

**Indoor Sports Complex and Training center
at Dinajpur**

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A thesis submitted to the Department of Architecture
in partial fulfillment of the requirements for the degree of
Bachelor of Architecture

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Declaration

It is hereby declared that

1. The thesis submitted is my/our own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I/We have acknowledged all main sources of help.

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Approval

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Abstract

The proposed indoor sports complex and training center at Dinajpur is a skill development and recreational project, covering an area of 15 acres. Situated in a potential development zone of Dinajpur city, this project aims to not only train and accommodate athletes but also provide recreation to the people of Dinajpur, accelerating the local tourism and commerce in the process. The project program includes indoor multisport arena, Gymnastics arena, Olympic sized swimming pool, basketball, volleyball, tennis, judo, taekwondo, boxing and table tennis training facilities, which will be available to local people for recreational purposes in off-seasons. Annual and seasonal competitions can be held in the arenas, attracting large number of crowds, for whom multiple facilities including café, lounges, seating galleries, vendors, parking and exhibition spaces will be provided. Additionally, visual emphasis has been given to this project with aesthetically pleasing geometrical forms and environment friendly innovative material usage.

Keywords: Sports; Dinajpur; Indoor arena; Space frame; Recreation.

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Table of Contents

Declaration.....	ii
Approval	iii
Abstract.....	iv
Acknowledgement	v
Table of Contents	vi
List of Tables	xi
List of Figures.....	x
List of Acronyms	xiv
Chapter 1: Introduction	1
1.1 Introduction to the Project	1
1.2 Aim and Objectives of the Project:.....	3
1.3 Project rationale:	3
1.4 Problem statement.....	4
1.5 Project Summary.....	4
Chapter 2: Literature Review.....	9
2.1 An overview of sports and sports facilities.....	9
2.2 Sports and gymnastics in Bangladesh.....	11
2.3 Spatial attributes and standards.....	14
2.4 Space frame structure principles.....	27

2.5 Delaunay triangulation principles.....	29
Chapter 3: Site Appraisal.....	30
3.1 Site surroundings.....	30
3.2 Historical background of the site.....	32
3.3 Geographical characteristics of the site.....	32
3.4 Land-use pattern.....	34
3.5 Accessibility and connectivity.....	35
3.6 Climatic conditions.....	37
3.7 Socio-economic analysis.....	38
3.8 Images of existing site conditions.....	39
Chapter 4: Case Study Appraisal.....	41
4.1 Tucheng Sports Center / Q-Lab.....	41
4.2 Bangladesh Krira Shikkha Protishtan (BKSP).....	48
4.3 Multi-Sports Complex Competition Winning Proposal (France).....	53
Chapter 5: Program Appraisal.....	56
5.1 Proposed project program analysis.....	56
Chapter 6: Design Considerations.....	60
6.1 Design considerations from site factors:.....	60
6.2 Structure & form considerations.....	62
6.3 Psychological aspects to consider.....	63

Chapter 7: Design Suggestions	65
7.1 Functional flowchart and zoning:	65
7.2 Conceptual and structural development:.....	66
7.3 Indoor arena spatial configurations:.....	69
7.4 Plans, sections and elevations:	71
7.5 Renders.....	79
References.....	82
Appendix A.....	85

List of Tables

Table 1 : Temperature & rainfall (Source : MET report, Climate of Bangladesh).....	27
Table 2: Economic activities & occupations (Source : MET report, Climate of Bangladesh).....	28
Table 3: Group A program chart (Source : bksp.gov.bd).....	50
Table 4: Group B program chart (Source : bksp.gov.bd).....	50
Table 5: Programmatic chart (Author. 2020).....	57

List of Figures

Figure 1: AAU basketball court layout (Source: Chiara & Callender , 1983).....	15
Figure 2: Tennis court layout (Source: Chiara & Callender , 1983).....	16
Figure 3: Volleyball court layout (Source: Chiara & Callender , 1983).....	17
Figure 4: Cricket Net Practice layout (Source: dlpsc.wa.gov.au).....	18
Figure 5: Swimming pool layout (Source: dlpsc.wa.gov.au).....	19
Figure 6: Table tennis dimensions (Source: dlpsc.wa.gov.au).....	20
Figure 7: Gymnastics court dimensions (Source: dlpsc.wa.gov.au).....	21
Figure 8: Judo area dimensions (Source: dlpsc.wa.gov.au).....	22
Figure 9: Taekwondo arena dimensions (Source: dlpsc.wa.gov.au).....	23
Figure 10: Boxing arena dimensions (Source: dlpsc.wa.gov.au).....	24
Figure 11: Traditional boxing competition arena (Chiara, Callender , 1983).....	25
Figure 12: Sports arena plan configurations (Chiara, Callender , 1983).....	26
Figure 13: Court layouts for a five-court hall (Sports England, 2012).....	27
Figure 14: Basic elements of double layer grids (Lan, T.T. ,1999).....	28
Figure 15: Construction of Heydar Aliyev center (Source:buildipedia.com).....	29
Figure 16: Delaunay Triangulation and Voronoi Diagram (Rokicki, W. and Gawell, E. ,2016).....	30
Figure 17: Site surroundings (Source: Google earth).....	31
Figure 18: Important nodes within 1 km radius (Source: Google earth).....	32

Figure 19: Site vegetation & topography (Source: Author).....	33
Figure 20: Site satellite view (Source: Google Earth).....	34
Figure 21: Site land use pattern (Source: Author).....	35
Figure 22: Road network & connectivity (Source: Author).....	36
Figure 23: pedestrian path network (Source: Author).....	37
Figure 24: Existing site conditions (Source: Author, 2020).....	40
Figure 25: View from exterior (Source : Archdaily © highlite images).....	41
Figure 26: North-West Elevation (Source : Archdaily).....	42
Figure 27: North-east Elevation (Source : Archdaily).....	43
Figure 28: South-West Elevation (Source : Archdaily).....	43
Figure 29: South-east Elevation (Source : Archdaily).....	44
Figure 30: Section 01 (Source : Archdaily).....	45
Figure 31: Section 02 (Source : Archdaily).....	45
Figure 32: first floor plan (Source : Archdaily).....	46
Figure 33: Second floor plan (Source : Archdaily).....	46
Figure 34: Third floor plan (Source : Archdaily).....	47
Figure 35: Exterior & interior of the project (Source : Archdaily).....	48
Figure 36: Master-plan zoning (Source : bksp.gov.bd).....	51
Figure 37: satellite view of the site (Source : Google earth).....	52

Figure 38: BKSP training facilities (Source : bksp.gov.bd).....	52
Figure 39: Aerial view (Source : Archdaily, © Luxigon).....	53
Figure 40: Indoor spaces (Source : Archdaily, © Luxigon).....	54
Figure 41: Sections and elevations (Source: archiscene.net).....	55
Figure 42: Structure and roof details (Source: archiscene.net).....	56
Figure 43: Design considerations from the site (Author ,2020).....	61
Figure 44: 3D Delaunay triangulation (Author ,2020).....	63
Figure 45: Functional flowchart (Author ,2020).....	66
Figure 46: Zoning and design development (Author ,2020).....	66
Figure 47: Delaunay triangulation derived from the site (Author ,2020).....	67
Figure 48: Derivation of form from triangulation (Author ,2020).....	68
Figure 49: Outer shell structure, space frame detail and joinery (Author ,2020).....	68
Figure 50: Spatial configuration of indoor arenas (Author ,2020).....	70
Figure 51: Site plan (Author ,2020).....	71
Figure 52: Ground floor plan (Author ,2020).....	72
Figure 53: Multi-sport arena plan: Ground floor and @17'0" (Author ,2020).....	72
Figure 54: Multi-sport arena basement plan (Author ,2020)	73
Figure 55: Swimming arena plan: ground level and @17'0" (Author ,2020).....	73
Figure 56: Swimming arena basement plan (Author ,2020).....	74

Figure 57: Auditorium and medical facility ground floor plan (Author ,2020)	74
Figure 58: Auditorium and admin facility first floor plan (Author ,2020)	75
Figure 59: Boy’s dormitory plans (Author ,2020)	75
Figure 60: Physical education classes and Gym plans (Author ,2020).....	76
Figure 61: Girl’s dormitory plans (Author ,2020).....	76
Figure 62: Multicourt arena section (Author ,2020).....	77
Figure 63: Swimming arena section (Author ,2020).....	77
Figure 64: Auditorium section (Author ,2020).....	78
Figure 65: Dormitory and PE classes + gym section (Author ,2020).....	78
Figure 66: North and south elevations (Author ,2020).....	79
Figure 67: West and East elevations (Author ,2020).....	79
Figure 68: Central pedestrian plaza (Author ,2020).....	80
Figure 69: Activity space: north of sports arena (Author ,2020).....	80
Figure 70: Multi-sport arena indoors (Author ,2020).....	81
Figure 71: Indoor pool (Author ,2020).....	81

List of Acronyms

BKSP	Bangladesh Krira Shiksha Prathisthan
NSC	National Sports council
WHO	World health organization
BSCB	Bangladesh Sports Control Board
BOA	Bangladesh Olympic Association
FIBA	International Basketball Federation
AAU	Amateur Athletic Union
ITF	International Tennis Federation
FIVB	Federation Internationale de Volleyball
FINA	Federation International de Notation
FIG	Federation International de Gymnastics
MAG	Men's Artistic Gymnastics
WAG	Women's Artistic Gymnastics
AIBA	International Boxing Association
ACP	Aluminum Composite Panels

Chapter 1: Introduction

1.1 Introduction to the Project

Sports and gymnastics are the means of both recreation and career for people all over the globe and regular physical activities are important aspects of any persons' well-being regardless of age and gender. As unfortunate as it may seem, the lives of majority in the 21st century are very much dominated by the rapid globalization and urbanization, putting the young generation through a system of structured education to specifically pursue their career in non-athletic fields, where sports and physical activities are given much less importance. Additionally, advancement of technology is actually paving the way for people, especially the youth to engage in digital entertainment now more than ever, depriving them from sports and physical activities. On the other hand, the benefits and impacts of sports can be noticed in every aspect of life as sport has diffused through financial markets (merchandising, elite sporting clubs), media outlets (advertising, broadcasting), the labor force (Sports scientists, coaches), local communities (through sports clubs), welfare (through charities providing youth sport activities), public spaces like gyms & stadiums and even politics (via events, for example: the Olympics and World Cups) (Batlle, 2019). Moreover, Sports and leisure infrastructure in an urban region represents the tourism infrastructure partially, promoting the establishment of restaurants, parks, conference centers, exhibitions, hotels and public facilities which primarily aims to support local tourism. (Cozea, 2013). Sports has the ability to elevate a county's value and prestige and thus many countries have established avant-garde sports facilities which has aided them to increase their reputation and get a spotlight in the sports entertainment industry. Big names in sports including Cristiano Ronaldo, Roger Federer, Kobe Bryant, Michael Phelps representing Portugal, Switzerland and USA in

Football, Tennis, basketball and swimming consecutively, could reach the peak of their potential as they could avail the best training facilities and programs.

Speaking of sports and physical activity among youth, Bangladesh has come a long way in terms of professionalism, as Bangladeshi athletes have significantly proven themselves in the international cricket scene & Olympic games as well as traditional sports & gymnastics on a national level. When it comes to instructing games with a curriculum synthesized & combined with general education, BKSP (Bangladesh Krira Shiksha Prathisthan) is playing a pivotal role in developing various games and sports and for extensive training to the potential young sportsmen (Islam, 2015). BKSP currently has one main institute for athletes at Savar & 5 other regional training centers in Dinajpur, Barishal, Chattogram, Khulna & Sylhet (<http://bksp.gov.bd>), with minimal facilities for practice & provision for players without any access to local youth communities.

Dinajpur, selected by National Sports Council (NSC) as the site for a new proposed indoor sports complex, lacks adequate training facilities for increasing number of young athletes as well as indoor games & recreational facilities for local residents. Despite of having a considerable number of talented people nationally, most of them don't get the opportunity to live up to their potential because of insufficient facilities in district level. District level is the initial platform for a sportsman or athlete progressing to division level and they eventually reach the national level which is the highest platform for a sportsman in our country. It is crucial for each district to provide at least one sports complex which allows potential athletes a platform to represent themselves nationally and internationally as well as acquiring necessary training.

This paper particularly focuses on the project aspects which will consider both the facilitation of sports & gymnastics training for athletes at district level and architectural spaces which will be feasible for the users, responsive to the site and environment.

1.2 Aim and Objectives of the Project:

- Motivate athletes to perform better by providing adequate training facilities and environment as well as raising the standard of sports infrastructure & equipment.
- Providing opportunities of skill development and empowerment for aspiring athletes.
- Accommodate trainees and athletes within the complex as well as providing leisure and recreation to the people of Dinajpur allowing the facility to generate revenue through public events.
- Ease of accessibility for visitors, visual connection of functions and spaces.
- Promoting competitive sports and athletics on a regional scale.
- Elevate enthusiasm for youngsters to pursue a career in sports & gymnastics.
- Producing a responsive design preserving architectural qualities.

1.3 Project rationale:

Along with social and economic development, sports play an important role in promoting social cohesion & career development, which is core objective of this particular project. In the form of non-formal education, sports has the capability to transform young learners into ‘good citizens’ through promoting leadership, teamwork & confidence (Spaaiz, 2009). Acquiring the characteristics of ‘good citizens’ should be a top priority for both athletes & non-athletic individuals. Another study suggests that sports training for professional career & high-performance sports require suitable environment, infrastructure & facilities which is one of the ten characteristics of elite sports developing system (Oakley & Green, 2001). It is

imperative for a developing urban region like Dinajpur to house a sports facility that serves both training & recreational facilities as well as aiding the local development.

1.4 problem statement:

- There are currently no sports complex in Dinajpur region prioritizing indoor sports training with all requirements met.
- The local community demands a recreational facility that serves as a public space as well as involving them in sports participation.
- A study suggests that majority of trainees at BKSP (71.43%) indicated that there are inadequate infrastructure & environment for training. (Shaybal & Marzina ,2016)

The issues stated above clearly indicates the necessity of a state-of-the-art sports facility which will aid in the development of sports training curriculum and quality as well as offering leisure to the residents of the city. This particular project aims to provide solutions for the given problems & integrate the solutions in the overall design process.

1.5 Project Summary

Name of the Project: **Indoor Sports complex and training center**

Implementer of the Project: **National Sports Council**

Location: **Dinajpur**

Site area available for the Project Development: **15 acres (653400 sq ft.)**

Built-up area of the Project: **331750 sq ft.**

Maximum ground coverage (Allowable): **50 %**

Total ground coverage of the project (Built forms): **190750 sq ft. $\approx$ 30 % of the site area**

Area allocated for greenery $\approx$ **60 % of the site area**

1.5.1 Proposed Program of the Project:

1. Outdoor facilities:

- 2 Basketball courts (Training + Recreation).
- 2 Tennis courts (Training + Recreation).
- 2 Volleyball courts (Training + Recreation).
- 5 cricket net practice pitches.
- Equipment shed & player's restroom.

2. Indoor arena (Group A):

- Multipurpose Gymnastics (Training + Recreation + Competition).
- Multisport court (Training + Recreation + Competition).
- Seating gallery for 1700 spectators.
- Toilet for spectators.
- Maintenance staff's rooms.
- Toilet + shower + locker facilities (basement).
- Player's lounge.
- Equipment storage room (basement).
- Electrical + Mechanical rooms.
- First aid + medical storage room.
- Inner Concourse (Public circulation) + lounge.
- Service.

3. Indoor training facility (Group B):

- 2 Judo arenas (Training + Recreation).
- 2 Taekwondo arenas (Training + Recreation).
- 2 Boxing arenas (Training + Recreation).
- Toilets.
- Storage + equipment rooms.
- Electrical + Mechanical rooms.
- Service.

4. Indoor swimming facility (Group C):

- 50m Swimming pool (8 lanes) (Training + Recreation + Competition).
- Seating gallery for 700 spectators.
- Toilet + shower + locker facilities (basement).
- Player's lounge.
- First aid room.
- Table Tennis (5 tables) (Training + Recreation).
- Toilets.
- Electrical + Mechanical rooms.
- Maintenance staff's rooms.
- Storage spaces.
- Water Pump + filtration room.

5. Common facilities:

- Auditorium (260 seating).

- Medical Center + staffs+ circulation + storage.
- Cafeteria (40 people indoors, 60 people outdoors) + kitchen + storage.
- Parking: 65 cars, 4 coach buses, 10 motorbikes.

6. Residential and educational facility:

- Boys dormitory (166 trainees + 18 trainers).
- Girls dormitory (97 trainees + 10 trainers).
- 2 Dining halls + kitchen + storage.
- 2 Guest's lounges.
- Recreational spaces.
- Service & storage rooms.
- 2 Security's rooms.
- Electro-mechanical rooms.
- Gym for trainees.
- Physical education classes.

7. Administrative facilities:

- Chief director's room.
- Staffs room.
- Director's (Finance) room.
- Director (Training) room.
- Executive Engineer's room.
- Assistant Engineer's room.

- Accounts room.
- Meeting Room.
- Toilets.
- Reception & lounge.

Chapter 2: Literature Review

2.1 An overview of sports & sports facilities:

2.1.1 Definition of sports:

The term 'Play' as written by German theorist Carl diem, "is purposeless activity, for its own sake, the opposite of work.". Play, sports, games & contest are actually inter-related, which can be categorized as spontaneous play and organized play (games) which again can be sub-categorized based on competitiveness (Thompson W.N. & Rowe D.C., 2020). To be precise, sports is usually referred to the activities which involve in physical athleticism or physical dexterity along with another category labelled as mind sports which are competitive, but non-physical activities. In fact, the exact definition of which sets apart competitive sport from other leisure activities varies between sources, & mostly is dependent on the competitive aspect of various games. The most reasonable definition of sports on an international basis as per Sport Accord, is the association of large-scale international sports federations (which includes football, athletics, cycling, tennis, equestrian sports and more). Sports also refers to competitive physical activity usually competed as individuals or played either in teams, either organized or through casual participation, maintain or improve physical ability and skills while creating a source of recreation for participants as well as spectators.

2.1.2 Sports complex:

A sports complex is usually defined as a facility covering a comparatively vast area which incorporates fields or courts dedicated to a particular sport or series of sports, as well as accommodating trainees, trainers & other recreational facilities. Sports facilities often serve the purpose for tournaments and leagues because they can accommodate a significant number

of audiences in sports event. The sports facilities built around the world for Olympics training & competition can also be labelled as sports complexes. Other common examples of sports complexes are football stadiums, track and field stadiums, gymnasiums and swimming complexes.²

2.1.3 Impact of sports facilities:

The world is moving ahead quite rapidly as development in all sectors has grown exponentially and sports has a major role in overall global development. Along with social and economic development, sports training, competition & business aid in promoting international relationship. Furthermore, planned sports activities through organizational training & events directly impacts both physical and mental development of athletes. (Ministry of Youth and Sports, Chapter-13). According to Chapin (2002), noneconomic impacts are as follows:

- (1) Social/psychic impacts – Referring to the recreation provided by sports and sports facilities to citizens in a community.
- (2) Community visibility and image impacts – which establishes the concept that a city or locality can be benefitted from being associated with a major sports facility or sports team;
- (3) Political impacts – Referring to the political income & profit that flow from a sports facility; and
- (4) Developmental impacts – Sports facilities have direct impact on the physical development of the surrounding area and in the district encompassing a sports facility (Chapin, 2002).

According to Theodore Hesburgh, it is imperative for youngsters to have access to sports and physical activities. It actually empowers youth by building higher self-esteem as well as

motivation which enables them to progress in academics, especially in schools where maintaining required grades is sometimes a pre-requisite for staying on the school's sporting team, only if they are members of the team. The physical benefits include preventing chronic diseases, maintaining a healthy weight and acquiring necessary skills which will facilitate athletic careers. Further studies have indicated that earnings and employment in the United States' amusements and recreation sector (the sector involving economy with professional sports) increases the earnings and employment at culinary establishments and retail establishments which is determined by with the size of the professional sports environment in the cities (Coates & Humphries, 2003).

2.1.4 Health benefits of sports:

World health organization (WHO) estimates that, physical inactivity is the fourth major risk factor of global mortality, as it's causing the death of 3.2 million people globally per year. (Hancock, C., 2011). Being physically active aids in the prevention of type 2 diabetes, heart disease and cancer. Furthermore, another study suggests that participants of regular physical activity have 20%-30% lower risk of suffering from depression. Sports and physical activity reduce the risk of these health issues significantly: All-cause mortality (30%), type 2 diabetes (30-40%), metabolic disease (30-40%), cardiovascular diseases (20-35%), coronary heart disease (20-35%), stroke (20-35%) (Sports Wales, 2014). Additionally, a study conducted by Sports England, suggests that, participating in regular sport can save £1,750 to £6,900 in healthcare costs per person. Also, the same study has unveiled that sports programs aimed at youths reduces the risk of criminal behavior by enhancing self-esteem.

2.2 Sports & gymnastics in Bangladesh:

2.2.1 History & background

Bangladesh has an extensive history of sports and which is again one of the most notable forms of recreation for general people and athletes alike. Kabaddi, the National sport of Bangladeshi, mainly originated from India, is a contact sport that was also played by the British Army both for recreation and facilitation of soldier recruitment from the south Asian communities. In recently years, Bangladesh has come a long way in professional cricket which has gained International notoriety. The popularity of cricket was first noticeable in 1997 when the Bangladesh national cricket team won the ICCP Trophy making them qualify for the 1999 Cricket World Cup held in England. After a decade in 2011, Bangladesh co-hosted the Cricket World Cup along with Sri Lanka and India, which had given our country further reputation in international cricket scene. Other popular games in Bangladesh include football, tennis, hockey, volleyball, archery, shooting, swimming and even chess and table tennis. A vast majority of the country's athletes compete at district levels and there are multiple university, armed forces, club, elite and public sector sporting teams who often organize sports competitions. To facilitate the country's growing interest in sporting activities, a vast number of sporting clubs have been established as well. National and occasionally international tournaments are hosted by these clubs, which requires the facilities to be kept in best condition possible.

2.2.2 National Sports Council (NSC):

After the war in 1971, Bangladesh Sports Control Board (BSCB) was established in 1972 and several major games federations were formed. The BSCB was later renamed to National Sports Council (NSC), as well as inaugurating 'The Ministry of Youth and Sports' prioritizing the promotion of sports throughout the country. The National Sports Council (NSC) bill was amended in 1974 specifically aiming to develop the sports and games industry and extend the training curriculum. Nearly all sports federations, divisional and District

sports organizations were affiliated to the NSC in order to organize sports events, provide initial coaching and training for entry level athletes. Almost 42 different sports federations are currently affiliated with the National Sports Council. Bangladesh Games is one of the largest domestic multi-sport tournament where athletes and sports teams from every district participate which attract large crowd and audiences (National sports council, 2015)

2.2.3 Bangladesh Olympic Association:

Bangladesh Olympic Association (also known as National Olympic Committee of Bangladesh) is the national integral of the global Olympic movement. The International Olympic Committee has direct authority over BOA which is responsible for organizing the participation of Bangladeshi athletes in the Olympic Games. BOA was established in 1976 and got its recognition in a few years after in 1980. The organization aims for developing and promoting of the Olympic Movement in the country as well as providing support to the government in the sport sector development by maintaining full autonomy in line with the IOC Charter (Bangladesh Olympic association, 2018), maintaining full autonomy. A wide range of sports are practiced in Bangladesh including Archery, Judo, Taekwondo, Boxing, Shooting, Table Tennis, Swimming, Gymnastics and so on. Bangladeshi athletes have a massive potential in the world stage and many promising youngsters are performing better than ever in athletics, especially the women gymnasts who have showcased noticeable skillset in the national and international tournaments.

2.2.4 Bangladesh Krira Shikkha Protishtan :

The Government of Bangladesh took the decision to establish the project of Bangladesh Institute of Sports in 1974, under the authority National Sports Council. The Bangladesh Institute of Sports, a government sanctioned department was established in 1976 which was renamed in 1983, to Bangladesh Krira Shikkha Protishtan (BKSP) and as such became an

autonomous organization through ordinance. Ever since the first commencement of regular coaching and academic training programs at the institute from 1986, BKSP has been serving with utmost integrity to achieve the goal of producing highly skilled sportspersons who will represent Bangladesh nationally & globally. Currently there are six facilities available nationwide, one main institute for athletes at Savar & five other regional training centers in Dinajpur, Barishal, Chattogram, Khulna & Sylhet (Islam, M.A., 2012)

2.3 Spatial attributes & standards:

2.3.1 Main typologies:

Physical activities associated with sports & gymnastics can be categorized into mainly two typologies based on whether shelter is provided or not,

- Outdoor games
- Indoor games.

Outdoor games are played outside the home or sheltered structures which require vast open spaces for the activities to be partaken. Example: Cricket, Football, Hockey, Athletics etc. On the other hand, indoor games are played inside a confined sheltered space having no interference of any kind of weather (e.g. Rain, Wind, etc.). Differences aside, both indoor and outdoor games help develop brain skills along with agility & finesse. Games like basketball, Boxing, Tennis, Swimming, Badminton, Gymnastics, Volleyball etc. Can be played both indoors and outdoors, but if spectator's seating gallery is provided then it's crucial to allocate the required spaces indoors in which case minimum spatial standards have to be maintained.

2.3.2 Basketball:

Basketball is the largest urban team sport of the world, played by two teams of five players on each side and 7 players in reserve on each team during competitions. The Basketball discipline is currently being promoted and structured by FIBA which is the sport's global governing body. The AAU basketball court requirements as per the standards given by Chiara & Callender in Time saver standards of building types are as follows- recommended Area Ground space is 448 m² minimum to 540 m² recommended (91.86ft x 49.21ft, 7290 sq ft including run-offs and sidelines), including clear space. Size and Dimension Playing court is 14 x 26 m with an unobstructed space of 1m minimum to 2m recommended on all sides. (Chiara & Callender , 1983)

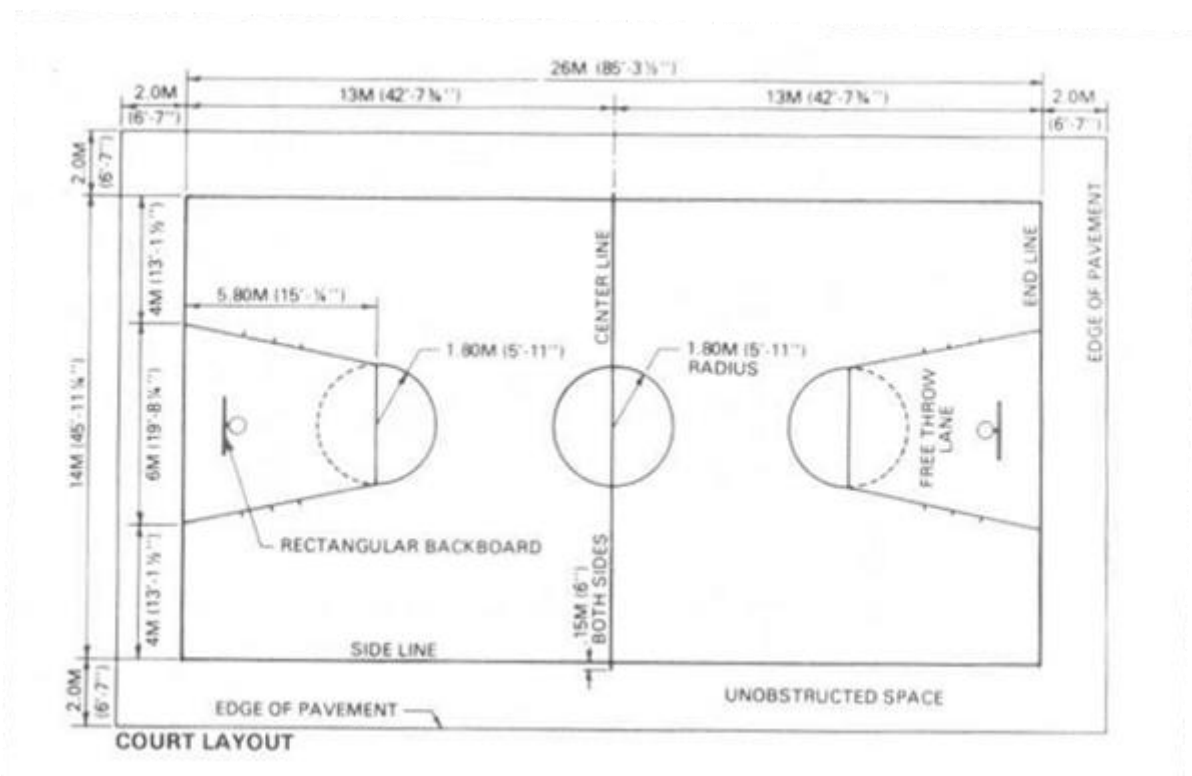


Figure 1: AAU basketball court layout (Chiara & Callender , 1983)

2.3.3 Tennis:

The International Tennis Federation (ITF) has defined the dimensions of a singles and doubles tennis courts. For practical purposes, most of the traditional tennis courts are built to doubles dimensions, which allows for both doubles and singles. All court markings are to be

2 in wide. Fence enclosure, if provided, should be 10-ft-high, 11-gauge, 1 3/4 in mesh chain link. Recommended area is 7,200 sq ft minimum. Size and dimension of the playing court is 36 x 78 ft plus at least 12 ft clearance on both sides or between courts in battery and 21 ft clearance on each end. (Chiara & Callender , 1983)

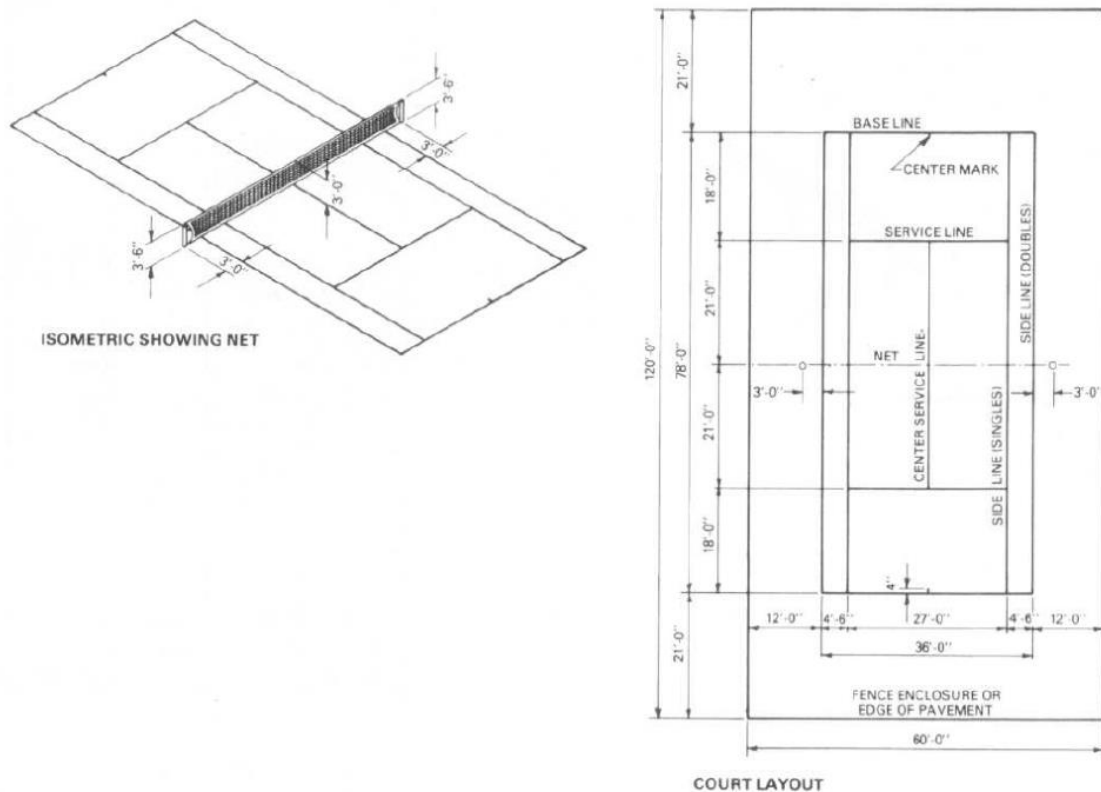


Figure 2: Tennis court layout (Chiara, Callender , 1983)

2.3.4 Volleyball:

Federation Internationale de Volleyball (FIVB), the international governing body for volleyball has been providing the rules for the all forms of volleyball since 1947. The established number of players in a court is six in a volleyball match. Every time their team wins back service from the opposition, each must rotate one position clockwise. Volleyball can be categorized into three disciplines:

- Conventional volleyball.
- Beach volleyball.

- Indoor beach volleyball

Net height at the center is 8 feet (Male) or 7 feet 41 inches (Female). Recommended area has to be 4000 sq ft in total. The recommended size and dimension for the playing court is 30 feet x 60 feet with additional 6 feet minimum, 10 feet preferred, unobstructed space on all sides for circulation. (Chiara & Callender , 1983).

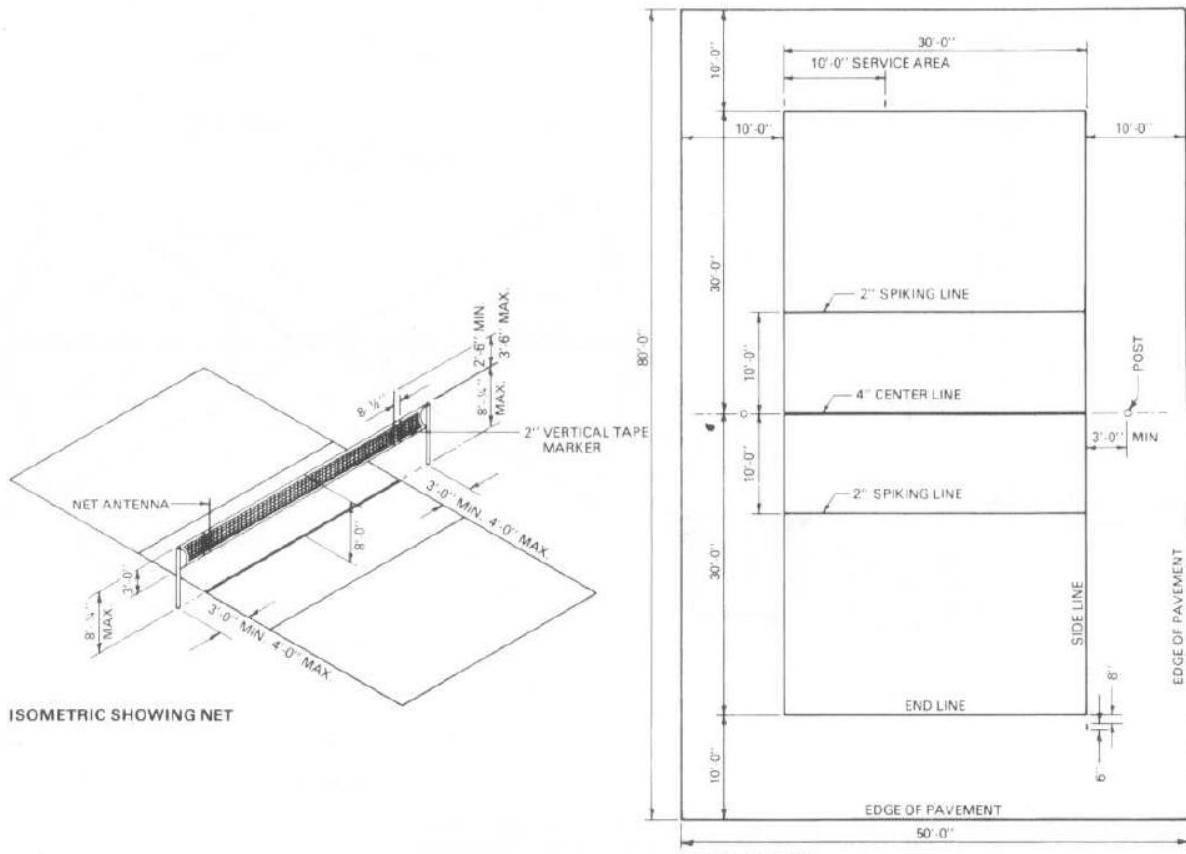


Figure 3: Volleyball court layout (Chiara, Callender , 1983)

2.3.5 Cricket Net Practice:

The recommended cricket net practice pitch is 20m long and 3.6m wide. The barrier height for back and side walls should be 3m /10 feet high, with additional multi--bay constructions. The dividing net need to be 21m long considering the occupational health and safety measure to protect the bowlers in adjacent nets. Additionally, peripheral nets have to have a minimum

side fencing length of 11m and all nets requires to be 27m long having a minimum 21m dividing fence to provide space for bowler protection and extended bowler run--ups.

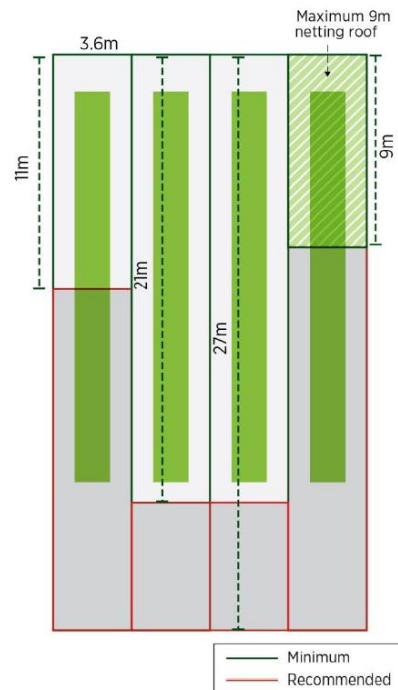


Figure 4: Cricket Net Practice layout (dlgsc.wa.gov.au)

2.3.6 Olympic Swimming Pool:

The global governing body for all types of aquatic sports such as water polo, swimming, diving, and, synchronized swimming is known as FINA (Federation International de Notation) which is responsible for managing divisional, national and international events such as the World Championships and the Olympics as well as providing training curriculum and state of the art environment for competitions and events.

Traditional Olympic pools are 50m in length, 25m in width and 1.35m deep (Max 6m) containing 300,000 gallons of water, having 8-10 lanes divided with lane ropes (2.5m width for each lane). Starting platforms for athletes is usually 0.5m to 0.75m high from the ground (dlgsc.wa.gov.au). Every pool requires a high-capacity plant room where the pumps and

filtration units will be allocated, usually the size of which is 50% of the total water area (Sports England, 2017).

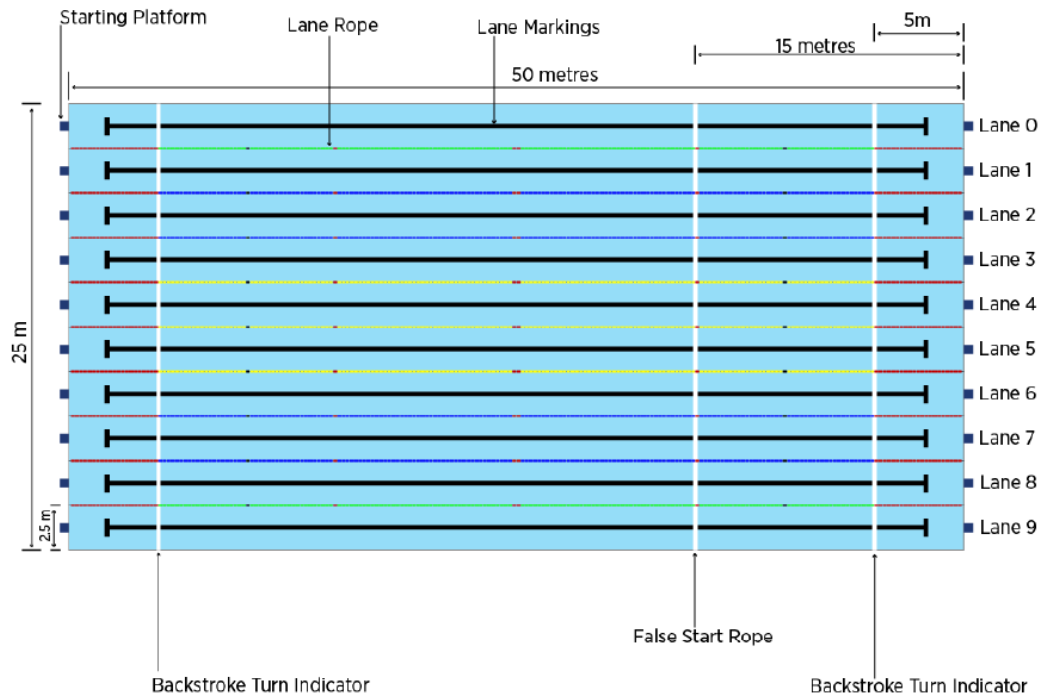


Figure 5: Swimming pool layout (dlgsc.wa.gov.au)

2.3.7 Table Tennis:

As mentioned before, International Tennis Federation (ITF) has set the dimensions of a singles and doubles tennis courts which is followed for practical purposes and all tennis courts are built to doubles dimensions, which allows for singles as well as doubles matches. Conventional table dimensions are: 9 feet in length, 5 feet in width, 6-inch-high net and a minimum clearance of 19 feet x 11 feet (for recreation: 28' x 13', for competition: 46' x 23'). (Dimensions.com, 2020)



Figure 6: Table tennis dimensions (dlgsc.wa.gov.au)

2.3.9 Gymnastics:

The disciplines recognized by Federation International de Gymnastics (FIG) and Gymnastics Australia are:

- - Gymnastics for all
- - Artistic gymnastics
- - Rhythmic gymnastics
- - Trampoline
- - Aerobic gymnastics
- - Acrobatic gymnastics

For competitive apparatus, Men's Artistic Gymnastics (MAG) require the following: floor, Pommel horse, rings, vault, parallel bars and horizontal bar, whereas for women's Artistic

Gymnastics (WAG): vault, uneven bars, beam, floor. The standard performance area is 12m x 12m and for competition 18m x 18m is followed.

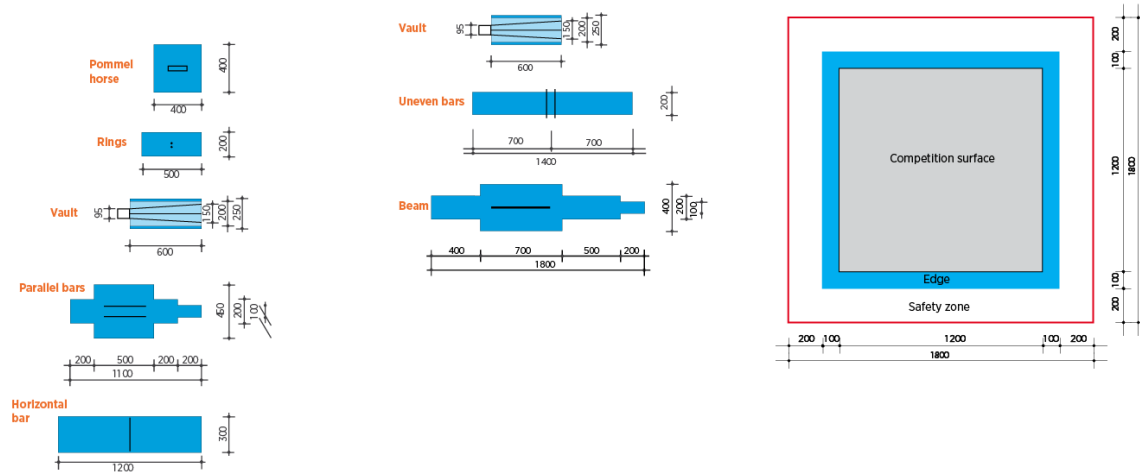


Figure 7: Gymnastics court dimensions (dlgsc.wa.gov.au)

2.3.10 Judo:

Initially a form of Japanese martial art, later adapted into a combat sport for Olympics, Judo is played between two opponents aiming to immobilize or take down each other with certain techniques and rules. The minimum competition area for Judo is 14m x 14m which is divided into two zones, the inner zone (8m x 8m to max 10m x 10m) called the contest area and the outer safety zone area has to be at least of 3m wide minimum. (dlgsc.wa.gov.au)

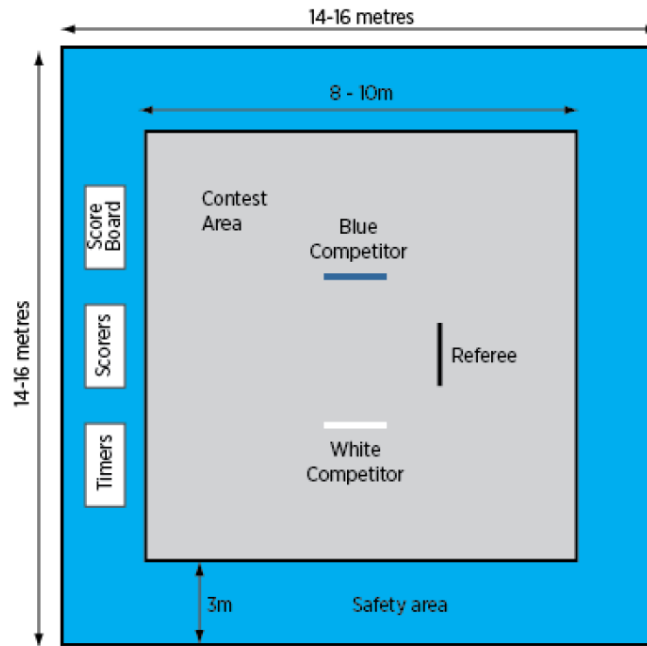


Figure 8: Judo area dimensions (dlgsc.wa.gov.au)

2.3.11 Taekwondo:

Another form of martial arts consisting various types of kicking moves, taekwondo is played on a flat, non-slip mat. The contest area can be installed on a platform 0.6m-1m high from the base and requires an area of either 10mx10m or 12mx12m. The performance area is octagonal in shape, having a diameter of at least 8m. (dlgsc.wa.gov.au)

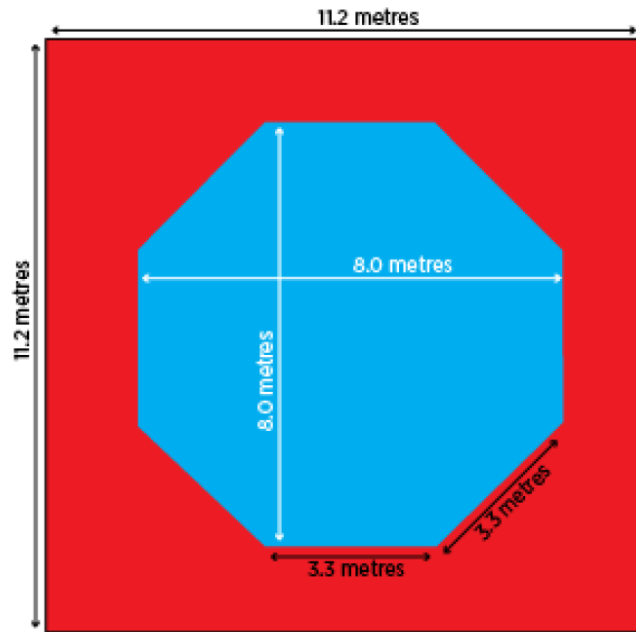


Figure 9: Taekwondo arena dimensions (dlgsc.wa.gov.au)

2.3.12 Boxing:

In a boxing match, two participants of weighing the same fight each other by throwing punches with their fists wearing gloves in a series of one-to-three-minute rounds. The ring is situated 85cm inward offset from the outer periphery. According to International Boxing Association (AIBA), the height of the ring should be 100cm from the ground, having an area of 6.1mx6.1m. (dlgsc.wa.gov.au)

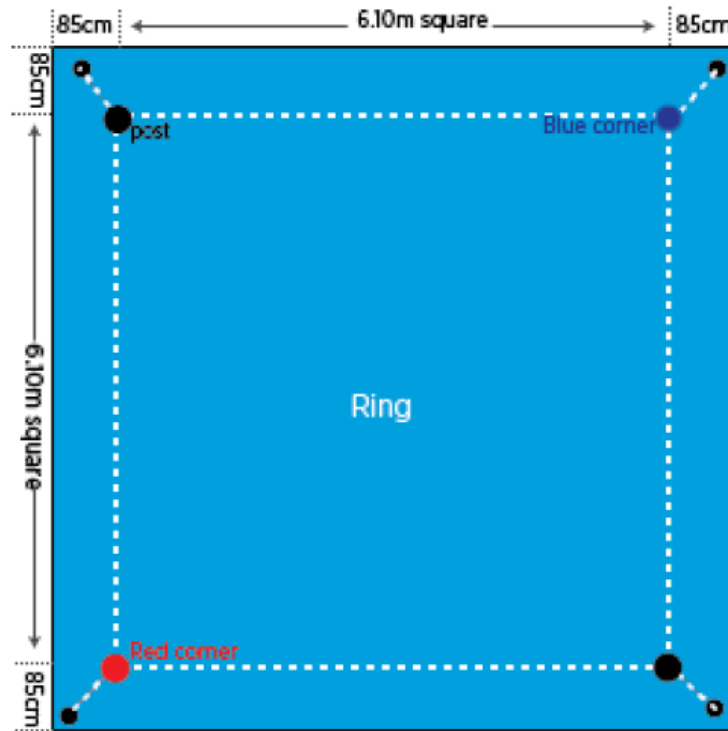


Figure 10: Boxing arena dimensions (dlgsc.wa.gov.au)

2.3.13 Sports arenas and multi-sport halls:

The concept of 'arena' actually derived from ancient Greeks, who invented the first Olympic competitions to showcase physical prowess. The primary function of indoor sports arena is to house competitive sports events as well as providing spectators with seating galleries so that they can enjoy those events. Traditional sports arenas house lounges, toilets, refreshment facilities and vendors alongside playing zones and seating areas. Additionally, Public circulation and player circulation has to be properly defined for convenience. University arenas usually have seating capacities of 12000 to 15000 spectators, but it's much larger in municipal arenas. Moreover, the size and seating capacity is determined by the population of the region, available highways and transit routes connected with the facility and the average income and affordability of users. (Chiara & Callender , 1983)

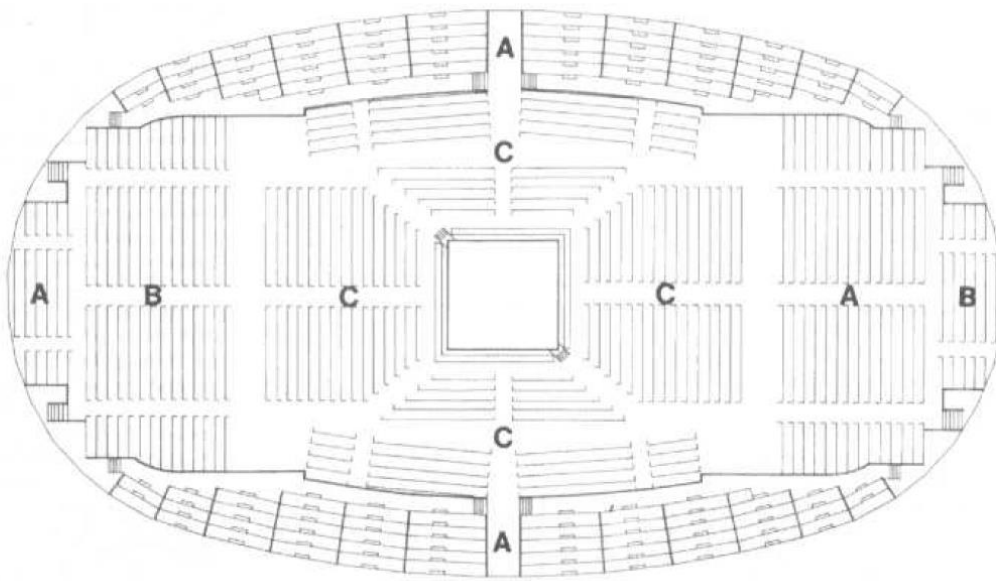


Figure 11: Traditional boxing competition arena (Chiara, Callender , 1983)

Different configuration types of sports arenas are discussed in Time Saver Standard based on the demand and design principles. The most common type of arena followed by most facilities is the oval configuration, although the rectangular configuration is simpler and more cost effective. Row spacing of seats should be 0.8-.85 m (0.4-.45m for standing areas). (Neufert, 2012). Moreover, riser height should be between 3-4 inches to 22.5 inches and risers more than 15 inches will require two additional steps to cover a tread of 3 feet. Recommended aisle width is 3 feet and suitable spacing should be between 14-15 seats. (Chiara & Callender , 1983)

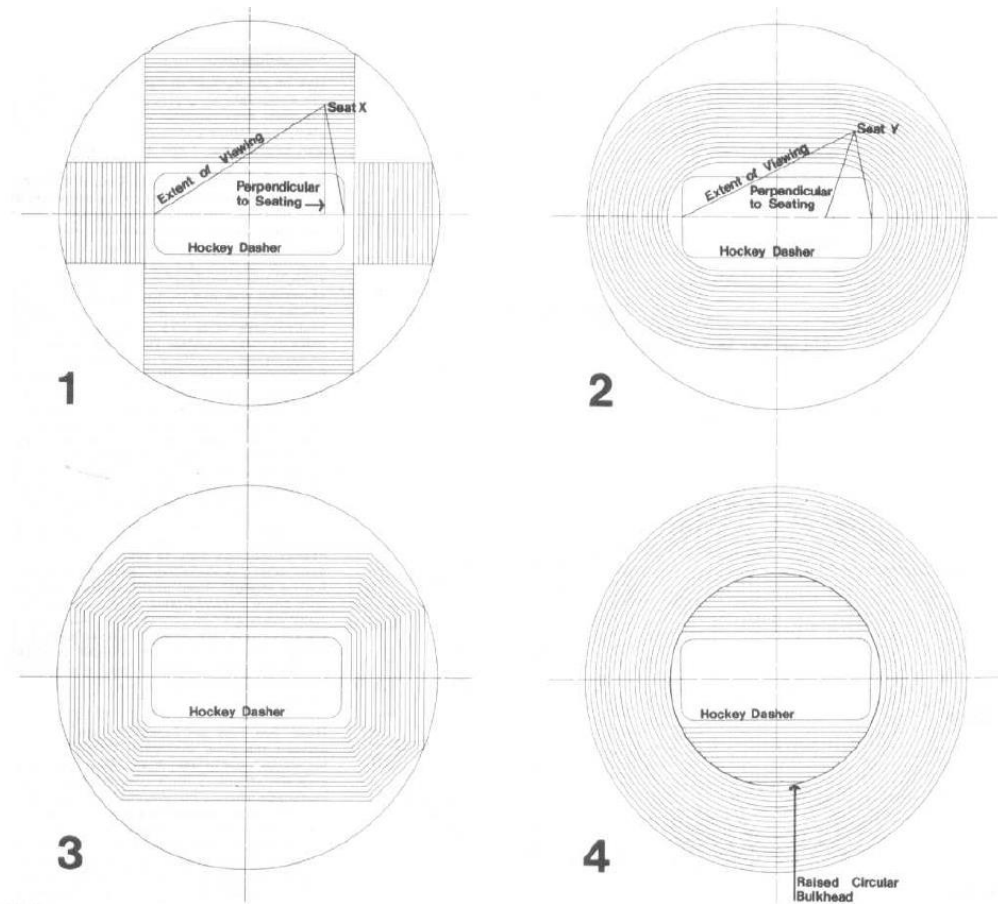


Figure 12: Sports arena plan configurations (Chiara, Callender , 1983)

Sports halls serve similar purposes as a sports arena, but might not always include seating gallery for spectators. According to Sport England Journal, sports halls can be categorized into for types based on the levels of games held:

- International.
- Premier.
- Club.
- Community.

Multisport hall sizes vary depending on types of sports accommodated, number of athletes and allocated area determined by program. Overall space (O/A) requirements, including dimensions for length, width and clear unobstructed height for each level of play, include the following: PPA (principal play area), R/O (run offs), T/O space for teams (T) and match

officials (O). (Sports England, 2012). Large sports hall size is measured considering badminton court as unit of measurement and can accommodate up to 8-10 courts under one roof. Standard sizes for four court hall, five court hall and six court halls are nominally 34.5 x 20.0 x 7.5 m, 40.60 x 21.35 x 7.5 m and 34.5 x 27.0 x 7.5 m. (Sports England, 2012) The benefit of multi-court hall is that a variety of sport types can be played in a single hall.

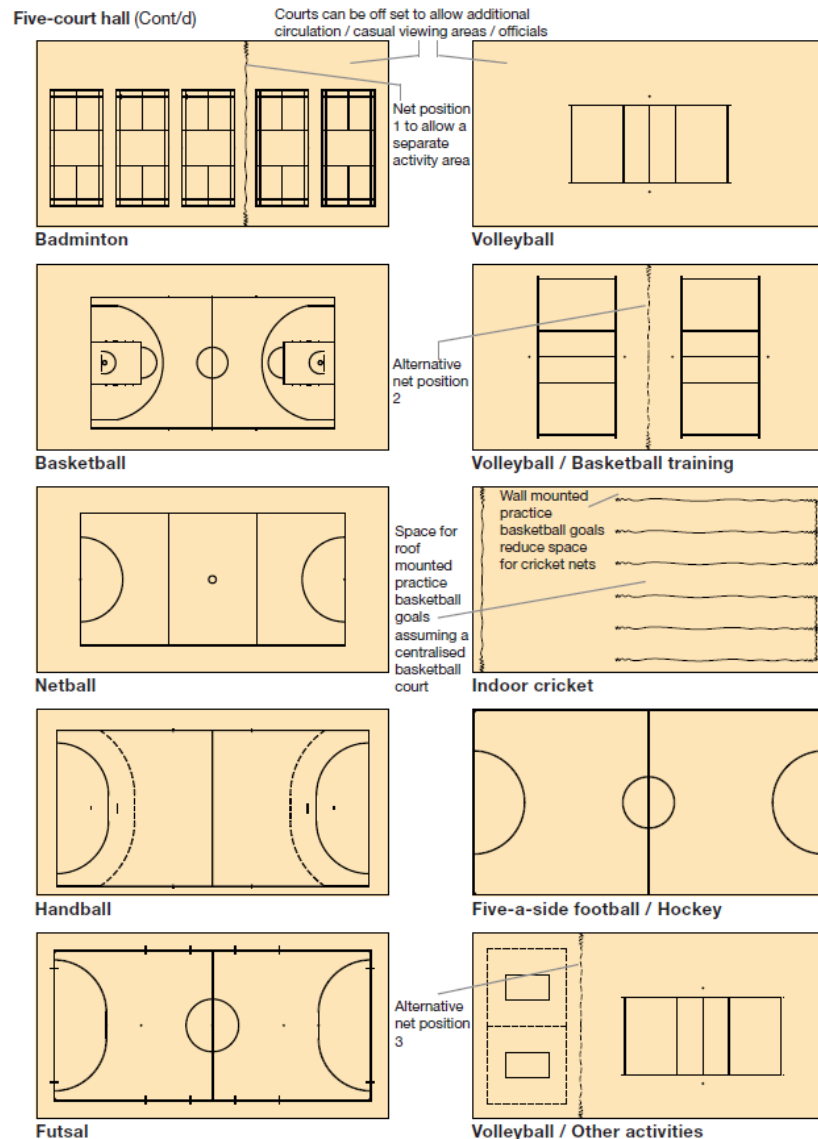


Figure 13: Court layouts for a five-court hall (Sports England, 2012)

2.4 Space frame structure principles:

Space frames were first ideated by Alexander Graham Bell around 1900. The use of space frame has noticeably increased over the last few decades in large scale construction and architectural projects. due to lightness, fast construction, economic value, visual pleasantness and immense structural potential. (Lan, T.T. ,1999) Space frame is a structure system comprising of linear elements organized in way that it can transfer three dimensional forces regardless of how complex the structural geometry is. Multiple architects have expressed the potential of space frame through their projects, most notably Zaha Hadid in her project 'Heydar Aliyev Cultural Centre'. Space frame usually follows grid construction which is known for the omni-directional spreading of the load whereas in an ordinary framing system follows the characteristic of linear transfer. (Lan, T.T. ,1999)

An important component of space frame structure is 'double layer grids' which consist of two planar networks of members which configures the top and bottom layers parallel to each other which are again interconnected by inclined web members and vertical and members. These grids are denoted by the hinged joints with zero moment or torsional resistance. Double layer grids primarily consist of the following:

- Planar latticed truss.
- A pyramid with a square base that is considered a part of an octahedron.
- Tetrahedron: A pyramid with a triangular base. (Lan, T.T. ,1999)

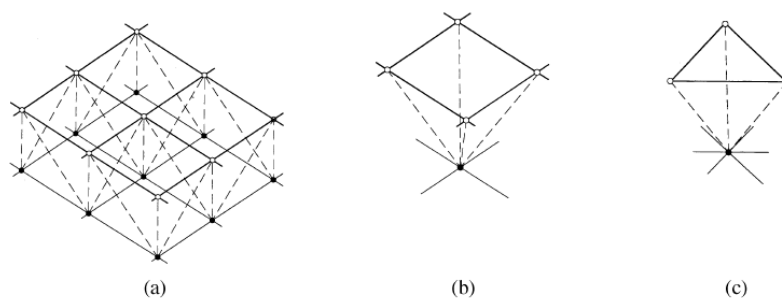


Figure 14: Basic elements of double layer grids (Lan, T.T. ,1999)

Recommended construction materials for Space frames are: structural steel pipe, tubing, channels or tees and pre-fabricated connectors which are used to join the members. Consulting manufacturer for details, module size, and allowable spans is crucial in initial design phase. Types of commonly known connectors are: Tubal Node Connector, Nodus Connector and Triodetic Connector.



Figure 15: Construction of Heydar Aliyev center (Source:buildipedia.com)

2.5 Delaunay triangulation principles:

Invented by Russian mathematician Boris Delaunay, Delaunay triangulation is a significant part of computational geometry, which can be described as a triangulation for a set of points in a plane where no point in that set is inside the circumcircle of any triangle in the given triangulation (so that there are no silver triangles). Voronoi diagrams are inter-related with Delaunay triangulation as they can be produced by connecting the centers of the circles acquired from the triangulation mentioned above. The real-life applications of Delaunay triangulation and Voronoi diagrams include producing 3d structural models, mapping terrain and producing parametric design. (Rokicki, W. and Gawell, E. ,2016)

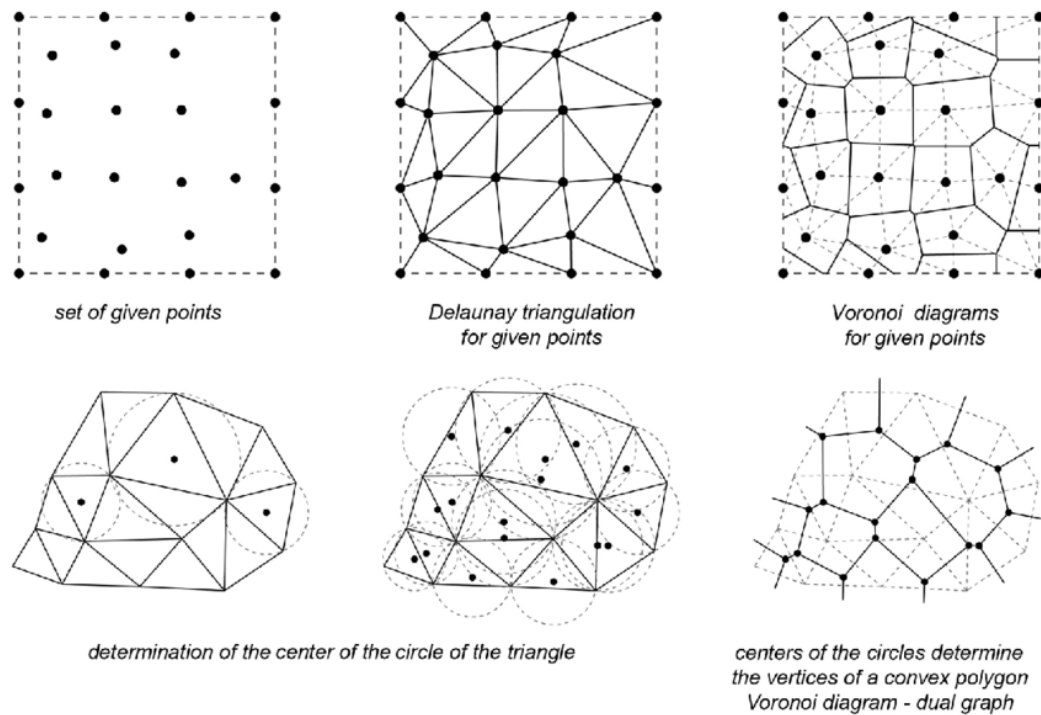


Figure 16: Delaunay Triangulation and Voronoi Diagram (Rokicki, W. and Gawell, E., 2016)

Chapter 3: Site Appraisal

The site selected for the sports complex project as proposed by NSC is located at a sports field owned by BKSP in CMB mor Dinajpur. The site will accommodate necessary training & recreational facilities for athletes as well as the surrounding community residents.

Location: **Gore-e-Shahid field, CMB mor, Dinajpur**

Area: **15 acres.**

3.1 Site surroundings:

The site for the project is situated at a significant zone of Dinajpur city center, adjacent to the restricted zone owned by Dinajpur police to the west, residential area & mixed-use development to the east, Large open space, playground, government owned storage facility &

railway station to the north and a public park to the south. Additionally, multiple schools, mosques, markets & admin buildings are situated with 1 km radius of the site.



Figure 17: Site surroundings (Source: Google earth)

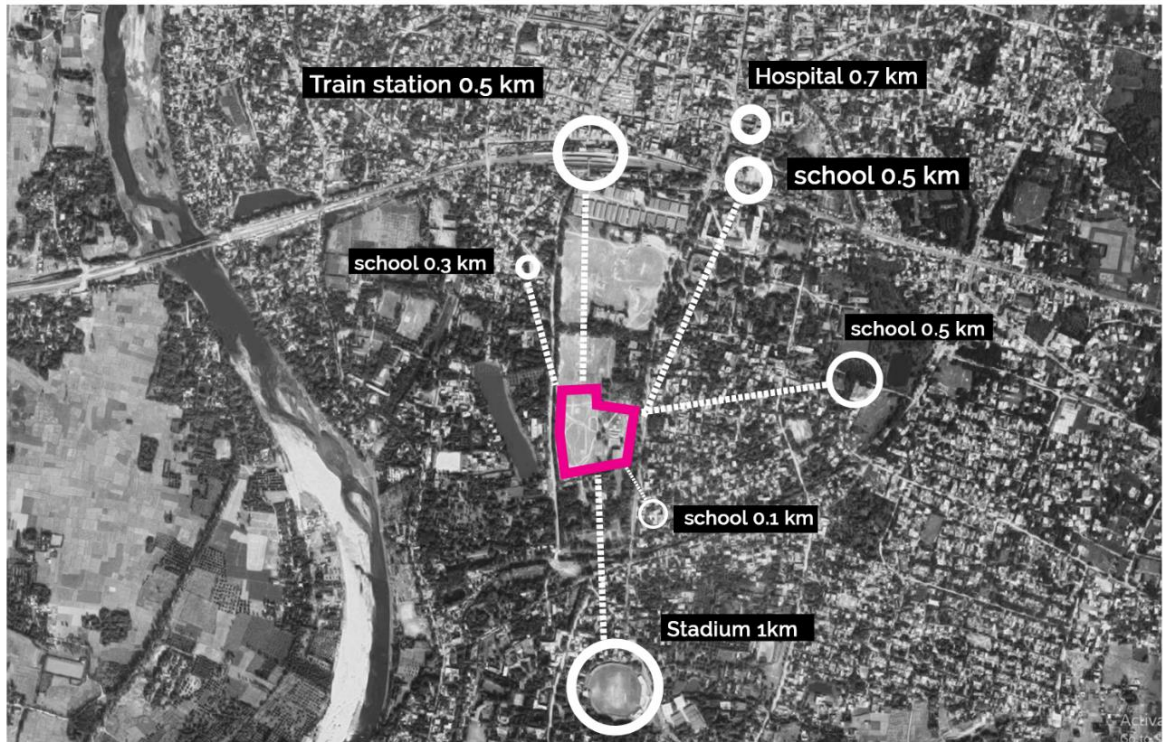


Figure 18: Important nodes within 1 km radius (Source: Google earth)

3.2 Historical background of the Site:

The Dinajpur region was initially a part of the ancient state of Pundrabardhana , one of the ancient districts during the beginning of British rule which is also named ‘Gandowana Land’. Eight years after the battle of Palashi in 1765, The British East India Company established administrative control of the region. Dinajpur town developed gradually after the cessation of Nawabi rule of Ghoraghat .According to Dinajpur Gazette, after a few years in 1783, an independent collectorate was inaugurated in Dinajpur. For the sake of administrative cohesion, a new district of Dinajpur was formed in 1786 alongside a district headquarter which was established later in 1793. (Dinajpur Statistics, 2011)

3.3 Geographical Characteristics of the Site:

3.3.1 Acquired statistics:

Dinajpur district is encircled by Rangpur and Nilphamary districts to the east, Panchagarh and Thakurgaon districts to the north, West Bengal (Indian State) to the west, Gaibandha & Joypurhat districts to the south. The district covers an area of approximately 3437.98 sq.km (1327.41 sq. Miles) and about 78.87 sq.km (30.45 sq. miles) is covered with greenery and forests. The geographical location of Dinajpur is between 25°10' and 26°04' north latitudes and between 88°23' and 89°18' east longitudes. (Dinajpur Statistics, 2011)



Figure 19: Site vegetation & topography (Source: Author)



Figure 20: Site satellite view (Source: Google Earth)

3.3.2 Analysis on geography and topography:

The site is surrounded by ample vegetation as it's located in a sub-urban area, with flat lands & open spaces & a water body to the west, which indicates that the local climatic conditions are stable & natural shade is plentiful. Amongst these the most conspicuous are Banyan, Peepul, Pakar, Shimul or cotton tree, Neem, Mango, Jack fruits tree, Babla, Black-berry, Guava, Banana, Wood-apple, Tamarind, Teak/Shal and Hijal trees are abundant which are considerably large to medium in size & height. The district barely has low-lying areas & marshes and thus the aquatic flora are less available compared to other districts of Bangladesh. (Dinajpur Statistics, 2011)

3.4 Land-use Pattern:

The site serves a residential zone adjacent to mixed use development zone as well as a civic zone in the north, east and north-east. A new line of commercial & mixed-use establishments is being developed to the east of the site, which is adjacent to the residential zone indicating

the potential of economic development. The nearby Civic buildings are the PWD office, RHD office & Police super office, along with a restricted police zone to the west, which indicates that the west-most zone would be less suitable for public interventions. There are recreational facilities to both north & south as well as 4 religious buildings within 1 km radius of the site. Also, there are six schools within 1 mile radius of the site which indicates that a large portion of the surrounding population range between children and adolescents. (Author. 2020)

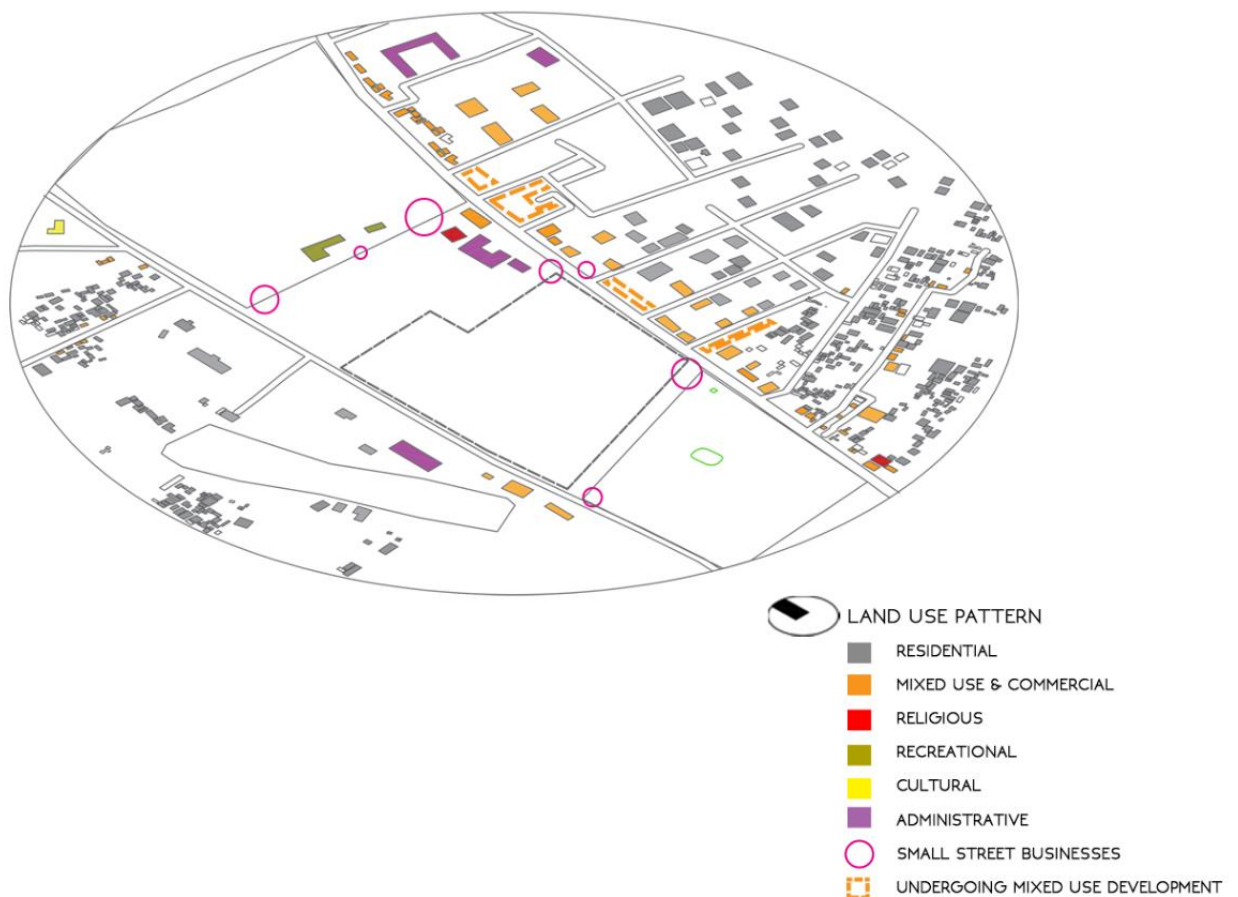


Figure 21: Site land use pattern (Source: Author)

3.5 Accessibility and Connectivity:

The site has adequate access from all sides, including the hospital road highway in the east(primary), mission road in the west (secondary) and circuit house road in the north

(tertiary). Mainly heavy vehicles like buses & trucks as well as cars, auto-rickshaws & rickshaws use the hospital road (main highway) to the east of the site, which connects the railway station with the site, measured at 40 ft in width. On the west, the DC house - mission road (Secondary road), 25 ft in width, is restricted to heavy vehicles due to being adjacent to Police occupied zone. The two roads are connected with tertiary paths, separating the Boromath field to the north & the Shishu park to the south from the site, accessed by bicyclers, rickshaws & pedestrians. (Author, 2020)



Figure 22: Road network & connectivity (Source: Author)

Furthermore, from further surveys and analysis of the satellite imagery, the existing pedestrian paths within the site were unveiled. The paths were generated due to frequent circulation of pedestrians (Occasionally cars and bikes), who used the open field for leisure purposes, walking, cycling and moving from point A to point B. These paths have the

potential to establish public circulation within the landscape design and pedestrian intervention within the project.

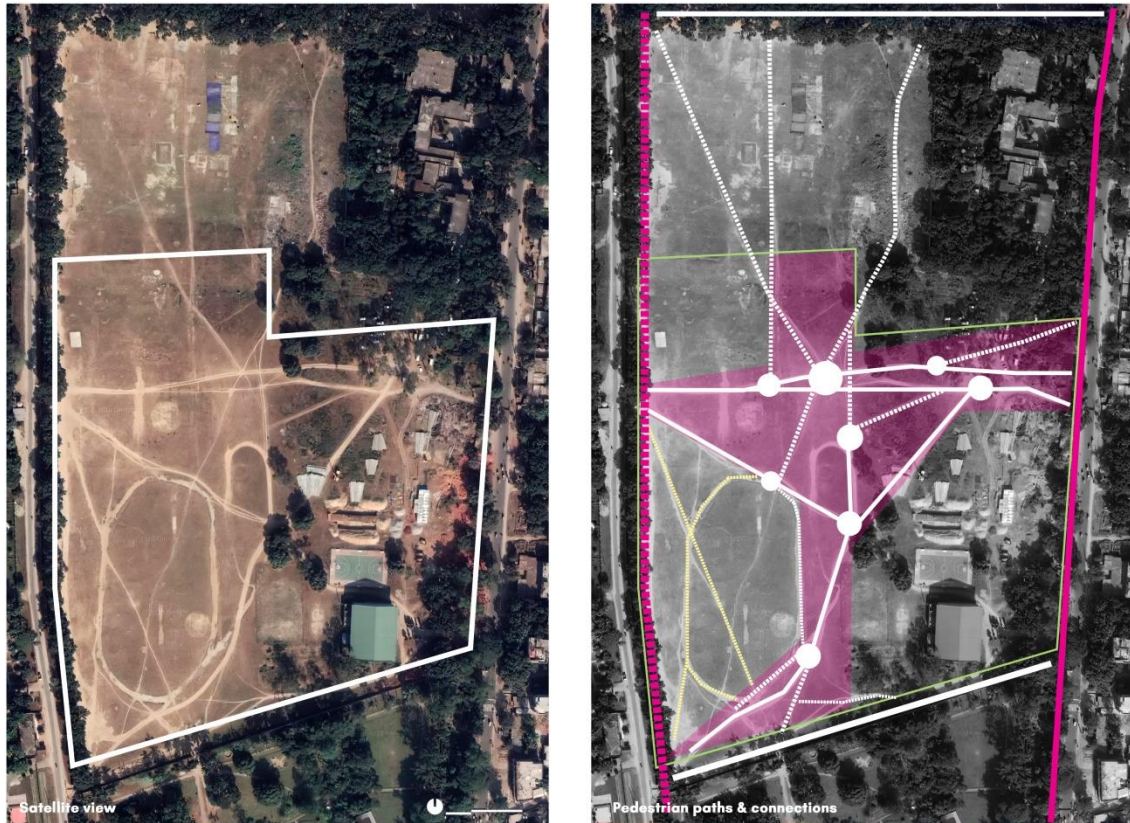


Figure 23: pedestrian path network (Source: Author)

3.6 Climatic Conditions:

The following charts indicate that, Dinajpur has rather extreme temperatures in Summer & Fall, due to lack of adequate water bodies in the region. The annual maximum temperature of 1981-2010 increased notably over southeastern as well as northeastern parts of Bangladesh but it decreased over the region of Dinajpur. The highest temperature recorded is 93.7 degrees F in April & the lowest is 50.7 degrees F in January. (MET report, Climate of Bangladesh)

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	17.4	19.8	24.3	27.9	28.5	28.8	28.7	28.8	28.4	26.6	22.3	18.8
Min. Temperature (°C)	10.4	12.3	16.7	21.5	23.9	25.3	25.9	25.9	25.2	22.3	16	11.9
Max. Temperature (°C)	24.5	27.3	32	34.3	33.1	32.3	31.6	31.7	31.7	31	28.7	25.7
Avg. Temperature (°F)	63.3	67.6	75.7	82.2	83.3	83.8	83.7	83.8	83.1	79.9	72.1	65.8
Min. Temperature (°F)	50.7	54.1	62.1	70.7	75.0	77.5	78.6	78.6	77.4	72.1	60.8	53.4
Max. Temperature (°F)	76.1	81.1	89.6	93.7	91.6	90.1	88.9	89.1	89.1	87.8	83.7	78.3
Precipitation / Rainfall (mm)	13	8	17	50	159	337	402	328	275	130	8	1

The precipitation varies 401 mm between the driest month and the wettest month. The variation in temperatures throughout the year is 11.4 °C.

Dinajpur Monthly temperatures 2015 - 2019

	January	February	March	April	May	June	July	August	September	October	November	December
Daytime Temperature	26°C	26°C	32°C	31°C	31°C	31°C	30°C	31°C	30°C	31°C	32°C	28°C
Night-time Temperature	8°C	11°C	15°C	20°C	22°C	25°C	25°C	25°C	24°C	21°C	15°C	11°C
Rainy days	2	0	5	5	12	26	29	25	25	12	0	0
Snow days	0	0	0	0	0	0	0	0	0	0	0	0

Table 1: Temperature & rainfall (Source: MET report, Climate of Bangladesh)

3.7 Socio-Economic analysis:

Non-agricultural activities play important role in the economy of Dinajpur. The following table shows-1 shows the total establishments in the urban and rural areas and persons engaged by sex and activity in Dinajpur district. It is evident that retail and wholesale trade has the highest number of people engaged which indicates that Dinajpur will experience rapid economic development in commerce sectors. (Dinajpur Statistics, 2011)

Table-1: Number of Establishments and Persons Engaged by Activity

Activity	Establishments			Persons Engaged		
	Total	Urban	Rural	Total	Male	Female
Mining and quarrying	3	-	-	451	444	7
Manufacturing	8090	2194	5896	41716	33848	7868
Electricity, gas and water supply	51	24	27	603	524	79
Construction	56	47	9	225	215	10
Wholesale & retail trade	47796	14717	33079	93649	87794	5855
Hotels and restaurants	5243	1601	3642	16605	15506	1099
Transport, storage and communication	1120	536	584	3422	3345	77
Bank, insurance and financial institution	770	293	477	6886	5401	1485
Real estate and renting	637	426	211	1406	1350	56
Public administration and defense	728	464	264	8156	7704	452
Education	4996	558	4438	27748	22373	5375
Health and social work	2015	612	1403	7394	5418	1976
Community, social and personal services	15328	2317	13011	28448	24581	3867
Dinajpur District	86833	23789	63044	236709	208503	28206

Source: Census of Non-farm Economic Activities 2001-2003

Table 2: Economic activities & occupations (Source: MET report, Climate of Bangladesh)

According to Dinajpur statistics, the total population of Dinajpur district (annual growth rate is 1.22%) is 29,90,128 (Male- 15,08,670 and Female- 14,81,458) with a sex ratio of 102:100 and population density of 868.Sq. Km, which indicates that there are fairly equal male and female residents in Dinajpur. Additionally, the number of educational institutions is as follows: non-government college: 91, non-government high school: 636, government high school: 6, junior school: 27, government primary school: 861, registered primary school: 866, private primary school: 25. This study indicates that the number of youth population is relatively high, and an establishment of a sports facility is crucial for recreation and health purposes. (Dinajpur Statistics, 2011)

3.8 Images of Existing Site Condition:



Figure 24: Existing site conditions (Source: Author, 2020)

Chapter 4: Case Study Appraisal

4.1 Tucheng Sports Center / Q-Lab

Location: **Tucheng District, New Taipei City, Taiwan 236**

Area: **13791.0 sqm**

Project Year: **2014**

Budget: **US \$ 14 million**



Figure 25: View from exterior (Source : Archdaily © highlight images)

4.1.1 Project brief:

Tucheng Sport Center was built at Tucheng District, New Taipei City on 2014 by Sense Tseng and Borden Tseng, the founders of Q-Lab. Their aim was to critically investigate architecture in an urban context, especially intensely over-population issues, and other cultural aspects that are related to contemporary society. Government decided to build the

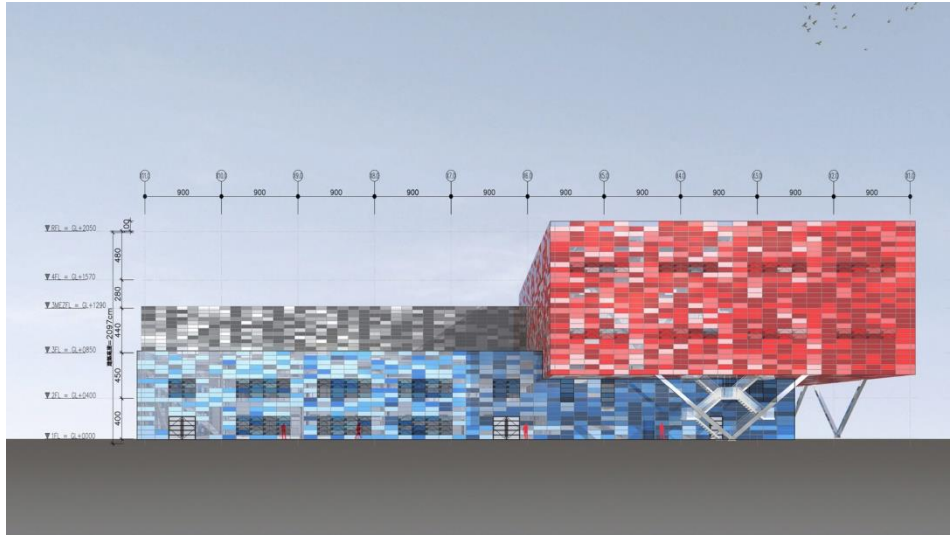


Figure 27: North-east Elevation (Source : Archdaily)

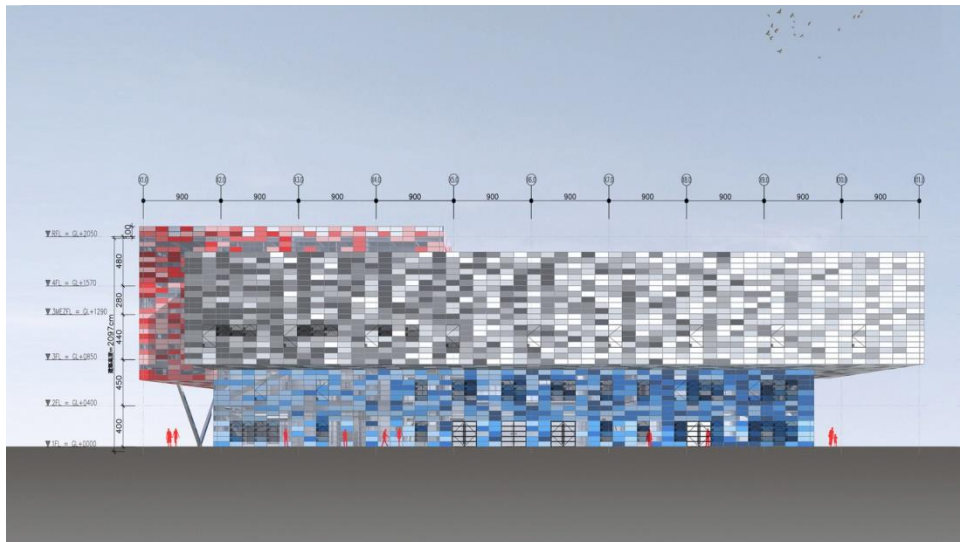


Figure 28: South-West Elevation (Source : Archdaily)

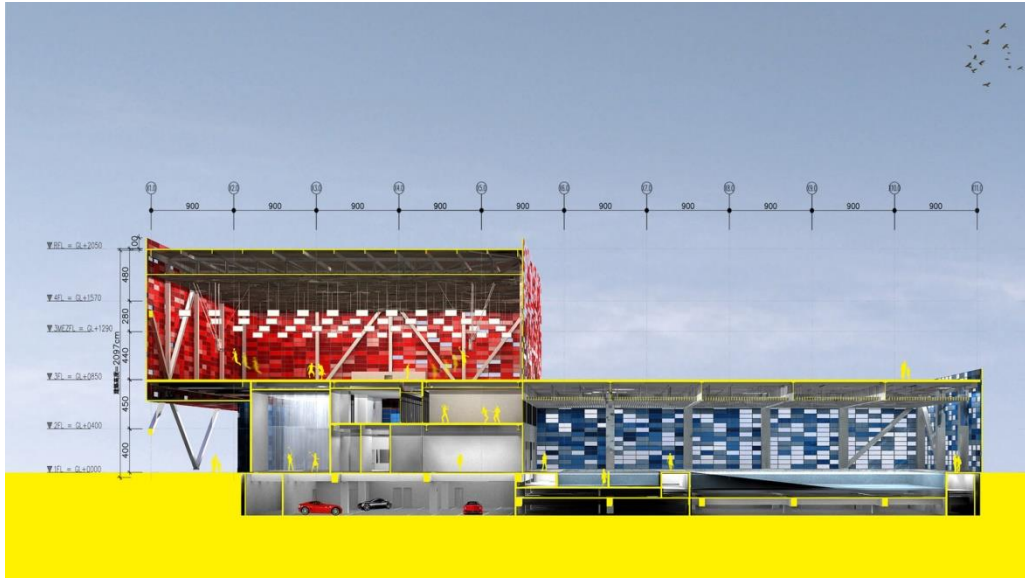


Figure 30: Section 01 (Source : Archdaily)

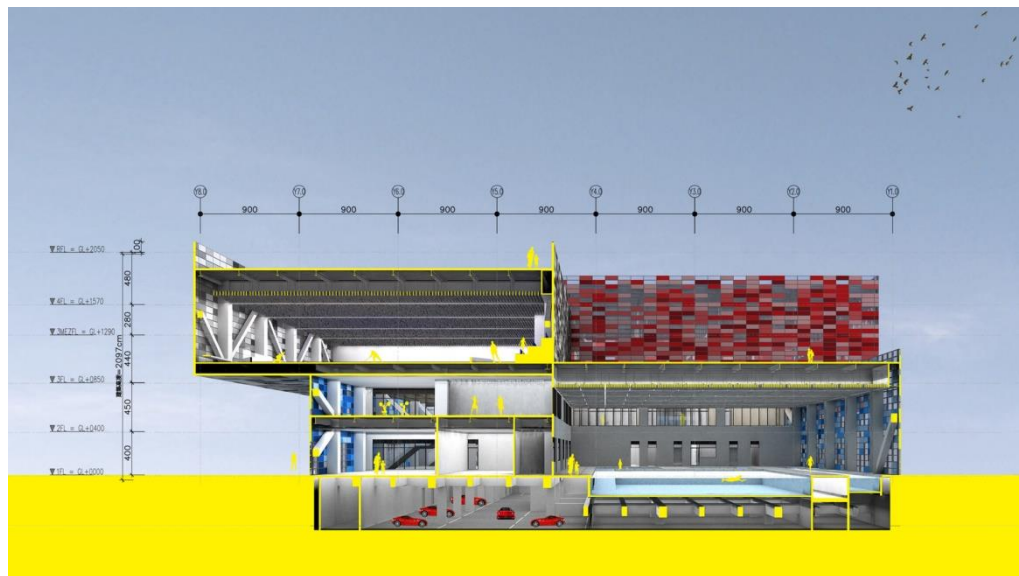


Figure 31: Section 02 (Source : Archdaily)

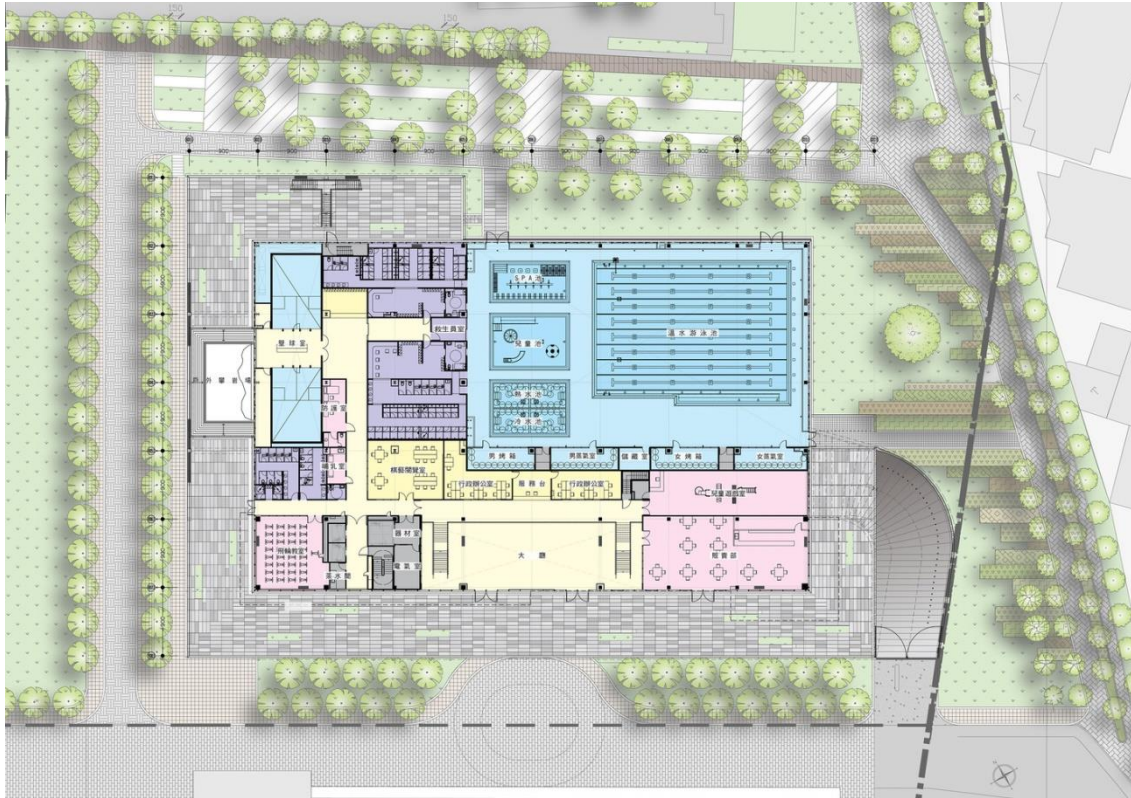


Figure 32: first floor plan (Source : Archdaily)

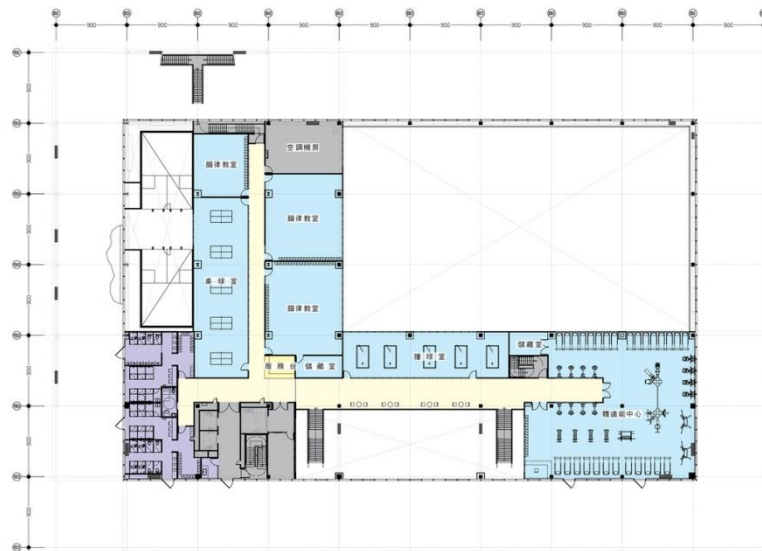


Figure 33: Second floor plan (Source : Archdaily)

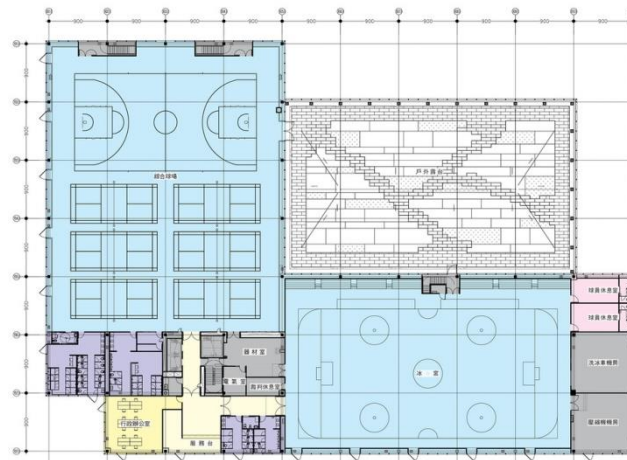


Figure 34: Third floor plan (Source : Archdaily)

4.1.4 Structural details:

- The facade of each massing is composed of aluminum panels in multiple gradients from shades of dark to light. This design element of lighter colored panels has been used for the zones with a high heat gain, while as the darker ones are used for areas with low heat gain. (archdaily.com)
- Moreover, the color gradient also adds character & aesthetics to the elevation, and elevates the quality of the entire visual composition.



Figure 35: Exterior & interior of the project (Source : Archdaily)

4.2 Bangladesh Krira Shikkha Protishtan (BKSP)

Location: **Zirani , Savar, Dhaka.**

Area: **115 acres**

Project type: **Sports & Training**

4.2.1 Project brief & programs:

Bangladesh Krira Shikkha Protishtan (BKSP) was originally established by NSC & has been accommodating & providing training facilities for Bangladeshi athletes since 1984. The main BKSP training institute is located at Savar, having a masterplan stretching a massive 115 acres. The masterplan consists of the following programs:

Outdoor facilities:

- Cricket fields for net practice (5)
- Athletic track & field (1)
- Hockey fields (2)
- Football fields (3)
- Shooting Range (1)
- Tennis court (1)

Indoor facilities:

- Gymnastics court (1)
- Swimming pool (1)

Residential:

- Boys hostel
- Girls hostel
- Staff quarters
- Trainers hostel

- Admin buildings

The number of trainees & coaches are given below:

Discipline	Existing in BKSP, Savar , Dhaka.		
	No. of Athletes		No. of Coaches
	Male	Female	
1.Football	86	36	15
2.Cricket	93	28	20
3.Athletics	22	13	10
4.Archery	18	18	4
5.Shooting	25	16	5
6.Tennis	27	8	4
7.Table Tennis	18	9	3
8.Handball	26	11	4
9.Volleyball	22		2
10.Basketball	35		5
11.Badminton	18	10	3
12.Hockey	81		5

Table 3: Group A program chart (Source : bksp.gov.bd)

13.Swimming	24	26	9
14.Gymnastics	15	15	4
15.Karate	26		3
16.Judo	13	13	2
17.Taekwondo	11		3
18.Wushu	27		3
19.Boxing	30	4	3
20.kabaddi	26	14	3
Total	643	221	110

Table 4: Group B program chart (Source : bksp.gov.bd)

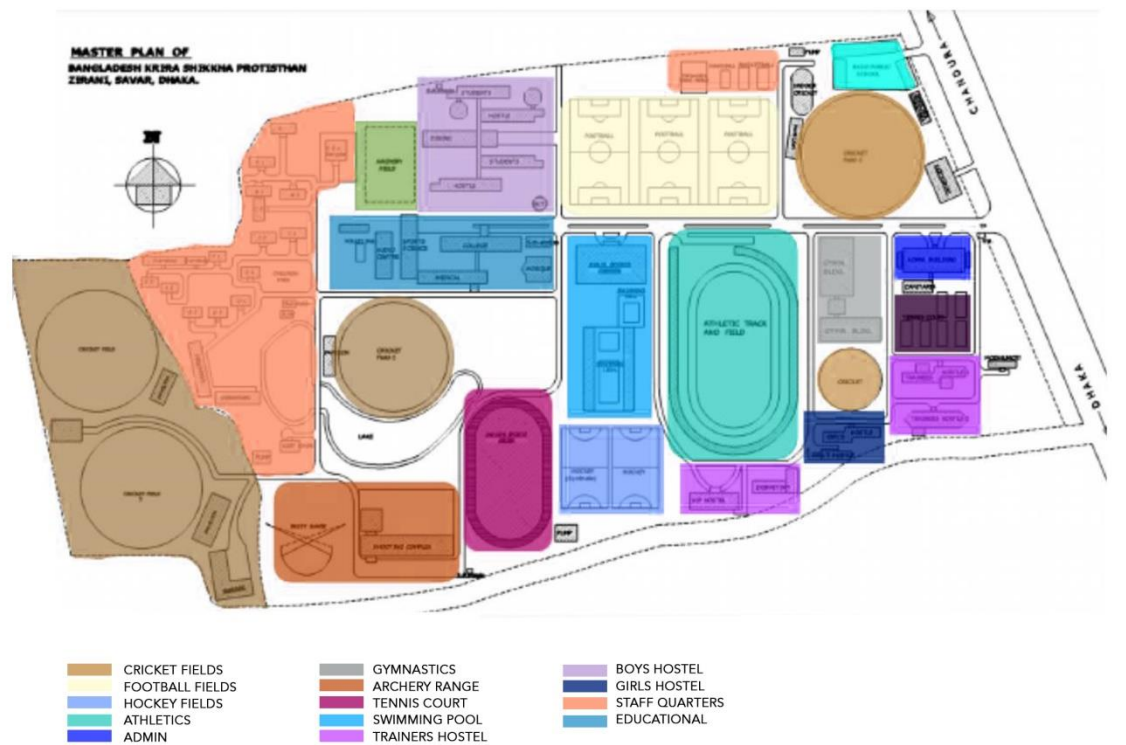


Figure 36: Masterplan zoning (Source : author)

4.2.2 Design inspirations (masterplan):

The project is located in Zirani, surrounded by residential & mixed-use areas. Vegetation is ample around the site as it's a sub-urban area in the outskirts of Dhaka city, suitable for a sports training facility due fresher environment with large open spaces & minimal traffic which similar to that of Dinajpur city.



Figure 37: satellite view of the site (Source : Google earth)

The overall masterplan mainly focuses on functional & spatial distribution, so that the trainers & trainees can access various facilities with more convenience as well as having flexible circulation.



Figure 38: BKSP training facilities (Source : bksp.gov.bd)

4.3 Multi-Sports Complex Competition Winning Proposal (France):

Architects: **Archi5 + Tecnova Architecture.**

Area: **5200 sqm.**

Location : **Antony, France.**



Figure 39: Aerial view (Source : Archdaily, © Luxigon)

4.3.1 Project brief & programs:

The multi-sport complex designed by ‘Archi5 + Tecnova Architecture’ became a winning entry as it integrated the aspects of a new urban ambition for the surrounding neighborhood as well as outstanding form and geometrical features merging with the landscape and context providing a theme for each function including gathering, meeting, sports activities, and events. The project is surrounded by a linear housing zone on one side and a botanical garden on the other, and functions as an attractive landmark, for the local residents preserving its own vocabulary of public space complementing the urban landscape elements. (Furuto, A. 2012) The project program include:

- A sports center for the College La Fontaine,
- Two gymnasiums,
- A climbing wall,
- Dojo,
- Boxing gym,
- Multipurpose room,
- Administrative offices, and
- Parking for 100 cars.



Figure 40: Indoor spaces (Source : Archdaily, © Luxigon)

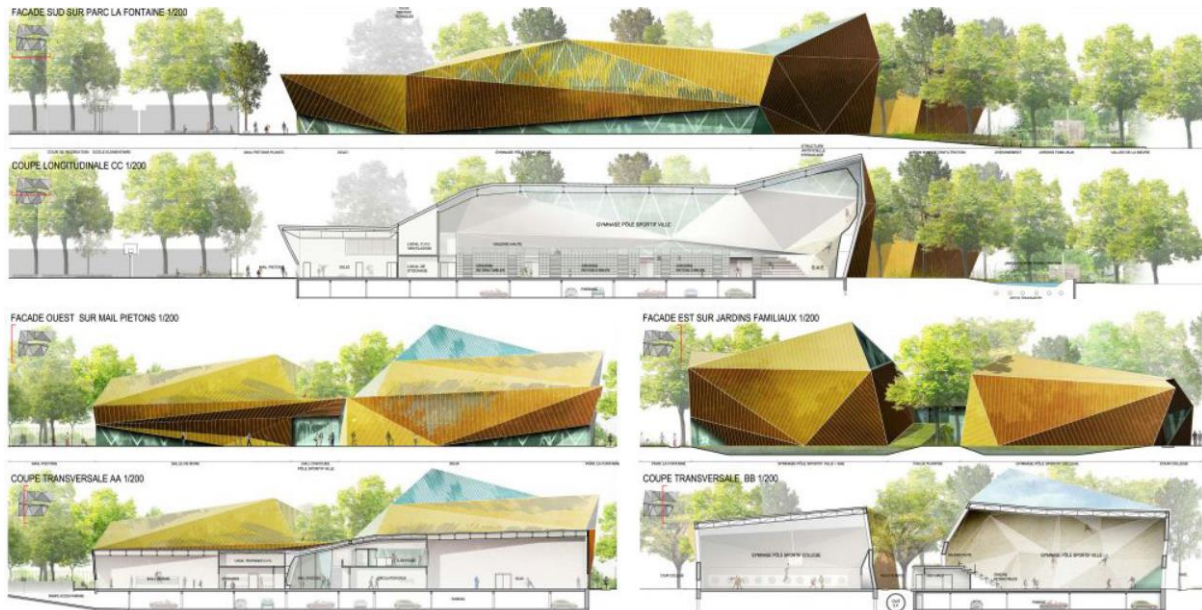


Figure 41: Sections and elevations (Source: archiscene.net)

4.3.2 Design inspirations (Form and structure):

The primary take-away from this particular project is the ability of the form and geometry to complement the contextual elements and deliver a visual and functional experience. It not only preserves the values of sports objectives, but also balances the relationship between nature and formal expression creating a contemporary and poetic built form. Moreover, it is structured by a set of vistas, which allows indoor and outdoor spaces to be interconnected. The main structure is composed of steel frame, which is covered with skin is made of an alloy of copper, aluminum and titanium, which does not oxidize, giving it a matte bronze exterior. Sufficient entry of light and air has been assured in the overall design. (Furuto, A. 2012)

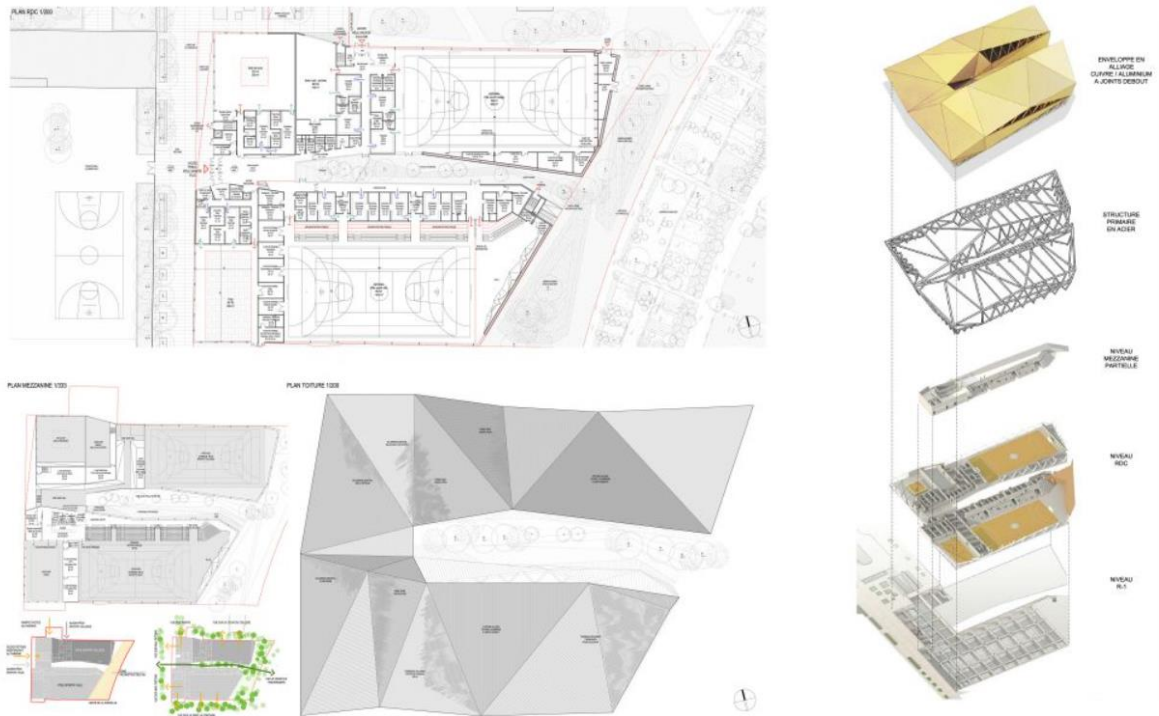


Figure 42: Structure and roof details (Source: archiscene.net)

Chapter 5: Program Appraisal

5.1 Proposed project program analysis:

The main program typology and summary have been shown in 1.5.1 and the in-depth program area analysis has been given in the table below.

<i>Functional spaces</i>		<i>Number of units</i>	<i>Number of users</i>	<i>Area per unit (in sft)</i>	<i>Total area (in sft)</i>
A. Administrative facilities					
1	Director General	1	1	250	250
2	Staffs	1	4	105	420
3	Director (Finance)	1	1	140	140
4	Director (Training)	1	1	140	140
5	Executive Engineer	1	1	140	140
6	Assistant Engineer	1	1	140	140
7	Accounts	1	2	110	220
8	Meeting Room	1	15	34	500
9	Reception + lounge	1	20	20	400
10	Common toilet (M)	1	4		150
11	Common toilet (F)	1	2		150
12	Circulation				2650
Sub-total					5300
B. Outdoor facilities					
1	Basketball court (Court +circulation)	2		5812	11624
2	Tennis (Court +circulation)	2		7260	14500
3	Volleyball (Court +circulation)	2		3670	8000
4	cricket net practice (Pitches) (Court +circulation)	5		1056	5280
5	Equipment shed & player's restroom.	1	68 (Peak)		2000
Sub-total					-
C. Indoor arena (Group A):					
1	Gymnastics court	1		10000	10000
2	Multisport court	1		10000	10000
3	Seating gallery	1	1700		14220
4	Toilet for spectators	2			1000
5	Maintenace staff's rooms.	2			330
6	Toilet + shower + locker facilities + lounge (basement)				7740
7	Equipment storage room (basement)	1			540
8	Electrical + Mechanical rooms	2			880
9	First aid + medical storage room	1			580
10	Inner Concourse (Public circulation) + lounge	1			39680
11	Entry lobby + reception + security	1		3760	3760
12	Cafe + kitchen + storage	1		3200	3200
13	Service	3		220	660
Sub-total					92590

D. Indoor training facility (Group B):					
1	Judo arena	2		1330	2660
2	Taekwondo arena	2		1350	2700
3	Boxing arena	2		660	1360
4	Circulation area for players	1		3050	3050
5	Toilets	1		480	480
6	Storage + equipment rooms.	2			390
7	Electrical + Mechanical rooms	2			600
8	Standing gallery + lounge + Public circulation (Upper level)	1			23830
9	Service	3		220	660
				Sub-total	35730

E. Indoor swimming facility (Group C):					
1	50m Swimming pool (8 lanes)	1		24700	24700
2	Seating gallery	1	700	6080	6080
3	Toilet + shower + locker facilities (basement)	1	30	3820	3820
4	Player's lounge (Swimming+ table tennis)	1		880	880
5	First aid room	1		180	180
6	Circulation area for players	1		2120	2120
7	Toilets	2			780
8	Table Tennis (5 tables)	5	10	540	2700
9	Electrical + Mechanical rooms	2			1300
10	Maintenance staff's rooms	1			200
11	Storage spaces	3			400
12	Water Pump + filtration room				4660
13	Service	1		220	220
14	Public circulation				21030
15	Circulation area for players				4110
Sub-total					73180

F. Auditorium :					
1	Seating gallery & stage	1	260	5200	5200
2	Foyer / lobby	2		1190	2380
3	Toilet (Male)	2	130	140	280
5	Toilet (Female)	2	130	140	280
6	Universal toilet	2		120	240
7	Green room	1	20	980	980
8	Electro-mechanical room	1	1	150	150
9	Control + maintenance room	1	1	980	980
10	Service			200	200
11	Storage room				150
				Sub-total	10840

G. Medical facility :					
1	Emergency room (Male)	1	3	400	400
2	Emergency room (Female)	1	3	480	480
3	Treatment room		2	130	260
4	Doctor's room	1	1	130	130
5	Nurse's room	1	1	130	130
6	Medical storage	1		200	200
7	Universal toilet	2	2	60	120
8	Toilet (Male)	1		140	140
9	Toilet (Female)	1		140	140
10	Security's room	1	1	130	130
11	Lobby + circulation			3460	3460
				Sub-total	5590

H. Residential and educational facility ;					
1	Bedrooms (166 male trainees)	55	166	270	14850
2	Bedrooms (97 female trainees)	32	97	270	8640
3	Male trainer's rooms	10	10	270	2700
4	Female trainer's rooms	8	8	270	2160
5	Dining hall + kitchen +Pantry (Male dorm)	1	84	3490	3490
6	Dining hall + kitchen +Pantry (Female dorm)	1	66	3090	3090
7	Guest lounge	2	30	570	1140
8	Security booth	2	2	50	100
9	Laundry + storage room	12		150	1800
10	Physical education classes	10	250	620	6200
11	Gym	1	40	4290	4290
12	Toilet+shower (Male dorm)	7	176	660	4620
12	Toilet+shower (Female dorm)	5	105	660	3300
13	PE class and gym toilet (Male+female)	3	290	600	1800
14	Dorm electrical room	2		270	540
15	Total circulation				49800
				Sub-total	108520

Total built up area **331750**
Site area **631620**

Table 5: programmatic chart (Author. 2020)

- In program A: Toilet ratio: male: female = 2:1 (For males, 2 WCs, 2 urinals).
- In program C: Spectators toilet ratio: 1 WC for first 80 people, 1 WC for every additional 100 people (Same ratio is followed for urinals). Male: Female = 1:1 (As per

the male-female population ratio of Dinajpur). WCs (Male): 9, WCs (Female): 9, Urinals: 9 (Distributed in two zones).

Player: Shower = 6:1 (T.S.S.), 1 toilet for every 4 showers has been provided (1 WC instead of every urinal in female toilets).

- In program E: Shower: player = 1:1 (Same ratio for changing closets). Peak number of competitors is considered (15 male swimmers, 15 female swimmers). 1 WC for every 5 showers, 1 urinal for every 5 showers is provided (Male). For females, it's 1 WC for every 2.5 showers.
- Total area for Parking and circulation of 65 cars, 4 coach buses and 10 motorbikes = 34200 sq ft.

Chapter 6: Design Considerations

6.1 Design considerations from site factors:

From previous site analysis, I have come to the conclusion that the site is situated in a flatland with ample vegetation and large open spaces open to public, along with mixed use and residential developments. It is a significant landmark in Dinajpur city as a variety of key nodes in the city itself are adjacent as well as connected with the site. The key considerations from site analysis for the design includes:

An axis intersecting the site is considered connecting the Open spaces in in the north with the public park to the west, which can be a potential pedestrian intervention as well as public access to the site, specifically local residents visiting the park & the school goers coming to the sports fields. The public facilities of the sports complex can actually function as pull

factor for people to access the open spaces more frequently, which has a very low rate of usage & often lacks variety in activities other than a few people taking casual strolling.

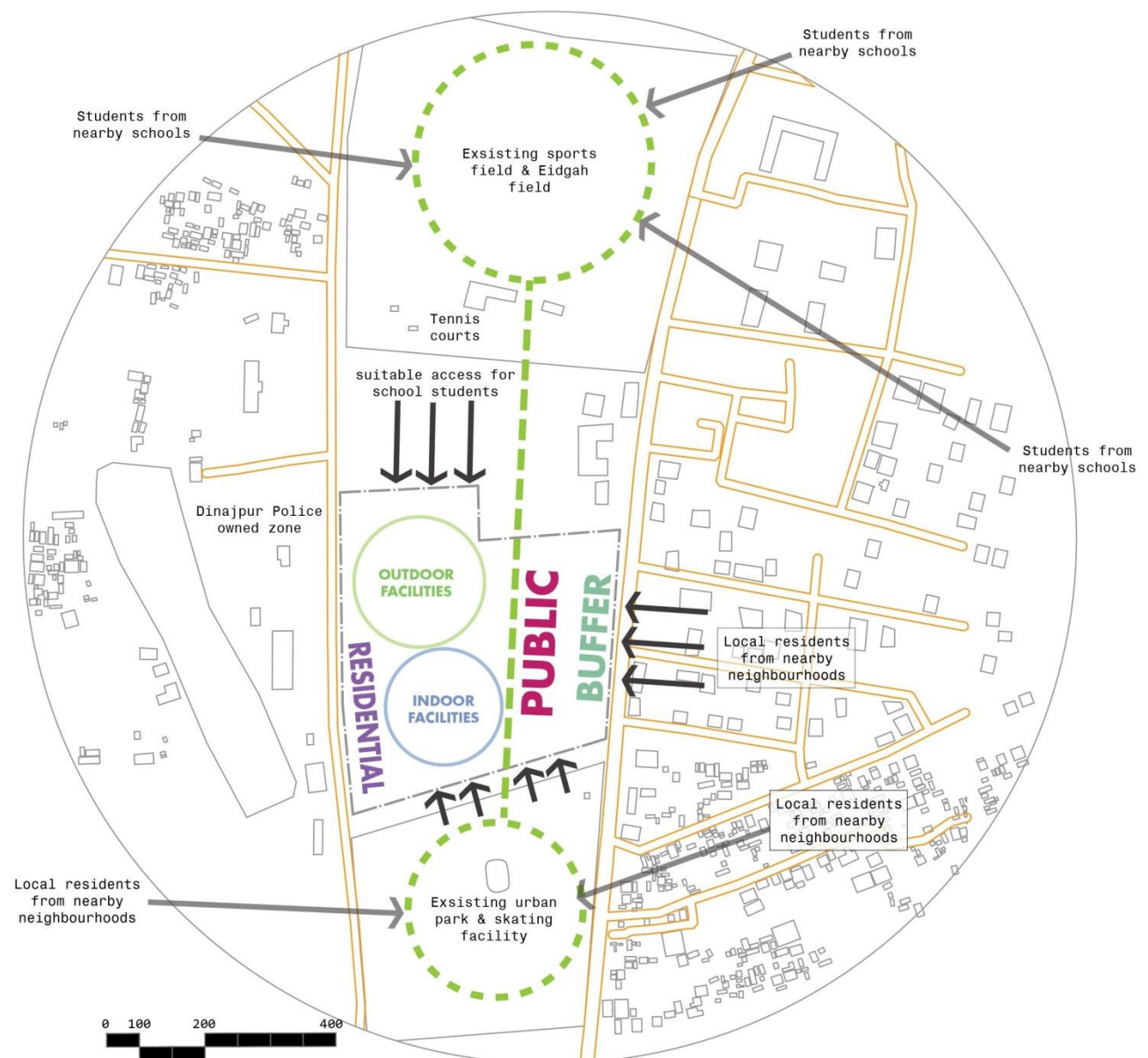


Figure 43: Design considerations from the site (Author ,2020)

The axis functions as a datum for organizing functional zones in a broader scale. Public interventions can be implemented in the east of the axis, adjacent to the mixed-use development zone and highway, and a key access point for vehicles, non-trainees and visitors. There's a potential buffer zone between the main complex facilities with the mixed-use zone & road.

- The outdoor facilities & indoor facilities are to be arranged in the west side of the datum, connecting with the public zone in different levels, creating a cohesive organization between semi-private & public functions.
- The suitable allocation for the residential facilities or dormitories would be the west-most side of the site, as it is adjacent to the more restricted police-controlled zone in the west.

6.2 Structure & form considerations:

The site is surrounded by suburban areas with mostly low-rise buildings, open spaces & lush vegetation, which creates a demand for a geometric composition and massing which will express the dynamism of sports architecture and create a visually aesthetic built form, complementing the environmental elements, establishing a more simplistic yet bold functional design, merging with the landscape & site topology. The suitable structural height is considered to be flexible to due to the minimal requirement space needed for indoor games. As for more prominent functions like multipurpose spaces & public facilities the landscaping will have a reflection of the functional spaces creating a visual fluidity as well as producing spatial cohesion, very similar to the geometric features of the sports complex by Archi5 + Tecnova Architecture.

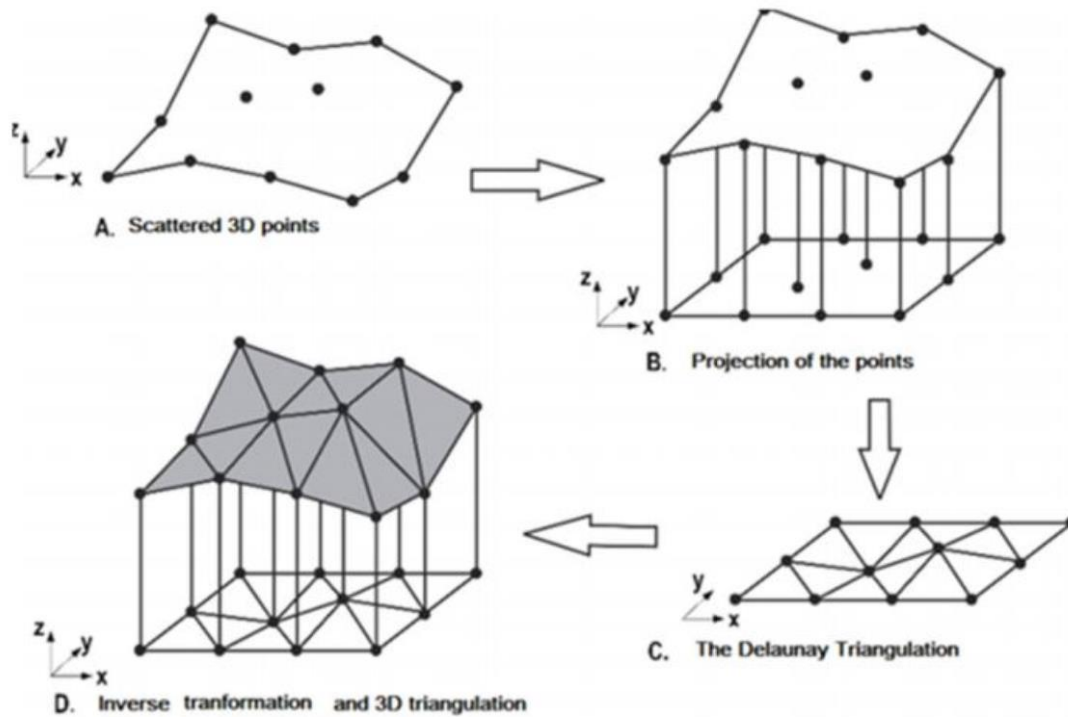


Figure 44: 3D Delaunay triangulation (Author ,2020)

Furthermore, I tried to derive the form and geometry from Delaunay triangulation, which allows three dimensional forms to be generated from scattered points in a 2D planar space. The points can be generated from the existing pedestrian path intersections and distribution of key junctions within the site (as seen in **figure 24**) which can again aid in producing the overall geometry of the design.

6.3 Psychological aspects to consider:

- *Trainees:* The mental development is crucial for next generation of athletes, as they are going to represent our country on the international stage in the future. The design must include adequate recreational spaces and learning functions, spaces for social cohesion, mental wellbeing and non-sports-activities. Environment is also a crucial factor for overall well-being of athletes.

- *Visitors/public:* The training activities should be transparent so that there's visual connection with visitors and public. The visibility will impact people depending on their age, older people will get the scope for leisure & entertainment while motivating and inspiring younger ones to pursue career as athletes or engage in physical activities. Field trips and leisure opportunities will be provided to maximize usage rate and serve the purpose of a sporting venue.

Chapter 7: Design Suggestions

7.1 Functional flowchart and zoning:

The overall functional distribution has been determined by several factors: the site factors discussed in site appraisal and part 6.1, proposed program typologies and the convenience of users. The entirety of the programs has been divided into three main categories based on public access: public, semi-public and private. Pedestrian circulation has been given a top priority in this project as the existing paths remained un-disturbed which again determined public access points, landscaping, spatial allocation and form development. The indoor sports functions are distributed into two main arenas, which has been dissected by a pedestrian path acting as a transitional spine from north to south. Additionally, a focal point is created in the pedestrian circulation junction, which is considered to be a suitable position for a public exhibition space, or hall of fame which serves as a potential congregation area for people where they will be able to learn about sports culture and history. Furthermore, the dorms will be inaccessible for public as well as the educational block. The auditorium and café will be open for public for refreshment and various events organized by the authority or sports clubs. On the other hand, the outdoor courts will be adjacent to the open field to the north.

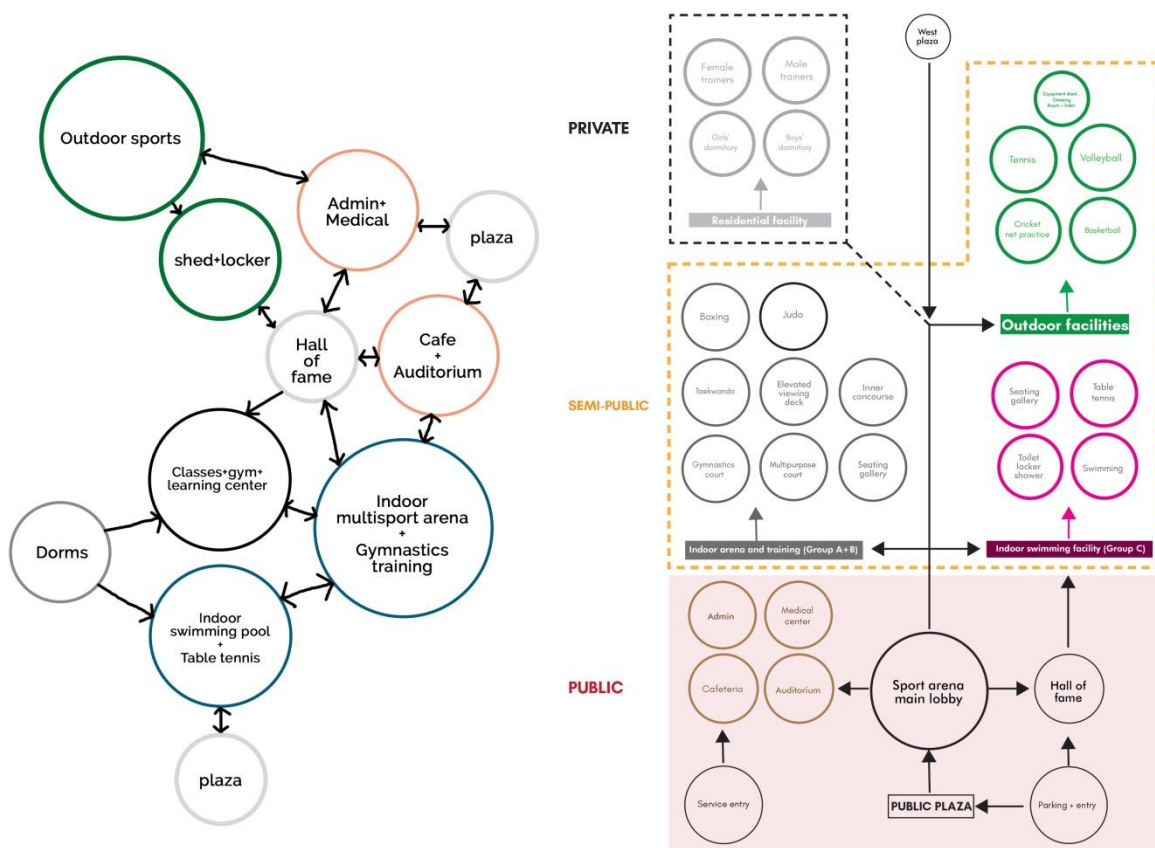


Figure 45: Functional flowchart (Author ,2020)

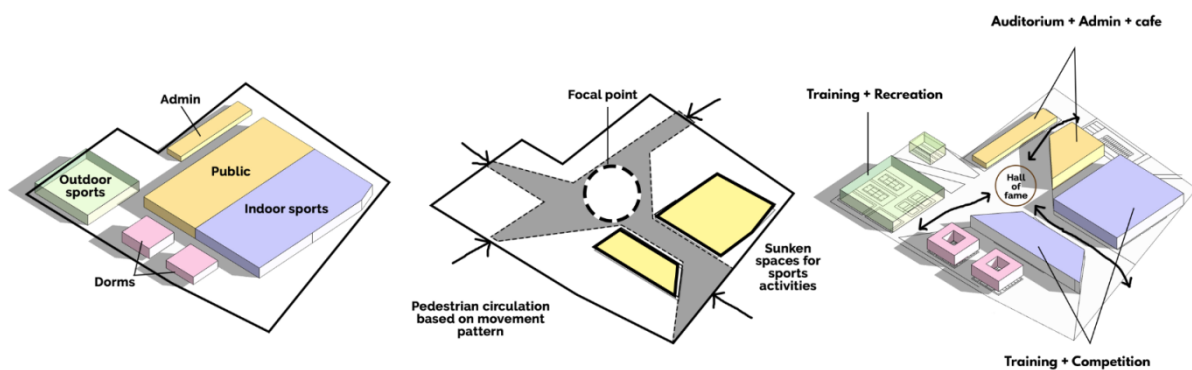


Figure 46: Zoning and design development (Author ,2020)

7.2 Conceptual and structural development:

Once the functional zoning is organized, I tried apply the principles of Delaunay triangulation and incorporate the triangulation generated from pedestrian paths in the design process, producing a tangible form. The two main arenas will be enveloped with a space frame

structure which will function as a skeleton for the entire triangulated shell. The outer skin will be cladded with Aluminum composite panel which is cost effective, light-weight and visually pleasant. Each triangular surface functions as a component of a singular space truss, transferring the load of the entire structure through each fold thus providing stability. Due to the massive span of each element, the depth of the frame has been decided to be at least 4 feet, which will transfer the load to cylindrical columns 2.5 feet in diameter. The number of columns is determined by the span of each triangular element as well as the individual height from the ground. For sunlight and ventilation, numerous skylights have been provided which is integrated with the structure, along with automated windows which responds to weather forecasts and microclimate. Additionally, the rectangular dormitories, adapting the courtyard inspired planar organization, includes triangulated aluminum and steel frames functioning as shading devices for the leisure activities on the roof.

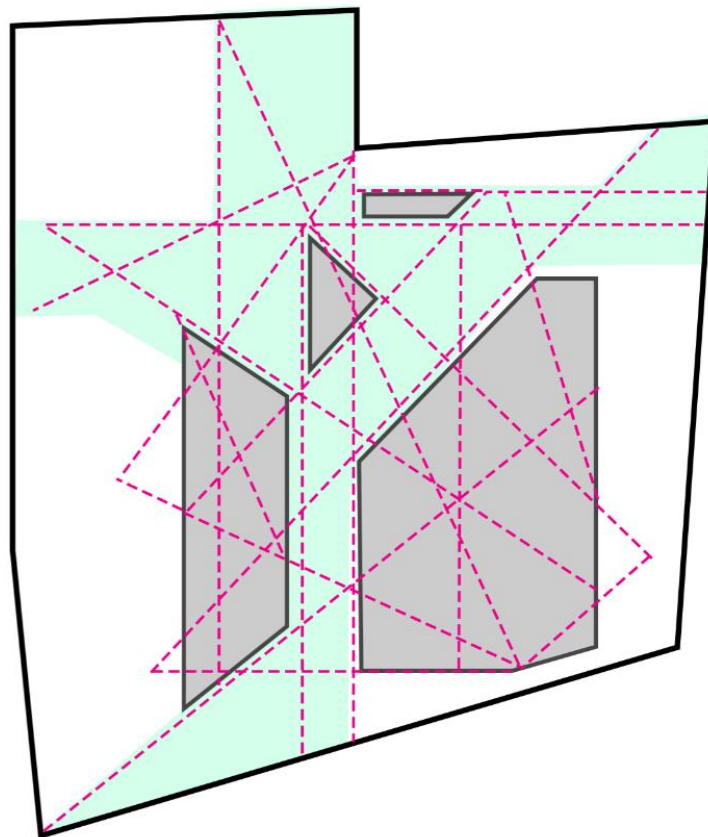


Figure 47: Delaunay triangulation derived from the site (Author ,2020)

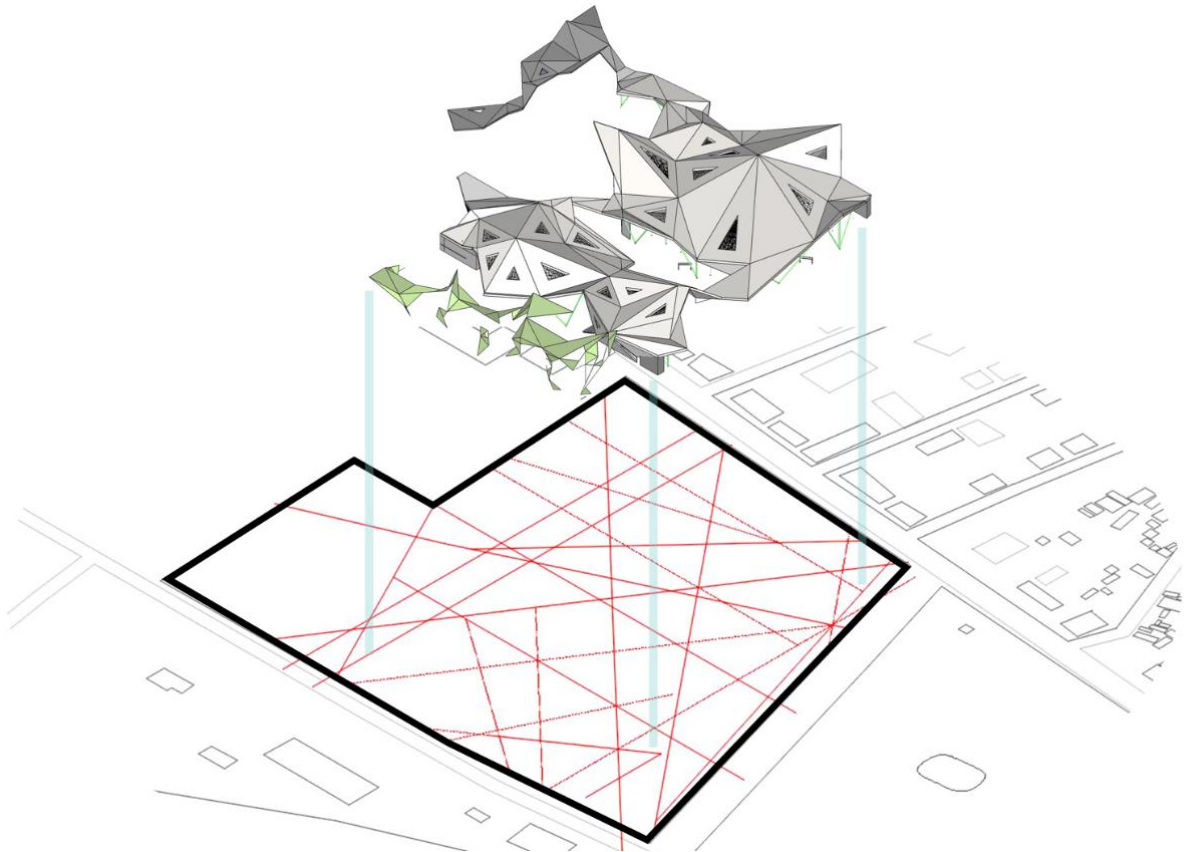


Figure 48: Derivation of form from triangulation (Author ,2020)

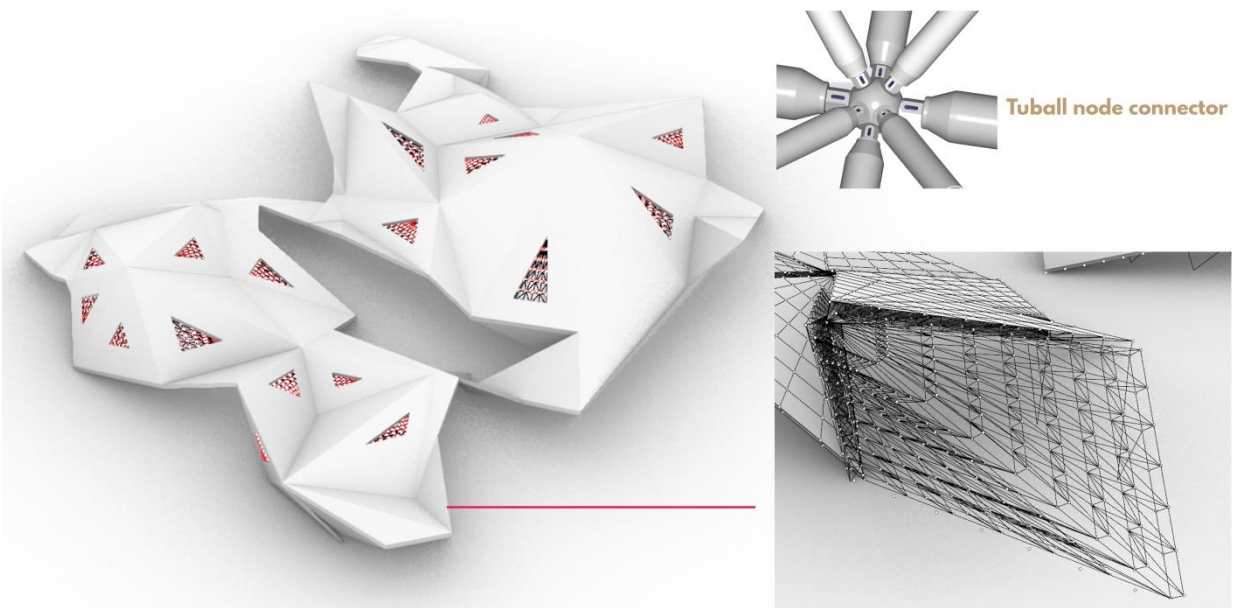


Figure 49: Outer shell structure, space frame detail and joinery (Author ,2020)

7.3 Indoor arena spatial configurations:

The two main indoor arenas are: Multicourt arena to the east and swimming pool arena to the west. Both arenas are designed to accommodate spectators seating gallery and other functions to serve visitors. The multicourt arena includes a five-court competition area as well as a gymnastics arena, where both training and tournaments can be held, along with a seating capacity of 1700 spectators. In the upper level at 15 feet from ground level, the standing gallery is accommodated along with a training area for Judo, Taekwondo and boxing. On the other hand, the swimming arena have capacity of 700 spectators, with lounge and toilet facilities along with Table Tennis training area at ground level. All shower and locker facilities are placed at basement level to allocate maximum space for public circulation at ground level.

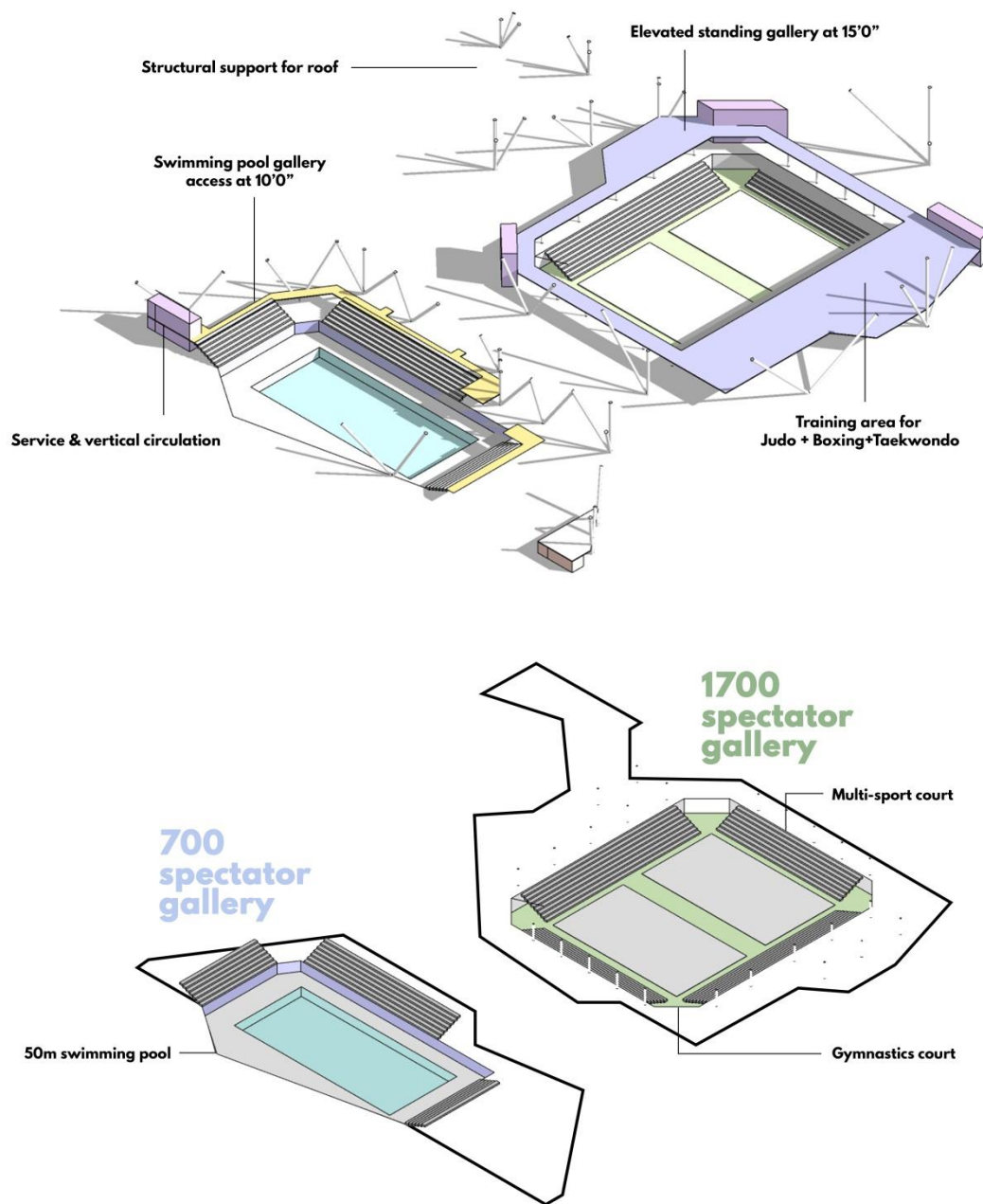


Figure 50: Spatial configuration of indoor arenas (Author ,2020)

7.4 Plans, sections and elevations:



Figure 51: Site plan (Author ,2020)



Figure 52: Ground floor plan (Author ,2020)

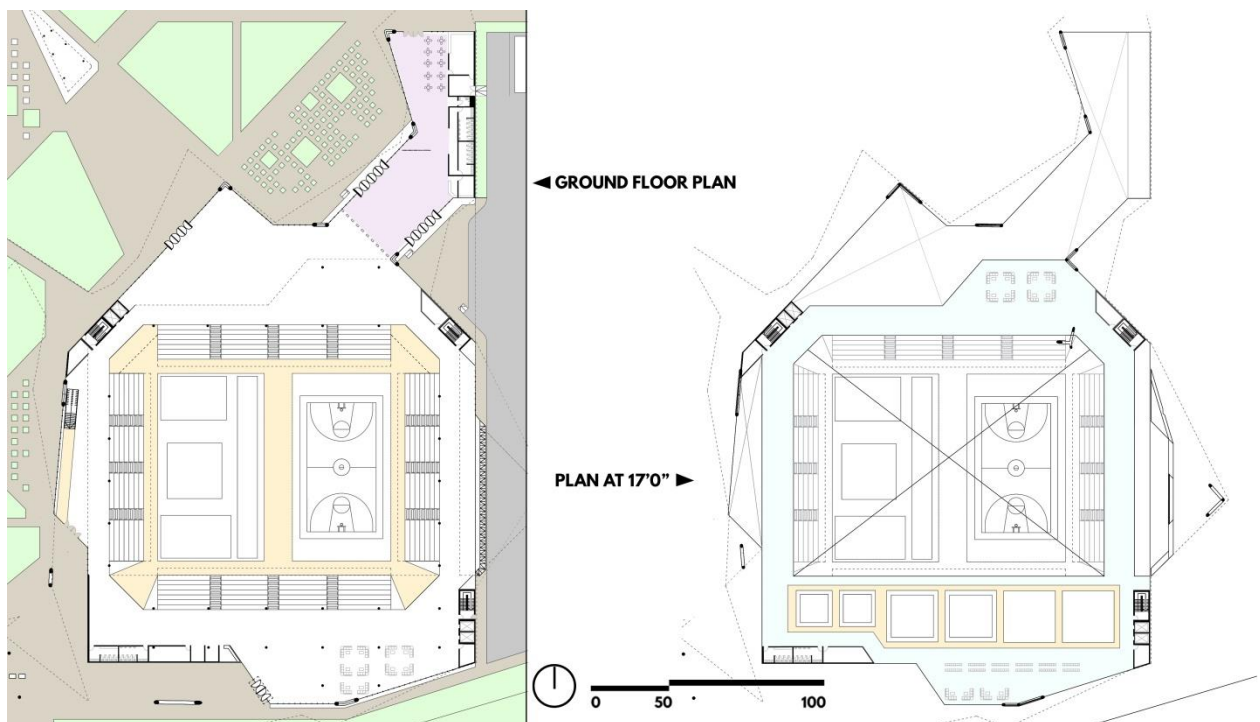


Figure 53: Multi-sport arena plan: Ground floor and @17'0" (Author ,2020)

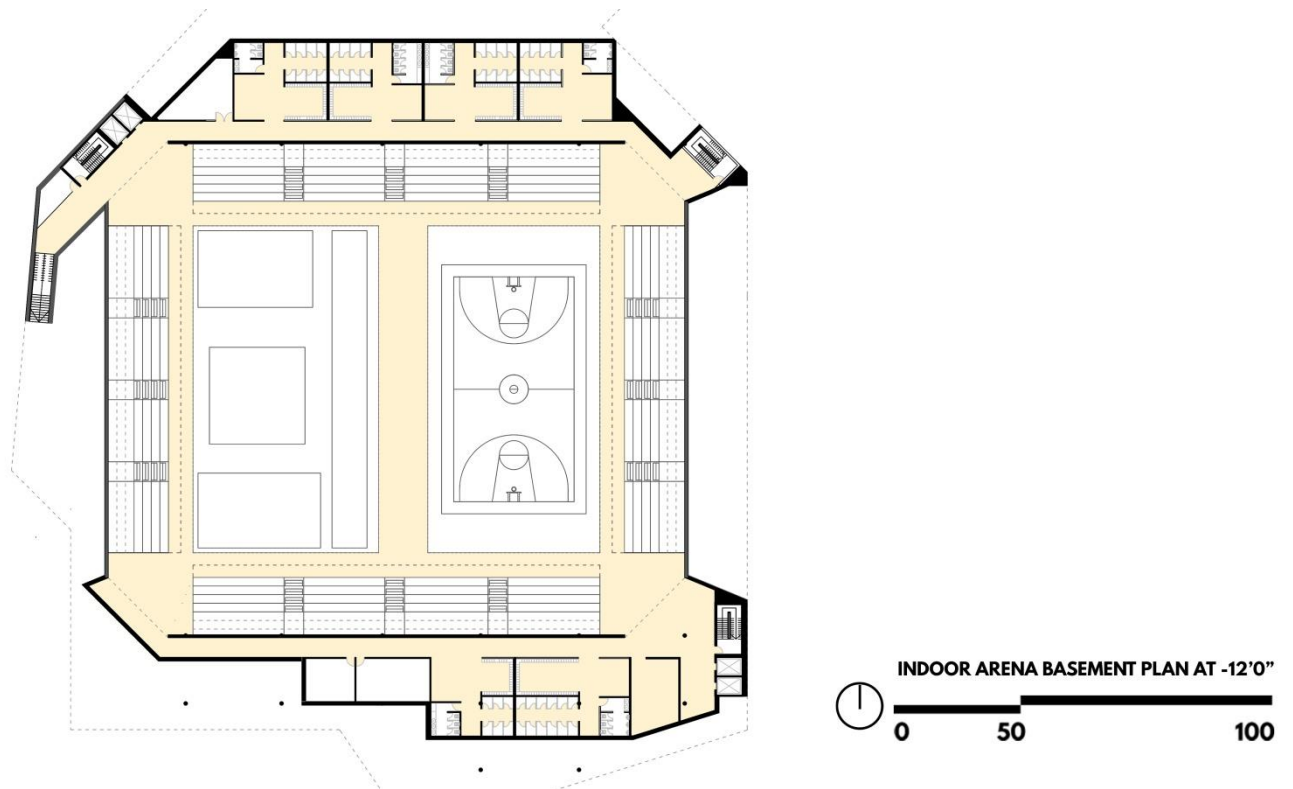


Figure 54: Multi-sport arena basement plan (Author ,2020)

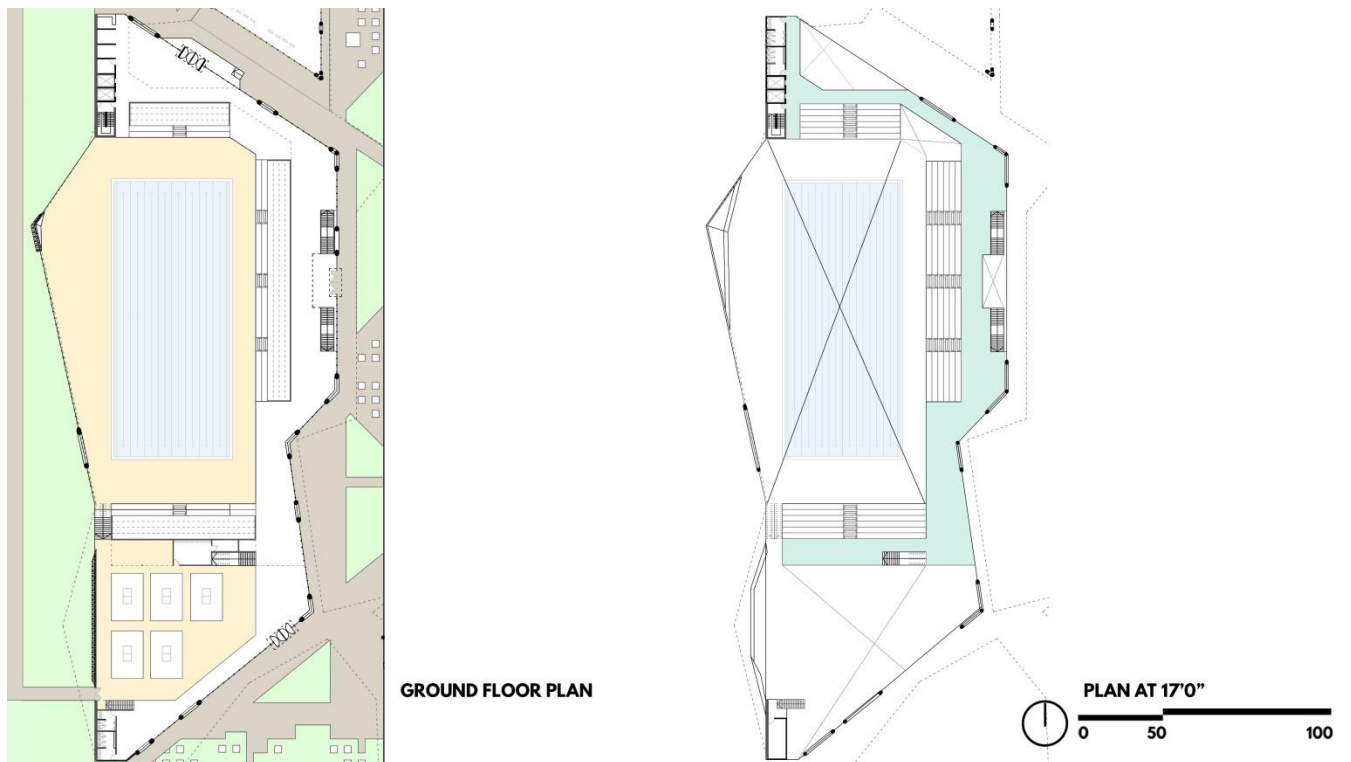


Figure 55: Swimming arena plan: ground level and @17'0" (Author ,2020)

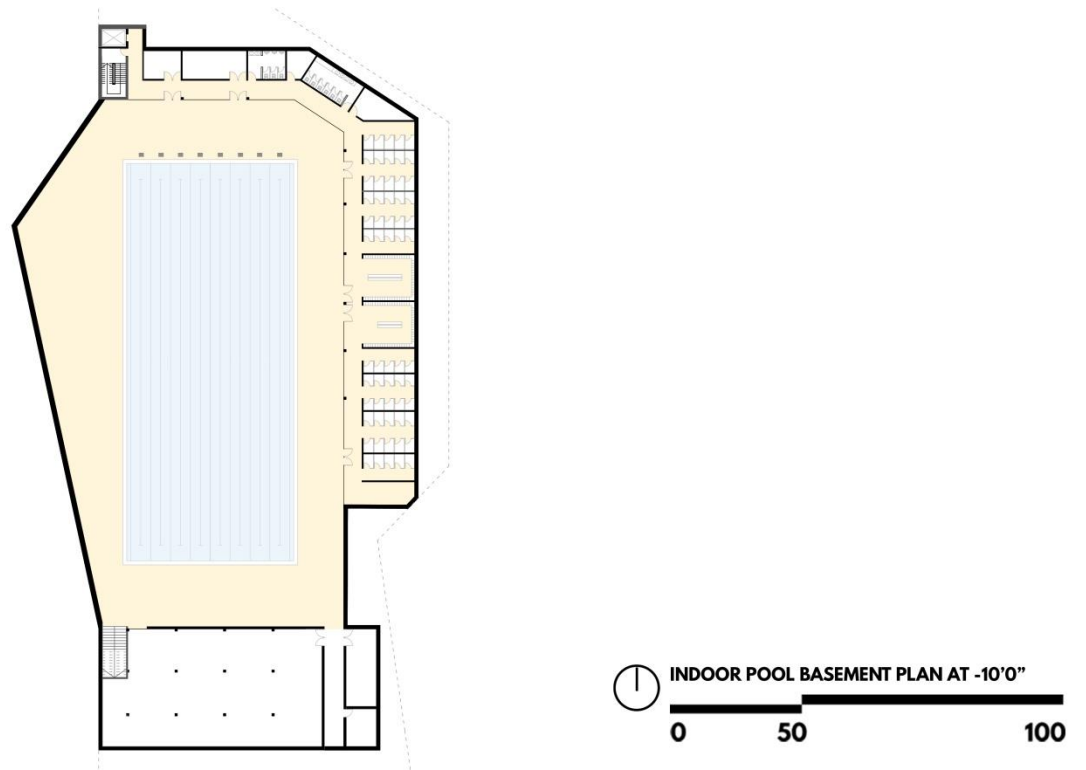


Figure 56: Swimming arena basement plan (Author ,2020)

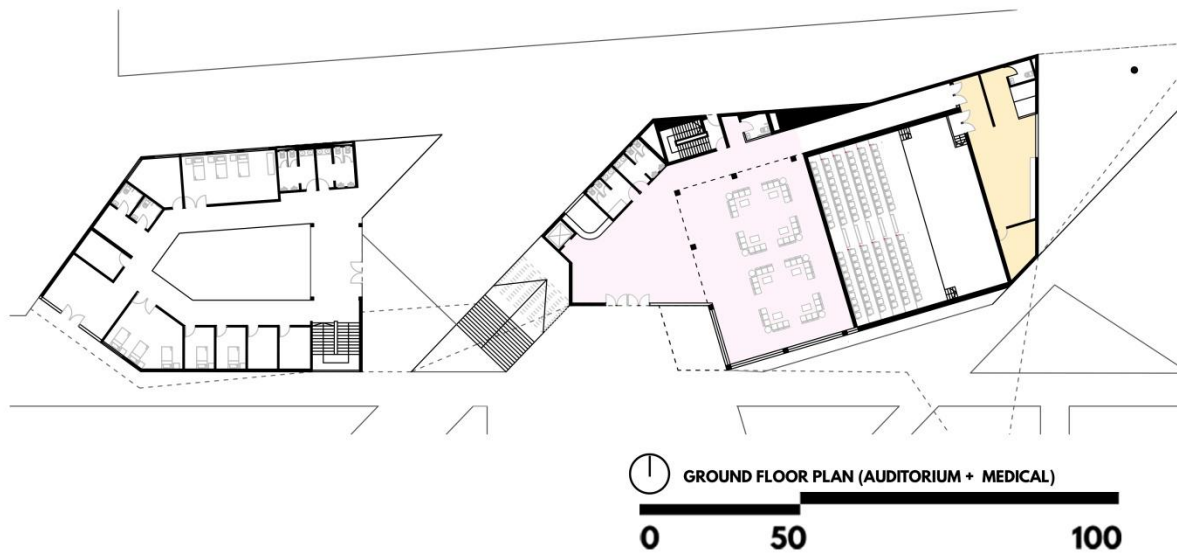


Figure 57: Auditorium and medical facility ground floor plan (Author ,2020)

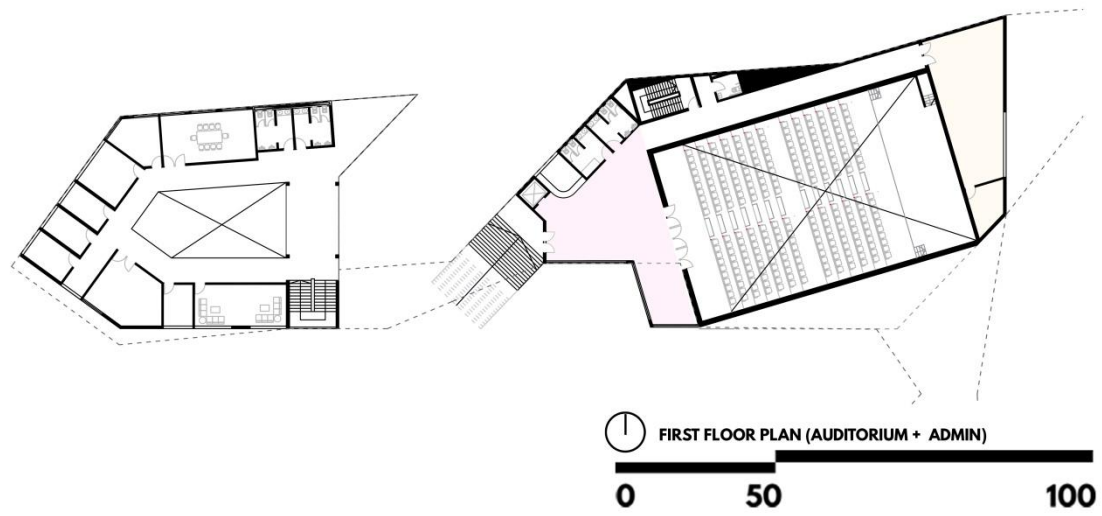


Figure 58: Auditorium and admin facility first floor plan (Author ,2020)

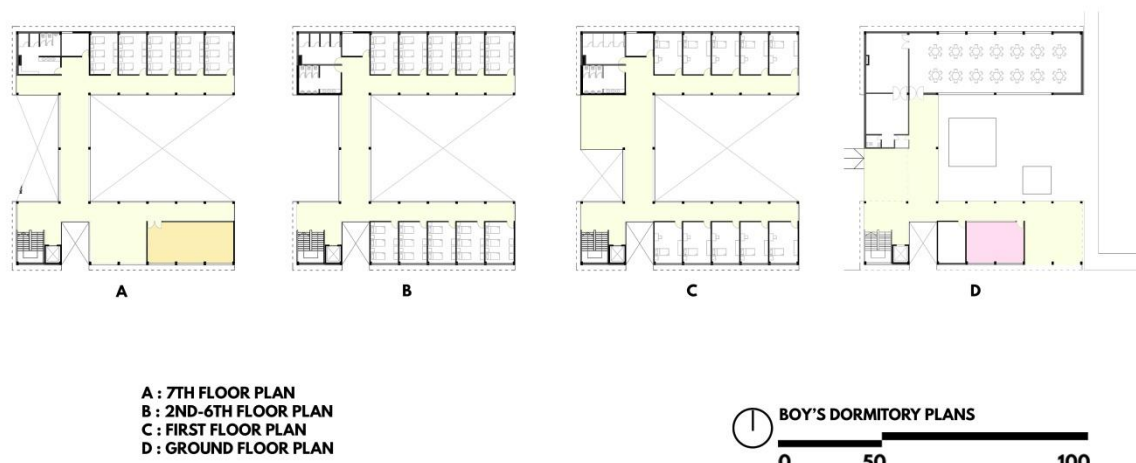


Figure 59: Boy's dormitory plans (Author ,2020)

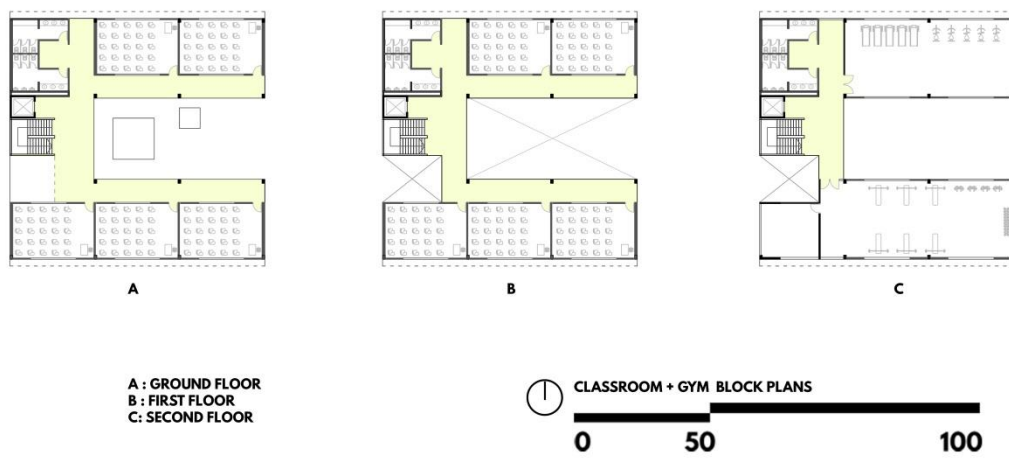


Figure 60: Physical education classes and Gym plans (Author ,2020)



Figure 61: Girl's dormitory plans (Author ,2020)

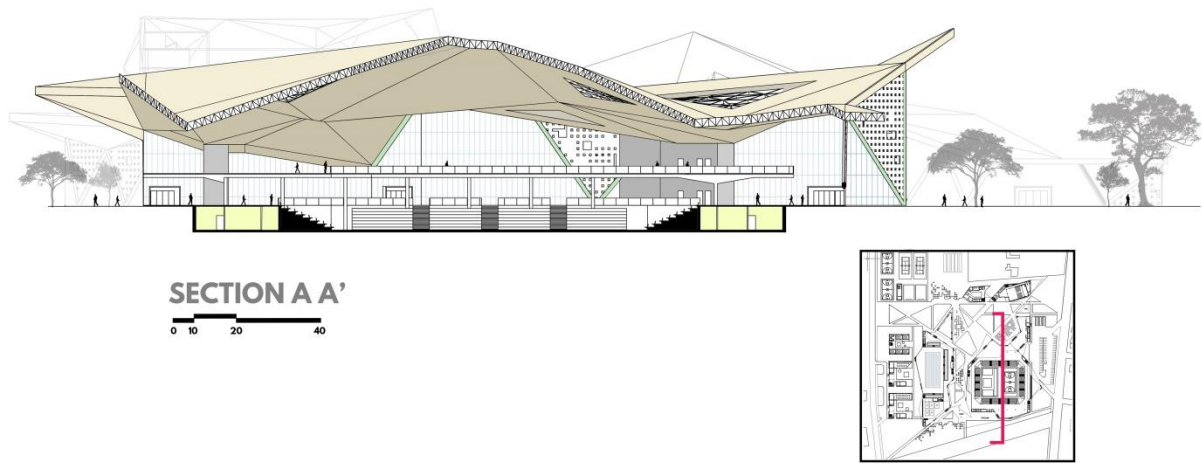


Figure 62: Multicourt arena section (Author ,2020)

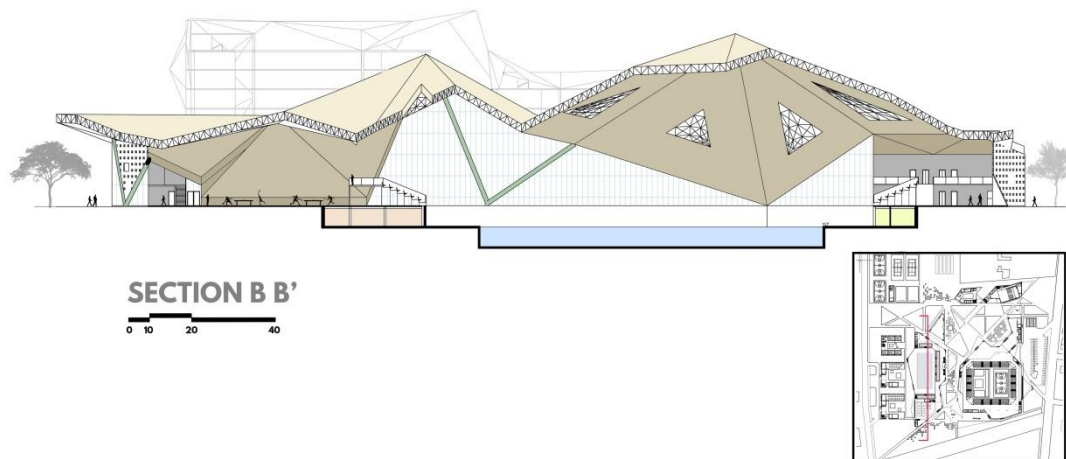


Figure 63: Swimming arena section (Author ,2020)

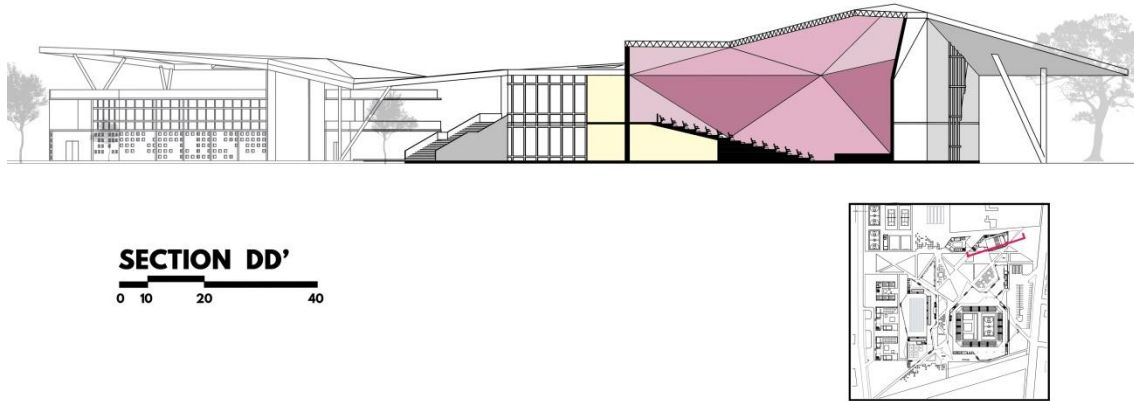


Figure 64: Auditorium section (Author ,2020)

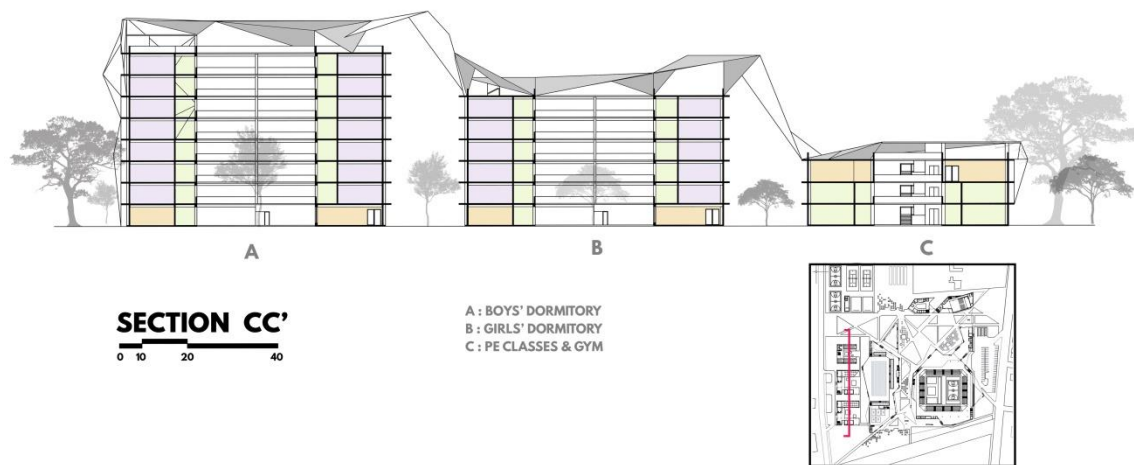


Figure 65: Dormitory and PE classes + gym section (Author ,2020)

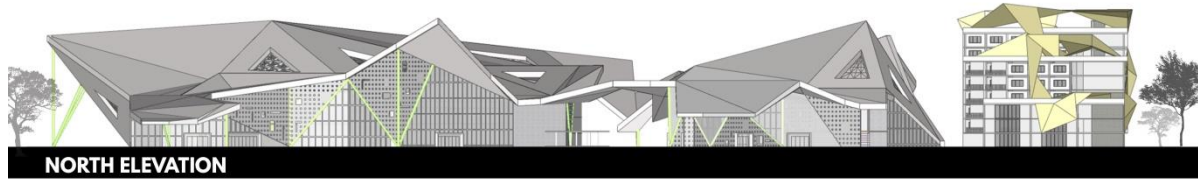
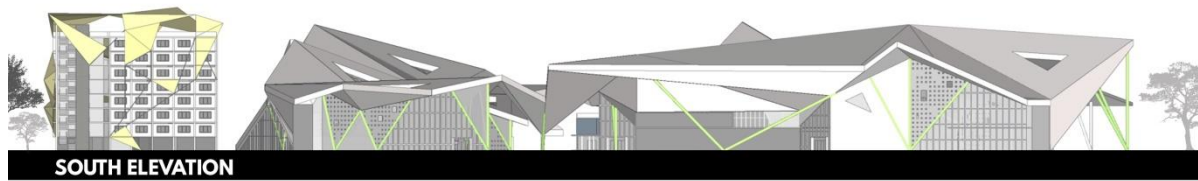


Figure66: North and south elevations (Author ,2020)

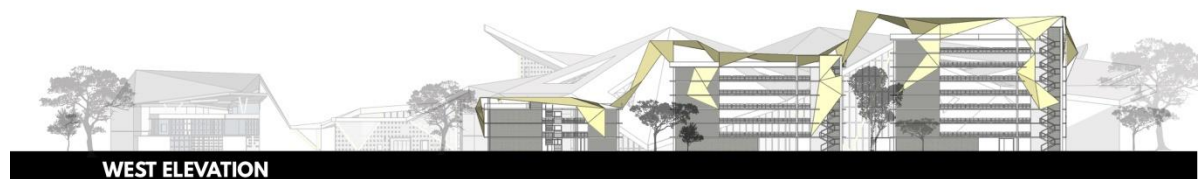
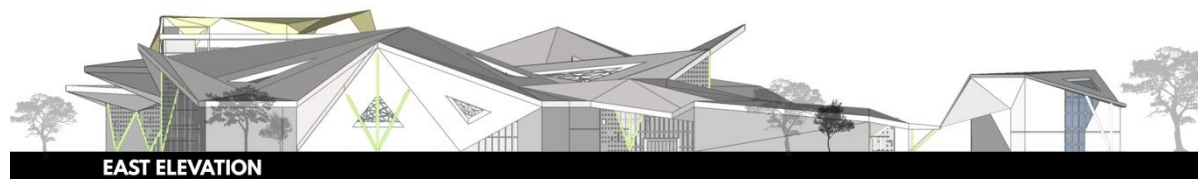


Figure 67: West and East elevations (Author ,2020)

7.5 Renders:



Figure 68: Central pedestrian plaza (Author ,2020)

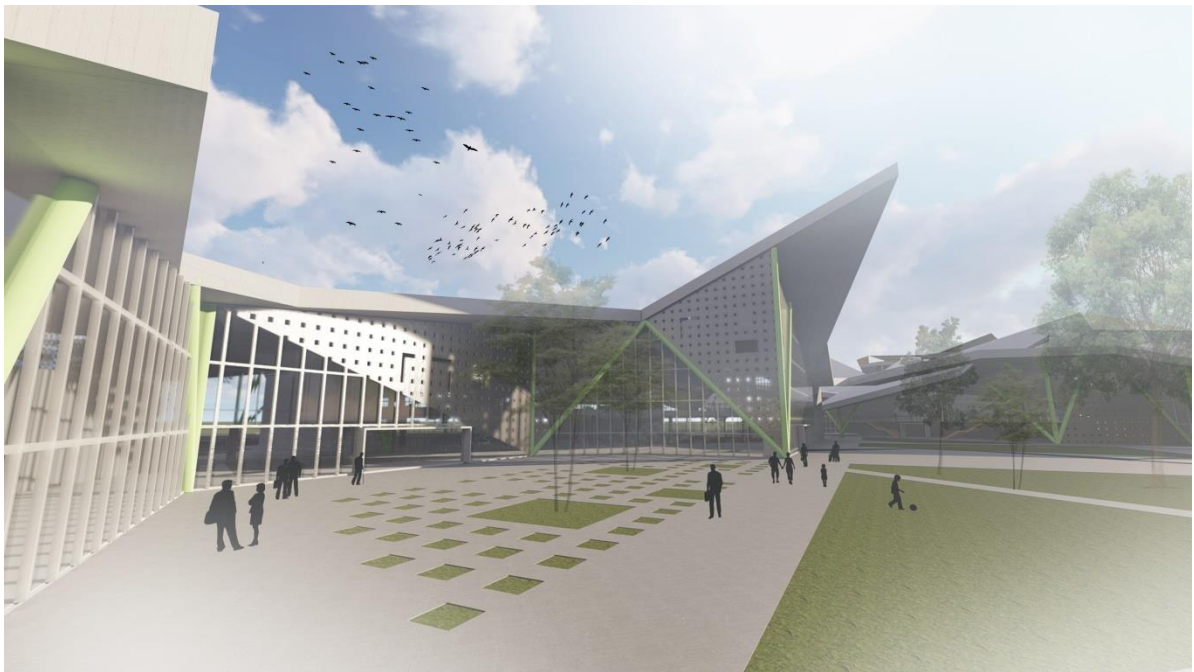


Figure 69: Activity space: north of sports arena (Author ,2020)

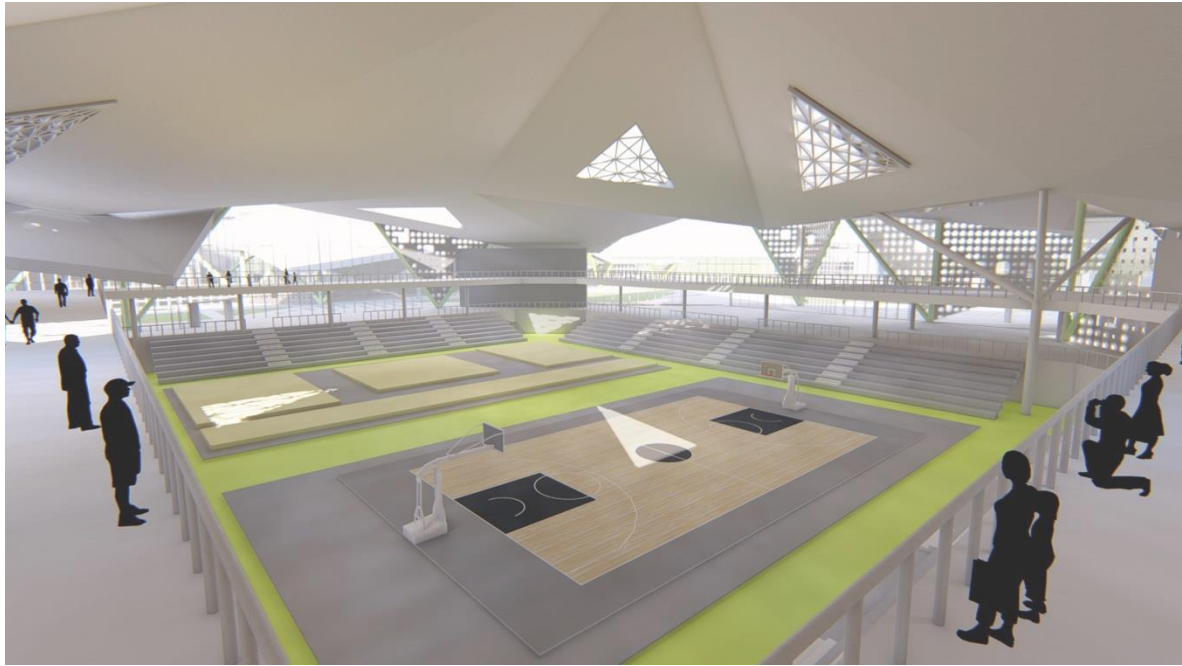


Figure 70: Multi-sport arena indoors (Author ,2020)



Figure 71: Indoor pool (Author ,2020)

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Appendix A.

ଅଂଶ-କ

প্রকল্পের সার-সংক্ষেপ

প্রকল্প পরিচালক মহোদয়
স্বাক্ষর
22.07.20

22.09.70

সুকুমার সাহা
সহকারী পরিচালক (পঃ ও উঃ)
জাতীয় ক্রীড়া পরিষদ, ঢাকা।