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ARTICLE

Inviting Nature into Academic Learning: Exploring the Possibility to Activate the Introvert Courts inside the University Buildings

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ABSTRACT

Established on peripheral sub-urban area of Sylhet city, Shahjalal University of Science and Technology is a public university well known for its beautiful natural environment and diversified landscape with green hillocks, waterscape, forests and biodiversity. But, the academic buildings of the campus were planned in an introvert way that the common void courts remain disconnected from the outside natural environment. Although designed with positive intention, most of the courts remain unused maximum the time of a year. As the campus natural environment is getting richer day by day and users prefer to spend more time in outside environment, it is high time to integrate nature into the academic learning. This research aims to explore the possibilities of these void courts to be incorporated with the outside natural environment to enhance joyful learning. A combined approach was adopted as research methodology consists of intensive physical survey, literature study, microclimate analysis, questioner surveys among the users, interviewing the field experts and selective national and international case studies. Lastly, a set recommendation has been proposed considering all the perspectives and issues that the research has identified.

1. Introduction

Sylhet is known as the "Green City" of Bangladesh for its distinct natural beauty. Each year the city attracts a huge amount of local inhabitants, investors and tourists to visit and settle here. The combination of natural hillocks, tea gardens and water bodies gives it a poetic outlook [1]. The Khadimnagar-malnicherra hilly area laid through the east-west direction adjacent to the city is the main belt of natural green consisting large area of reserve forest, tea gardens and rich biodiversity zones. The west corner of this natural belt is very close with the hilly forest zone of the Shahjalal University campus situated on the sub-urban territory of the city. This connection act as a major factor on campus green and biodiversity pattern that increasing day by day (Figures 1 and 2).

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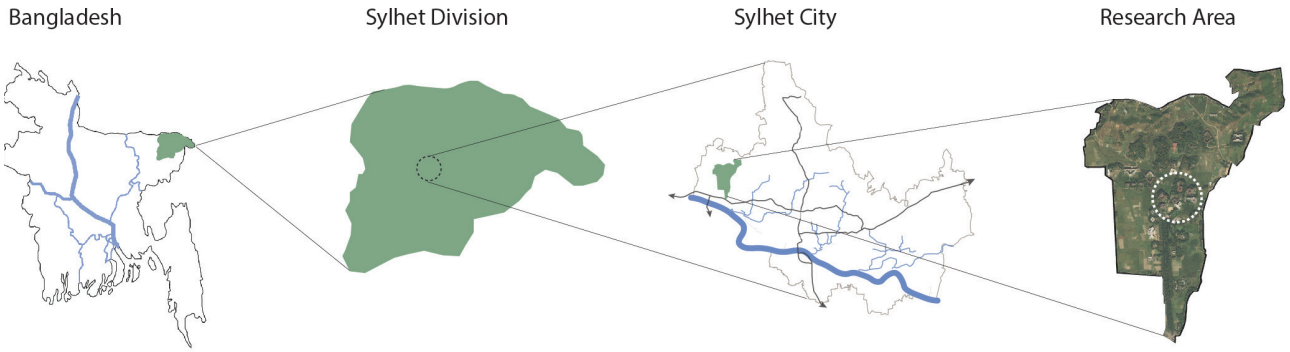

Figure 1. Location map and study area

Figure 2. Campus green cover change over time (Google Earth satellite view)

1.1 Study Area

Established in 1986, Shahjalal University of Science and Technology (SUST) has 320 acre land area counted as one of the major ecological hub in Sylhet city [2]. SUST has an image of green and natural sub-urban campus with a series of low height reserved hills with rich biodiversity that increasing every year. Only 9% is the built area inside the 320 acre campus where 29% has been occupied by the academic buildings built on the flat land which indicates the remaining vast open green space that encourage outdoor learning. There are a large number of courtyard buildings designed for academic, residential and recreation purposes. The campus has five academic buildings named as A, B, C, D and E n to hold the activities of 27 departments of 6 schools (Figure 3). Designed in an introvert manner, all academic buildings have one square shaped open to sky central courtyard surrounded by single loaded circulation corridor with classrooms, offices and supporting spaces. As the classrooms and offices started from the ground floor level, comfortable common gatherings zones are totally absent. Enclosed nature of the voids blocked the interaction possibility with outdoor nature (Figure 4). Despite some marginal uses and maintenance courtyards remain empty and unused maximum time of the year. Although few space modification and rearrangement occurs often in those buildings, courtyards somehow remain unnoticed; even sometimes used as temporary dumping space for broken furniture, goods or instruments. An irresponsible modification in the internal courtyard inside the library building caused darkness in the inner floors and permanent dependency on artificial lighting.

1.2 Courtyard: Significance and Modification

A courtyard can be defined as an open-to-sky enclosed space that surrounded by building or walls, have been designed and improved through the integration of social, cultural and environmental factors. Inducing both physiological and mental sensation of its users, courtyard acts as modifier of microclimate that improves comfort of the internal spaces in a building [3]. As an open and cluster space, courtyard fulfils various aspects as functions, leisure, social perspectives, or microclimatic and acoustic protection [4]. Almost all ancient civilizations of the world including Indus valley, Mesopotamia, Egypt, China along with Greek-roman classical period used courtyard in their built forms as prominent design feature [5]. Courtyard performance depends upon its aspect ratio and configuration, degree of exposure, boundary conditions, orientation, and type of surroundings [6]. Adopting courtyard from other climatic zones neglecting indigenous cultural, social and climatic properties of the community may lead to extreme thermal distress in buildings [7]. It has been seen the central courtyard creates a negative pressure zone within which improves the natural ventilation performance where accelerated airflow evacuates the heat upward [8].

Proven successful in past, many of the traditional courtyards around the world have undergone modifications. Although traditional residential courtyards begun to diminish by the second half of the 20th century in Cyprus

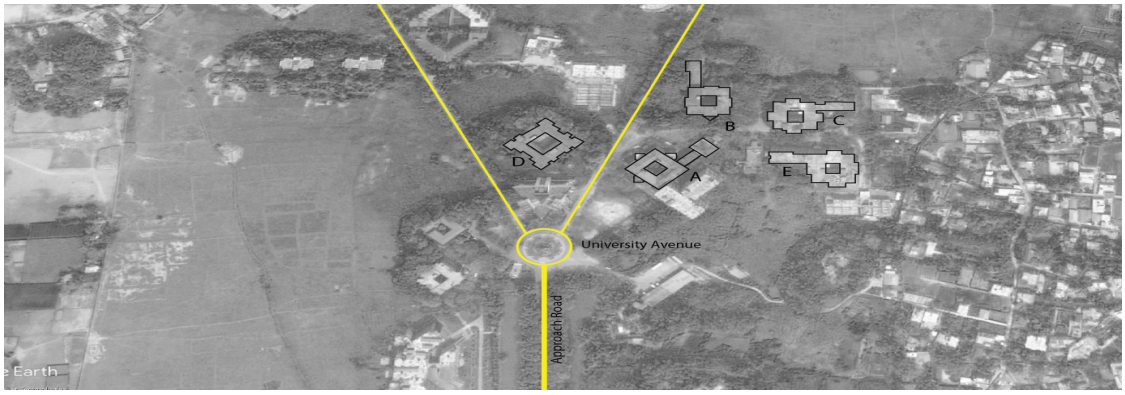

Figure 3. Academic buildings of SUST (Google Earth satellite view, 2020)

Figure 4. Academic building E: Floor plan and drone view

due to technological advancement, changing lifestyles and socio-economic status, but use of courtyards in educational buildings begun to rise at a remarkable rate for its multidimensional perspectives [9]. In Hong Kong University campus healing properties has been promoted on building courtyards where gardens promoted social support inside a courtyard while the meditation garden acted positive for the academic ambience and helped to construct a good sense of privacy and control [10]. Extreme weather or functional need can create diverse ideas as design of greenhouses in the interior courtyards where presence of water and targeted plant species could create a comfortable microclimate and add significant value [11]. Built form around a courtyard is very familiar in Bangladesh, from rural to urban and vernacular to contemporary architectural works, found almost every region of the country. Ancient educational institutes such as 'Shalvan Vihara' and 'Somapura Mahavihara' remaining till bear the traces of inner courtyards. Many educational and institutional building has been designed with inner courtyard mainly for climatic and social advantages. Courtyards in public buildings such as hospital, government offices, college and universities often leftover due to poor maintenance, sometimes become a place of negligence and waste dumping.

1.3 Academic Learning within Nature

Social and psychological behavior of the students powerfully influenced by campus environment also encourages stress reduction [12]. Students get in touch to natural, significant and influential features of the campus during the field visit and get conscious about the importance of natural surrounding and biodiversity conservation when they engage with campus landscape [13]. As the learning process takes place over entire campus with a continuous flow, fragmented or dedicated indoor rooms are not sufficient to make sure total learning [14]. Stewarding nature helps to build resilience through healthy ecosystem services, competence and social bonding [15]. Installing natural elements inside a courtyard would produce impressive environmental benefits and the thermal comfort [16]. Large number of plants lowers the temperature by evapotranspiration and photosynthesis activities as vapour is released to reduce the temperature of the surrounding [17]. Significant change in academic learning at the university level worldwide engages environmental and social responsibilities to ensure sustainability in local and global context although

ecological priorities are still neglected in physical planning phase in most areas [13].

Except few historical conservation or revitalization, study on courtyard reuse or modification is very rare in the field of research. Along with environmental possibilities and socio cultural significance, these courtyards have enormous potentiality to be turned into prospective valuable space for the entire campus. This research aims to explore the potentiality of these courts to connect with the outdoor natural environment to enhance academic learning. At first, the research attempts to identify the present scenario of these courts and related other factors. The next step is to understand the experience and demand of the stakeholders with suggestion from the experts who has experience on designing courtyards in this context. National and international case studies on courtyard design in academic buildings included on the next step and finally a set of acceptable, applicable and manageable recommendations has been proposed. In recent decades a clear paradigm shift has been noticed from a mechanistic to more socio-ecological approach on regenerative design and development around the globe [18]. Composing environmental concerns in aesthetic and emotional terms in the university level has the ability to break down the conventional paradigms to foster sustainability, ecological consciousness, interactive spaces, and speculative dialogue across the disciplines [19].

2. Materials and Methods

In this section, the methods used to obtain the results in the paper should be clearly elucidated. This allows readers to be able to replicate the study in the future. Authors should ensure that any references made to other research or experiments should be clearly cited. A combined approach was adapted to understand the scenario from multidimensional perspectives. Along with the physical survey and literature study research attempted to understand specific experience from the users to identify the factors behind the current scenario and also count the suggestions for future improvement.

2.1 Physical Survey

Physical survey was conducted separately for each academic building to collect information on court enclosure, aspect ratio, building material, surface and vegetation, drainage etc. to construct proper physical overview. The survey also included socio-cultural dimensions to understand the user behavioral pattern and expectation, social and cultural impact on indoor learning environment, recreational use etc. Computer aided model with proper geo location for each building were created for climatic analysis. Both physical and computer based data were compared for different time periods and seasons (Figure 6). Satellite images (Figure 2 and Figure 3) along with photographs (Figure 5) and drone view (Figure 4) have been used to clarify the actual scenario.

2.2 Questionnaire Survey

A survey was conducted among the students of Shahjalal University of Technology, Sylhet from January to March in 2020 asking their opinion toward usage of the inner courts in their academic buildings. The survey included 50 students chosen randomly from each of the five academic building. The questionnaire included a set of ten questions (Appendix A.2.). Eight of those were focused on the necessity of the courts, consistency of use and view towards rethink whether last two was an invitation to broader opinion. Collected data later converted to Likeart scale format (Appendix table A.1.) and create an unambiguous scale to use in satisfaction analysis [20]. The sample size was determined by the following formula: $n = N/1 + N (e)^2$, where 'n' is the sample size, 'N' is population and 'e' is the level of precision which is ±20%. The other two questions covered the ideas, needs and suggestions regarding building specific courts.

2.3 Expert Interview

Opinion from expert bodies helps positive decision making. In this case experts were chosen based on their experience, locality, professional affiliation and academic knowledge. The study team selected two persons as experts from relevant study field, were interviewed about the design intension, present condition, shortcomings, possibilities, affordable and sustainable suggestions on rethinking the existing courts in the academic buildings of the campus considering the surrounding natural advantages. It is to be mentioned that the both selected persons are active faculty member of the University, has more than 12 years of experience in academy and nearly 20 years in architecture profession.

2.4 Case Study

Academic open to sky courtyards were the primary consideration as case studies. Significant features, design intention, appearance, aesthetical appeal, users perception marked as other criteria. Later, cases narrowed down to climatic similarities, relevant building height and mass, aspect ratio and aperture and sensible design for more intensive study. The selection ended up with one national

and one international project. For national selection climatic and socio cultural context were also considered. In case of international, sustainable and innovative solutions were considered. First one is the Faculty of Animal Husbandry designed by American architect Paul Rudolph in Mymensingh city of Bangladesh and the second one is the University Presidency building in University of Brasilia, designed by brazilian architect Paulo de Melo Zimbres and Érico Weidle which was built with attractive gardens in a welcoming way visualized as an oasis.

3. Results and Discussion

Academic Building A has the only soil covered courtyard in the campus where other four has plastered ground. None of the courtyards has any define activity. All of the courtyards discourage physical accessibility due to solid brick railing on corridor side. Academic Building D has the largest courtyard and has notable seasonal activities as cultural program, exhibition, mini concerts, indoor sports etc. (Figure 5). Rainwater runoff system works quite well in almost all the courtyards. As seen in Table 1 only academic building 'A' courtyard has some vegetation but not in any clear planned way. The aspect ratio is square but the size of the courtyards mainly contributes to the diverse functional entity. A clear lack of ownership was observed during the survey. Often different departments dump their debris on the courtyard and remain there for a long period of time. The physical barrier was one of the primary deterrents behind the lack of connectivity to the courtyard. From the questioner survey among the participants 210 questionnaires returned maintaining 84% of response rate. The result of students' response regarding the courtyard usage survey is showed in Table 2.

According to Table 2, majority of the respondents agreed on the necessity of a courtyard in their academic buildings. 43% of the respondents feel the extreme necessity of courtyards, 31% of them felt courtyards are very necessary. Despite the fact only 21% of the respondents thought that the use of courtyard is fairly moderate and a majority of 53% of them responded the present usage of courtyard as 'poor'. In the following question they were asked about the idea of modification to connect outdoor nature, 57% of them responded 'very

Figure 5. Present condition of the courtyards of Academic building A, B, C, D and E

Table 1. Overview on comparative physical analysis of different courtyards

Subject	Academic buildings				
	A	B	C	D	E
Aspect Ratio	Square	Square	Square	Square	Square
Dimension(Sq.ft.)	46X46	42X42	44X44	66X66	40X40
Enclosure Material	Exposed Red Brick Wall, Painted Concrete columns				
Ground Material	Soil	Concrete	Concrete	Concrete	Concrete
Permeable Surface	100%	0%	0%	0%	0%
Vegetation	Wild grass, Medium height plantation around edge, One Large Plant around the center	No Vegetation, Algae grow during Rainy season	No Vegetation, Algae grow during Rainy season	No Vegetation, Algae grow during Rainy season	No Vegetation, Algae grow during Rainy season
Drainage	Disconnected Inlet	Disconnected Inlet	Connected Inlet	Connected Inlet	Connected Inlet

Table 2. The result of student response on courtyard survey using Likert scale

Topic of the question	-2	-1	0	1	2
Necessity of court	9%	5%	12%	31%	43%
Usage of court	15%	53%	21%	7%	4%
Modification of court	2%	9%	28%	57%	4%

likely' about repurpose, 28% of them thought the idea was 'likely', 2% of the respondents thought the idea as 'waste of resource'. Then the students respond over six functional ideas, and they choose according to their needs specified to the courtyard they occupy. Shadow analysis help to determine the courtyards exposure to direct sunlight, which influence the use frequency, placement of any function, vegetation and so on. 3ds max geo-location was used to locate the models in their exact locations shown in Figure 6. Three different daytime data of 16th of May & 1st December was generated for each courtyard to overview the major difference between summer and winter. According to this analysis during winter the whole daytime can be utilised for any kind of use as there is no direct sunlight to ground, but there are direct sunlight on the surrounding walls. On contrast in summer exposure is greater resulting in direct use to a smaller extent. Figure 7 demonstrates the count of response on several functions for different courtyards. Here some basic functions like waiting zone, food zone, and cultural activity zone were much anticipated by the responders. Then occasional sports and large cultural activities were popular in the larger size courtyards. Outdoor classroom as a co-curricular function varied with the activity type of different departments occupying different building courtyard.

Experts had expressed their thoughts on multidimensional perspective of actual scenario. Mohammad Shamsul Arefin, Assistant Professor and landscape specialist stated that landscape modification with nature can easily make these courtyards more active and valuable even those are different in size. Innovative and separate modification ideas for each courtyard with different seasonal appearance will break the chain of monotony that can create a unique identity for each academic building. Different ideas may include diverse plantation, seating zone, game zone, amphitheatre etc. but should not include any water bodies as those are hard to maintain and may lead to increasing mosquitoes in campus. Hanging creepers, shaded trees or multilevel plantations on different floors can provide a volumetric green escape zone for the users. He also added plastered ground and surrounded solid railing

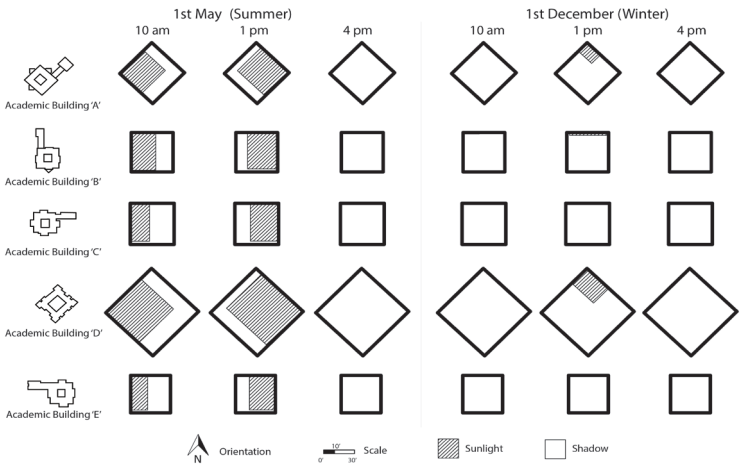

Figure 6. Shadow Analysis of Courtyard Illustrated

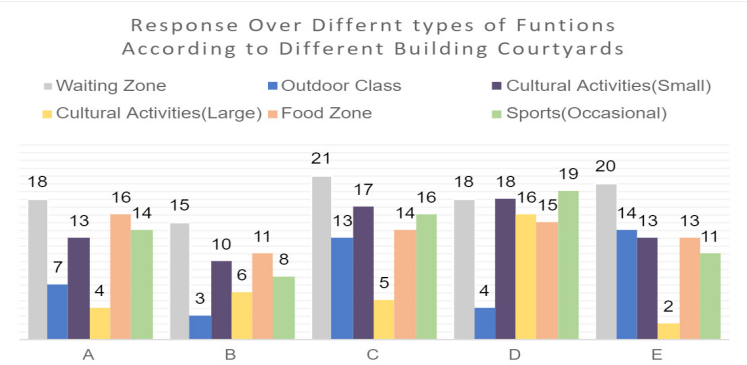

Figure 7. Response on different types of reuse proposal according to different building courtyards

should be removed with more transparent solution to encourage accessibility where ground may include stone chips, grass and attractive landscape furniture with proper drainage installed to deal with heavy rain. The campus is already rich in biodiversity, courtyards with seasonal flowers, fruits and leaves will attract various species of birds and insects that will offer natural stability and healthy learning environment. Kawshik Saha, Associate professor in the same Department, emphasised the universal acceptance of courtyard through its long and successful journey from vernacular to contemporary practice. During his stay in Andalusia he noticed the successive role of courtyard against harsh weather. Enclosed courtyards are common in the contemporary public buildings in the country due to compact structural design, climatic consideration as a source of ventilation and light along with aesthetic purpose as garden and cultural priorities in some cases. He argued that, socio-cultural significance was not considered on designing the courtyards in SUST. Poor accessibility and unnecessary plastered ground made those spaces dumb and trapped. He thinks, student behaviour pattern should be analysed for sustainable modification and outdoor natural environment and biodiversity must be counted on any kind of modification. As student occasionally use some of those courts as badminton court, mini concert, religious ritual as 'Swaraswati puja' and 'Ifter party' and fresher reception program, it clearly indicate the rich cultural environment present in the campus where courtyards might play a major role to construct the cultural backbone of future generation. Vertical landscape and plantation works, seating facilities, provision for outdoor classes, amphitheatre, gallery or multipurpose use character whatever the solution must come through user preference and participation for prime success. Alternation should be minimum, limited to the maintenance capacity, he also added.

Designed by Architect Paul Rudolph, Bangladesh Agricultural University has several prototype courtyards for different faculty connected through shaded corridors. Unique ambience, accessibility and connectivity made the learning environment admirable. The ground level is inviting and accessible with different potted floral plantation over different season is a significant feature here. Architect Paulo Zimbres showed significant natural and structural mingle on his courtyard design in University of Brasilia, Brazil where semi shaded frame used with creeper like vegetation created a pleasant learning and recreational atmosphere (Figure 8).

Figure 8. Faculty of Animal Husbandry, Bangladesh Agricultural University and University Presidency building, University of Brasilia, Brazil

Source: Author and Internet

It is clear that the green natural environment campus of present days is very different from the state when SUST start the journey as a university proposed on a barren paddy land with some treeless hillocks. When the introvert courts were proposed the outdoor environment does not contained any significant natural features. But with the time the campus landscape, scope of work, vision of the authority, user's perception and also the campus planning criteria changed a lot. Peoples concern for natural campus and learning environment added more dimensions on the demands of the users. As seen on the physical survey analysis the courts have many potentialities to integrate the natural environment inside the built form. The users demand also aligned in the same way. Climatic analysis also shows that the courts are quite comfortable to modify with natural features to foster the public gathering and different activities. Expert's opinion, national and international case studies indicates that it is the prime time to invite outdoor nature inside those less active introvert courts with sensible modification proposal. The study concludes with the following recommendations:

- An integrated approach through the participation of the authority, users and field experts could provide the specific guideline to meet the expected result under the capacity of management.

- Impermeable ground surface should be replaced with soil and semi paved solution.

- Solid boundary wall around the court should be removed for better accessibility. Ground level can be left without formal functions to encourage social gathering and informal learning. Small pocket space or balcony on different level will connect the users with outdoor nature.

- Tree selection and plantation should be planned under expert opinion and observation. Multilevel plantation could add a new dimension and foster biodiversity. Vertical creepers on the west side of the court will provide shade on adjacent circulation corridor.

- Modifications of each building court should be considered separately considering the visions, surroundings, user demands, existing uses and scope of maintenance. Creating new identity for each would be more inviting and will help to grow sense of ownership among the users.

- The seasonal variations and different types of positive social gathering should be considered in modification proposal. The desired change should inspire the users, create surprise for the visitor and encourage others to follow.

There are a number of limitations in this work. Larger response from questioner survey could generate more accuracy which was not possible due to time restriction. Scientific measuring and intensive analysis were not possible due to lack of fund and manpower. Design and performance of academic courtyards are common research topic but reusing or modification of public space is still a new topic. So, lack of previous studies in the chosen research area was a negative influencing factor.

4. Conclusions

This research is a primary attempt to stand for the modification of the less used common spaces with natural features to make those leftover assets more live and joyful to the users. This study can easily contribute on creating new resources with less attempt and money even with economic regeneration. In case of Bangladesh, considering this modification issue on the larger public building courtyards can add a significant change on the people's perception of built environment.

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Appendix

Table A.1. Likeart scale value used in Courtyard survey:

Topic of the question	-2	-1	0	1	2
Necessity of court	Not at all	Slightly	Moderate	Very	Extremely
Usage of court	Very poor	Poor	Fair	Good	Very good
Modification of court	Waste of Resource	Not Likely	Likely	Very Likely	Burning Need

A.2. Questions used in survey:

1. Which academic building you belong to?

i)A ii)B iii)C iv)D v)E

2. How important do you think the presence of courtyards in the academic buildings in the campus is?

i)Unnecessary ii)Roughly necessary iii)Necessary iv) Very necessary

3. How are the courtyards of the academic buildings of the university being used?

i)Going unused ii)Being used sparingly iii)Being used properly

4. What is the scope of versatility of the courtyards of the academic buildings of the university?

i)There is no chance ii)There is a fair chance iii)There are opportunities

5. Which academic building are you currently directly involved with?

i)A ii)B iii)C iv)D v)E

6. What kind of courtyard activities in your academic building can ensure its proper use in the future?

i)Sports ii)Cultural iii)Occasional iv)Waiting zone v) Co-curricular vi)Others

7. Which academic building courtyard do you like the most?

i)A ii)B iii)C iv)D v)E

8. Which courtyard of an academic building do you feel is not being used properly?

i)A ii)B iii)C iv)D v)E

9. What other courtyard do you see that is being used better than your campus?

10. Any other comments on the courtyard of the academic building on campus?