrialization and urbanization has resulted in over exploitation and excessive abstraction of groundwater by pumping more and more water out. This is what is happening in Lahore where the main issue of public concern is water level recession mainly due to over pumpage compared to lesser recharge' [6]

'In view of the city's projected expansion towards the south and the west in the long run, the Government of Punjab plans to carry out riverfront (and urban) development on both sides of the Ravi riverbank along a 33 km long stretch. The proposed project is intended to be a first of its kind in Punjab emphasizing the much-needed transformation of freshwater reserves such as the Ravi River, and the incorporation of such natural features into the broader framework of urban development. A major feature of the project would also concern the introduction of renewable sources of energy. To this end, several project preparatory measures are proposed to be undertaken in order to contextualize the project with respect to varying scales of impact – at the regional, divisional, metropolitan and local levels.' [7]

Keeping in view the existing situation of the site, we have proposed some projects for the students. The students have identified the problems and have tried to give some solution through parametric architecture. They have chosen their own sites and identified the issue.

4. Parametric architecture design studio

Urban design in contemporary times is taking up new horizons and new dimensions of design have been established. Communities and new development will be diffenert from the one in which we are living today. Various aspects and challenges like climate change, global socioeconomic conditions, and various other parametres will shape the communities of the future. This changed urban form will definitely require the use of new digital tools for the future development of communities.

Terzidis says that architects and designers in contemporay times, often miss a great opprotunity avaible to them through the use of digital tools, merely because of lack of awareness about them that can make the deign processs a lot more easire and comprehensive. [8]

So, this research will focus on using parametric architectural concepts and tools to develop more comprehensive architectural solution keeping in view the furturistic urban developmen tof river ravi urban dvelopment.

Parametric architecture uses the concept of parameters to design an architectural project. It creates a relationship between design elements to produce a wide range of architectural solutions that can be changed at any stage of design process. Consequently, parametric design process offers an immense opportunity for the architects and engineers to explore wide range of design

solutions. [9] At the same time, it uses parameters to solve the issues of architectural design projects. Then these parameters are used to set a relationship between design elements to provide a wide range of possibilities for architectural issues. So it provides better options for the architects to speed up their design process in a very short period of time. [10]

Patrik Schumacher coined the term parametricism for the first time to represent multiple new trends in architecture based on parameters. Earlier, parametric architecture was defined under the category of architecture as a whole and was used to solve the problems lying with construction. It was never being used to develop architectural concepts or generation of form for the projects. [11]

According to Schenkel, parametric architectural applications have hereditary two critical fundamentals. These are that all units begin with a point in space and then these units are studied in three dimensional architectural environment rather than two dimensional or layering methods. And that the underlying concept of parametric modelling is based on data, variables, and their relationship to other basic fundamentals, which can then respond to variations of input data. [12]

Form generation is a major issue in architectural design studio that has been debated for design approach, from function relationship, aesthetics, context, etc. In the recent years, computer technology has revolutionised the architectural design process and form generation. These techniques are generally named as 'parametric techniques' or 'generative design.' These techniques allow architect to come out of tradition way of thinking about form, rather it gives an opportunity to predict the design form from the design process and computer generated modules. "They shift the emphasis from form making to form finding" [13]

But what does actually mean by thinking in parametric term? And how does it help the architects to process their design? 'The basic principle of parametric modeling is to develop a generic description of an object or class of objects, in which the shape is controlled by the values of a set of design variables or parameters'. [14] so to create a parametric model we need to generate a connection between geometry of design and its mathematical logic.

Many architects around the world are using parametric software tools to create a geometry that they can be controlled at any stage of design process. Mainly Grasshopper – a plugin in

Rhinoceros software and paracloud Gem were used by the students to create visual stimulations of the concepts developed by the students. 'Grasshopper should be used as a tool in over all design process; it can be an addition to the process, which allows architects to produce innovative new possibilities and to test a variety of new ideas in rapid and simple way.' [15]

5. Studio Methodology

Architectural studios are essential part of education for an architectural student and its proceedings imitate the actual working process of architectural field. However, there is little research being done that how parametric architecture practice enhances and can be a solution to contemporary architectural and urban issues. Many architects around the world have tried to explore the studio methodology for parametric architecture. For instance, LAB architecture studio in Beijing, they have proposed design for Beijing's Soho Shang-Du buildings, where they have proposed a design based on codes of planning which have been translated into parameters which can be transformed at any stage of design process and it is completely aligned with the regulation of building regulations. [16] So the design process and actual design are linked up with design constraints.

In this studio, authors tried to couple parametric architectural methodologies, tools with the actual architectural projects and ultimately reframe the question and come up with the variety of solutions. Participants were introduced with digital tools early in the studio and they developed their concepts from early stages.

The studio took an important historical river front of Ravi in Lahore for the exploration and trying to have certain solutions for the site through parametric architectural tools. Within this site, there is a mix of commercial, residential and historical context. Students meticulously explored the site and tried to figure out the major issues that has caused the major setback to such an important site. One of the major reason they came up with was the site completely neglected by the authorities. There is no controlling authority there to govern the and stop the waste water mixing in river. Secondly, there is uncontrolled slum area attached to the site that is also creating problems. Third, there is no proper administration and management for convenience of the tourists to come and enjoy this heritage site of Kamran Baradari in river Ravi and explore its natural beauty.

The typology of the studio is based on giving solutions to real problems of the site using parametric architecture concepts and tools. Students were asked to visit the site and look for the real problems related to heritage, urban development, and economic condition. They had conducted surveys and interviewed the residents. After the detail survey, an analytical report was prepared. During presentations, various problems and projects were discussed for the proposed site. Later, the projects were finalised for the same site but different location. There was variety of projects that were proposed keeping in view the existing problems of the site. Mainly the projects were related to tourism development, creating connections among different historical sites, promenade that spreads along the bridge and conservatory and educational spaces. These projects were proposed after detailed discussion and study of the site. At this stage, students were asked to prepare a report regarding the work that was done up till now to finalize this stage. The

next stage was to look for the solutions using parametric architectural tools and concepts.

In the next phase, parametric architecture concepts and tools were introduced. Students were asked to design a module taking inspiration from their first phase of research i.e from the site context and issues. After continuous discussions, each student designed a module using parametric architectural tools like Rhino and Para Cloud Gem. Although these tools were new to them but they still tried plenty of options using online tutorials and lectures. They implemented their module design on their final form while exploring so many options that grasshopper gives them. That was a very useful exercise for the students. The students were also exposed to Arch-GIS that was also explored by students for their projects. Final product of their projects was all completed and finished using parametric architectural tools that gave them a new opening for exploring new ideas and preferences. It was an informative exercise for the students.

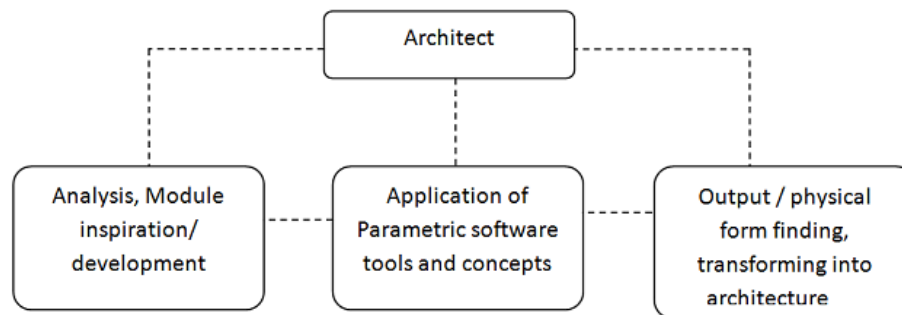


Fig. 1: Parametric architectural methodology applied in studio

6. Proposed Project 1

The first project selected was around Kamran's Baradari that is located in the river Ravi along the Ravi Interchange Bridge. It is the first place that a person sees when he enters in Lahore. To promote tourism on the site, this project was introduced, in which an overhead bridge would be used to connect three heritage sites; Lahore Fort, Kamran Baradari and Tomb of Jahangir. As shown in fig 4 master plan. Kamran's Baradari is surrounded by many other historical buildings like Shahi Qila, Tomb of Jahangir, Badshahi Masjid, walled city, etc. Lahore Fort is the most visited area by tourists. Jahangir's Tomb is located on the right side of the river. The neighbouring area of the Ravi is under slums which makes this site marginalized from rest of the urban community. So, a project is proposed through which we can restore its importance by enhancing tourist and

local people's visit to this place. By linking these sites together through a track can help Baradari to restore its historical place. The site selected starts from the Lahore fort to Kamran Baradari to tomb of Jahangir. The three selected sites are shown in figure 4 and then connected to each other through an overhead bridge and there would be three pavilions connected to the bridge. Total track selected is app. 4km. The bridges is divided in four equal parts. Each part has a pavilion as before each pavilion there is a cycle rack.

The concept of the module for the structure is derived from the link that is connecting the heritage sites together and the flow that would be created by the cycling track. The concept of connection is applied on the module parameters where the two parts are joined. The concept of flow is derived from the cycling track and is applied on the bridge of track. The inspiration of module is taken from chaharbagh. The module

was designed on Paracloud Gem and was seen from different sides by flipping it as shown in fig. Later, the module is populated on Rhino and para cloud Jam and applied on bridge and floating

pavilions. The bridge design was all covered with series of modules that also provide shelter and shade against the direct sunlight and floating pavilion showcases the exhibitions.

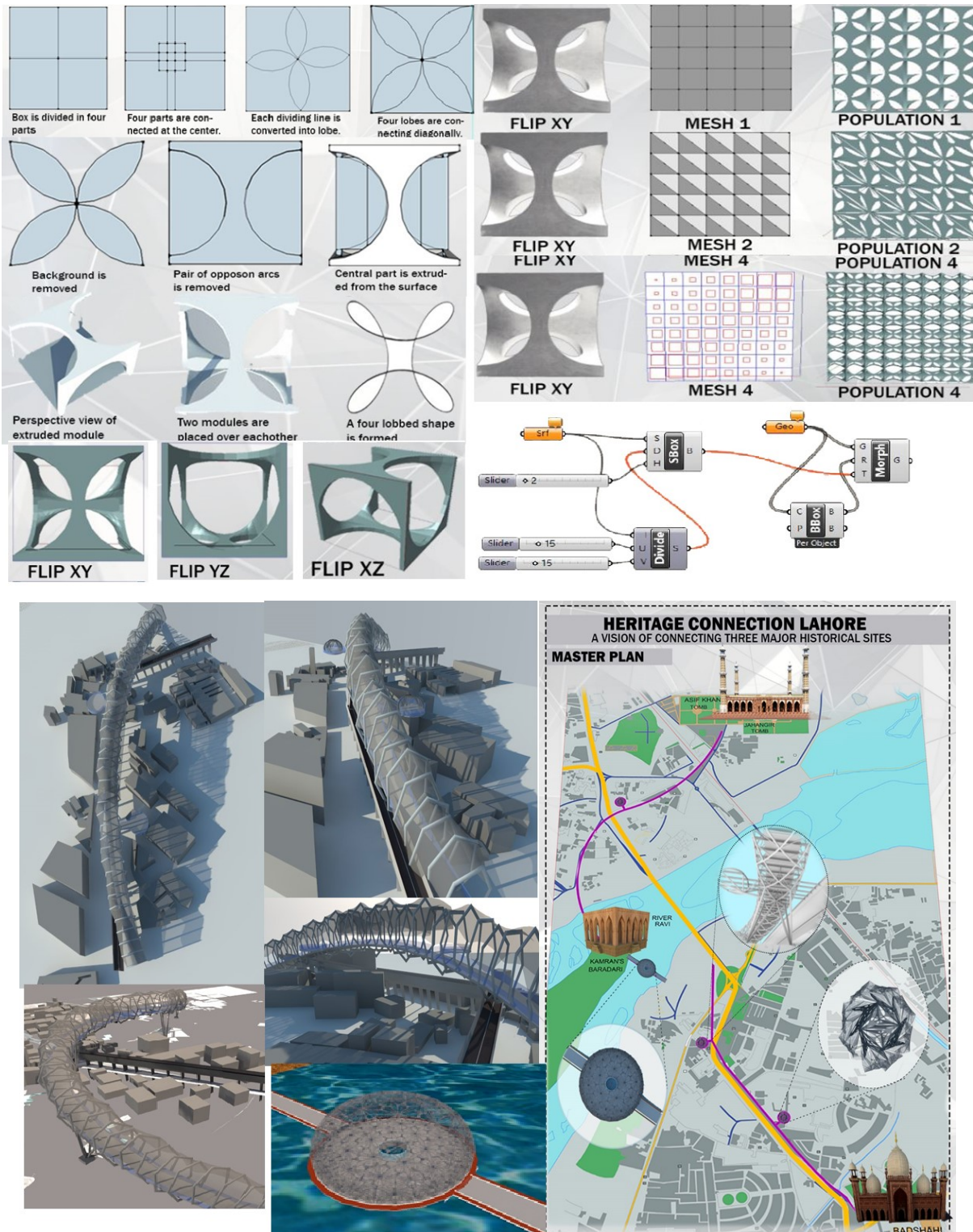


Fig. 2: Proposed site diagrams of the project 1.(source: Umema Khalid)

7. Proposed project 2

The second project is also on the same site of river Ravi, but a distinct concept is used to

enhance the urban area. This project is proposing an ecologically sustainable mega structure along the dried riverbed, healing the scar both in the landscape and in the minds of lahoris. In facing the

ecological and environmental degradation, loss of cultural identity and erosion of our spiritual connection to our identity, the solution is to create a structure with the existing canal carved through it with the possibility of return of more water and to have a water decontamination system within. The project encompasses combination of garbage gathering tentacles, aquaponic gardens and water filtration system that returning the atmosphere in a form of bio-design.

The primary reason for selecting eye as an inspiration, it is the only organ that interacts with the external factors and reacts with the environment. Like the building structure the eye counter acts to external physical forces like wind dust and sunlight. Thus, it is fitting to incorporate the eyeballs function and structure. Eye lids protect the eye from foreign particles, such as dust as well as, bright light that may enter. Due to reflex, the light becomes completely shut. It also helps filter out bigger particles. The inspiration for the structural shape of an eye is taken from the sclera (which literally translates into structure) as shown in fig 3. To mimic the random organic assortment of our muscles we use the voronoi formula in grasshopper. 'Voronoi diagrams are a method of spatial data interpolation into polygons around each point in such a way, that each location from the area surrounding a given point is closer to it than to any other point. This method, which was invented over 100 years ago by a University of Warsaw professor Georgy Voronoi (1868–1908), and which has been used in many disciplines of science all over the world, finds new applications in the digital age.' [17]

The voronoi patterns are added to the mesh and to the module to support the idea of increasing surface area for absorption which helps in creating the micro-climate. The module populated will react accordingly to external factors by allowing and stopping sunlight. The module is now populated on grasshopper and experienced during three different timings of the day. As light increase, the module will react and closes and works inversely as light decreases. Grasshopper slider is used for movement of the module. Mechanical system along with plants will be installed that will help break down the toxins, and contamination and mechanically collect large plastic bags floating. The promenade and conservatory will make connections with the two banks of the river creating a healthy social environment for the visitors. Growing plants that are native to this area in attempt to revive the ecosystem of the area. Also, the Baradari Bagh is extended the way it was before the river deteriorated them. The promenade is providing with multiple zones of use defined by different

uses and varying materials. Various kinds of bazaars are allocated on the way of promenade.

Micro-climate is created through incorporating cooling mist system that is integrated in certain pipes that creates a mist hence creating a microclimate of its own. The trees and plants will create its own oxygen which in turn will also help the environment to flourish. River front regulation is usually an important means of urban micro-climate. It is important for continuation of life, not only perpetuating the water cycle, soil conservation, water flood, water conservation features, adjusting the temperature, air purification, dust noise reduction, ease of urban heat island effect, effectively adjusting the city's climate and environment; in a word sustained healthy development of the city.

Project will also incorporate local floating bazaars that will be a source of income for the locals while allowing the visitors to have social interaction and opportunity to participate in activities. It also incorporates a flat exhibition platform which is open for planning according to event as shown in figure 3. Its structure and placement give it a floating effect. The glass and steel cooled conservatory bring back the environment and vegetation of Ravi region of Lahore. The whole project revolves around giving and generating, it will be like host organism feeding the environment for its nourishment.

8. Project 3

The third project selected is along the major Slum area besides the River Ravi. The concept was to introduce the areas of public realm involving the slums children to introduce learning spaces and playing areas, so that the children can play as well as learn the basics. The major motivation for this program is to bring play-based context to attract the learners and allow them to solve the issues through experimentation and in creative and amusing ways. The green Landscape areas were also incorporated to provide pleasing environment keeping in view the children psychologically.

Primarily, there are three fundamental elements that are considered important for the designing the children-friendly school. These are Security, physical condition, and healthy environment. These three fundamentals must be considered while designing if the school design must be inclusive and holistic learning space. Secondly, Child natural development phases must be considered while designing the school. Their learning capabilities are different at different phases of the development. For instance, children at younger age can't understand the complex

concepts as the older ones. They cannot grasp the whole environment compared to their senior age

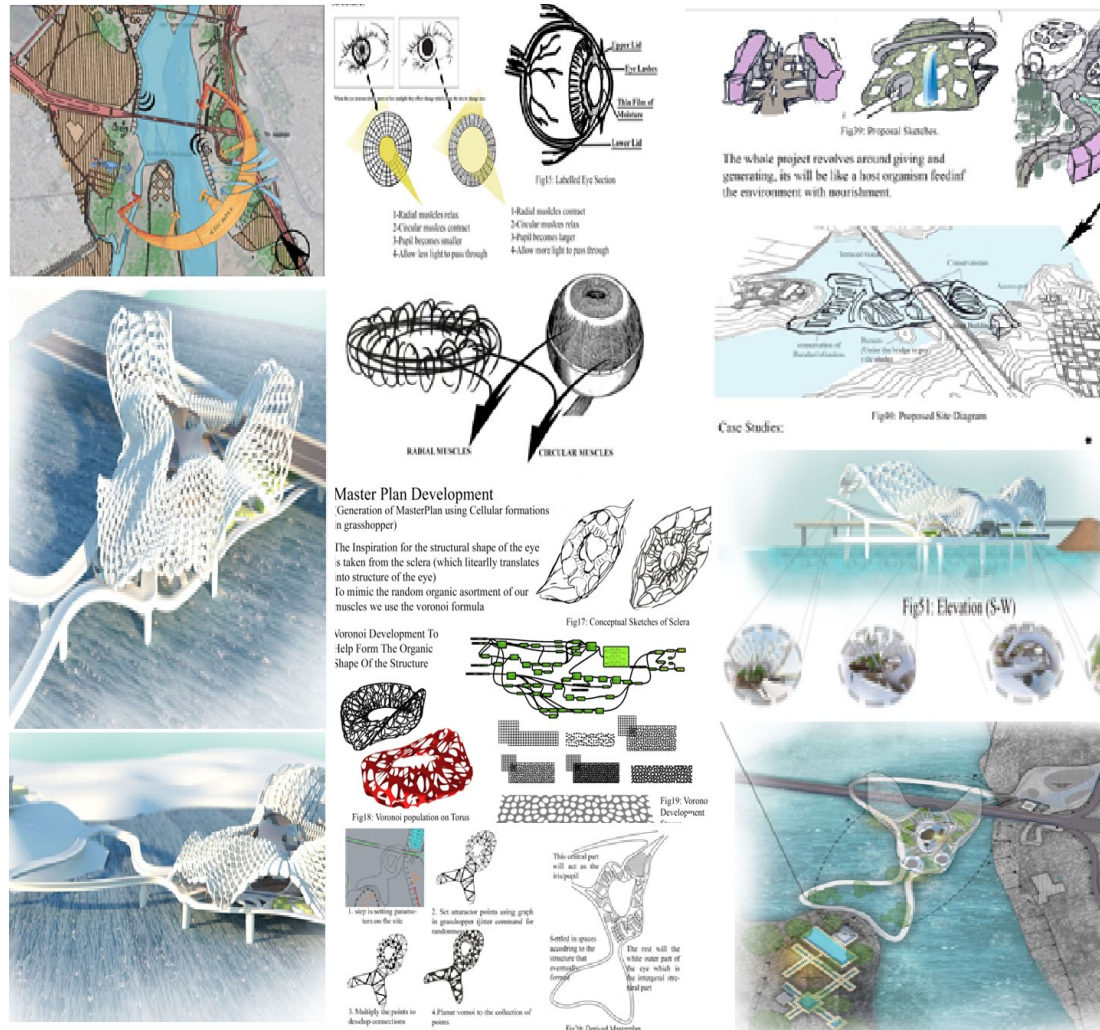


Fig. 3: Proposed site diagrams of the project 2. (Source: Maham Usman)

group. So, these two fundamental variations of the children development phases must be kept in mind while designing child friendly school, also in selection of teaching methodology and learning environment, furniture and materials adopted for finishes. [18]

The concept of school is inspired from Dandelion flower. As the petals surrounds the seed of the flower and protect it from external factors, in the same way the seed is a child, and the petals are the environment, school and family of the child which protects as well as impacts the psychology. The three corners show the three-dimensions and circular arcs represent the petals that surround the inner triangular structure.

The master plan was also inspired by the Dandelion flower pattern. The five ports of the master plan represent the ports of flower emerging from the centre. In the centre the focus point was created, i.e., the climbing ropes connecting the trees for the children to experience the climbing activity. Some parts are in the water and some part

is in the sand. The learning pavilions are also there, for the children education and learning. The materials used are local , i.e., the pavilions are made of bamboos, while the cave like structure is made of sand and earth. The pavilions are connected to pathways and green areas for views and landscaping. Trees also have a soothing and comforting effect on the learning atmosphere and its users. Planning the school landscaping is a good way to involve children in the understanding of a child-friendly school.

The main pavilion was designed with bamboo and its Columns consist of bamboo bunches rising from their stone foundations to the bamboo canopy. The main idea was to show people how to build with sustainable materials like bamboo, local earth, and sandbags. The pavilions are made by joining the bamboos and bamboo poles are connected by intersecting and overlapping of the bamboo poles.

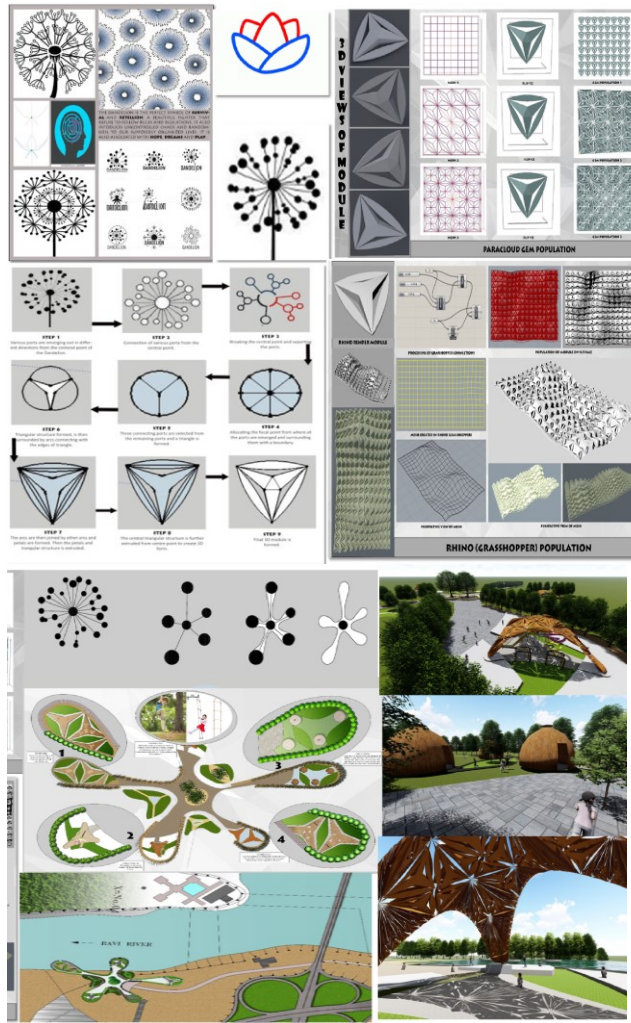


Fig. 4: Proposed diagrams of the project 3.
(Source: Aleena Asad)

9. Significance and conclusion

Primarily, the major learning-outcome of this research-based studio was an exposure to the students about an innovative way of handing the site analysis and understanding the site constraints while using them as design parameters. This was a major achievement with reference retooling of architecture and urban design studio according to contemporary needs of digital age. As mentioned in introduction, in contemporary digital age architecture and urban design studios cannot be conducted in typical standardised methods. We need to connect the actual constraints to design development process. The studio instructors tried to establish innovative concepts and ideas related to parametric architecture and using them to develop architectural projects. The second learning outcome the studio was the student s' understanding about the importance of Ravi river front development and its connected heritage that has a strong potential for tourism and economic development. Students have tried to explore multiple options through their design proposals to

achieve the sustainable urban development and bringing attention towards the strong heritage connection of river Ravi. The third significant outcome was the inovative approach of design projects to uplift the river front that can be a way forward for athorities to look into these aspects of river Ravi while developing the urban area around it.

In addition, the students along with instructors have also tried to study the possibilities of connecting and making river Ravi attractive, providing secure and uninterrupted entrée. Research shows that the existing transportation linkages or routes are the major obstacle daunting people from reaching and enjoying the riverfront. To find solutions to several existing problems at the river Ravi, distinctive design proposals are given that comprise of a safe, pedestrian-friendly walk ways to the site from the main city. The proposals also incorportes the opportunities for the local people to start their own small scale business. Likewise, it also gives options for the acess to people using cylces using cycling track that not only connects the heritage sites but also provides a healthy activity for the commuters.

This research can also be analysed and concluded using its strengths, weaknesses, opportunities and threats using SWOT analysis method as shown in figure 5. It shows the research has a great opportunity for students and has a strong potential for future urban delopement of River river front. The innovative approach of parametric studio methodology can be used to bring discourse in architectural design studio pedagogy.

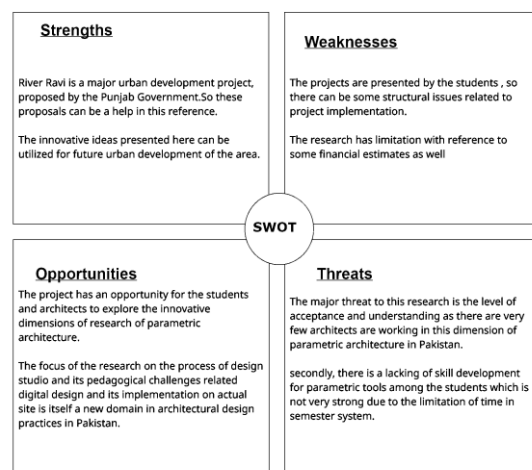


Fig. 5: SWOT analysis

The research also highlights the benefits of using parametric architectural tools which majorly include the innovative design production in contrast to conventional computer-aided design

(CAD) practices. Specifically, this research has put together the design solutions and interpretations based on the parametric modules providing theorists and scholars of design an approach to benefit from the parametric concepts.

10. Recommendations

The major recommendation based on the research is to use innovative and digital techniques to explore the architectural and urban design projects that actually improvise the site constraints during design process. Parametric architectural tools have embedded these concepts into the design process that are more aligned with contemporary needs of digital age.

Secondly, any kind of construction on the site of River ravi should aim to improvise the current situation through utilizing the natural asset by opening up opportunity for locals and at the same time development of tourism keeping in view the strong cultural heritage connected to the site. It should offer secure and uninterrupted connection to riverfront and connected heritage sites area for tourists, local people. Secondly, it should expand spaces of public realm and green landscape areas and assist the local business opportunities and local artists. The projects discussed above attempt to provide a unique solutions for all these concerns.

11. Limitations of the research

Main focus of this research is to propose effective connections and attractions for the main urban area to the river Ravi. Besides, the research can make the stages of development of design process more sensible and practical. The major limitaion of the study is that it does not include the study of financial constraints during the implementation of the project that may require many infrastructural changes. The research is only limited to proposal and design stage only.

12. Acknowledgments

The authors would like to express gratitude to the participants of the research Umamah Khalid, Maham Usman and Aleena Asad, members of the research team and the Department of Architecture, University of Engineering & Technolgy, Lahore for participation in the design process.

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