THE INFLUENCE OF URBAN FABRIC TYPOLOGIES ON PEDESTRIAN WAYFINDING

Alaa ElDin Nagy Sarhan*, Yasser Ahmed Farghaly and Ahmed Amal Mamdouh

Architectural Engineering and Environmental Design Department, College of Engineering and Technology, Arab Academy for Science, Technology and Maritime Transport, Alexandria, Egypt.

*Corresponding Author E-mail: alaaeldinsarhan@aast.edu

ABSTRACT:

Normally, in unfamiliar urban environments, wayfinding process obliges human beings to recognize the urban street network to be able to have a good sense of orientation. Wayfinding is the ability to reach a destination from an origin which requires a high awareness of the space navigated. In this concern, Lynch's theory of legibility has been essential in the urban design and planning fields showing the concept of urban imageability that is dependent on five elements which include paths, edges, nodes, landmarks and districts. However, recent research has suggested that planning according to the urban fabric typologies could address the limitations of Lynch's approach to urban spatial cognition. From this perspective, this research employs a methodology that combines a set of guidelines considering the imageability of streets which should enable appropriate distribution of the visual clues according to the typology of the urban fabric to guide the pedestrians through their walking trips in order to reach easily their destinations. Furthermore, the research follows a comparative analysis between the legibility of the radial, curvilinear and organic urban fabric typologies of Lisburn city centre in Northern Ireland, UK which signifies that the radial urban fabric is the most legible typology which provides the most essential features for efficient pedestrian wayfinding.

KEYWORDS: Wayfinding, Spatial cognition, Urban Fabric Typologies, Urban Legibility, Pedestrian Movement.

تأثير أنماط النسيج الحضري على الوضوح الحركي للمشاه

علاء الدين ناجى سرحان* و ياسر أحمد فرغلى و أحمد أمل ممدوح

قسم الهندسة المعمارية و التصميم البيئي ،كلية الهندسة والتكنولوجيا ، الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري، الإسكندرية ، مصر.

*البريد الاليكتروني للباحث الرئيسى: E-mail: **alaaeldinsarhan@aast.edu**

الملخص:

تحتم عملية وضوح وجهة الحركة للمشاة في البيئة الحضرية غير المألوفة التعرف على شبكة الطرق لاكتساب الإدراك وتحديد المسارات التي يتم التنقل فيها. عملية الوضوح الحركي هي القدرة على الوصول إلى وجهة من نقطة بداية و التي تتطلب إدراكاً كبيرًا بالفراغ الذي يتم التنقل فيه. ولذلك فإن نظرية لينش لقراءة النسيج العمراني ضرورية في مجالات التصميم والتخطيط الحضري التي تظهر مفهوم الصورة الحضرية التي تعتمد على خمسة عناصر تشمل المسارات والحدود والعقد والمعالم المميزة والمناطق. ومع ذلك، فقد أشارت الأبحاث الحديثة إلى أن التخطيط وفقًا لأنماط النسيج

الحضري يمكن أن يعالج قيود نهج لينش في الإدراك المكاني الحضري. من هذا المنظور، تستخدم هذه الورقة منهجية تجمع بين مجموعة من المبادئ التي تأخذ في الاعتبار مفهوم التصور الحضري الذي يتيح بدوره التوزيع المناسب للدلائل المرئية وفقًا لتصنيف النسيج الحضري لتوجيه المشاة من خلال رحلات المشي الخاصة بهم للوصول إلى وجهاتهم بسهولة. و قد تناولت الدراسة تحليل مركز مدينة ليسبورن حيث تمت المقارنة بين ثلاثة انواع من النسيج الحضري وهم الإشعاعي والعضوي والمنحني وقد خلصت الدراسة بأن النسيج الحضري الإشعاعي هو الأكثر هيمنة والأوضح لتوجيه حركة المشاه.

الكلمات المفتاحية: الوضوح الحركي ، الإدراك المكاني ، أنواع النسيج الحضري ، مقروئية النسيج الحضري ، حركة المشاه.

1. INTRODUCTION

In cities, pedestrian movement is a matter of public health that should be without any stress or anxiety. Therefore, the factor of way showing is essential for well-planned urban environments. Wayfinding is defined as the process of finding an individual's way from an origin to a destination. It is a crucial portion of everyday life activities which is dependent not only on the individual's personal cognition but also the legibility of the built or outdoor environments in addition to the availability of aids to support his/her wayfinding [1,2]. Lynch (1960) defined the action of wayfinding as a process in which people use environmental cues or information to position themselves and find their way from place to place [1]. In urban wayfinding, the strategic supporter is the environmental image that is the general mental representation of the exterior natural or built world that is apprehended by a city observer [3,4].

Learning a specific environment for a city observer usually occurs kinaesthetically (which refers to urban scenery) within a number of trips along with experiences and skills that become gradually generalized and stored[5,6]. *Landmark knowledge* which is considered as a point of reference is the first stage in environmental knowledge. People for example, learn to recognize their homes rapidly, in case they are temporary shelters or permanent dwellings such as a hotel being aided by landmarks during their movement activity [5–8] [9].

Afterwards, people begin to store in their minds their thoughts and understanding of the spaces between the landmarks. This stage is acknowledged as *route knowledge*. For example, newcomers may learn how to walk from their hotel to the any desired node and head back to their hotel. Afterwards, they can describe this sequential journey to enable friends and family to make the same route to have the same experience. Finally, after encoding multiple experiences of route sequences in peoples' minds, it is assumed that most people gain *survey knowledge* which is defined as an understanding of the large and global scale spatial configurations, such as neighbourhoods, major paths, landmarks and locations of attention which are spatially connected to one another. Survey knowledge is also thought of as constructing a cognitive map [6].
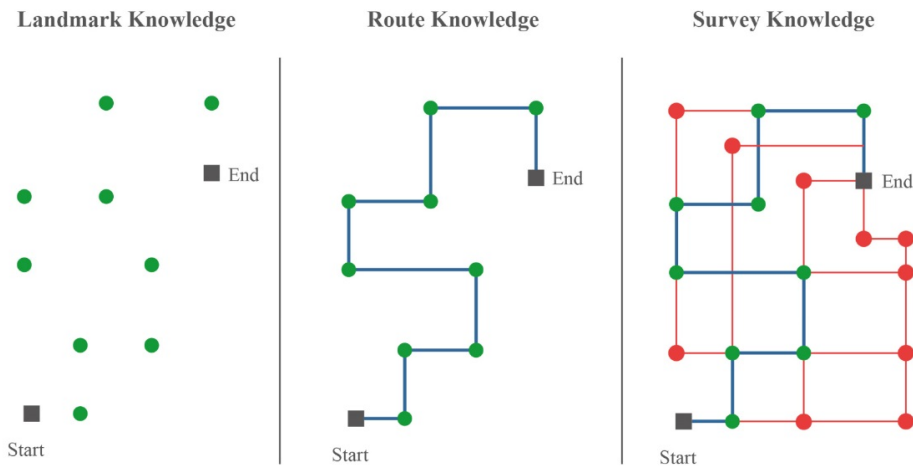

Figure 1: Stages of environmental knowledge acquisition. (a) Knowledge of reference points, (b) knowledge of paths, and (c) knowledge of spatial relations within a place Source: [6].

Lynch (1960) was the first to explain the term of urban legibility. He outlines the clarity or legibility of an urban environment as "the ease with which its parts can be recognised and can be organized into a clear pattern" or "the degree to which the occupants of a settlement are able to communicate to each other through its symbolic physical features" [3]. Identity and legibility studies provide evidence on how memorable positive features can be highlighted or negative design features can be diminished. Legibility analysis can also demonstrate the degree to which urban fabric improves or obstructs the local and regional way-finding and the community's sense of identity within a city. [10,11].

Figure 2: Lynch's Five Elements of Imageable City. Source: [3].

Whereas, imageability is a quality that amplifies the sense of orientation. A highly imageable city accordingly has to be significant and create a unique sense for its citizens [4]. Moreover, Emotions are connected with the spatial features particularly and with the apparent coherence (or non-existence of it) in the whole scene. Many Studies have assured that an imageable and legible environment can meet the needs of safety, sense of belonging and good cognition [4,11–14]. Furthermore, the five elements of the city image that are paths, edges, nodes, landmarks and districts are usually recognized and used to describe a collective view of the neighbourhood or town [10,11].

Paths are passages of movement or driving comprising streets, walkways, and mass transit lines. Edges are rectilinear, same as paths, but do tend to obstruct movement coming to them despite the large movement capacities they can encounter [13]. While, districts are the middle-sized sectors of the city. They are theoretically two-dimensional areas into which the observer moves. Nodes are planned spots in the city where city observers can enter by accessing crossings. They are normally associated with movement and may be represented by some sort of transportation hub such as a bus stop or mass transit station. Whereas, landmarks are a kind of indicators in the urban spaces which are perceived and remembered due to their form, structure or their socio-cultural importance [3,12,13].

2. IMAGEABILITY IN URBAN FABRIC TYPOLOGIES

Since it is the articulation and distinction of solids and voids that form up the fabric of the city and establish the visual orientation between spaces, Trancik has classified the urban fabric typologies using the figure-ground technique which is a graphic tool suggested by Gestalt for illustrating mass-void relationships [15,16]. The "field" of solids and voids creates this urban pattern, often called the urban fabric, and is composed of buildings and spaces. Accordingly, such solid and void relations could hold the potential for including major landmarks and open spaces that provide focal points for the city observers [15].
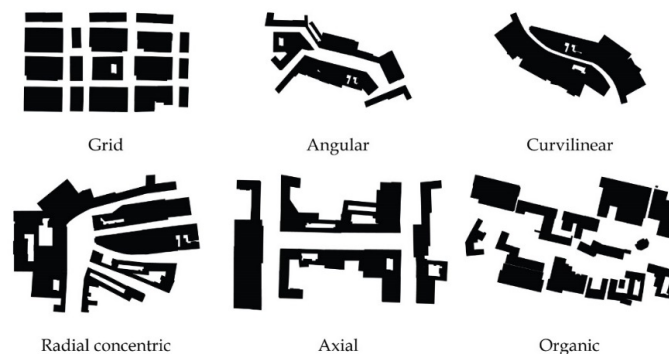

Grid   Angular   Curvilinear

Radial concentric   Axial   Organic

Figure 3: Urban Fabric Typologies. Source: [15].

The urban fabric is a two-dimensional abstraction in plan view that explains the structure and order of urban spaces [15]. Not only is the figure-ground technique revealing the collective urban form or character, but it helps to identify the relational differences in urban solids and voids which in turn allows one to classify them by type [15]. Subsequently the Spatial orientation is well-defined by the configuration of urban blocks [15,16].

Figure-ground studies reveal the collective urban form as an arrangement of patterns of solids and voids that can take on several configurations, such as the orthogonal or diagonal connection that is known as the modified grid, the random organic that is generated by terrain and natural features, and the nodal concentric that is linear and wraparound forms with activity centres [15].

2.1 GRID URBAN FABRIC

Normally, a monotonous repetitive grid of streets without hierarchy, salient elements or landmarks leads to disorientation [3,7,8]. Although the typical urban grid reduces wayfinding features by its nature, its morphology does not discriminate the main spaces, so that navigation through it tends to be dispersed all over its spaces [17].

o Jim McCluskey (1979) argues that in order to symbolize the grid pattern, a square can be used to cut off the monotony resulting from the repetition of urban blocks [8]. Landmarks should be located at the junctions especially where nodes exist as well as important crossings such as the crossing of non-continuous roads. Moreover, succession of diverse nodes parallel to continuous grid urban fabric help in recognition of streets [18–20].
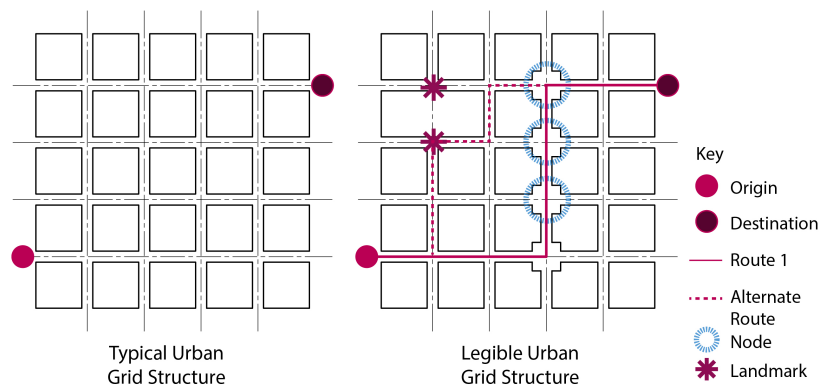

Figure 4: Wayfinding in grid urban structure. Source: adapted from [3,7,8].

2.2 RADIAL URBAN FABRIC

Radial patterns generally are used in urban squares and plazas as more complicated arrangements of crescent, squared or circular forms. This type of layout results in several interrelated spaces of different appeal and characters which are directing to the same focal point [8].
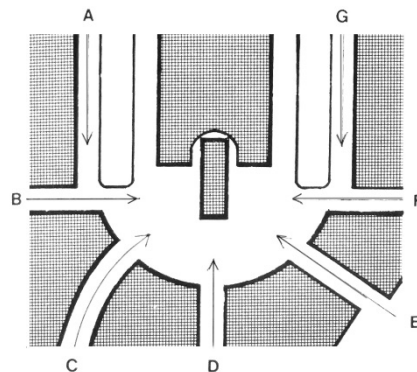

Figure 5: Radial Pattern. Source: [8].

In the given illustration in Figure 5, the central landmark is a church that has been thrust forward into crescent so that it blocks the view BF, through the crescent and becomes the focal point for all incoming routes at B, C, D, E and F as well as for all views from buildings along the crescent. The radial pattern is characterized by its complexity and multiple choice of routes with non-related angles that can result in stimulating and varied environments [8].

Normally, radial urban fabric is dependent on a central reference space from which the streets emerge. Accordingly, a radial node should hold a distinct directional landmark which in turn acts as a joining focal point of a dominant character in the centre point of the node [8].
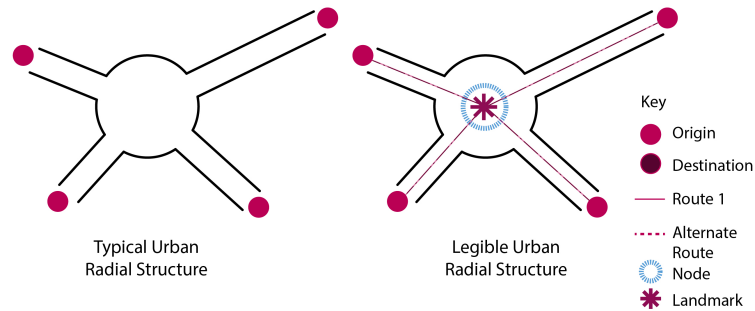
Figure 6: Wayfinding in radial Pattern. Source: Researcher.

2.3 AXIAL URBAN FABRIC

Jim McCluskey (1979) viewed the street alignments and their influence on the city observers. The parallel boundaries of a straight street, if are continuous for a lengthy distance, seem to come across in infinity [8]. This effect is emphasized when the borders are contained by buildings or vegetation providing a highly dynamic space feel [8]. It is important to close up the end of a straight linear street in order to enclose the space defined by the land surface and its sides [8]. Thus it helps to implant a sense of place into the linear space and to arouse a satisfying sense of complement [7,8]. The interest of the road can be greatly enriched for the city observer if it has a focal point [7,8].

Figure 7: Linear Street alignment with a focal point. Source: [8].

The use of vertical elements as well as incorporating non-symmetrical landscape elements help stimulating slow motion in the space and thus perceiving the surrounding landscape becomes easier. Additionally, the axial urban fabric provides the opportunity for creating spatial sequence through the art of landmark localization [8].

2.4 ANGULAR URBAN FABRIC

For the angular fabric to be easily perceived, nodes should be localized at the transitions of the angular street and articulated by diversifying them. Accordingly, the typical landmark localization strategy is to create it at the junctions between the two ends of the angled street [8,21]. A variety of impressions can be carried by a change in angle of the route alignment. When the angle is small, a long view seems continuous even when the vista is eventually closed by the buildings [7,8].
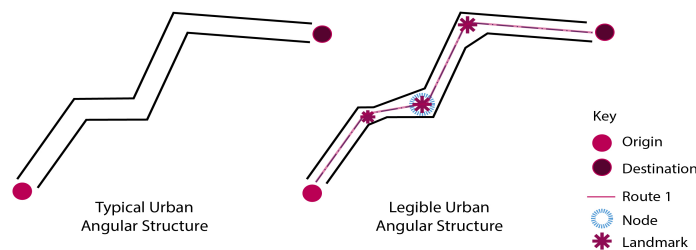
Figure 8: Wayfinding in angular urban alignment. Source: Researcher.

2.5 CURVILINEAR URBAN FABRIC

In curved routes, the curvature will slowly amend the orientation of the observer with the escorting promise of the vista growing or with a different view being eventually revealed when the end of the curve is reached [8]. As the pedestrian moves along the curved alignment his/her observation ahead is continually changing [8]. This type of route can be planned as a series of gradually changing, inter-related views that increases the observer's anticipation [7,8].
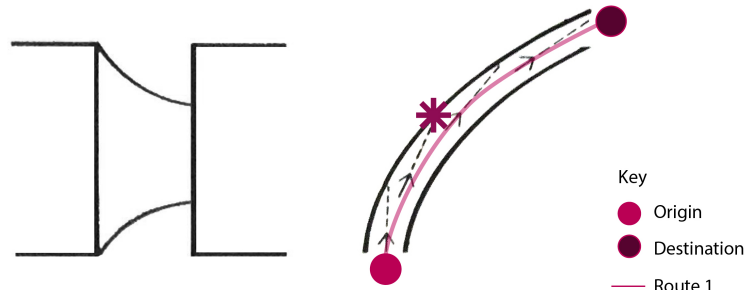

Figure 9: Wayfinding in curvilinear streets alignment. Source: [8] adapted by the researcher.

Using vertical lines of façade such as vertical windows and openings provide emphasis which balances the onward sweep of the curvature [8]. The curvilinear urban fabric is similar to the angular urban fabric, which requires articulation of the end nodes. However, landmarks should be located at any point on the curved street for its potential for changing views along it especially at the intersections [8,21].

2.6 ORGANIC URBAN FABRIC

Although not having a defined form, organic urban fabric is considered to be highly efficient in incorporating sequential visual elements. However, it requires numerous and diverse directional elements to guide the new coming observers. Additionally, the numerous transitions of streets which exist by nature in the organic urban fabric creates the potential for having nodes in between these transitions enabling more emphasized social activities [8]. Organic routes provide the opportunity for sheltering in non-repetitive manner as well as the creation of static spaces, when different aspects of a dominant building or view are glimpsed along a route a sense of continuity is experienced [8]. The organic city fabric, unlike straight
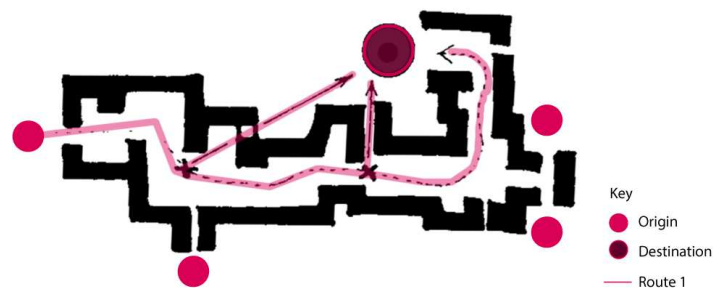

Figure 10: Wayfinding in organic pattern with respect to landmarks. Source: [8].

Table 1: Legibility guidelines for the six urban fabric typologies. Source: Researcher.

Elements of Imageability / Urban Fabric Typology	Landmarks	Nodes
Grid	Landmarks should be located where nodes exist, important crossings and the crossing of non-continuous road.	Succession of diverse Nodes parallel to continuous grid urban fabric help in recognition of streets.
Radial	Should hold a Distinct Element a well as incorporating a Focal point of Dominant Character in its centre.	
Axial	The use of vertical landmarks as well as Incorporating non-symmetrical landscape elements. Additionally, the axial urban fabric provides the opportunity for creating spatial sequence through the art of landmark localization.	
Angular	Should be Located at Junctions.	Incorporating diversity between the starting and the ending nodes.
Curvilinear	Should be Located at middle of the curvature.	
Organic	Incorporating directional elements which aid in creating sequential views.	

3. EXAMPLE: LISBURN CITY CENTRE MASTERPLAN, NORTHERN IRELAND, UNITED KINGDOM

Located in Northern Ireland, Lisburn is the second largest city which has an extensive and delighted history that is echoed in its buildings. The Lisburn City Centre framework is a vital tool in managing the future of Lisburn. It has been set by Lisburn and Castlereagh City

Council (LCCC) to organize the schedule for the next phases of the city's development [23]. The site selection is based upon its urban form which includes radial, curvilinear and organic urban fabric typologies. However, the organic urban fabric is the most significant typology in
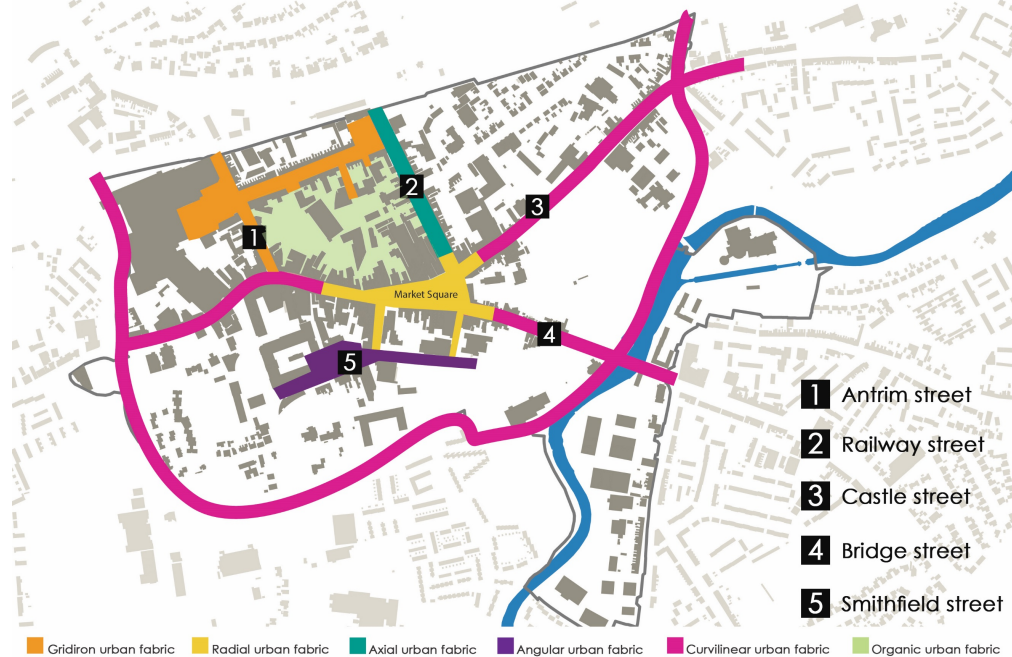

Legend:
1 Antrim street
2 Railway street
3 Castle street
4 Bridge street
5 Smithfield street

Gridiron urban fabric ■ Radial urban fabric ■ Axial urban fabric ■ Angular urban fabric ■ Curvilinear urban fabric ■ Organic urban fabric

Figure 11: Lisburn city centre urban fabric. Source: [23].

the urban form of the city [23]. The composition of its varying landmark buildings provides a strong visual curiosity as well as accentuating its functions and spaces that have been traditionally important to the city.

Although the overall street network is recognized by its diverse buildings and activities, the landmarks are located near the city centre gates. Accordingly, the framework studies the relation between the pedestrians and their interests in providing spaces for events in front of landmark buildings and predicts the sequence of movement and interaction within different open spaces [23–25].

INFLUENCE OF GRID URBAN FABRIC

Gridiron urban fabric in Lisburn city centre exists within the secondary streets in the city centre. These secondary streets provide the pedestrians with shortcuts that depend on diverse visual clues. For example, in Antrim street, the street ends with an open space in front of frontages that not only attracts the pedestrian movement to it, but also articulate the intersection with the perpendicular streets.

Figure 12: **Perpendicular relation between Antrim street and Bachelors walk street. Source: [26].**

3.1 INFLUENCE OF RADIAL URBAN FABRIC

The urban fabric of Lisburn city centre holds the distinct focal point of Market square incorporating a distinct sculpture and the Irish Linen centre & Lisburn museum in its centre which acts as directional reference points for the surrounding existing residential – commercial land uses [23]. A sequence of visual cues in the gateway spaces would aid to create a sequential serial vision supporting the qualities of anticipation and mystery which ensure easy readability of the spaces for the new coming pedestrians. Additionally, the abstract and attractive terraced facades of Lisburn unite to guide the pedestrians through key streets and spaces in a relaxing and satisfying manner [26]. Normally, shifts in building alignments propose a change in direction or activity, while protruding corner buildings overlooked on both sides enable sharp choices to be made as to which path to take. Moreover, the proposed Lisburn lightscape plan cope with the measures to enhance gateways with high potentials to light landmark buildings which punctuate the main arrival routes [23,24].

Figure 13: **The planned sequence of the Serial vision from Market square. Source: [23].**
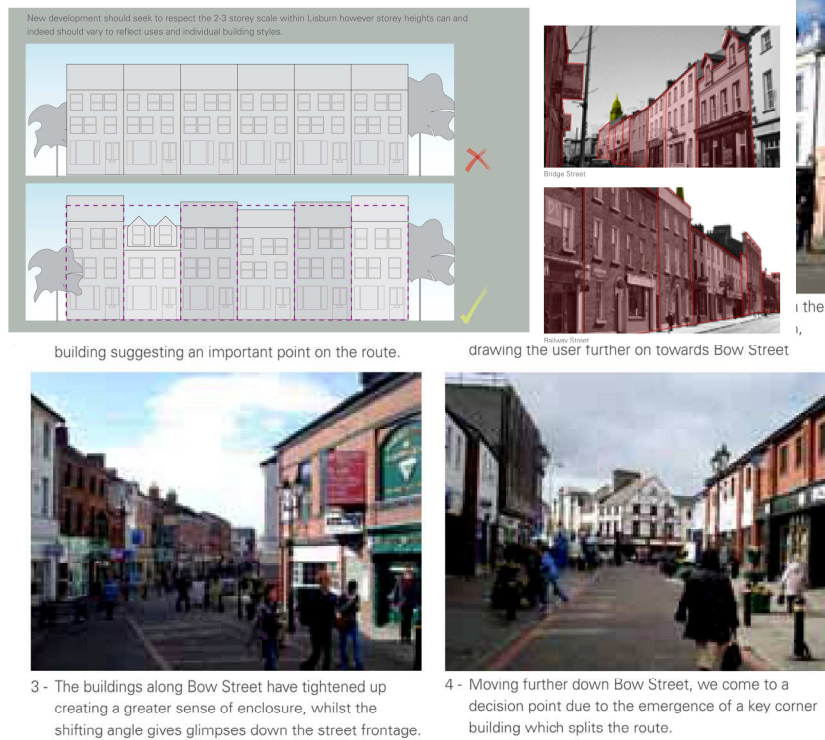
Figure 14: Serial Vision from Market Square. Source: [23].

Figure 15: Left: Market Square plan view showing its radial form. Right: Perspective view. Source: Google Earth.

3.2 INFLUENCE OF AXIAL URBAN FABRIC

Lisburn city centre encompasses numerous axial streets that are perceived as dominant solid masses at both sides of these streets. The verticality of these masses encourages slow pedestrian movement that helps in efficient spatial knowledge of these streets. For example, the city council plans to enhance the building heights in order to create hierarchical compositions that accentuate more the axially of this street. Moreover, the Market square represents an Axial node that orients the pedestrians from one street towards two streets or vice versa as shown in figure 15.

Figure 16: The rhythm of the streetscene as proposed in Railway and Bridge Streets. Source: [24].

3.3 INFLUENCE OF ANGULAR URBAN FABRIC

The angular transition is revealed at the transition between Smithfield street and Linenhall street where there is a space of public events in addition to a weekly Tuesday market opening [26]. The city council set plans about Smithfield Square with a programme of activities including music, comedy and performance and occasional outdoor entertainment. With these festivals taking place in Lisburn, it will provide a focal point for pedestrians to easily be oriented and encourages the pedestrianization of the surrounding streets as shown in figure 17.
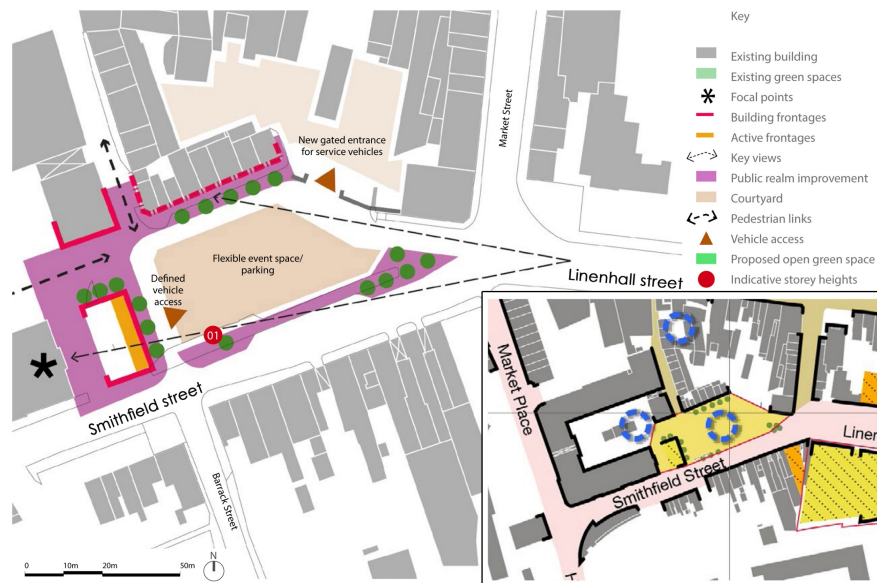

Figure 17: **Angular transition in Smithfield street with respect to the surrounding visual clues. Source: [26].**

Figure 19: Public events in Smithfield square. Source: [23] .

3.4 INFLUENCE OF CURVILINEAR URBAN FABRIC

The curvilinear urban fabric is planned to be significant around the boundary of the city centre passing by the renewed gateways which are representing the major urban nodes of the city centre of Lisburn enabling for strong urban continuity as shown in figure 19 [23].

As the public realm development of Lisburn city centre mainly focuses on the pedestrian experience, it aspires to equalise the inequality between spaces provided to vehicles and pedestrians as well as creating an adaptable streetscape which enable a wide range of activities and public events. Physical developments combined with a programme of events help to make the public realm a magnet in its own nature and ensure a vibrant environment which helps marketing businesses in the city [25].
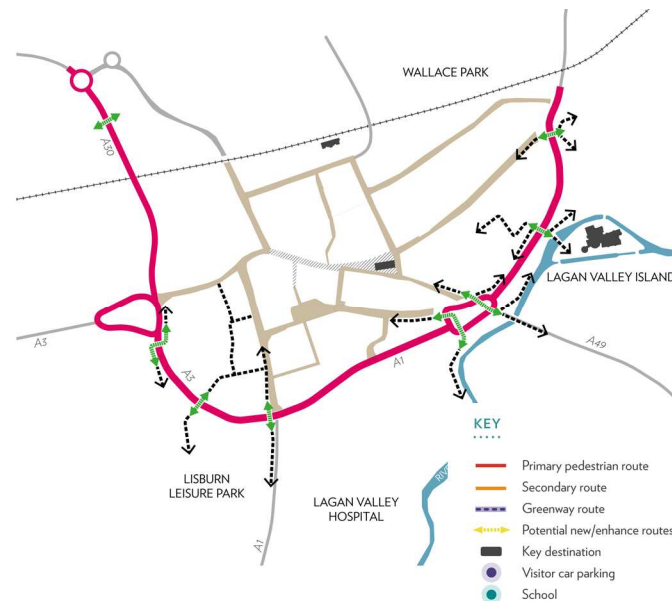

Figure 20: Roads hierarchy map showing the curvilinear urban pattern. Source: [23].

3.5 INFLUENCE OF ORGANIC URBAN FABRIC

Beside the serial vision strategy in its organic urban fabric, its varied street alignments and directions, the Lisburn city centre comprises directional wayfinding elements such as signage that guide the pedestrians during their navigation [23]. Moreover, the organic pattern provides the pedestrians with discontinuous streets which affect their wayfinding ability within the city centre [23].
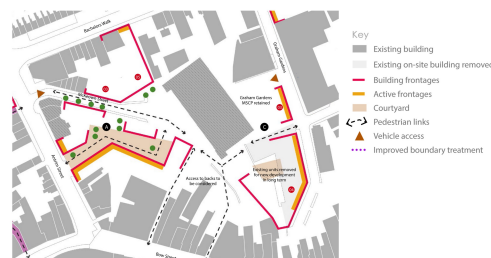

Figure 20: Organic pattern with respect to pedestrian links. Source: [23].

3.6 FINDINGS AND RESULTS

The findings of the comparative and analytical approaches used in this research signify that the radial urban fabric dominates the urban form of Lisburn city centre. The radial urban fabric acts as an attractor of movement where the most important commercial destinations exist, while curvilinear urban fabric acts as a connector which leads to the radial core of the city centre. Furthermore, the organic urban fabric is the least dominant typology and has the

least features essential for having an appropriate spatial orientation. Whereas, the gridiron, angular and axial urban fabrics have relatively lower influence on pedestrian wayfinding.

Table 2: Comparative analysis of the influence on pedestrian wayfinding between the urban fabric typologies of Lisburn city Centre. Source: Researcher.
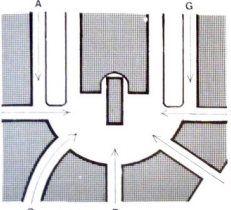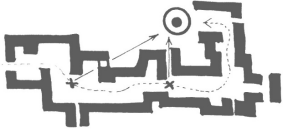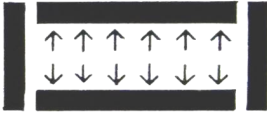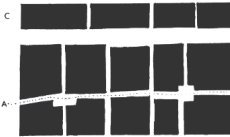
Elements of Imageability / Urban Fabric Typology	Nodes	Landmarks
Gridiron	The nodes are positioned at the end of grid street patterns.	Landmarks as street structures are not well perceived, instead the streets are accentuated by the active frontages.
Radial	The node of the radial pattern is dominant it acts as a destination. The radial pattern act as a magnet which attracts the pedestrians from all the city centre gates.	The best localisation of landmarks exists in the centre of the Radial urban fabric core. Radial pattern can enhance spatial orientation with only one centralized landmark. However, gateways should incorporate distinct landmarks as well.
Axial	Axial node is revealed at the core centre of Market square that aid pedestrian to be oriented by the terminating landmark building.	Axial streets hold a diverse character and follow the principle of 'landmark buildings.
Angular	The angular transition of Smithfield street is marked by the open area of public events that encourage the pedestrians to arrive from two streets to this transition on a weekly manner.	The landmarks exist at the termination of view when heading through Smithfield street and Linenhall street to the angular transition between them.
Curvilinear	The nodes act as gates to the city centre with a continual manner that encourage the exploratory walking to occur from one node to another.	Landmarks are efficiently distributed along the curvature of the curvilinear urban fabric marking the gates as an indication for arrival.
Organic	The nodes are poorly distributed. Organic urban fabric in Lisburn city centre comprises of minimal number of nodes.	Although this pattern allows for landmarks distinction, landmarks are not sufficient for efficient wayfinding. Organic pattern requires several landmarks in sequential manner.

4- CONCLUSION

Planning urban environments without putting into consideration the relationship between the urban fabric typology and the elements of the city leads to spatial disorientation. Previous researchers claimed that the spatial orientation for the new coming pedestrians is a core feature in the unfamiliar urban environments in order to perceive and store the urban image easily. This paper discusses from a cognitive perspective that each urban fabric typology has its guidelines in order to orient the new coming pedestrians. The findings of the comparative approach between the different urban fabric typologies in Lisburn city centre revealed that the radial and the curvilinear urban fabrics dominate the urban form of the city centre.

The literature review and case study affirm the different influences of the six urban fabric typologies. The gridiron urban fabric allows for continuous movement by the effect of its permeability in spatial orientation which helps destination nodes at junctions. The radial urban fabric functions as a strong attractor of movement for its dominant form. The axial urban fabric provides a formal sense and controls the human movement speed by the effect of the elements distributed on both sides of axial streets. The angular urban fabric imposes a transition between angular streets so that the node at the angular junctions has a strong visual accessibility from both streets. The curvilinear urban fabric provides the observer with the sense of anticipation and encourages the activity of exploration. Whereas, organic which is significant in Old City layouts, helps in narrating the space story and the placement of informal commercial and social gathering activities through its streets.

Table 3*: The general influences of the six urban fabric typologies on pedestrian wayfinding behaviour. Source: [7,8,27] edited by the researcher.

GRIDIRON	• Enables the continuous movement of pedestrians with the ability to return in the same direction without being disoriented.	• Can be disorienting if there are no landmarks along its paths.	Figure 21: Grid Urban fabric.
RADIAL	• Direct numerous streets to one focal point. • Provides the opportunity for pedestrians to settle in its centre doing several activities such as commercial and social gathering activities. • Can be easily used to create urban squares. • Used as nodes where landmarks direct the observer movement.	• If there are no landmarks the observer will easily be distracted and lose his destination. • Leads to unsafe crossings when mixing the pedestrian movement with car movement.	Figure 22: Radial Urban fabric.
AXIAL	• Articulates parallelism in the city • Mostly used for formality with strong ornaments on both sides to control human movement. • Used to focus the vision on one destination point.	• All roads linked to it should be of smaller size in order to give importance for the main axial road.	Figure 23: Axial Urban fabric.
ANGULAR	• Provides a changing scenery for the pedestrians that continually stimulate the sense of vision. • When being small scaled, a long view remains even when the vista is eventually closed by the containing buildings. • Provide multiple views of the street facades more than the linear form path.	• Accessing the main angular street from a secondary street perpendicular on it can disorient the observer if there are no enough visual cues.	Figure 24: Angular Urban fabric.
CURVILINEAR	• Offers more relaxed movement from point to point. • Curved paths increase anticipation along movement. • They are used in creating the private plazas of private housing units in the city. • Controls movement speed the more curvature the slow is motion.	• Creates unsafe crossings in case of the small radii paths. • If repeated on one path with reverse curves the path will disorient the observer specially when there are traverse routes.	Figure 25: Curvilinear Urban fabric.
ORGANIC	• Can be a sequence of static enclosed static places arranged along paths which controls the human movement keeping the speed low. • Offers the best visual experience for its varied orientations created by its form.	• Lacks urban continuity. • Increases the time of the trip spent when travelling from the start point to the end point.	Figure 26: Organic Urban fabric.

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