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RESEARCH ARTICLE

Exploring 'Complex Adaptive Assemblage' in Urban Design: A Case Study of Rethinking Informal Vendor Activities around Dhaka New Market Shopping Complex

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ABSTRACT

The subject matter of Urban Design has long been criticised for having no substantial basis to formulate a significant groundwork of theoretical framework in general. Despite having the capability to formulate solutions in creative ways of thinking, Urban Design is subjected to further arguments regarding subject matters due to criticisms. While exploring this substantial amount of literature, this paper aims to put the process of urban design thinking into a hypothesis of the theoretical framework of "Complex Adaptive Assemblage". In doing so, for more empirical purposes, a real-life scenario of informal vendor activities around a formal shopping complex in Dhaka city is chosen to explore the hypothesis. As a result, using the relevant understanding of the theoretical framework, a synergy is generated to analyze three design proposals aimed to accommodate informal vendor activities within the formal market area. An in-depth observation along with a pictorial survey has been conducted in three selected entry points of the retail premise that display the diverse agglomeration of the shoppers and vendors. The outcome discusses how the synergy works as a viable theoretical framework in the urban design thinking process. This theory-centric hypothetical urban design exercise for a real-life case study eventually has the potential to review the similar context of informal retail activities that is evident in many Global South countries.

Keywords: Urban Design; Complex Adaptive Assemblage; Urban Complexity; Assemblage Thinking; Urban Informality

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1. Introduction

Dhaka, the capital city of Bangladesh, being one of the most densely populated cities of the global south, is mired in various complex urban problems like traffic congestion, urban informality, congested development, natural environmental degradation, mismatched urban management processes, and so on. Thus, being guilty of earning the title of one of the least liveable cities, it is high time to investigate possible ways to improve the adverse urban conditions through effective and substantial urban development strategies based on nuanced facts and knowledge. Urban problems in Dhaka can be explained by numerous academic literatures, but converting these theories into practical solutions is a more difficult task. Urban Design, criticized for generating metaphorical and conceptual outcomes [1], needs to evolve into a discipline that can effectively address complex urban challenges.

This paper aims to relate urban development theories to viable practical domains by theoretically examining urban design's role in producing effective solutions to tackle the existing complex urban issues in the global south. The method adopted for this exploration is the synergy of "Complexity Science System" and "Assemblage Thinking" [2] to develop a reliable urban design solution aimed at a public marketplace in Dhaka. By doing this, the study tries to explore the possibility of the Urban Design thinking process as a scientifically viable means through conceptual framework generated by the aforementioned synergy.

2. Research Aim, Objective, and Question

Every human society and city is comprised of a set of complex systems [3], and the multidisciplinary nature of complex systems can be applied to explore fields like urban design [4]. For this reason, all cities are products of a system of complexity, and the problems arising from complex systems canfeel intimidating to solve. Thus, contemporary urban developers, like urban designers, may tend to adopt simplified ways (i.e., a top-down approach) due to the difficult nature of complex urban systems; however, urban problems are anything but simple. Hence, the result of development proposals without considering the issue of complexity can consequently make the urban development process itself problematic [5]. This paradox puts urban development studies in a situation that demands more effective ways to address urban problems, and urban design is not at all free from this. Therefore, an approach towards more realistic and effective ways of thinking in Urban Design can be regarded as a worthwhile endeavour.

The research aims to question this perception of the Urban Design process following a structured theoretical framework towards the urban design decision-making process. The process of any design takes into consideration many contesting issues to arrive at one coherent possible solution, which can be difficult in itself. The final decision needs to go through a structured framework based on strong theoretical ideas to establish its validity as a viable possibility, which will be the aim of this research.

The research will fulfill the objective by combining the ideas presented by "Complexity Science System" and "Assemblage Thinking" to create a synergy based on a theoretical framework posed by the hypothesis. The synergy will be further evaluated through urban design solutions focused on urban informality. The evaluation of the solution to this issue through urban design will be the central focus of the research question. Accordingly, this paper will analyze and synthesize the hypothetical Urban Design proposals using the theoretical framework of the synergy of the "Complexity Science System" and "Assemblage Thinking" to put forward a systematic approach to the urban design thinking process. In the end, the research will explore the question, "Can the Synergy of 'Complex Urban Assemblages' be a viable method that can provide a scientific way to analyse urban design proposals?"

3. The Case Study: Dhaka New Market

3.1. The Shopping Complex

The after-effect of a large amount of Muslim migration from India after the 1947 Indian subcontinent's partition instigated significant urban growth in Dhaka between 1950 and 1960 [6]. Dhaka's New Market shopping complex, which was completed in 1954, accordingly falls into this phase of urban growth (**Figures 1** and **2**). This shopping centre became an economic and cultural landmark of Dhaka within a short time. Most probably, the local warm and humid climate did

not enable paved and courtyard-like open urban spaces that can be found in European cities. Instead, the newly built city marketplaces naturally transformed into an alternative for quality urban public space as the city embarked on its modern phase. This shopping centre was developed according to the style of 1960s ribbon commercial development[6, 7]. It has maintained the original single-storey structure to this day, comprised of shops facing internal pedestrian pathways, providing an open-to-sky spatial environment. Vehicular access is prohibited in the internal pathways and the exterior facade of the market is completely made of solid brick walls. Therefore, the spatial arrangement of the market provides an introverted environment, contrasting with the noise and bustle from the adjacent roads, resulting in an urban-scale place for the whole city's inhabitants. This overall positive built environment also played a crucial role in the market conserving its original spatial look at present even with the pressure of shopping-mall-like commercial transformation.

Figure 1. Bird's eye view of New Market shopping complex.
Source: Google map.

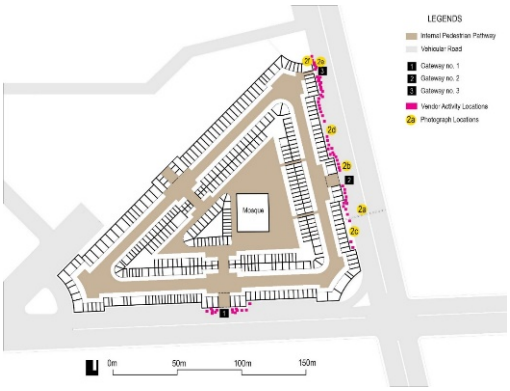

Figure 2. Existing plan of Dhaka New Market shopping complex.

The lack of further expansion of the shopping complex restricted the number of shops, resulting in a limited number of formal vendors allocated within empty open spaces along the internal pathways and additional informal vendors along the exterior periphery (**Figure 2**). As the rural economy of Bangladesh cannot sustain its population, Dhaka as a capital had to experience exponential growth in informal urban activities in the form of both slum settlements and street vendors; which enabled some informal vendor activities along the interface of the market and the roadways.

3.2. The Nature of Informal Activity along the Market Interface

The informal vendor activity along the adjacent road edges poses both a complicated and complex challenge from an urban development perspective on how this should be addressed. On the one hand, the urban thinking presented by Jacobs[8] and Christopher[9] suggests that informal vendor activities enable a vital and lively quality to public life in urban spaces surrounded by modern and bare building facades and pavements[1]; while on the other hand, the informal activities are causing hampers in pedestrian and vehicular movements by illegally encroaching on places where they should not be.

The vendors sustain their illegal activities through a cycle of negotiating with urban authorities, facing eviction after an unspecified period, and then regaining vendor activity by renegotiating again with the same authority[10]; this mode of informality is termed "latent informality", which is instrumented as a regulatory form to control urban informality by less resourceful urban authorities[11]. This cycle can be framed as "resilient" for urban vendors to continue their informal activities within the existing legal and administrative mechanisms[12], but this mode of urban management should not be relied on for the long term when considering the dire need to upgrade the existing urban quality of Dhaka city. We can see that informal activities are happening by encroaching on the roadside and pedestrian pathways (**Figures 3** and **4**). This is creating congestion, which is the main opposition point for allowing such activities, despite the important role they play in providing a good quality urban life.

Figure 3. View of Gate.2 showing the market-road interface nature.

Figure 4. Accommodating pedestrians along with informal retailing on the interface.

The process of relocating urban informal activities does not work, as they always return back unchanged or in other forms[12]. Additionally, the lattice-like urban structure suggested by Christopher[9] indicates that the unique urban context of New Market is required for the continuation of the system within which informal activity can be conducted. Therefore, the main challenge for urban design would be accommodating urban informal activity within the tight spaces available along the market edge and subsequently, the design would focus on the market's interface design.

4. Literature Review

The research aim was directed towards a wide array of academic literature that later pinpointed a few further elaborations to finally come up with the theoretical framework. **Figure 5** shows the diagrammatic relationship between those state-of-the-art topics of the scholarship explored for this distinct study.

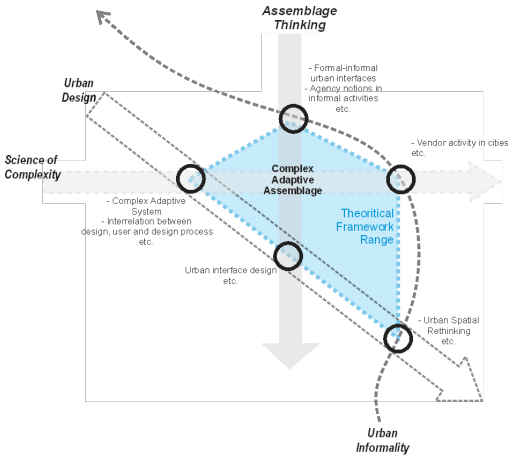

Figure 5. Diagram showing the interrelation found between literature topics.

4.1. Urban Design Subject Matter

Complexity in design is intrinsic within the design product, the process of designing, the working dynamics of designers involved, the user perception of the design product, and also within the interrelations between the four elements mentioned above[13]. This framework indicates how complexity is embedded within the urban design context by the nature of how urban design products are perceived by the users, how complexity is to be perceived by the designers and how the design process must be analysed. Assemblage thinking in urban design may be thought out from the "socio-spatial" aspect of agency[12] within urban life. In urban design, there is no set group of users but a wide variety of backgrounds. With the addition of informal vendors, it is a useful view to deal with the wide range of users' perspectives. Spatial thinking involving urban informality is usually done through a top-down approach which often undermines the intrinsic dynamics of informal practice itself. This is the aspect of urban design that is usually criticized as an unfitting solution to complex urban problems that was first addressed by the works of Jacobs[8] and Christopher[9].

4.2. Urban Informality

The definition of urban informality cannot be ubiquitous because the notion and legal interpretation of urban informality itself are not universal[11]. Therefore, the nature and interpretation of urban informality in both the global north and south would substantially contrast with each other. However, it is mostly disregarded by Western urban-related studies as a symptom of failure or limitation in the urban regulation process[11]. The evolution of European organic and informal medieval cities to contemporary formal and planned cities may explain the reasons behind the preferential view on formal ways of urban development approaches in Western democratic cities. On the contrary, present-day global south cities may show both organic/informal and planned/formal developments which put their urban issues in very different propositions. Urban informality is a socio-economic outcome of global south cities to cater to the rural migration to the cities, where the governing body cannot manage to formalise the growth pattern[12]. Moreover, as it is linked with poverty, it is probably impossible to eradicate it from global south cities[14]. Thus, the existing Western perspective of

urban informality can be taken as a grain of salt, not as the ubiquitous one.

In the global south, urban informality is regarded as a positive mode of socio-economic activity to some extent and can be argued to provide vibrant qualities through urban activities within unused empty spaces, enabling opportunities to earn a livelihood and so on. Additionally, Jacobs's [8] suggestion of livable and vibrant urban qualities can be found in informal urban setups in various modes. This mode of informal activity also gives various scopes of adaptability and robustness in urban lifestyle. Therefore, urban informality thrives in a very complex system within a specific urban setup which may or may not be visible to everyone. Modern designers, however, prefer a formal look at spaces in general [1] and this may result in overlooking the intrinsic complexities within the chaos of urban informality. These oversimplified interventions thus enable shortsided compromises [1, 5] regarding the existing resilience and adaptable qualities within informal practices.

Urban informality, due to its high nature of complexity, is very difficult to overcome and aptly termed a "wicked problem" [4]. However, this does not mean it is pointless to explore this phenomenon but the opposite. To do this let us go through the following points:

- Firstly, urban public spaces need to be just spaces even for informal vendors. We should keep in mind that in countries like Bangladesh, these activities play a vital role in the socio-economic development of urban poor groups, in the forms of vendors and shoppers [15].
- Secondly, the legal status of informal activity needs to be defined on a contextual basis. As there is no universal definition of urban informality at the moment [11], the legal view of urban informality near the shopping complex can be contextualised according to the local aspirations of urban space development.
- Thirdly, the illegal status of informal vendors enables the existing cyclic order of controlling informal activities in a rather exploitative manner. Despite providing a vital role in viability, social development, and the image of the city through street vending [7], they should be utilised as the most effective element in urban development.
- Fourthly, urban informality is such an essential and permanent part of cities in developing countries that the focus needs to be shifted in the direction where formal and informal can coexist [14], which aligns a lot with the aim of this paper.

From the previous discussion on urban informality, it is evident that to deal with such wicked problems of urban complexity in Dhaka's urban spaces, we need to adopt "thinking outside the box" and novel approaches to deal with. Furthermore, urban informality belongs to a complex socio-economic phenomenon subjected to various debates, which posit urban informality to be stated as "Understanding the complexity and resilience of informal urbanism is one of the great urban challenges of our time" [12]. Additionally, to harness the benefit of any form of urban complexity, a detailed look is suggested [5].

4.3. Urban Complexity

The science of complexity has a long history and has been used to understand the world surrounding us as a combination of various complex sub-systems [16]. This science also pointed out the limitations of the "Newtonian Worldview" to incorporate "human behaviour, societal norms, adaptive abilities and evolutionary processes" [17]. Therefore, the science of complexity has found its stance within urban studies in dealing with the solution of complicated urban problems.

An urban system shares the rules that complex systems are generally based on: volatile, uncertain, complex and ambiguous outcomes [18]. Consequently, the notion of complexity in urban studies is not a novel one and has been the subject of various research works. The works of Jane Jacobs and Christopher Alexander from the 1960s can be considered the starting point for of thinking of a city's problems as complex ones [1, 19]. The ideas of complexity in urban research rely on various theoretical frameworks of systems theory, dynamical systems, cybernetics, non-linearity, uncertainty, chaos theory, entropy, self-organisation, emergence, ecological complexity, complex adaptive systems, resilience, and evolutionary theory [1, 3, 5, 12, 17, 20, 21], and more than 50 complexity science frameworks like these have been generated in urban studies [18]. Some examples of academic works derived from such complexity science frameworks are urban ecological complexity [5], urban informality [12], urban street networks [22], and many more. However, these works mostly address urban studies from urban planning, urban policy-making, and urban management, but rarely from ur-

ban design's point of view. This indicates that complexity in urban design is still ongoing and there is still much more to explore, which is also suggested by Dovey and Pafka [2]. However, the status of urban complexity seems to be present in every city but the nature of complexity varies within each city, which suggests that the complexity issues in Western cities would not be the same in developing cities. Therefore, the issue of informal urban activities in global south cities can be relatable to complex scientific theoretical frameworks. The nature of urban vendor informality is "chaotic and uncertain" [14], and how they "emerge" through transformative change between "dynamic and robustness" [3] and "self-organisation and resilience" [12] within existing are all related to complexity concepts.

Lastly, it is important to acknowledge that urban complexity tends to prevail in every city, even on smaller scales after all the formal efforts to control it. The reason behind adherence to such conditions is to be able to self-organise through unexpected external challenges that may arise in the future [3]. Such unexpected changes are termed as "uncertainty" in complexity sciences [4] which makes this an additional criterion in complex problem-solving thinking in urban design.

4.4. Assemblage Theory or Thinking

Assemblage theory or thinking has been adapted from the works of French philosophers Gilles Deleuze and Felix Guattari in the 1980s and later in the 2000s was further integrated into social sciences by Manuel DeLanda [19]. From this time, it has been adopted into urban studies to explore and understand various phenomena, especially involving the dynamics of human agency. Assemblage thinking can be in the form of both organic and non-organic elements [23] which can be relatable to urban design in the case of "users" and "physical design elements" respectively. Dovey [12] suggests that assemblage thinking can rethink "place" with the ideas of "process", "identity formulation" and "becoming". The author also states that two important parts to take notice of are: "two-fold" and "territorialisation". Furthermore, Dovey and Wood's [24] empirical study on urban interface based on "private-public" two-fold assemblages pictures a comprehensive way to adopt assemblage thinking in urban studies and additionally, how they can be further interpreted in other ways. Hence, in examining urban street informality for the selected case (**Figure 6**), assemblage thinking enabled us to figure out how the vendors internalise their domain of activity within the relational dynamics to their immediate surroundings.

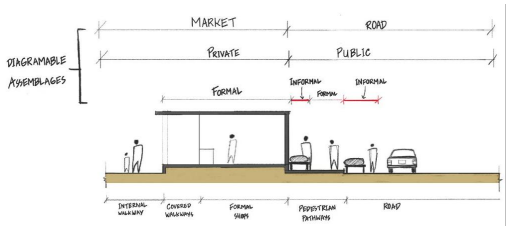

Figure 6. Sectional diagrams showing existing assemblages in Dhaka New Market.

In conclusion, we can summarise assemblage thinking in urban design to explore how the agency of actors involved in urban spaces plays out their dynamics in both social and spatial domains at the same time. Madanipour [25] suggests that the available actors are urban governing agencies as "regulators", urban developers as "producers" and the activity generators as "users". Additionally, this may also help us to understand the insights into the question relating to how the existence of cities can be further continued with its inner dynamics [26].

4.5. Complex Adaptive Assemblage

The term "Complex Adaptive Assemblage" refers to a synergy between the "Science of Complexity" and "Assemblage Thinking" suggested by Dovey and Pafka [2] and Dovey [12] as a way of counterpointing the argument on Urban Design's position as a proto-science. It is based on their opinion that Urban Design's primary theories are bound to empirical knowledge outside of the domains of scientific knowledge. Thus, their main argument is that there is substantial contrast in the pathways between Urban Design theories and conventional scientific frameworks; and most importantly—how they should be addressed. A systematic view of the possible synergies between these elements would give some insights on this matter.

Complex adaptive assemblage acknowledges the temporal dimension of urban complexity by incorporating the notion of "complex adaptive system". This implies that an urban system as a complex adaptive system always tries to attain the perfect urban state where complexity is non-existent but never actually accomplishes that state [3]. These phenom-

ena can be explained as a coping mechanism for cities to be able to adopt new modes of operation when facing complex challenges. Therefore, sometimes urban complexity cannot be eliminated completely and must be examined accordingly. Moreover, the primary Urban Design theories are based on Western cities, which may result in substantial gaps in the process of understanding informal urban situations[2]. Every city in this world is unique, because of its unique local contextual forces of geography, climate, culture, tradition, and so on. Therefore, this synergy may also provide some insights into Urban Design's validity in different contexts, in this case, the global south.

As Urban Studies share many common urban theories, it would be important for this theoretical synergy to be relatable to other relevant fields. This relatable approach can be helpful for Urban Design to find common ground with other disciplines in solving complex urban problem issues. Another issue to consider is the multi-scalar aspect[12]. In this case, the multi-scalar element mainly originates from the power dynamics between higher-level stakeholders: regulators (local political and administrative bodies) and users (informal vendors). It would be crucial to keep in mind that the existing controlling mechanism will try to maintain the same status quo in the changed setting proposed by urban design. How this aspect plays out in the urban design process is one of the important aspects to explore.

5. Methodology

The synergy between Complexity Science and Assemblage Thinking can be achieved in numerous ways, but in Urban Design this mixture must be in the specific way where the interconnection will be more important than the ingredients themselves[2]. Therefore, the evaluation of Urban Design will be based on the various ways in which possible interconnections can be established relating to the theoretical framework range that has been taken into consideration for this study (**Figure 5**).

5.1. The Complexity Dimensions

The synergy, reflecting this multidisciplinary aspect of Urban Design, would be more appropriate if complexity and assemblage were incorporated through basic forms of complexity science and humanities terms for effective understanding purposes. Keeping this in mind, the complexity dimensions chosen for the framework are from Boeing's[1] measurement indicators of urban complexity in the field of Urban Design. The indicators are:

1. Temporal: the amount of information generated within a timeframe; the uncertain future knowledge yet to be found.
2. Visual: the amount of variety that can be experienced visually; activity, building elements.
3. Spatial: complexities related to spatial distribution and resultant dynamics between users.
4. Scalar: how power interactions shape the urban features; zoning, landmark, public-private relationships.
5. Connectivity: the issue of proximity/social interaction/ mobility.

The science of complexity can be interpreted in urban studies in various ways, but a more precise scientific framework focused on urban design would be most appropriate, which is the reason these complexity dimensions are chosen.

5.2. The Assemblage Dimensions

While reviewing the literature, the selected case of Dhaka Newmarket has resonated with the multiple types of assemblages that are happening simultaneously (**Figure 6**), and all of them should preferably fit into the same synergy framework. For a simplistic understanding of assemblage issues, the assemblage resources chosen from the work of Murray Li[27] and Durose et al.[28] are:

1. Vision: identification and framing of an issue to make it a basis for future action.
2. Social relationships: using human reputation and networks to engage other situated subjects.
3. Knowledge: diverse ways of gathering professional, technical, and local knowledge.
4. Materials: bodies, funding, and physical spaces such as buildings.

These resources are the common features that can be found in all the acting assemblages in the shopping centre. Another benefit of these resources is that they encompass the interaction and transactions at the individual level, which is helpful from a bottom-up approach[18, 29]. The following diagram (**Figure 7**) shows the generic formulation process of the synergy framework that derives from synthesizing the significant theories, hence working as a basis for the study

to test the hypothesis.

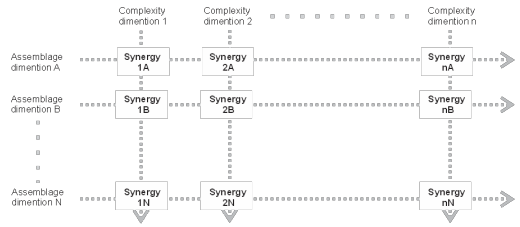

Figure 7. Diagram showing the framework of the synergy formulation.

5.3. Adopting Matrix Data Analysis Diagram Table for Generating the "Complex Adaptive Assemblages" Synergy

These two contrasting ideas are juxtaposed with each other in matrix data analysis (**Table 1**). Each cell of the table contains inquiries about the corresponding combined assemblage resource and complexity measurement instruments. One exact synergy could produce multiple questions, but those specifically embodyng the fundamental principles of design parameters towards the solution formulation process are provided in the table. Converting qualitative data into graphic format can be a concise and efficient way to present information, showcasing details that are buried in longer written formats [30], which may be preferable for designers for more ease in graphical analysis.

After this matrix table is completed, more tables are generated to convert the qualitative data embedded in the inquiries to numerical data. The scale for evaluation is based on the designer's ability to comprehend and adopt the ideas of "Complex Adaptive Assemblages" and subsequently establish this framework as a basis for scientific experimentation. The table showcases the "Complex Adaptive Assemblages" ideas generated through inquiries. It should be mentioned that the questions provided are more sample-based rather than objective-based. Not all possible questions are given due to a simplistic approach for better understanding.

5.4. Evaluation of Design Proposals

To understand the design evaluation process by converting qualitative "Complex Adaptive Assemblages" into quantitative values from **Table 1**, it is seen that each cell generates various questions and inquiries that are embedded with the dual essence of different dimensions of both urban complexity and assemblage ideas and therefore can provide depth of knowledge to delve into before moving to design proposals.

The design proposals provided here are at a very conceptual level and not detailed ones that are subject to actual implementation. These samples are basic in nature to present the overall analysis simplistically. The evaluation parameters are firstly based on the designer's understanding of the user activity patterns' performance within the designed space configuration. Then these performances are further evaluated through the corresponding questions relating to specific "Complex Adaptive Assemblages" to test the Urban Design approach's ability to tackle the complexity of informal urban problems. The numbers assigned to each question are determined by how the design proposal responds to the inquiry by the seven principles of universal design. The principles are: equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, and size and space for use [31], which are the ubiquitous parameters to guide and subsequently evaluate the design.

The proposals will result in some level of change in the existing physical arrangements of the complex, which will be considered a disruption in the existing urban system. As the system is adaptive, it will change its internal structure to cope with the external forces [3] resulting from the modification by design proposals. It should be the intention of the designers to consider the options that require a minimal level of physical modification to avoid the emergence of a large level of complexity issues.

6. Results

This section provides three hypothetical design proposals and their evaluation based on the framework established in **Table 1** above. The responses of both authors of this paper, belonging to the built environment design discipline, are also provided as a quantitative evaluation model for the qualitative aspects which are generated as table formats for respective design proposals (**Tables 2, 3,** and **4** for design proposals 1, 2, and 3 respectively).

Table 1. Generation of "Complex Adaptive Assemblages" through questions representing inquiries embedded with the synergy of one specific dimension of urban complexity and one specific assemblage resource.

Urban Complexity / Assemblage Resources	Temporal	Visual	Spatial	Scalar	Connectivity
Vision (*Accommodate the informal vendors within a formal setting*)	How can the design proposal of a permanent setting sustain through time? What would be the adaptability nature over time?	What exact types of informal street vending should be allowed?	How to spatially distribute and what numbers should be allowed?	How will the dynamics between informal vendors, urban authorities, and formal shop owners play out?	What should be the level of proximity between formal and informal vendors? How can it be maintained through new development?
Social relationships	How will the new gateway generate new human interactions and reactions?	How do human relations between vendors and customers accentuate the visual image of the shopping centre at entry level?	How to maintain spatial autonomy in the gateway space between: 1. placement of vendors 2. fow of pedestrian circulation between road and market?	How can the balance of interactive dynamics between formal shop owners, informal vendors and customers be maintained with the new design proposal?	What should be the level of social interaction between formal and informal vendors? How can it be maintained through new development?
Knowledge	How is the new knowledge generated from the evolving usage of the gateway space throughout time?	What exact variety of activity can produce the desirable "visual complexity"? What types of goods can be allowed to be sold by the informal vendors?	How can the designer generate and evaluate the most successful layout?	How can the shopping centre management body maintain the hierarchy of agency of actors involved within the gateway? How planners can mediate the dynamics of the actors involved in creating successful urban space quality?	What bottom-level connections are relevant to the top-down design and planning process?
Materials	How will the new gateway be perceived by the users? How successfully will it play the role of active urban space?	How can the space be visually heterogeneous and not end up with a liminal image?	How should the space be divided? What exact number of vendors should be allowed? How much area should be allocated to each vendor?	How will the role of human agency play out within the allocated arrangement?	How to maintain the existing connectivity issues in the new spatial development schemes?

6.1. Design Proposal-1

Here, the existing gateway is modified by making it wider. The newly available space gained from such modification gives the scope to incorporate informal vendor activity within (**Figure 8**). The wider gateway provides some formal space to accommodate informal vendors, but the opaque nature of the interface between formal and informal domains remains non-existent. Therefore, a more contested assemblage dynamic will be active in this scenario. The entrance provisions for shoppers are a bit flexible and more distributed along the gateway. The shoppers have many options to enter the market complex while getting to visually see the vendor goods more closely. This arrangement gives more visual options and complexity within the space. **Table 2** is generated

by giving numerical values to corresponding inquiries based on how this urban design proposal addresses the issues.

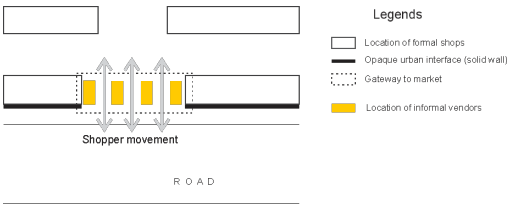

Figure 8. Plan showing design proposal-1.

6.2. Design Proposal-2

The second proposal is very much like proposal 1, but provides a more defined interface between formal and informal domains (**Figure 9**). A solid wall is provided at the gateway to give both visual and physical segregation at the formal-informal assemblage boundary. This is a better response to the hostile assemblage situation in the previous scenario. The scope for shoppers/customers to enter the shopping complex is more defined. However, the vendors at the two edges of the yellow zones will have more exposure to potential customers as most interactions are likely to happen at these two points. Therefore, from the vendor's point of view, this arrangement will not be desirable in contrast to the proposal-1.

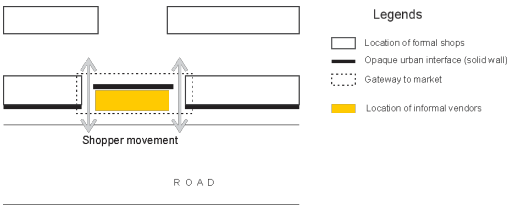

Figure 9. Plan showing design proposal-2.

6.3. Design Proposal-3

The third proposal incorporates informal vendors along the external interface of the market where some formal shops must give up some of the spaces for accommodation. Here, the gateway remains the same (**Figure 10**). This option results in fewer changes in the existing physical setup, which will lead to fewer disruptions and consequently a lower level of adaptive changes within the system. Therefore, this option has the highest probability of being preferred by the management body. Formal shoppers may also prefer this due to low visual and physical territorial issues at the assemblage boundary layers. The vendors may end up with less favourable options from the scope exposure to the shoppers' attention, but they will be better off from the encroaching on the road status.

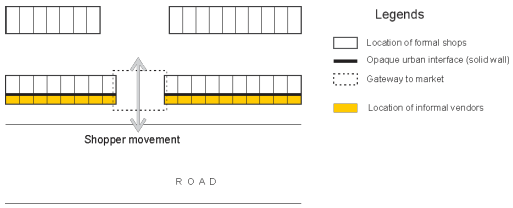

Figure 10. Plan showing design proposal-3.

7. Discussion

7.1. Deciphering of the Synergy Framework

The hypothesis of the synergy of "complexity sciences" and "assemblage thinking" as a basis for the theoretical framework can produce a method in which urban design can be put into a basic analysis, investigation, and evolution process. Here, we can see that the various complex issues regarding informality within an established urban setup can be incorporated into the urban design thinking process. The methodology expresses how each design proposal fares within the wide array of questions generated from the relative urban complexity and assemblage forces. The questions also embody the basic principles of universal design parameters and the problem-solving objective: urban informality. Hence, in this research, it was found that the "complex adaptive assemblage" synergy can work as a basis for developing an urban design theoretical framework, but other dimensions, like urban design as a discourse and the issue of urban informality in this case, may be required for a more rigorous and comprehensive method. The interconnections found in the literature review framework (**Figure 5**) also indicate a similar proposition.

Another finding is that the framework can convert qualitative information into numerical values. Although the values are representative of the urban design thinking process, they are very much relevant to urban design as the thinking originates from the subject matter itself. Therefore, this synergy can be interpreted into frameworks that produce quantitative data, which can be further incorporated into the scientific method through systematic observation, measurement, exploration, testing, and generation of further hypotheses. This underpins the essence of the research objective behind the

Table 2. Quantitative evaluation of design proposal-1.

	Temporal	Visual	Spatial	Scalar	Connectivity
Response of Author A					
Vision	0	3	3	1	1
Social relationships	1	2	3	0	1
Knowledge	0	3	3	0	2
Materials	1	3	3	2	3
Response of Author B					
Vision	2	3	3	3	3
Social relationships	3	3	3	3	3
Knowledge	3	3	3	3	0
Materials	3	3	3	3	3

Note: Response format: 3 = good; 2 = medium; 1 = bad; 0 = can't be determined.

Table 3. Quantitative evaluation of design proposal-2.

	Temporal	Visual	Spatial	Scalar	Connectivity
Response of Author A					
Vision	1	3	3	3	3
Social relationships	2	3	3	2	3
Knowledge	0	2	3	3	2
Materials	2	3	3	2	3
Response of Author B					
Vision	2	1	2	2	2
Social relationships	2	2	3	2	2
Knowledge	3	1	3	3	1
Materials	2	1	3	3	2

Note: Response format: 3 = good; 2 = medium; 1 = bad; 0 = can't be determined.

formulation of the synergy by Dovey and Pafka[2]. This research thus further invigorates the status of urban design as a proto-science.

Another purpose of this synergy is to combine science and humanities subject matters into one framework[2]. Urban design's multidisciplinary nature posits itself into the "Jack of all trades, master of none" category, which can discredit the subject as a viable means for undertaking both theoretical and practical levels. The formulation of the synergy framework (**Table 2**) and further implementations of it demonstrate the possibility of interdisciplinary mental structuring in urban design. Another criterion is the ability to be overall straightforward and comprehensive towards the readers. For example, the subject matter of complexity is not preferred by urban studies professionals due to its inability to be easily understood[3]. Therefore, it was intentional for the framework to be concise, and the synergy can be interpreted as such.

7.2. Scope for Multi-Professional Approach

The degree of complexity of urban issues makes it impossible to be mediated by only one profession, even though urban design incorporates both subjects of science and humanities. The design outcome is always "static" in nature, and it is human society or the "complex system" that is always "dynamic" due to its inner mechanism related to withstanding unexpected challenges. Accordingly, it would not be urban design's place to navigate this matter alone.

The numerical values in **Tables 2–4** indicate that the resultants of temporal and scalar ones seem to yield lower values compared to spatial, visual and connectivity ones. This is because the latter three are the "fun and games" component of the spatial design process and therefore will generally yield high-valued variants. However, temporal and scalar resultants are related to aspects that cannot be achieved through static product outcomes. The subject matter of urban planning is much more applicable to time and political factors in urban development; therefore, it would be outside the spe-

Table 4. Quantitative evaluation of design proposal-3.

	Temporal	Visual	Spatial	Scalar	Connectivity
Response of Author A					
Vision	3	3	2	2	3
Social relationships	3	3	3	3	3
Knowledge	0	1	3	2	2
Materials	3	3	3	0	1
Response of Author B					
Vision	3	3	3	1	1
Social relationships	1	1	1	0	1
Knowledge	0	0	0	0	1
Materials	1	3	3	0	0

Note: Response format: 3 = good; 2 = medium; 1 = bad; 0 = can't be determined.

cialised domain of design to properly answer the temporal and scalar questions. This limitation posits the framework to be able to incorporate inter-professional involvement of designers, planners, managers, urban authority officials and policymakers to some degree to deal with wicked urban problems.

7.3. Subjective Bias of Design Process

The design decisions can be subjected to each designer's own preferences regarding architectural styles and aesthetic values, the perception of challenges in urban problems, and the understanding of subject matters explored in this paper. As a result, we can see that the response of many synergies yields different values from the two authors of this paper. This variation exposes the contradictory nature of each designer's preferences, but the framework provides an opportunity for nuanced exploration of urban complex problems through a collaborative design process. This additionally suggests that a broader view of the user base can be more accurately achieved through a group of designers rather than one designer.

7.4. Limitations and Recommendations

The evaluation process in the results section is purely based on the understanding of the authors on the subject matters related to the synergy. Therefore, the values provided are subject to biased views and limited to a range of knowledge mentioned within the literature review section. The purpose of this research is to test a hypothesis to some acceptable degree, which was not largely affected by this bias.

The research is based on a single case study, which means this method may not yield a level of acceptable outcomes in other similar case studies. For a stronger standing on the hypothesis basis of this research, different contextual studies are required.

This research paper is not without limitations and rather poses more questions than answers that can be addressed within. The case study's context is only focused on urban informality issues, which deals with only one specific type of urban design. Other examples, like waterfront design, park landscape design, urban renewal, urban infill, gentrification, and many more, deal with unique contexts and thus each requires different dimensions within the same synergy to be evaluated, analysed, synthesised, and tested. Therefore, this paper puts forward "a framework" rather than "the framework" for urban design. To do that, further investigations and arguments are needed, which are outside the scope of this paper. This research demonstrates only one dimension of urban complexity and one dimension of assemblage thinking to formulate the synergy framework. This can also be done with other dimensions and therefore a multiple number of variations of the hypothesis formulated by Dovey and Pafka[2] is possible.

This method can be further developed by incorporating more empirical and academic literature focusing on other angles in the same topics. For example, the works of Hussain[32] on Dhaka New Market focused on local cultural perceptions of the market as an urban space, giving more insights related to how the urban assemblages work in the case study. In her work, it was found that informal vendors found a mechanism for allowing a safe interrelation with the formal shops of the market. There is competition within the formal

and informal sectors to capture potential customers and this is the reason for the hostile situation within the formal-informal assemblage. In this arrangement, the informal vendors located at the outer periphery act as advertisements of goods available in the formal domain to potential buyers. We can see how the "resilient and self-organising"[12] and "dynamic and robust"[3] aspects of complex adaptive systems are working in this particular context.

Moreover, Rahman's[33] study on the New Market's conservation value also provides more insights from the assemblage point where it shows that the physical arrangement of the market has a strong preference for the layout to remain as it is, from all the stakeholders. This insight suggests that option three is more acceptable to shop owners from the formal assemblage.

8. Conclusions

In conclusion, it is evident that every city has a self-organizing mechanism to withstand various challenges in complicated ways which can be interpreted as "diversity and redundancy"[12], "dynamic and robustness"[3], or "urban ecology"[5], or any other terms. During this withstanding period, the urban environment goes through some internal changes and to understand these changes through the urban design discipline, a framework is required[25]. With these ideas and knowledge in mind, this research tries to formulate an urban design framework based on a prior hypothesis by Dovey and Pafka[2] to understand the complex problems around a shopping complex in Dhaka city. In doing so, the research tries, firstly, to frame the nature of urban complexity and how it may be addressed, specifically regarding informal vendor activity in this case; secondly, how the designers of the urban development producer group can critically dive into the analysis and evaluation process of urban design proposals; and thirdly, how to perceive urban design theories originated in a western mindset against the context of the developing world's perspective. Additionally, the limitations posed by these propositions are acknowledged as much as possible.

Author Contributions

Conceptualization, M.E.B. and F.N.; methodology, M.E.B. and F.N.; software, [not applicable in this study]; validation, M.E.B. and F.N.; formal analysis, M.E.B.; investigation, M.E.B.; resources, M.E.B.; data curation, M.E.B.; writing—original draft preparation, M.E.B.; writing—review and editing, M.E.B. and F.N.; visualization, M.E.B.; supervision, M.E.B. and F.N.; project administration, M.E.B. and F.N; All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

All data generated or analyzed during this study are included in this article. This qualitative study has generated a few graphical schemas representing the spatial database derived from observations mostly to understand urban design decisions and presented in the article. No additional data is available otherwise.

Conflicts of Interest

The authors declare no conflict of interest.

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