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A comprehensive approach to facilitate wayfinding in healthcare facilities

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Abstract

The physical setting is the patient's first impression of a healthcare facility and an important factor for their perception of care quality and their overall satisfaction. Wayfinding difficulties in complex healthcare settings can cause stress to patients and families, missed appointments, and distract staff time to giving directions. Improving a wayfinding system is a sophisticated problem that is influenced by multiple factors. Springing from the notion that hospitals are small cities, urban design strategies have been employed in healthcare studies to define the pictorial factors that shape occupant spatial cognition and mental image. People's ability to navigate in unfamiliar surroundings is affected also by layout complexity. Research findings using space syntax provide strong evidence for understanding the connection between spatial configuration and people's cognitive strategies and path choice preferences. Now, a new generation of technology-driven wayfinding tools is being added to the mix to help guide visitors to their destinations while contributing to a more enjoyable visit. This study proposes a comprehensive approach that reviews the environmental factors that facilitate wayfinding in hospitals. Also addressed are the analytical methods that are developed to enhance the design and assessment of wayfinding systems. Lastly, the author provides a conceptual model that describes the relationship between the environment and health outcomes to help guide the development of future research and design.

Keywords: Wayfinding, spatial characteristics, space syntax, technologies, experience

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Introduction

The healthcare built environment plays a distinct and complementary role in defining patient satisfaction and wellbeing, in addition to affecting other health-related outcomes such as length of stay, pain, medication intake, and stress (Huisman *et al*, 2012). Andrade *et al* (2013) demonstrated that patient perception of the built environmental quality is a major determinant of satisfaction in outpatient clinics. Additionally, hospital qualities and amenities are reported to impact patient perception of healthcare providers (Swan *et al*, 2003) and affect their choices regardless of hospital location and distance (Goldman *et al*, 2010).

Reaching a destination is one of the initial steps that a patient seeks to solve in a hospital. Difficulties surrounding this process may cause inefficiency in accessibility and circulation (Abu-Obeid, 1998), anger and hostility (Abu-Ghazzeh, 1996), stress, anxiety, frustration to patients and their families, and distracting staff time to giving directions (Ulrich *et al*, 2010). Consequently, it is crucial to design environments that augment spatial perception and cognition in order to facilitate wayfinding and enhance overall experiences.

Researchers have extensively studied various environmental features that contribute to wayfinding performance as spatial characteristics, spatial configurations, signage system and modern technologies. Certainly no simple design recommendations can be formulated to justify the intricate design of wayfinding. For instance, adopting one concept as simple configuration, by repeating form components, might lead to wayfinding difficulties according to Abu-Obeid (1998). Therefore, the study represents a holistic approach that aim to identify these factors and address ways to appraise them in order to enhance the design and evaluation of wayfinding in hospitals.

A review of the published literature in the field of environmental psychology and behaviour was conducted to define the environmental characteristics that influence cognition and wayfinding efficiency. Additionally, web-sites of the space syntax biannual symposiums were reviewd in order to determine studies that carry robust implications and contribution to the research in healthcare environments. The following sections start with discussing recent research on each of these factors, followed by addressing the methods and tools that are developed to depict and evaluate them. The implementations of modern technologies that are developed to enhance wayfinding are also presented. The author argues at the end for a conceptual model that characterises these factors and their potential effect on cognition, wayfinding efficiency, and psychological functioning, to serve as a guide for new designs and future explorations.

Wayfinding and environmental characteristics

Wayfinding is the process of solving spatial problems while navigating from one point to another. It encompasses three mental operations: information processing, decision making, and decision execution (Abu-Ghazzeh, 1996). The process is facilitated through occupants' mental perception

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and cognition, which are the two basic components of information processing. The development of environmental knowledge is built up gradually through different stages. It starts with recognizing landmarks, followed by obtaining route knowledge and ends by developing general configurational structure of the environment.

A number of theoretical frameworks were established to depict the environmental elements that facilitate encoding a new environment. Lynch's (1960) concept of place legibility was one of these attempts that focused on the physical elements that facilitate people's understanding and navigation within cities. He defined paths, edges, districts, nodes, and landmarks as the basic elements that support one's image of a place. Hospitals share many attributes of cities and urban planning. A clear hierarchy of circulation (main, secondary streets and back alleys) is essential for complex hospitals as is in cities urban paths. Nodes and landmarks serve similarly as reference points along paths. For instance, well designed departmental entries, nurses' stations, and courtyards can operate as important nodes as well as landmarks. Eventually, distinguishing departmental and functional zoning can act equivalently to cities districts and edges to facilitate legibility (Allison, 2007).

Unlike Lynch, who placed less attention on the relational characteristics among the physical elements, Weisman (1981) raised a broader view for the environmental variables that impact wayfinding ability. He reported that layout configuration and complexity, degree of differentiation between locations, visibility levels, and signage are important variables in predicting wayfinding behaviour. Configurational complexity is suggested to have the greatest influence on wayfinding and perceived legibility (Haq & Zimring, 2003; O'Neill, 1991). In a recent study, Slone *et al* (2014) controlled for the environmental variables that affect wayfinding performance by using two designed virtual environments that differ only in their layout complexity. Inter-connection density, which was developed by O'Neill (1991), was used as a measurement of complexity to quantify the average number of connections at each decision point. Time consumed to reach destinations and number of errors committed were significantly associated with layout complexity.

Relying solely on the floor plan is insufficient if not supported by environmental differentiation. This is emphasised by Baskaya *et al* (2004) in their study of two unfamiliar polyclinics where they indicated the importance of landmarks and spatial differentiation for acquiring environmental knowledge. Applying changes to form, surface properties and architectural style can help achieving this distinctiveness. On the other side, visibility plays an important role as well. In a study comparing visual access to the destination and presence of signage, Carpman *et al* (1985) found that visibility was superior in affecting wayfinding behaviour of people entering a hospital.

Signage and landmarks represent additional environmental information that people rely on to find their way. Presence of landmarks may lower cognitive workload and facilitate higher success rates (Nothegger *et al*, 2004). Conventional signage systems such as maps, symbols, and user guides can reduce wayfinding difficulties if appropriately designed and positioned. Crowding, discomfort, anger, and confusion can be significantly decreased as well (Baskaya *et al*, 2004). Nevertheless,

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signage may be inadequate if building design fails to attain sufficient visual access, degree of differentiation, and apropriate complexity (Abu-Ghazzeh, 1996; O'Neill, 1991).

Space syntax analytical methods

Measuring the built environment in accurate and precise ways allows for quantitatively investigating various human behaviour and cognition. Space syntax theory was mainly developed to understand the social logic of spaces. Its methods and their subsequent software programs allow for quantifying and understanding how spaces are arranged and connected to one another, which can be further utilized as independent variables to investigate social and cultural attributes (Hillier & Hanson, 1984).

Empirical studies using space syntax show that wayfinding performance and human navigation decisions are largely affected by the design and layout intelligibility of buildings and urban settings (Haq & Luo, 2012). The various analytical methods that space syntax offer allow for measuring and assessing number of the environmental characteristics that contribute to place legibility, thus extending it as a reliable tool to predict wayfinding difficulties and assess design proposals before complex buildings are constructed.

Complexity

Space syntax measurements of connectivity (the number of direct connections to other spaces) and integration (how well one space is connected to all other spaces) allow for representing layouts configurational properties and the degree of their complexity. Peponis *et al* (1990) carried one of the early studies in healthcare settings using space syntax. They examined wayfinding behaviour in 100-bed hospital and found that integration measures accounted for major variation in spatial usage. Additionally, Haq and Zimring (2003) examined wayfinding performance in three complex hospitals. The results pointed to the changeable ecology of users' behaviour according to their knowledge of the place, with a main dependence on layout topological values. These, in addition to other studies in healthcare settings (Khan, 2013; Lu & Bozovic-Stamenovic, 2009) support the importance of topological characteristics in wayfinding and exploration.

Differentiation

Applying convex and axial maps to analyse the arrangement of programmatic spaces can help in revealing the hierarchical order of hospital functional zones. Thus, disclosing information about a level of spatial differentiation in addition to predicting accessibility and patterns of movement. In a study focused on understanding cultural differences between Chinese and U.S. nursing unit design, Cai and Zimring (2013) examined how territoriality and hierarchal order of spaces reflect cultural differences and potentially affect accessibility and movement. Furthermore, Zadeh *et al* (2012) determined the potential effects of hospitals spatial organization on movement, flow, and

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operational efficiency by analysing the spatial ordering and space flow of five acute care settings using the justified permeability diagram technique.

Visibility

Legibility of spaces is also influenced by the degree of visual access. In space syntax, visual information is described by the isovist which is "the set of all points visible from a given vantage point in space" (Benedikt, 1979, p.49). When performing the spatial analysis, space syntax provides the ability to investigate both visibility and accessibility situations (figure 1).

Kim and Kim (2009) concluded in their study that spatial usage had higher relationship with visibility compared to short distance. The analysis of visibility and permeability relations of three defined routes in an art museum depicted how visual information and connections may add more structure and levels of prediction to visitors' movement (Beck & Turkienicz, 2009). Additionally, Morgareidge *et al* (2014) combined space syntax analysis with discrete event simulation in order to analyse the potential influence of spatial configuration of a new emergency department on the effectiveness of visual surveillance, movement, and communication.

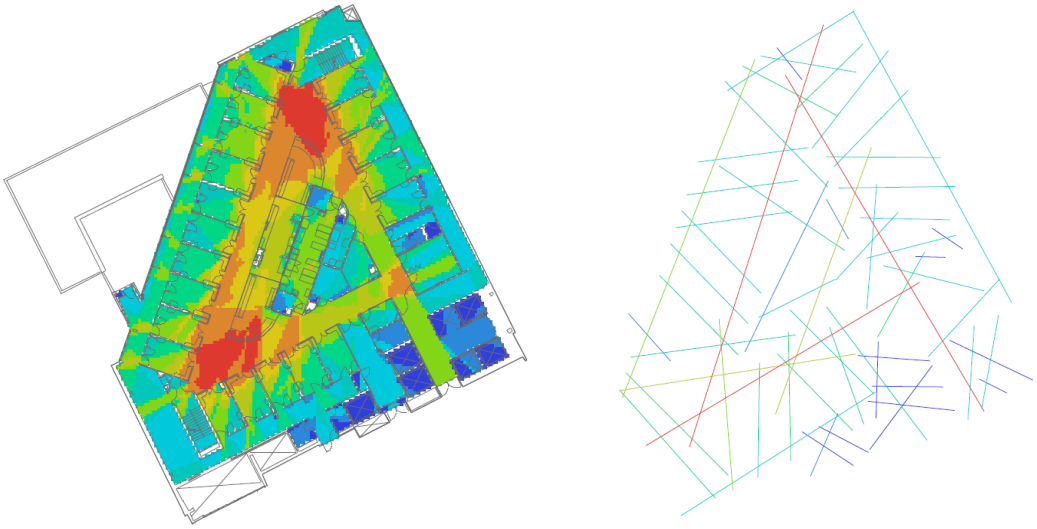

Figure 1: Example of Visual graph and Axial Map analysis (Cai & Zimring, 2013)

Signage

With the aid of space syntax, Tzeng and Huang (2009) examined the effect of placing signage at the most segregated areas of an outpatient clinic. The results emphasised the importance of signage location and design in affecting wayfinding behaviour. Dalton and Dalton (2009) developed the concept of multi-layered network to overcome the misrepresentation of traditional space syntax analysis for situations where specific spaces are visible but not directly accessed. They further introduced the concept to address the presence of signage in complex building by

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assigning a degree to these particular situations. Permitting the presence of signage in the syntactical analysis can alter the description of spaces and allow for an integrated understanding of the built environment, which can enhance the prediction of wayfinding difficulties in early design stages.

Modern technological applications

Wayfinding systems benefit from the technological advancements that became part of our daily life. High-definition displays, touch-screen kiosks, and online information are examples of these developments. With the widespread of smartphones and their concurrent applications, location-aware apps are developed to guide people navigation. They provide a new dimension to traditional wayfinding systems by generating maps that show the shortest path to a desired destination. Moreover, augmented reality (AR) is becoming part of these developments (figure 2), in which digital information is provided through a phone's camera (Goldiez, 2004).

The need for tracking technologies to identify locations, like extensive WiFi stations, is essential for effective AR. To overcome this issue, Koninklijke Philips Electronics (2012) introduced the modulated lighting navigation system, where each light point in the care facility contains different identifiers similar to the GPS coordinates. This can be detected by a devoted smartphone application in order to show users their current location and guide them to their destination.

Similar to the concept of smartphone, is the wearable head-up display (HUD) which has implications for aiding wayfinding as well. For instance, HUD eyeglasses can provide directional information right in front of ones eye by optically merging electronic images with a real world scene (Goldiez, 2004). These examples indicate that technology has many potential applications to enhance wayfinding performance, however, future exploration is still needed.

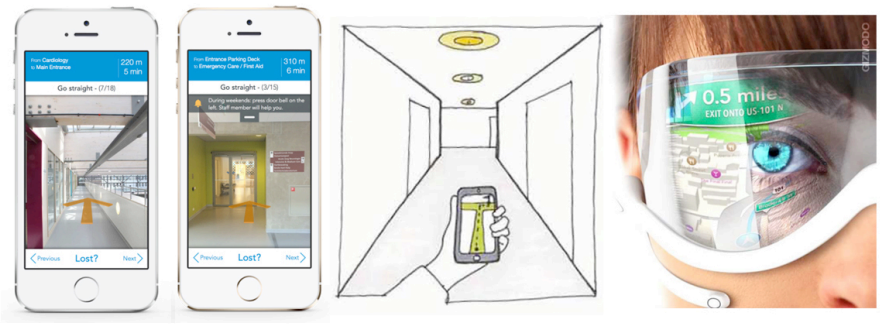

Figure 2: Illustrative photos for smartphone apps and HUD eyeglasses

Integrated wayfinding system

Wayfinding performance is affected by various elements, therefore, it is crucial that healthcare designers assess the presence and effectiveness of these elements on their early designs.

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Navigation is also influenced by other factors such as cognition levels, spatial perception, spatial strategies, and individual differences.

A conceptual model is constructed in Figure 3 to describe these factors and their potential effect on wayfinding, creating a comprehensive guide to facilitate designing, evaluation and encourage future explorations. The assessment of wayfinding proposals is suggested to path through the analysis of spatial configurations, visual features, environmental information, and technological systems adopted. The model situates the development of cognitive knowledge and mental perception as mediators between the objective cues of the built environment and the psychological functioning and wayfinding performance outcomes thereby, suggesting that these effects may be partially affected by individual's characteristics and cognition.

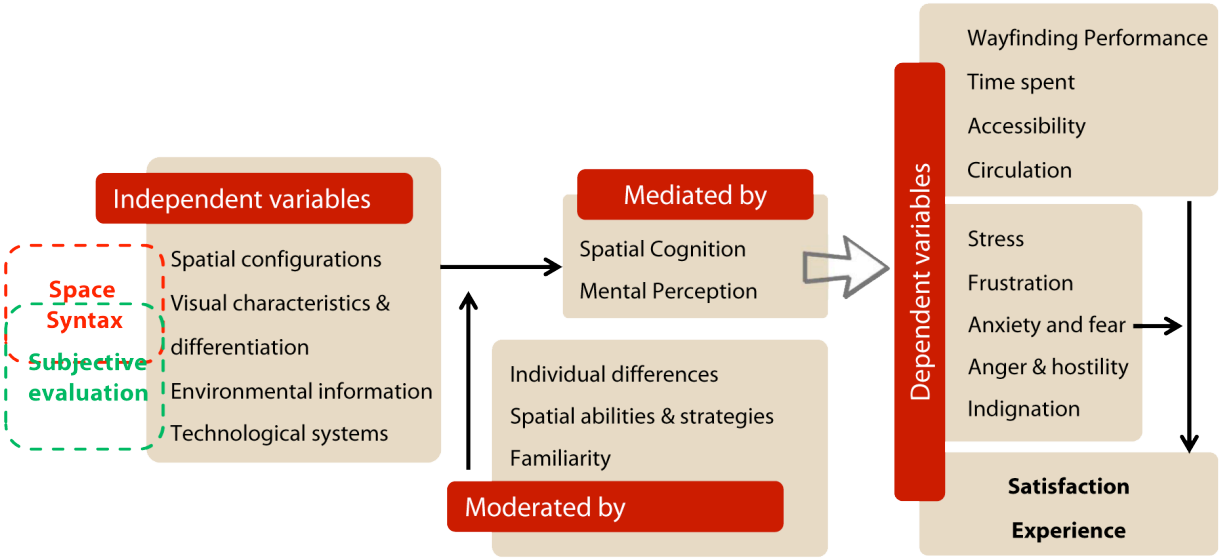

Figure 3: Conceptual model for the environmental effects on wayfinding

Discussion

Architecture and interior design may impact patient psychological and social outcomes. Facilitating wayfinding in complex hospitals has been always an objective for healthcare providers in order to enhance travel between diagnosis and treatment units. Poor wayfinding systems can affect healthcare expenditure through the missed appointments and distraction of staff time, leading to user dissatisfaction which can ultimately impact the organization's brand. Applying coordinated wayfinding solutions can reduce cost over the lifespan of a hospital as suggested by Sadler *et al* (2011) in their study of the "Fable hospital 2.0".

This study contributes to the existing knowledge by addressing the environmental factors that provide orientation cues and discuss the analytical methods that assess them. The developed model summarises these factors and their cognitive consequences and effects, serving as a guide

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for future design and research. Finally, it should be noted that providing efficient environmental design does not lessen the importance of organizational performance in establishing successful operational systems that aid wayfinding such as setting up appointment reminder cards that include orientation information, providing convenient websites, and training personal to efficiently handle direction requests. By doing this, smooth and seamless journeys can be realized and sustained leading to enhancing overall patient and visitor experience.

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