Original Article

A framework for place-making using Alexander's patterns

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Abstract Christopher Alexander's book, *A Pattern Language*, introduces 253 design patterns that offer a vast grab bag of neo-traditional design options for place-making. One of the more compelling strengths of the text is the connectivity rule which indicates that each pattern is closely connected to other complimentary patterns. What remains unclear is which of these patterns are most influential. In this research, a quantitative assessment through network analysis is used to visualize the networks within Alexander's patterns and examine each pattern's relative importance for place-making. Findings suggest that five design patterns – Wings of Light, Arcades, Building Complex, Pedestrian Street, and Path and Goals – are, relatively, the most significantly influential and highly connected patterns. These patterns prioritize the importance of the quality of building arrangements, the function of building edges and emphasizes pedestrian-friendly design. The findings of this paper could be used to prioritize specific goals and for long-term place-making during initial design and planning.
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Introduction

The patterns introduced by Alexander (1979) in the book, *A Pattern Language*, are valuable design and planning resources. The vision unveiled in Alexander's book opposed the modernist approach to design of separated land uses, non-human-scaled design and single-occupancy automobile-oriented development. The ideas embedded within Alexander's patterns are similar to the beliefs of new urbanists, with a strong emphasis on community engagement and participatory feedback. In fact, *A Pattern Language* is now sometimes used as tool for community planning projects requiring active participation of residents (Schuler, 2002). This is possible because of two attributes of the book: a user-friendly design guide which can be understood by non-professionals and a well-organized collection of design issues and their respective solutions.

Historically, towns once grew without the help of either architects or planners. Citizens were able to create towns in which they felt relaxed, peaceful, alive and vibrant through patterns of inhabitation (Alexander, 1979). *A Pattern Language* emphasizes this urban design process and seeks to recreate the quality of the historic designs evoked by user-friendly layouts. The book argues that a town should be built the way that towns were originally, using information provided by a majority of non-professionals. In this sense, it was somewhat pitched as a "do it yourself" reference book for amateurs and professionals who wished to plan towns or communities. To enhance the

The street absolutely will not work unless its total area is small enough to be well filled by the pedestrians in it—PEDESTRIAN DENSITY (123). Make frequent entrances and open stairs along the street, instead of building indoor corridors, to bring the people out; and give these entrances a family resemblance so one sees them as a system—FAMILY OF ENTRANCES (102), OPEN STAIRS (158); give people indoor and outdoor spaces which look on the street—PRIVATE TERRACE ON THE STREET (140), STREET WINDOWS (164), OPENING TO THE STREET (165), GALLERY SURROUND (166), SIX-FOOT BALCONY (167); and shape the street to make a space of it—ARCADE (119), PATH SHAPE (121). . . .

Figure 1: Linked patterns to pedestrian street pattern.
Source from Alexander *et al*. (1977, p. 489).

understanding of town building for non-experts, the book defines a series of design patterns based on specific issues using a consistent template, providing both design principles and recommendations which are detailed with easy to understand pictures and diagrams. This systematic writing structure assists laypeople in easily understanding the basic rules, ideas, and solutions for community design (Lea, 1994; Sime, 1986). Non-professionals can also easily create their own patterns to fit local contexts by modifying the introduced patterns.

Another innovation of *A Pattern Language* is its connectivity rule. This rule signifies that one pattern cannot stand alone, but is part of a collection of closely tied design elements that can contribute to creating a place. Place, according to Alexander (1979) is a quality established, mostly by non-professionals, to make people feel vibrant, alive and unselfconscious. In *A Pattern Language*, the author argues that sequential influences between patterns are just as important as the individual patterns themselves. It is posited that the likelihood of creating better places becomes higher when a person who becomes involved in a planning project understands the networks within each interdependent design pattern. A well-woven network of patterns can help place-makers enlarge their list of potential design solutions to existing issues and deliver more benefits to non-professionals who may not have accumulated experience in community design.

Unfortunately, the linkage between patterns in Alexander's book is only expressed in a descriptive and qualitative way. An example of a verbal description from the book is presented in Figure 1. These verbal descriptions are valuable, since the knowledge presented was accumulated from the authors' experiences in academia and practice. As a user, however, the links within these patterns are difficult to follow, considering the large number of patterns presented and the multiple scales (e.g., site, community, municipality, and etc.) involved with each.

While Alexander's patterns are an informative and useful tool for community design/planning, an analysis which synthesizes these patterns would help to identify networks within the immense number of presented patterns, create a hierarchy among these patterns and define the primary linkages between all identified patterns. Using network analysis, this paper attempts to quantitatively assess and visualize the network of available patterns for community planning projects and develop a hierarchy within them. The approach utilized identifies core patterns within the complex set presented by Alexander, so that users can isolate patterns by first-order, specifically during periods where time and capital are limited.

Literature review

Christopher Alexander: Patterns, overlaps, order, and value

Christopher Alexander's scholarly portfolio is comprised of many noteworthy books, as well as a range of design projects. The central thesis of Alexander's oeuvre is that there are underlying problems in cities and the process of designing physical forms can act as a solution to those problems (Ockman and Eigen, 1993). The initial exploration of this premise began in his 1964 dissertation, *Notes on the Synthesis of Form*, which incorporated survey and observational data to analyze social patterns of villages; these patterns were then presented as drawings, or what Alexander referred to as stem diagrams (organic hierarchical attempts at organizing social patterns). Post

dissertation, Alexander began to realize that his efforts to organize patterns within tree-structured diagrams did not afford the ability to account for overlap and continuity among patterns. In a critique of his earlier studies in *A City is Not a Tree* (1965), Alexander posits that a semi-lattice organizational form of diagramming allows for a more accurate and a more complex framework. The semi-lattice structure allowed for increased complexity through the accommodation of overlap between parts while the stem diagrams were more restrictive and could only categorize each portion into discrete units. As an example, Alexander claimed that a town without pattern overlaps was inadequate and the separate patterns would separate city functions, ultimately destroying the city.

In 1975, Alexander undertook one his most famous building projects, applying his pattern theories to town building. *The Oregon Experiment* (1975) sought to demonstrate how some of the theoretical ideas developed by his pattern approach could be used practically by a community. Academics, students and experts participated in a piecemeal and ever-evolving design process, breaking free of the traditional campus master planning and allowing the university to develop according to user preferences and patterns. The book is a strong example of Alexander's position that successful design can only emerge through collaboration between users and experts.

His next undertaking would ultimately seek to both reveal and assess identified patterns. Arguably Alexander's most commended and criticized book, *A Pattern Language: Towns, Building and Construction* (1977), posits that there are unconscious patterns by which humans both identify and live in space. The ultimate goal of the book was to develop an applied language to enable common users to become conscious of their inherent living patterns and educate the populace about elements within their town, housing, street system and built environment; these patterns would then help inform and become an integral part of the design process. The book's intent was to create a bridge between professional designers and habitual users of space. To break free of the common abstract principles and wildly theoretical design conceptions of the time, Alexander sought to both describe a conceptual framework and thoroughly map its principles.

Building off the praise of the 1977 publication, Alexander sought to echo his earlier premise and inform architects on how to design for these patterns in *The Timeless Way of Building* (1979). Its central argument is that patterns developed simply by living life allowing unconscious cognitive relationships with space to be discerned, consciously recognized and further improved upon (Bhatt and Brand, 2008). The proposition is put forward that designers should alleviate themselves from any other method of design and utilize the inherent patterns created by continual usage to develop designs. Only in holistic perception can an experience of a more real world, one that is radically different from the physical world as seen, be undertaken (Grabow, 1983). More recent publications of Alexander somewhat deemphasize his previous underscoring of patterns and highlight the importance of order, define what order is and discuss how order should be produced. In *The Nature of Order* (2002), Alexander derives his definition of order-based processes which occur within the built environment in a similar manner from which his *Pattern Language* was developed. He also calls for a normative framework to create order in the built environment (Bhatt and Brand, 2008).

While Alexander's notion of the importance of user-defined patterns has been highly acclaimed by many, it has also been highly criticized. This criticism has come, primarily, due to Alexander's emphasis on user-driven values. Value is hard to define in quantitative terms; it is the ultimate holistic, emergent phenomenon (Mehaffy, 2007). According to Alexander, value is a sharable phenomenon, and one that can be discussed, discerned and ultimately physically realized, to some degree. For many, Alexander's approach is the ultimate enforcement of blandness, only a large pool of average tastes combined into a diagrammatic form (Seamon, 2007). Many believe that value is a purely subjective entity, but Alexander believes that value is not entirely subjective. While the many factors contributing to value are variable, Alexander posits that we must dissect and decipher it carefully, using rigorous scientific methods (Mehaffy, 2007).

Influences of Alexander's patterns

A Pattern Language (Alexander *et al*, 1977) takes the premise that patterns – design references – for community and architectural planning are one of the most heavily utilized materials in planning and architectural projects. The book presents 253 patterns that can be implemented for place-

making in urban design. Its goal is not solely focused on suggesting design solutions to existing issues, but it is a philosophical critique of modern planning approaches to increase the understanding of pre-modern traditional environments (Bhatt, 2010). The book principally emphasizes that community planning should not primarily be taken on by private developers, but should rely more on the empowerment of everyday users. According to Dovey (1990), patterns collected from everyday experiences are more powerful because urban patterns are directly formed from individual experiences.

The theoretical positions of Alexander's patterns have influenced many contemporary urban and regional growth strategies. Particularly, design components of Alexander's patterns can be seen in New Urbanism philosophies through Traditional Neighborhood Developments (TND), urban villages, Transit-Oriented Developments (TOD), and smart growth (Moudon, 2000; Silver, 2006). Both Alexander's patterns and new urbanist placemaking strategies pursue walkable, compact, human-scaled and socially and culturally mixed neighborhoods as well as revitalized public spaces to revive strong community life (Lund, 2003). Both frameworks also provide an emphasis on people's daily lives and the influence of design on people's behavior. The relative strength of Alexander's patterns over New Urbanism is its practicality of implementation. New Urbanism is closer to a normative theory or provisioning of future planning directions (Moudon, 2000). Form-based codes or Smart Codes with transect zoning, however, are recent efforts of new urbanism to interact with design practice. Alexander's patterns are carried out with much more detailed information in an effort to deliver design practices to non-professionals. This thoroughly aids in expanding the practice of community design, research and education as demonstrated in works of Schuler (2002) and Duarte and Beirão (2011); the former attempted to use a pattern language to communicate with participants through an on-line platform and the latter developed an urban form analysis procedure following the basic guide of a pattern language.

Alexander's patterns: Roles and types

A pattern is a careful description of a solution to a recurring problem in architectural and community design. *A Pattern Language*'s 253 referenced patterns are classified into three sections: town (pattern numbers 1–94), building (95–204) and construction (205–253). Patterns for town plans are presented as a prerequisite to create large-scale town planning frameworks. The section for building plans is broken down into four groups: the overall arrangement of groups of buildings (95–118), their interactions with streets and outdoor spaces (119–126) and interior design concerns (127–205). Guides for construction provide increased detail into the philosophies presented and aid in understanding how to make buildable structures.

Regardless of the different roles of each presented pattern, each is explained in a single chapter within an orderly format (Salingaros, 2005) consisting of six parts: (1) a picture of the example discussed with a pattern number, (2) other patterns connected to the pattern presented, (3) issues addressed by the pattern, (4) proposed design principles for implementing the pattern, (5) solutions provided by the pattern and (6) a reiteration of patterns connected to the presented pattern. A uniformly arranged format for each chapter also allows basic understanding of design principle is put forward. For example, let's assume that a person is interested in "Arcades," which can be found in chapter 119 on page 580 in the book. One will follow the following order to get the comprehensive idea of Arcades:

> The chapter presents a definition and picture of Arcades.
> It introduces the types of places where Arcades can be easily formed and create synergy: For example, Cascade of Roofs (116), Pedestrian Street (100), Paths between Connected Buildings (108), and Parts of Circulation Realms (98). The numbers in parentheses refer to each pattern's chapter number in the book (in other words, further details of Pedestrian Street, for example, can be found in chapter 100).
> The issues and problems of disconnected buildings which do not invite the public in are discussed. Arcades are mentioned as one of the effective solutions for this matter.
> Four primary design principles are suggested; (1) arcades need to have the character of the inside of the building to which they are attached, while being public; (2) arcades should be covered with many openings; (3) edges of the ceilings have to be low; and (4) the effect of arcades can increase when they pass through between buildings.

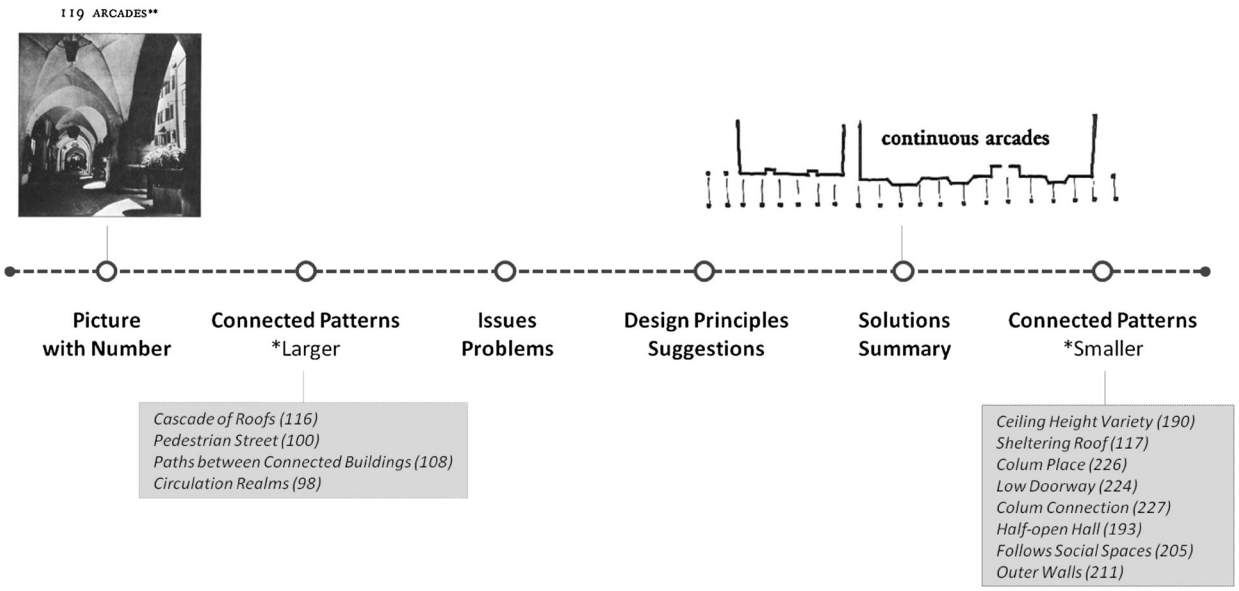

Figure 2: A template for pattern description: design solution for creating better Arcades.
Note: Diagram is created by authors, but two pictures above were retrieved from Alexander *et al.* (1977, p. 580 and 583).

The summary of the actual design solutions is described with texts and diagrams. Several other linked patterns that help create better arcades, such as Celling Height Variety (190), Sheltering Roof (117), Column Place (226), Low Doorway (224), Column Connection (227), Half-open Hall (193), Follows Social Spaces (205), and Thickening the Outer Walls (211), are then mentioned (Figure 2).

The connectivity rule

Overlaps in characteristics appear at the beginning and/or the end of each pattern and are listed as larger and smaller patterns in the book. To help explain the relative hierarchical positions of patterns, let's call a pattern in our interest pattern X, for example. All Xs have larger and smaller linked patterns which are pooled within the set of 253 patterns from the book. Pattern X can be more successful with the help of smaller patterns connected to X, while larger patterns lay the groundwork and necessary conditions to make pattern X actually occur on the ground (Park, 2015). Taking the example of Arcades (119) again, Arcades are stated to be more easily implemented where a Pedestrian Street (100) – a larger pattern of Arcades – is already established. To create more effective arcades, design elements of Building Edge (160) – a smaller pattern of arcades – should also be seriously and concurrently considered. The orders of larger and smaller (or highly and less influential) patterns are not, however, fixed, but relatively determined within the pool of 253 patterns depending on the characteristics of pattern X. In addition, the chapter numbers categorizing patterns do not necessarily signify a hierarchical order. To illustrate, Pedestrian Street (100) is a larger pattern in which Arcades can be linked (119), but it is not always a linkage for other smaller patterns. Pedestrian Street (100) is also a larger pattern for activity node (30), but is a smaller pattern for promenade (31). This suggests that Pedestrian Streets are essential foundations to create activity nodes, whereas a promenade should be designed for pedestrians to be more successful. The connections created between patterns form an intricate network (Figure 3).

These connections are one of the most noteworthy aspects of Alexander's patterns (Prakash and Fielding, 2008). Jointly collected design components enable users to understand upcoming or related design issues and set the priorities of design patterns while identifying larger and smaller patterns (Salingaros, 2000). A combination of patterns can compromise or complement one other; a higher complement ratio contributes to create more desirable places (Hillier and Hanson, 1984; Newman, 2013, 2016). Users can easily expand a potential design list following the path of connected patterns. First, decide on a few necessary patterns for your project. Second, find larger and smaller patterns which are related to the chosen patterns. Third, drop seemingly less important patterns based on a given users' own

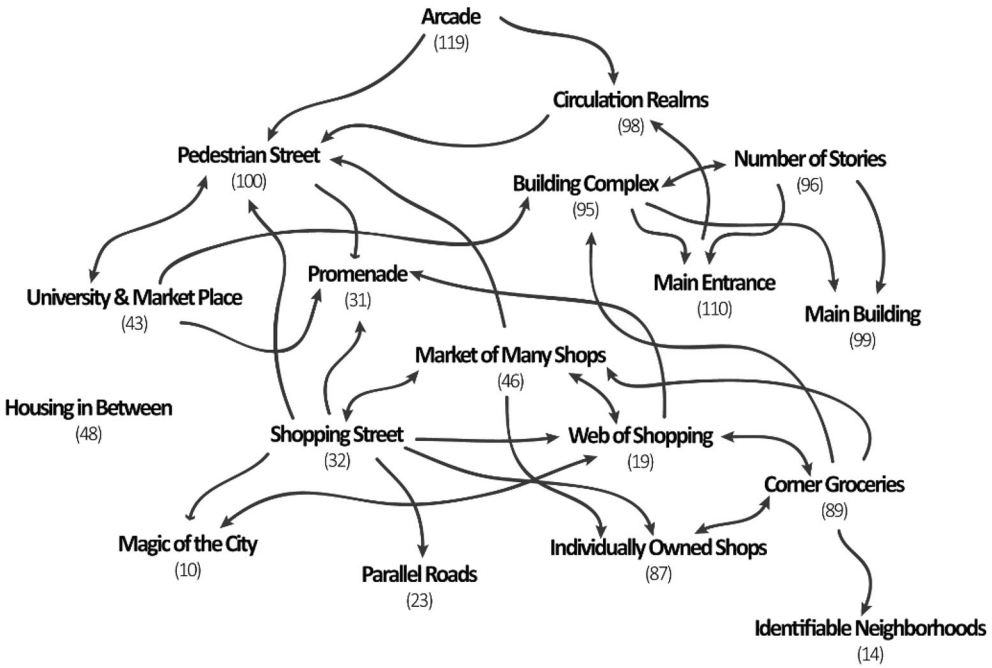

Figure 3: Example: connected patterns to pattern number 119, Arcade.

judgment or limits. This process can nurture the design and expand its program, while also including patterns which may have been previously unrecognized by users due to a lack of knowledge or a simple oversight. However, users may find some difficulties when interpreting the complicated links created by a number of connected patterns, as described in Figure 3. In addition, it is not clear how to drop seemingly less important patterns in a complicated network. Finding the most active patterns within a network of patterns is not an easy task. Therefore, a method to observe networks within these patterns and identify the relative importance of each needs to be developed.

Research Objective

The ability to synthesize the vast set of patterns presented by Alexander and identify the most prominent networks, or interconnected patterns, is a daunting task. A quantitative method to conduct such an undertaking would provide designers and planners with a starting point for identifying the most prominent and applicable patterns for community design and place-making. The objective of this research is to use a network analysis to statically assess overlaps and interconnections within Alexander's patterns to identify the most crucial patterns for place generation. Achieving such an objective could provide designers and planners a platform for decision-making when choosing patterns with which to plan or design. This method could also be applied to living cities and neighborhoods to identify their existing patterns and any connected patterns which may merit future implementation.

Methods

Network analysis

Network analysis (NA) is employed in this study to visually and statistically identify the structure of patterns. Originating from the sociological exploration of kinship and marriage (Maas and Hox, 2005), NA has been widely used to assess social structures; examples include a friendship network, a kinship network or a network of members within an organization (Scott, 2012). NA has been expanded to many disciplines outside of the social sciences, wherever a structure has networks of components and needs analytical measurement. For example, NA has been used to track disease transmission in the medical sciences, analyze social media networks in communication studies or evaluate geographic transport networks in planning or architecture (Otte and Rousseau, 2002). The merit of NA comes from its underlying theories: graph and network.

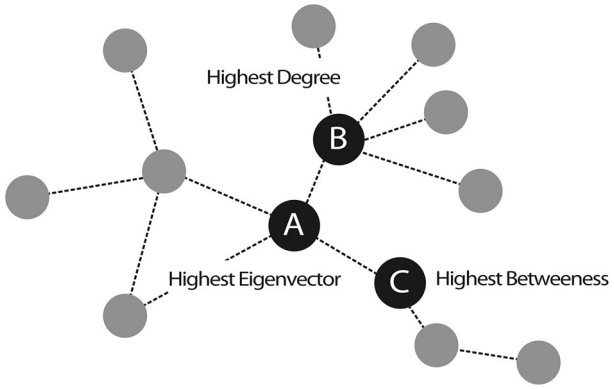

Figure 4: Highest degree, betweeness and eigenvector centrality in a network.

Graph theory is typically used to assist in visually presenting associations by drawing nodes and vertices (often called edges, links, or ties) that connect nodes while network theory suggests that one can tell more about a phenomenon by studying its interconnections rather than studying individual characteristics (Sailer and Penn, 2009). Each theory attempts to fully understand an entire picture, assuming that the interactions between entities influence the whole group. Distribution of nodes and their linkages can be better identified by various NA metrics such as density (the general level of connectedness), closeness (or distance), tie strength (weak and strong links) or centrality (key and central nodes) measures (Flanagan *et al*, 2011). This paper employs only a centrality score because one of the primary goals is identifying core patterns for community planning based on Alexander's patterns. Moreover, finding the central position in a given network is major focus of NA across studies (Valente *et al*, 2008).

Degree, betweenness, closeness or eigenvector are the most frequently used centrality measures (Valente *et al*, 2008). Based on degree centrality, we can capture a node with a high value that tends to actively influence other nodes in the network (Kim *et al*, 2011). This is the simplest and powerful metric to show the popularity of nodes. A high between-centrality of a node indicates that the node has a large number of shortest paths to other nodes. Simply stated, high values of betweenness on nodes are located at the critical points or strategic positions of the network which act as intermediaries that can disconnect other parts. Eigenvector centrality is an extended version of degree centrality, but weighs the importance of linked other nodes of one node. This is useful to show which node is linked to the most influential nodes and also counts indirect connections (Bonacich, 2007). However, only degree, betweenness, and eigenvector centrality were employed in this paper. Closeness centrality calculates the average time needed to spread information from other nodes based on the length of the vertex (Park, 2015), but, this is a less useful measure because the 'speed' to reach other design patterns was not within our scope of interest. Statistically, moreover, closeness and degree were typically strongly related to each other (Bolland, 1988).

Figure 4 is an exemplary diagram that explains the simple concept of degree, betweenness and eigenvector centrality. Node B reports the highest degree centrality score because it holds the largest number of connections, is the focal point of this network, and mainly controls the flow between the other nodes. Meanwhile, node C has the highest betweenness centrality score and is not as active as node B, but it works like a bottleneck of roads that connects other parts of the network. If it fails or is removed, the entire network will be broken into two parts and may cause disruptions in the complete system. Node A has a higher eigenvector centrality, but has a relatively lower degree centrality compared to node B. Node B holds five connections, while node A is linked to four nodes. However, node A seizes more popular nodes like B and C than node A.

Analytical process

In order to demonstrate the network and unveil the most critical patterns useful for community design and planning purposes, 126 patterns were gathered from the book, primarily dealing with issues of how to frame towns and communities,

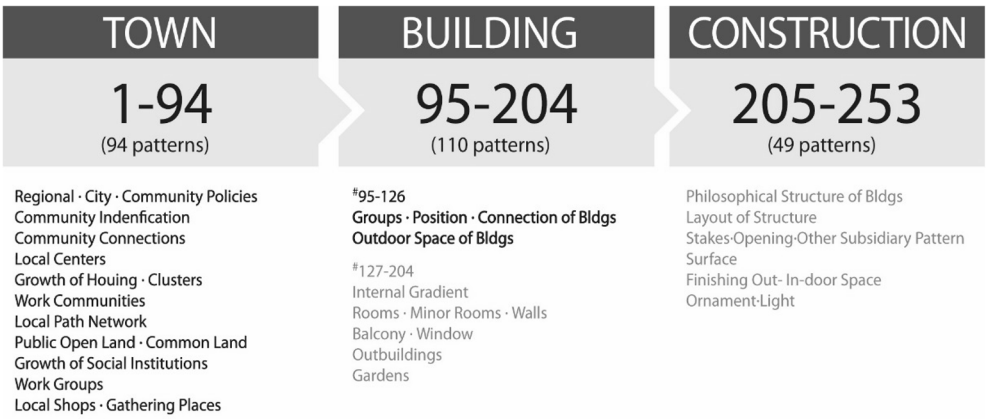

Figure 5: Three groups of patterns (Town-Building-Construction Chapters). *City or Community-level design concerns are highlighted in bold.

lay out groups of buildings and arrange interactions with streets and outdoor spaces of buildings (Figure 5). Patterns from chapters 127–253 were excluded from the analysis because they are primarily concerned with the interior design of buildings and more specific building construction details.

To eliminate bias, all linked patterns were gathered with no distinctions between larger or smaller patterns. The orders of larger and smaller are relatively determined by the chosen pattern, and are not permanently fixed. Links of patterns were coded as a parallel edge list, which stores a pair of connected patterns in both directions as one connection. The chapter's number was used to represent each pattern for coding. For example, as illustrated in Figure 6, Shopping Street (chapter 32) and Pedestrian Street (chapter 100) were coded as 32 and 100, respectively. If two pairs of connections between 32 and 100 were found in the list – 32 is a larger pattern of 100 (32–100) and 100 is a smaller pattern of 32 (100–32) – those connections were coded as one link (32–100). Nine hundred and thirty-three pairs created from 126 starting patterns were collected for the analysis. NA was performed with Ucinet 6.0 for centrality scores and the associations were visually organized using NetDraw 2.141 (Borgatti, 2002).

Results

Degree, betweenness and eigenvector centrality scores of patterns within the twenty highest-ranking patterns were compared (Table 1). In the network, the pattern with the highest degree centrality score was wings of light, followed by Pedestrian Street, Activity Pockets, Arcades, and Building Complex. These five patterns hold the most connections to other patterns and the most critical design patterns for community planning. Wings of light was also the pattern with the highest betweenness centrality score, followed by Arcades, Activity Pockets, Pedestrian Street and Hierarchy of Open Space. These five design patterns act as bridges that must be crossed to reach each group of design patterns that are clustered with similar characteristics or are closely connected. Building Complex showed the highest eigenvector score followed by Wings of Light, Arcades, Path and Goals, Circulation Realms and Pedestrian Street. Each pattern serves as an important node connected to other critical neighboring patterns in the network observed.

Different centrality measures identified slightly different aspects of importance of patterns in a given network. Thus, a composite rank score was made to find a core pattern. Patterns ranked in the 99, 95, 90, 75, and 50 percentiles of each centrality metric were given five to zero points in ranked order. For instance, patterns falling in the 99th percentile were assigned five and from 95 to 99 per cent, four points, and so on. Patterns located in the less than 50th percentile were not assigned any points because their original centrality scores did not substantially vary and there was no distinctive inflation point from each point. Their degree centrality ranged from 0.81 to 1.61, betweenness from 0.00 to 0.03 and eigenvector from 1.72 to 4.24. Finally, the rank scores of each pattern were composited. Percentile grouping was used because centrality scores express the relative

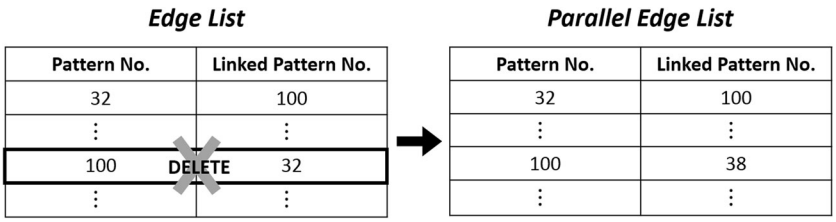

Figure 6: Example: edge list and parallel edge list.

Table 1: Patterns with high frequency and centrality scores ranked in the top 20

Degree (①)		*Betweeness (②)*		*Eigenvector (③)*		*Rank score (① + ② + ③)*	
Pattern name	*Score*	*Pattern name*	*Score*	*Pattern name*	*Score*	*Pattern name*[a]	*Score*
Wings of Light	20.16	Wings of Light	17.96	Building Complex	38.77	Wings of Light[10]	14
Pedestrian Sstreet	17.74	Arcades	14.89	Wings of Light	37.01	Arcades[4]	11
Activity Pockets	16.94	Activity Pockets	14.06	Arcades	36.14	Building Complex[1]	11
Arcades	16.94	Pedestrian Street	10.57	Path and Goals	32.01	Pedestrian Street[2]	11
Building Complex	14.52	Hierarchy of Open Space	9.00	Circulation Realms	31.99	Path and Goals[16]	10
Path and Goals	13.71	Path and Goals	8.90	Pedestrian Street	30.15	Activity Pockets[8]	9
Circulation Realms	12.90	Building Complex	8.85	Positive Outdoor Space	28.56	Circulation Realms[24]	9
Path Shape	12.10	Something Roughly in the Middle	8.08	Activity Pockets	27.56	Positive Outdoor Space[19]	9
Roof Garden	12.10	Circulation Realms	7.60	Main Entrance	27.18	Roof Garden[35]	7
Positive Outdoor Space	12.10	Building Thoroughfare	7.55	Path Shape	26.39	Path Shape[16]	7
Something in the Middle	11.29	Courtyards which Live	6.92	Building Fronts	26.35	Courtyards which Live[35]	7
Building Fronts	11.29	Roof Garden	6.66	Site Repair	25.92	Hierarchy of Open Space[35]	7
Courtyards which Live	11.29	Positive Outdoor Space	5.91	Courtyards which Live	23.01	Something in the Middle[44]	6
Hierarchy of Open Space	11.29	Shielded Parking	5.76	South Facing Outdoors	21.49	Building Thoroughfare[19]	6
Half-Hidden Garden	11.29	Half-Hidden Garden	5.57	Cascade of Roofs	21.23	Building Fronts[26]	6
Shielded Parking	11.29	Sheltering Roof	5.40	Number of Stories	20.72	Main Entrance[35]	6
Pedestrian Density	10.48	Building Fronts	4.92	Roof Garden	19.76	Site Repair[52]	6
Main Entrance	10.48	Stair Seats	4.46	Half-Hidden Garden	19.28	Shielded Parking[19]	5
Site Repair	10.48	Number of Stories	4.42	Structure Follows Social Spaces	18.69	Half-Hidden Garden[35]	5
Building Thoroughfare	10.48	Path Shape	3.86	Pedestrian Density	18.62	Stair Seats[26]	5
Stair Seats	9.68	Main Entrance	3.84	Hierarchy of Open Space	18.56	Number of Stories[52]	5
Cascade of Roofs	9.68	South-Facing Outdoors	3.83	Stair Seats	17.95	Pedestrian Density[24]	5
Number of Stories	9.68	Site Repair	3.69	Building Thoroughfare	17.92	Cascade of Roofs[59]	5
South-Facing Outdoors	8.87	Small Parking Lots	3.18	Shielded Parking	16.72	South-Facing Outdoors[52]	5
Small Parking Lots	8.87	Car Connection	2.69	Family of Entrance	16.61	Sheltering Roof[83]	5
Entrance Transition	8.87	Cascade of Roofs	2.59	Something in the Middle	15.99	Car Connection[70]	5
Sheltering Roof	8.07	Entrance Transition	2.12	Sheltering Roof	15.01	Family of Entrance[70]	5
Family of Entrance	7.26	Pedestrian Density	1.98	Car Connection	14.61	Gallery Surround[121]	5

[a] Numbers attached to the right refer to the rank of each pattern measured only by frequency.

order of each entity within a given network; in this sense, making a sum of raw values of three different centrality scores seems less meaningful. As shown in Table 1, the combined rank scores indicated that wings of light is the most critical and influential pattern followed by other patterns ranked in the top 5: Arcades, Building Complex, Pedestrian Street and Path and Goals. Those five patterns were positioned at 10th, 4th, 1st, 2nd, and 6th in frequency, respectively, which implies that

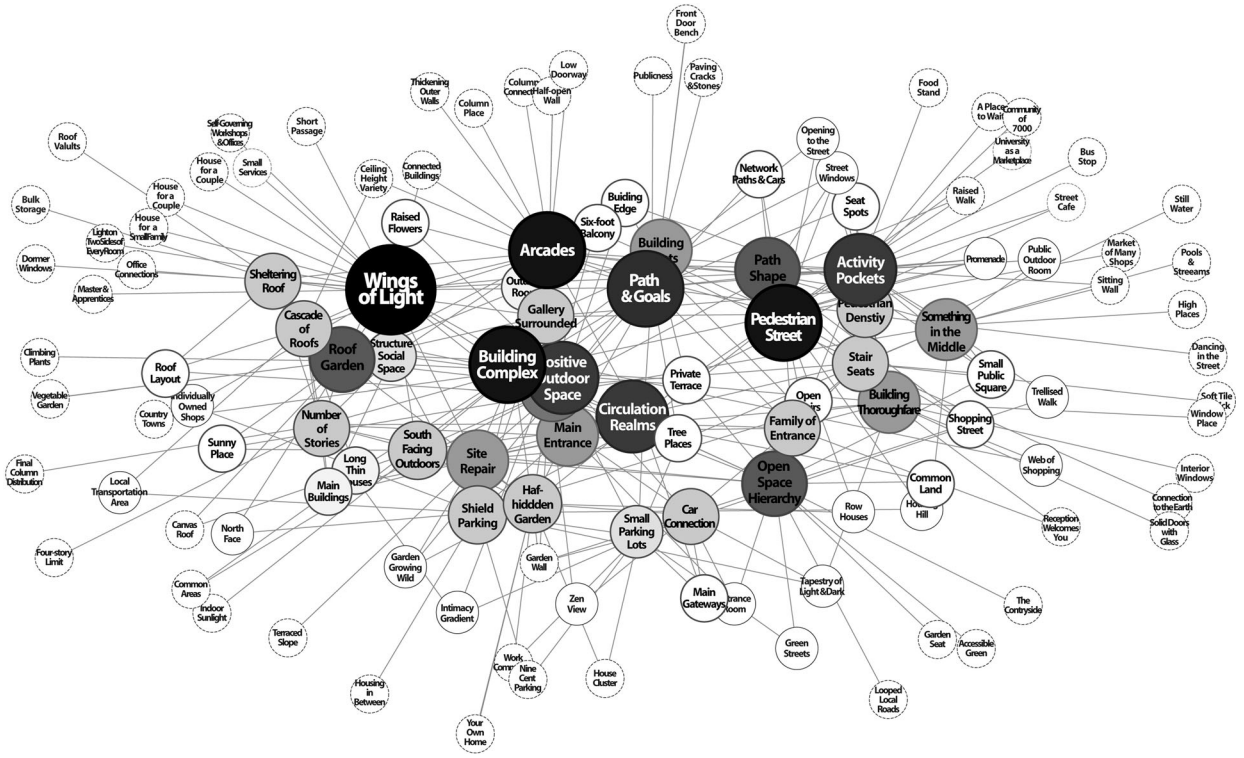

Figure 7: The overall network of patterns for community and neighborhood design.
Note: Figure was drawn by using NetDraw and recreated based on the rank score.

simply counting the frequency of the appearance of patterns may not be the appropriate approach to identify the core patterns, when connections and sequences between patterns exist.

Figure 7 enables us to investigate the overall configuration of patterns. If one pattern presented as a node is located close to the central area of the network, it generally suggests that this entity plays an important role in the network. If it were placed in the peripheral area in a network, it would imply this entity is less active or less critical in a given network.

Discussion

Christopher Alexander rates each pattern on a scale of zero to two stars, which indicates the level of confidence for design challenges. Two-stars indicates that one could be confident that the suggested pattern can be implemented to effectively solve community problems. One-star means that one could address the problem with a suggested pattern; the implementation of these patterns, however, requires care and must be adjusted by the specific conditions of projects (Buschmann *et al*, 2007). Four out of the top five patterns were given two stars, which suggests we can be fairly confident in our findings based on the assumptions of *A Pattern Language*.

Wings of light** is found as the most influential and critical pattern for community design from our analysis. This pattern emphasizes a careful concern for natural light when placing or locating groups of buildings, but does not simply highlight the shape of buildings. It encourages capturing natural light and suggests that the proportions of a building need to be broken down into a series of wings rather than a big box style of architecture (e.g., strip malls). Long and narrow wings of buildings allow a community to have a more connected streetscape with a great cascade of roofs and façades, arcades and short passages to construct the flow of social spaces. Further, enclosed spaces surrounded by wings of buildings can serve as gardens, plazas, small stages for events or seating spots for outdoor activities.

Arcades** refer to exterior arches that cover walkways around buildings. This feature

should be a part of buildings to generate enclosed feelings but create accessible public spheres for pedestrians. Arcades are more essential in wet or hot climates. Beyond functional advantages, arcades contribute to the creation of consecutive façades appearing as a unique streetscape.

Building complex** emphasizes smaller size buildings with several breakdowns for different social entities inside and outside. Connected buildings with arcades, paths and bridges are especially encouraged. According to Gehl *et al* (2006), having rhythmic segments of buildings can create various scenes on the street that promotes the richness of outdoor space.

Pedestrian street** highlights an increase in pedestrian movement on thoroughfares. Large numbers of pedestrians on streets can encourage social interaction. The importance of a pedestrian-friendly design has been continuously discussed by several researchers and planners from development to comprehensive plans. For example, Jacobs (1961) highlighted the importance of vital streets. She argued that a vibrant street life with large numbers of people can overcome the blight of neighborhood dullness, crime, and inactive community life.

Path and goals* refers to the laying out of paths and terminuses for walking. This pattern claims that intermediate goals such as outdoor rooms, trees, entrances, seats and statues are more important than the final destinations and they should be connected with short paths. This design pattern calls attention to design components related to walkability, orientation, route decisions and destination recognition in current way-finding behavior issues, all of which are affected by people's visual and psychological perceptions (Emo *et al*, 2012).

The top five patterns found in this paper highlighted that building layouts, the quality of edge design and pedestrian-friendly environments are particularly important for town design/planning. Building layouts such as wings of light, arcades and building complex particularly addresses how to lay out buildings in order to encourage lively outdoor activities by increasing public activity in edges of buildings and the integrated use of public and private spaces (which is also often called semi-public or semi-private space). Edges are not just facades of buildings. They are exchange points, sitting and standing spaces and experience zones within the city (Gehl, 2013). The rhythm made by windows, columns, niches or fragmented building wings promotes active and vital public reteams (Gehl *et al*, 2006). If this frontage fails, city life may be impoverished. Enhanced edge designs can induce the needs of pedestrian-oriented improvements in public spaces because pedestrian movements are closely tied to the success of edge deigns.

Another design concern is how to create pedestrian-friendly streets (Path and Goals and Pedestrian Street). Restructuring infrastructure (Path and Goals) or improving streets for walking is the usual starting point of the typical physical town reconfiguration. Pedestrian flow and its vitality are often mentioned as important components for downtown redevelopment (Faulk, 2006; Jones and Foust, 2008; Robertson, 1990). More recently, New Urbanist philosophies and sustainable design principles also encourage walkable and pedestrian oriented environments, regardless of dominant land uses. While both pedestrian-friendly environments and vital edges contribute to increasing the richness of people's experiences, the level of involvement of the public and private sectors are different. Structuring pedestrian-friendly streets often requires involvement by the public entities, while edge design or remodeling can be a starting point in community improvement because it does not require the large amount of money and time typically required for large-scale public projects. The difficulty of managing private spaces can be somewhat overcome by voluntary joint efforts between public and private sectors or through planning policies. As Alexander has shown, providing good and/or bad examples of edge design could also help the public understand better. Plan approval or design review could be another method of enforcement. The public sector may suggest design recommendations to private developers. Or, the political governing authority of the area could create covenants that property owners should follow.

While this study examined the sequential influences of 126 community design patterns comprehensively, most communities may not necessarily need each identified core pattern. In other words, Pedestrian Street, Arcades or other primary patterns found in this study may not always be priorities for a given project. As mentioned, one of the strengths of using Alexander's patterns is utilizing ideas and suggestions of locals who are

non-professionals. To solve issues in a local context, a participatory process should be integrated. However, there are conditions that lead to more meaningful participation of communities for place-making. First, Alexander's patterns themselves and the outcomes of this paper provide a foundation to understand the basic physical implications of design principles and ideas for communities. Knowledgeable and empowered participants in the community can then begin discussing how to locally fit patterns provided by Alexander's book. As suggested by Schuler (2014) who has attempted to implement the pattern language approach in community planning, tailor-made patterns for local needs can be developed based on several steps: (1) generating, selecting and discussing patterns; (2) refining, combining and evaluating selected patterns; (3) a community should brainstorm the consequences and links between patterns; and (4) as demonstrated in this paper, the community members or participants should locate complicated links of patterns based on NA.

This study both validates the existing process presented by *A Pattern Language* as well as provides a quantitative methodological approach to measure interconnections between patterns (both existing and newly identified) to inform design decisions. To illustrate, let's assume a community creates several neighborhood design patterns for downtown redevelopment through workshops or brainstorming sessions and participants set a goal to increase residential land uses. As a next step, we may imagine some complementary design patterns to complete or promote residential uses such as diverse retail opportunities, reuse of historic resources, a successful public transit system, diverse housing types, and access to water bodies, if possible. From there, to connect to the waterfront, for example, people could think of other matching design patterns such as a promenade, green streets or bike paths. Simultaneously, one could add more relevant patterns from *A Patten Language*. The pattern, access to water, suggests the implementation of small parking lots, promenades and parallel roads as complementary patterns to promote increased access to water. By iterating these steps, participants could create a web of design patterns and then a community can find local centrality with NA. A community could also decide the first-tasks order by utilizing the composite rank score as described in this paper.

Conclusions

The experience-based design process of *A Pattern Language* can strengthen community development or neighborhood planning projects, since the guide is well-structured and easy to understand (even for non-professionals). Because the process is flexible to further modification, adding new patterns and revising existing patterns for specific projects is fairly simple. The connectivity rule of these patterns provides a fuller explanation of design sequences and a chance to estimate the synergy when several patterns are mutually considered. While the original guide provided by *A Pattern Language* was comprehensive, descriptive and qualitative, the method presented by this research offers another opportunity to look at the nebulous connections of patterns in a quantitative manner. With NA, the most substantial patterns for neighborhood planning are identified and the network of patterns are visually presented. The findings suggest an extreme importance on building arrangements, edge spaces and streets for pedestrian design for place-making. This approach can be employed as a preliminary work of community members before getting down to a real plan with experts or enhancing the knowledge of residents about community design. While this study began investigating all patterns related to community/town planning to find critical design patterns, users may consider a subset of patterns that are relevant to their situation and allowed in the circumstances given in that local area by following the same analytical process. Identifying and understanding the primary contributing patterns helps planners or community members set priorities for their future physical reconfigurations; patterns ranked at the top can be considered as first-order tasks. It can also enhance existing knowledge concerning the consequences of design implementation. It is now possible to visually demonstrate those consequences to the public for better appreciation.

This study also has a few limitations. As mentioned above, the research demonstrated how all patterns at the community or neighborhood level perform in general, not patterns for specific planning projects. If interest is in a certain type of planning project, modification of the starting patterns may be necessary which may lead to dissimilar outcomes. The study only used existing patterns suggested in the book. While the book has been one of the popular design

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references gained from long experience by several researchers and practitioners and is also currently employed in many New Urbanist design suggestions, the hierarchy presented among the connections should not always be seen as correct by readers and is dependent upon community conditions and needs. For future implementation, planners or participants need to carefully re-examine the suggested patterns and develop patterns and their connections that locals require based on their existing respective issues. There is little guidance on how to help communities to develop their own prioritized patterns. Future studies should further examine how locally fitted patterns could be developed through a participatory community planning process for place-making.

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