

ANALYTICAL STUDY OF THE SPATIAL DIVERSITY IN ADDITIVE MODULAR ARCHITECTURE; WITH SPECIAL REFERENCE TO DUTCH STRUCTURALISM

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Abstract

The research is based on stimulations of the modular architecture towards spatial diversity in buildings. The main attributes of the research is established on Dutch structuralism as the hypothetical base for the study. Comparing the typical buildings, their spatial arrangement of forms and spaces, which generate through structuralism comprise of high diversity alongside different spatial qualities. The complex form generated through the combination of small forms, creates distinctive spatial diversity in such forms contrasting with the typical building arrangements and its spaces. Rather than accomplishing organic forms, Structuralists regularly practice the hypothesis of modular architecture, which formulates solid forms to resulting with meaningful edges and spaces within the interior spaces. Local approaches to modular architecture have developed with simple modules for simple construction further their informal arrangement of functions. Considering modular architecture in Sri Lanka, the author has chosen two case studies with similarities and differentiate and critically analysis internal spaces in each case and support to comprehend the dimension of varieties in spatial diversity.

Keywords: *Spatial diversity, Additive principle, modular architecture, Dutch structuralism*

1. Introduction

The notion of well-being and the feeling of users always deals with Architecture. When designing a masterpiece, the vital factors of the final outcome is "Form" and "Space". The mutual relationship between Form and Space can interconnect with each other both positively and negatively. That relationship explains the development of space as an output of form, on the other hand, the development of a form creates spaces within it. The final outcome of the objective manifesto is when these two factors are balanced equally.

A building morphological system can be a keyword or a mind opener to generate programmatic basis or architecture and nature. Structuralism is a theory which is based on that particular building morphological system identified as an architectural structure. In history, the Dutch structuralists have focused into more informal methods of solving problems. Dutch structuralism is more into international problem-solving methods than local ones, in bigger areas and the problem-solving procedure was also in a different perspective, as the building process becomes increasingly complex, ambitious and global. One of the main concerns was forgetting the theoretical features of the building and forcing on the function. When considering the building types and forms, more or less they all may look the same. Paying attention only for one element or a cell was a key feature on theory. Managing and organizing that simple cell into many formations and innovative structures as per need was designing position in that process. Structuralism introduced a way of thinking about architecture as part of a bigger configuration or morphology. And it offers a strong approach to think of the individual entity and the whole simultaneously.

When considering the spatial qualities of these buildings, the spatial diversity is minimal because of the clustered design morphological system, but when considering the larger area that will show the spatial diversity will increase the building size with the complexity. That lacking spatial diversity and its behavior with form will be discussed in this research. And also, there are some buildings which are designed considering all these factors as well. This research will more over conduct into the local context while discussing these international theories by considering modular and additive construction. Within the country and the spatial diversity of these buildings. And the design limitation with achieving more innovative spaces while designing. The research will consider and discuss the design gap within another type of buildings with this particular building type with a different perspective, spatial diversity.

2. Theoretical exploration on Dutch structuralism

With the worldwide economic crisis, abandoned buildings and urban sites have increased and has gained attention for alternative design practices. It paves the way into the concept of Structuralism, which concentrates on the ability to practice in transformable, adjustable, sustainable ways with changing circumstances and conditions. The first step is to learn the issues focused on architecture, urban design, and landscaping.

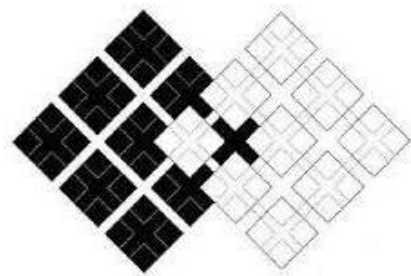


Figure 1: Structuralist forms
Source: open Structures, S.Frausto

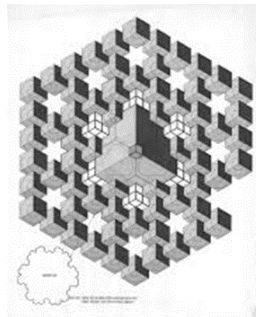


Figure 2: Structuralist forms
Source: open Structures, S.Frausto

Considering Dutch architecture, their culture was always innovative and as buildings got complex, they transformed within. Looking at the built environment, there's the possibility of learning and creating the opportunity for innovative architectural knowledge based on the collaboration between architects, designers, citizens, politicians and institutions.

2.1 THE ADDITIVE PRINCIPLE IN DUTCH STRUCTURALISM

The main concern in structuralism is the attention given to the role of architects and finding alternative definitions for architectural projects. Similar to notions such as openness and generosity, structuralism also faces issues regarding the understanding of the design and taking into account other spatial agencies.

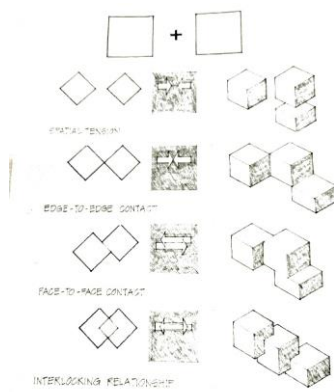


Figure 3: Additive forms
Source: Architecture space form and order

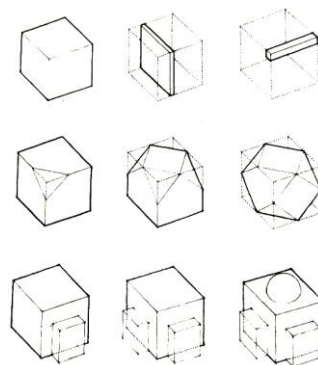


Figure 4: Additive and subtractive forms
Source: Architecture space form and order

Structuralism can be specified as a set of basic principles rather than a particular style. While being related to the whole system of users, inhabitants, budget and management issues, the previously mentioned openness and formlessness are also about being flexible in the designing phase. Having control of the single cell and being flexible and maintaining a certain control can be stated as the best thing about structuralist architecture.

2.2 APPLICATION OF ADDITIVE PRINCIPLE IN ARCHITECTURE; DUTCH STRUCTURALISM

When considering the use and misuse of spaces, when an architect designs a building, he is aware that that its original purpose would change. Again, with the factor scarcity, notions are relying on economic factors since it has proven that demolishing a building is more expensive than reusing it. Therefore, scarcity would be a great way to reboot the ideas about flexibility and openness in modern-day buildings.

2.2.1. Spatial collaboration /Configuration

Spatial arrangement and the spatial designing procedure are the main part when it comes to additive principle. This focus on choosing a particular module and adding it to create the intended spaces. Dutch structuralism tends to improve this quality of the procedure and created a unique way of designing problems regarding architecture.

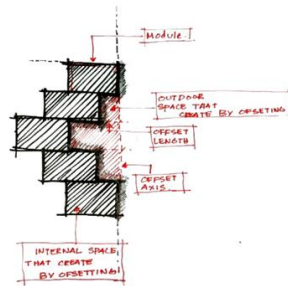


Figure 5: Spatial collaboration
Source: By author

2.2.2. Constructional system

After designing the spaces, the next part is the constructional system and method. In this process adding the additive principle into the constructional system helps to detail the construction parts, like the columns sizes and structural joints. Dutch structuralism takes place in these cases. They tend to dig deep into these theories and invent more practical and suitable design solutions even for small details.

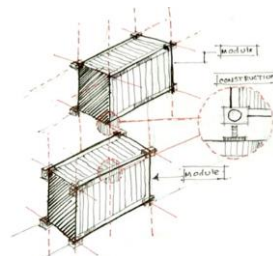


Figure 6: Constructional system
Source: By author

2.2.3. Building transformation strategies

After designing a building, the building will eventually transform through many paths. It may grow, extend or some parts can be reduced. And the building may be renovated to some extent. All these are form and space transformations. This process can be done by applying the additive principle.

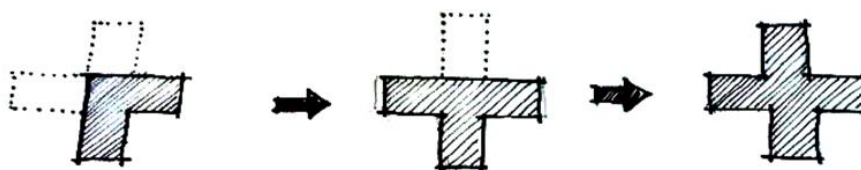
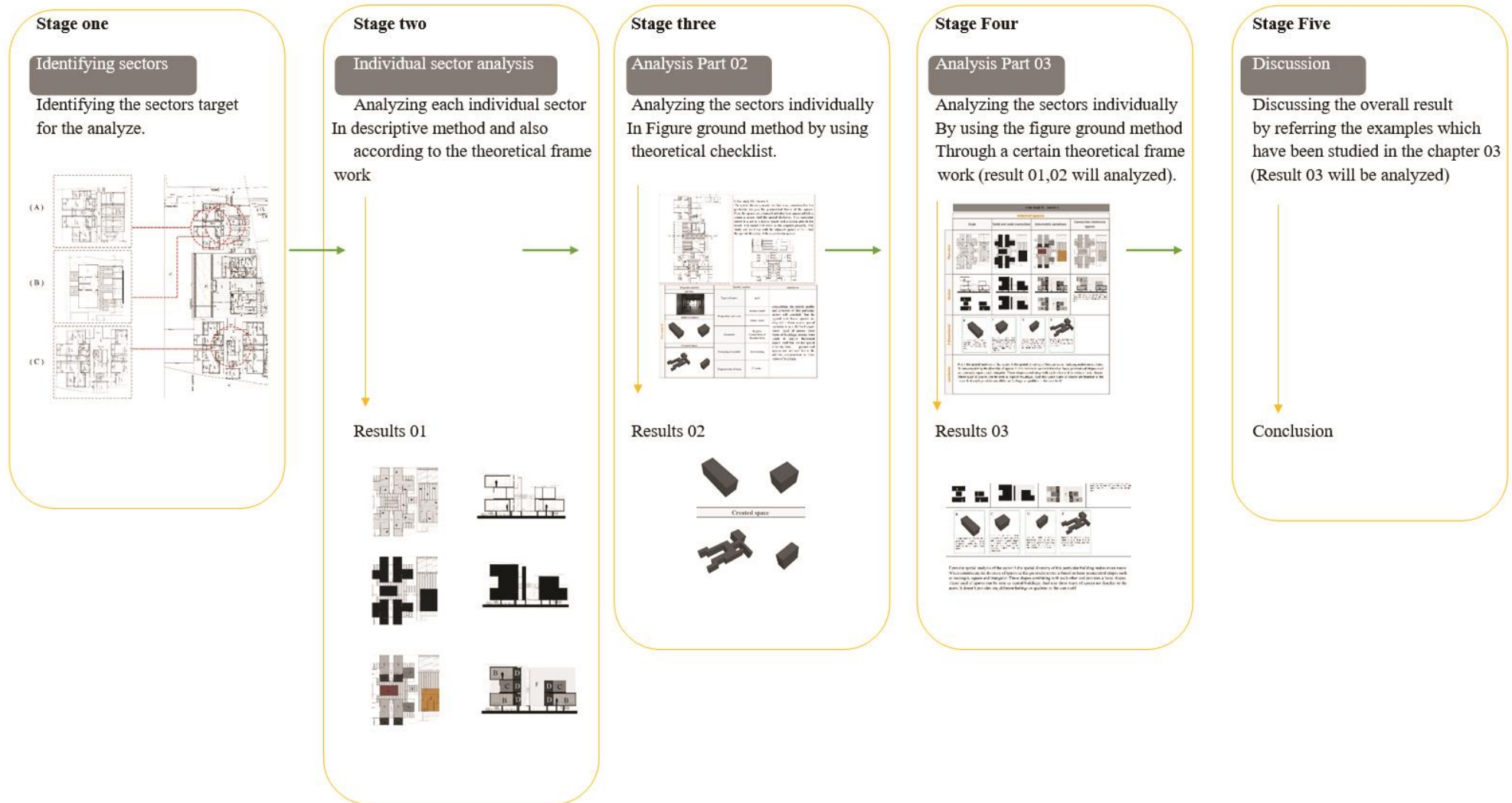


Figure 7: Building transformation (From transformation)
Source: By author

3. Theoretical insight of spatial diversity

Space is a primary structure: which acknowledges people to understand external reality. The objects we act and their shapes, size, and relationship are decided by space. Instead of the space acting as the main structure a person's body moves with objects in places. Spaces provide ways of energetics movement to the surrounding without boundaries. Meaning can be gained through the actions applied to them. The idea of the material reality of things deems their "topics" neighborhoods. The effects of the real space realities are restored on symbolic things such as the principle in the existence of objects for us. The positioning factor can be explained, and understood easily in places where it can be used as a potential location. It is mandatory for any object to be loaded, in some cases removing another object. Therefore, the places of their definition are structured by various spaces. The composition of these spaces was ordered on the basis of their connection and interdependencies. There may be contradictions between the interior and exterior coatings and inconsistencies, such as transparency or metaphysis. Space has implied itself due to the state of the formation, between what is contained inside and what is kept outside.

4. Research design



5. Analysis

Case study 01: Petti Petti by Architect Sudesh Nanayakkara

Table 1: Case study 01 : figure ground-- sector A

Case study 01- Sector A				
Internal spaces				
	Scale	Solid and void connection	Volumetric variations	Connection inbetween spaces
Plan view				
Section				 <small>in this particular case the connection between two spaces are defined with another intermediate space D and D spaces connecting through the F space.</small>
3 Dimensional	 <small>this particular space is a simplest space the additive main component creates this main space. simple rectangular shape space.</small>	 <small>space C is made from subtracting the main space in to half. almost a square shaped space this particular case this type of spaces using as the secondary additive cell or component.</small>	 <small>space D is made out from the in-between space in the two additive components when laying the space B and Space C automatically space D arrives.</small>	 <small>Space F is the main result space which is made from B C D spaces mainly by using main two additive spaces.</small>
conclusion	<p>Form the spatial analysis of the sector A the spatial diversity of this particular building makes more mean. When considering the diversity of spaces in this particular sector is based on basic geometrical shapes such as rectangle, square and triangular. These shapes combining with each other and provides a basic shapes. These kind of spaces can be seen in typical buildings. And also these types of spaces are familiar to the users. It doesn't provides any different feelings or qualities to the user itself.</p>			
<p>Discussion: From the information shown in the particular sector leads to the overall idea about the spaces created with the human scale. Considering the solid and void spaces and volumetric variations observations are made. The scale of the building is minimal considering with the human scale. These spaces give a typical and basic impressions. When considering the diversity of the spaces are much more similar as basic shapes.</p>				

Table 2: Case study 01: figure-ground-- sector B

Case study 01- Sector B				
Internal spaces				
	Scale	Solid and void connection	Volumetric variations	Connection inbtween spaces
Plan view				
Section				
3 Dimensional	 this particular space is a simplest space.the additive main component creates this main space. simple rectangular shape space.	 space C is made from subtracting the main space in to half. almost a square shaped space.this particular case this type of spaces using as the secondary additive cell or component.	 Space F is the main result space which is made from B C D spaces.mainly by using main two additive spaces.	 Space F is the main result space which is made from B C D spaces.mainly by using main two additive spaces.
conclusion	<p>Form the spatial analysis of the sector B the spatial diversity of this particular building makes more rigid. When considering the diversity of spaces in this particular sector is based on basic geometrical shapes such as rectangle, square and triangular. These shapes combining with each other and provides a basic shapes. These kind of spaces can be seen in typical buildings. And also these types of spaces are familiar to the users. It doesn't provides any different feelings or qualities to the user itself.</p>			
<p>Discussion: The created spaces are smaller in scale when comparing with the human scale. Basic shapes include with the design. The spatial diversity of this sector is higher in a certain way. But the spaces create with a limited number of faces and planes the scale of the particular sector is small when comparing with human scale. Spatial diversity is also minimal.</p>				

Table 3 : Case study 01: figure-ground-- sector

Case study 01- Sector C				
Internal spaces				
	Scale	Solid and void cnection	Volumetric variations	Connection inbtween spaces
Plan view				
Section				
3 Dimentional	 this particular space is a simplest space.the additive main component creates this main space. simple rectangular shape space.	 space C is made from subtracting the main space in to half. almost a square shaped space this this particular case this type of spaces using as the secondary additive cell or component.	 Space G is the main result space which is made from B D spaces.mainly by using main two additive spaces.	
conclusion	<p>Form the spatial analysis of the sector B the spatial diversity of this particular building makes more rigid. When considering the diversity of spaces in this particular sector is based on basic geometrical shapes such as rectangle, square and triangular. These shapes combining with each other and provides a basic shapes. These kind of spaces can be seen in typical buildings. And also these types of spaces are familiar to the users. It doesn't provides any different feelings or qualities to the user itself.</p>			
<p>Discussion: The particular sector is relating to the above sector. However, there are similar spatial qualities included in the above sector. The created spaces are smaller in scale when comparing with the human scale. Basic shapes include with the design. The spatial diversity of this sector is higher in a certain way. But the spaces create with a limited number of faces and planes the scale of the particular sector is small when comparing with human scale. Spatial diversity is ai minimal stage.</p>				

Case study 02: Economic enter and market, Keppetipola

Table 4 : Case study 02: figure-ground-- sector A

Case study 01- Sector A					
Internal spaces					
	Scale	Solid and void cnection	Volumetric variations	Connection inbtween spaces	
Plan view					
Section					
3 Dimentional	<p>this particular sace is made from adding all other spaces (E D F G spaces) in togather. this space acts like a semi outdoor space. this spaces is deisgned to gather people around the cafeteria area.</p>	<p>This space is acts like the main module in this building itself. spactial characters acts like typical shape. these type of spaces can be seen in anywhere in Sri lanaka. this space accomodate around 10 people at a time</p>	<p>This space is acts like the cafeteria in the moment. spactial characters acts like typical shape. these type of spaces can be seen in anywhere in Sri lanaka. this space accomodate around 25 people at a time</p>	<p>this particular space Storage unit sace in this particular building spactial characters are simple and also its familiare to people. typical spaces where can design in simple colaboration of elements.</p>	<p>This space is created from subtracting a part from space. rare type of space which can be made by adding simple clemnts in to a single platform.</p>
conclusion	<p>Form the spatial analysis of the sector A the spatial diversity of this particular building makes more mean. When considering the diversity of spaces in this particular sector is based on basic geometrical shapes such as rectangle, square and triangular shapes. These shapes combining with each other and provides a basic shapes. These kind of spaces can be seen in typical buildings. And also these types of spaces are familiar to the users. It doesn't provides any different feelings or qualities to the user itself.</p>				
<p>Discussion: Considering the sector the spaces that creates modules are limited. But shape collaboration is in higher state. Rather than using a single type of basic shape. The connection between spaces is minimal so the space is limited to the faces and planes. Limited faces, limited planes, and limited connections. Less spatial diversity.</p>					

Table 5 : Case study 02: figure-ground-- sector B

Case study 02- Sector B				
Internal spaces				
	Scale	Solid and void connection	Volumetric variations	Connection inbetween spaces
Plan view				
Section				 <small>There are repeated A spaces, there are no connection directly within these spaces but B space is created automatically to create connection within it.</small>
3 Dimensional	<div style="display: flex; justify-content: space-around;"> <div style="border: 1px dashed gray; padding: 5px;"> <p>A</p> <p>this particular space is made from adding all other spaces in together, this space acts like the main modular space in the case study.</p> </div> <div style="border: 1px dashed gray; padding: 5px;"> <p>B</p> <p>the modular space adding in to eachother and creates this massive space, rectangular spaces are repeating and creates this particular space.</p> </div> </div>			
conclusion	<p>Form the spatial analysis of the sector A the spatial diversity of this particular building makes more defined.. When considering the diversity of spaces in this particular sector is based on basic geometrical shapes such as rectangle, square and shapes. These shapes combining with each other and provides a basic shapes. These kind of spaces can be seen in typical buildings. And also these types of spaces are familiar to the users. It doesn't provides any different feelings or qualities to the user itself. this particular sector.</p>			
<p>Discussion: This particular sector is created with similar arrangement but considering the spatial diversity, narrow spaces and connections are higher. But the module arrangement is a simple typical arrangement. But there are no any unique spaces. No major connections through the modules and adjacent spaces.</p>				

4. Conclusion

All the identifications of spatial transformation patterns and the spatial study and empathies are discussed as a conclusion of each sector. The outcome of the study has demonstrated local cases that have used basic forms and shapes to generate spaces where the density doesn't vary. Through the analysis of the literature review and the international cases, the advancement of Dutch structuralism has significant achievement as complex spatial diversity. From the figure-ground study, an overall conclusion is discussed under the shapes and forms and their complexity of the space and the spatial quality. Attributable to the spaces generate through the theoretical framework, all the spaces contain define meanings. Project A refer to Petti Petti by Architect Sudesh Nanayakkara and project B refer to Economic enter and market in Keppetipola. Both projects are generated through simple forms with less variety of spatial qualities. According to the analysis of the spatial diversity in both projects with

modular construction, the spaces are not well defined to express meanings. In projects A and B, the designed spaces lack significant unique spaces and the most complex shapes carries a minimal number of faces and planes to it.

Comparing project, A and B, the overall idea about the created spaces and scale with the human figure are different. Considering the solid and void spaces, both has limited the modules neither shape collaboration is in a higher state. The spaces create with a limited number of faces and planes the scale of the particular spaces are small when compared with human scale and spatial diversity is at a minimal stage in the project A while Project B module arrangement is simple without major connections through the adjacent spaces. The achieved spaces with various shapes and forms are so complex in international case studies even though those spaces are designed within certain restrictions. The Spaces which are designed without limitations have developed into desirable spatial quality.

In local case studies, the advancement of this procedure isn't developed into a desirable level due to lack of variation in faces, levels, and volumes. For instance, the modular architecture with several modules is not capable of providing variation except giving a maximum level of two stories in the local context. There is a significant improvement in modular architecture in international practice comparatively. The author has identified that modular architecture has improved during the past years and that there is a possibility to change the spatial configuration in the interior scale, heights and volume in addition to the modular form. The structuralists have taken the modular architecture into an innovative level. For instance, the container box can be used to produce various spaces and arrangements. As a result, they have identified that these theories can be applied to develop well-defined spatial arrangements. According to the local case studies, the prefabricated units are the main consideration as the modular architecture but in international cases, the way they have interpreted the spaces are defined as the modular architecture.

Using structuralism instead of typical design procedure, the achievement of the spatial diversity is high as well as the framework helps to create pathways to achieving the desired spatial quality. Complex shapes contribute to achieving contrasting spaces and all the spaces including planes, edges and faces construct with meaning. The spaces can be defined with meaningful function along with theories in modular architecture. The author has identified that using the above theories would help achieve the efficiency in building functions and it is fundamental to consider this procedure in designing modular architecture while preventing dead spaces along with unnecessary visual connections. In the local context, the concept of modular architecture is at a primary stage where the final outcome of the research demonstrates that this level could be developed through innovative approaches.

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