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Design-use nexus of primary schoolyards in Riyadh

A socio-spatial analysis

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ABSTRACT

Public school spaces in Saudi Arabia have been designed as a standardised, one-size-fits-all model that confines learning in specific times and spaces. The rapid global innovations in curricula, pedagogies, and technology have put such disciplinary school regimes and architecture under the pressures to change, adapt, and support more contemporary student-oriented learning approaches. This pressure reveals socio-spatial tensions in the design and use of school environments to meet the policy changes. This research employs spatial analysis methods to investigate the design-use nexus in three modern schoolyards. Space syntax (Hillier and Hanson, 1984; Hillier, 1996) is triangulated with behavioural analysis, interviews with teachers and principals, and photography to construct narratives from socio-spatial practices. Space syntax is used to generate "Visibility Graph Analysis" (Turner *et al.*, 2001) and isovist maps (Benedikt, 1979) from the observed and recorded locations of teachers, staff, and CCTV. Seven socio-spatial patterns emerged from analysing schoolyards. These findings are discussed against theoretical notions of "spatial agency" (Awan et al., 2011), "disciplinary technology" (Foucault, 1977), human geography (Tuan, 1976; Fielding, 2000), flexibility (Hertzberger, 2005; Woodman, 2016), proxemics (Hall, 1966), and human territoriality (Sack, 1986). With the limited number of studies in educational settings, especially schoolyards, that employed space syntax with other qualitative and behavioural analysis methods, this research endorses such a triangulated approach to foster evidence-based design.

KEYWORDS

Schoolyard, Visibility Graph Analysis, Isovist, Saudi Arabia, School Architecture.

1 INTRODUCTION

Public school spaces in Saudi Arabia have been designed as a standardised, one-size-fits-all model that confines learning in specific times and spaces. The rapid global innovations in curricula, pedagogies, and technology have put such disciplinary school regimes and architecture under the pressures to change, adapt, and support more contemporary student-oriented learning approaches. This pressure reveals socio-spatial tensions in the design and use of school environments to meet the policy changes. This paper derives from a PhD study concerned with the alignment of learning environments, architectural programming/briefing, and educational aspirations in Saudi Arabian public primary schools. It aims to investigate the design-use nexus in modern schoolyards through theoretical lenses.

2 THEORY

2.1 Schoolyard (space) and recess (time)

In Saudi schools, schoolyards are most used during recess. 'Schoolyard', 'school campus' or 'school ground' have been used as synonyms. Most dictionaries define a schoolyard as an outdoor play area adjacent to the school. However, recent movements envision schoolyards beyond playgrounds—as fertile environments for learning and satisfying students' curiosity (e.g. Broda, 2007; Danks, 2014). In this study, schoolyards represent the outdoor school region surrounded by walls.

Recess is the most prominent function at schoolyards (Prompona et al., 2020). Recess is "unstructured break time between periods of relatively rigorous academic time" (Pellegrini and Holmes, 2006:37). Recess is when children can play, behave naturally, interact with their peers, and make less instructed choices. It is the "free time" for students at school, which can take place indoors, but more likely outdoors (Pellegrini and Holmes, 2006).

2.2 Theoretical frameworks

Control and authority at schoolyard spaces can be discussed in light of "spatial agency"—the socio-spatial practices in constraining structures (Awan et al., 2011). In the same vein, the concept of "gaze" suggests control through the existence of fields of visibility or technology (Foucault, 1977). Such a normalised power can make students feel and act as if their behaviour is monitored most of the time.

Socio-spatial practices are also linked with the geography of school users. Since the 1970s, the academic focus of human geography has become robust and part of what was physical geography (environmental determinism and geology). For Tuan (1976, p. 266), "humanistic geography achieves an understanding of the human world by studying people's relations with nature, their geographical behavior as well as their feelings and ideas in regard to space and place". Tuan

(1976, p. 268) used the term "geographical knowledge" to describe how people build their practices based on "ideas regarding space, location, place, and resource".

Fielding (2000) examined the concept of "moral geography" through writing stories from English primary schools. He suggests that our belief system, values, and moral assumptions are "in-built" factors that dictate our interactions in space and place (p. 230). He adds that institutional power and control have created beliefs that dictate the behaviour of the school community by identifying, for example, what is a good teacher and what is a good student.

Geography is also linked with personal distances and their meanings. The notion of proxemics (Hall, 1966) is helpful to discuss the physical distance between students and teachers in schools. Hall has contributed to the architectural discourse of personal distances and behaviour. For Hall (1966), proxemic behaviour is not consistent universally but changes across cultures. Therefore, he identified "distances in man" as a range distance, not a specific value.

Schoolyards spaces can also be flexible to afford and represent multiple educational purposes. However, the architectural literature suggests that flexibility might be a generic term that combines form, function, time, and movement (see, for example, Hertzberger, 2005; Woodman, 2016). Woodman's (2016) effort to "re-place" flexibility as a learning process rather than a given built product provides a detailed illustration of four components of flexibility: "Adaptability", "transformability", "polyvalence", and "fluidity". He proposes that adaptability denotes frequent architectural change that occurs at a small scale over *time*, while transformability refers to the conscious transformation of the architectural *space* (Woodman, 2016). The term "polyvalence" was originally used in chemistry and was first introduced to the architectural discourse in the 1960s by Hertzberger (Woodman, 2016; Ring, 2017). According to Hertzberger (2014), polyvalence implies the capacity of space to be interpreted into several *forms* and *functions* by its users. For Hertzberger, making polyvalent spaces that afford "unexpected" and unplanned changes is intentional. Therefore, he described a polyvalent space as an "inviting form" for change (Hertzberger, 2014:109). Till (2009) used a different notion to discuss a similar concept. He suggests that a "slack space" is a space that is "not determinedly programmed … manifestly designed, but probably not overdesigned" (134). Such a notion looks at flexibility beyond the physical movement of objects such as partitions but as a window for new social life to unfold (Till, 2009). Woodman interpreted polyvalence in an educational context as a flexible *function*—"a space that can be pedagogically used in various ways without the form itself having to change" (2016, p. 60). Finally, "fluidity" or "agility" indicate the movement of teachers and students in learning spaces (Dovey and Fisher, 2014; Woodman, 2016). The 'flexibility' terminologies are utilised in the discussion of the research findings.

2.3 Space syntax in schools

Space syntax (Hillier and Hanson, 1984; Hillier, 1996) in schools can help to illustrate the sequential depth of spaces and their visibility, which can affect the social relations among

students who use the space (subjects), and teachers and CCTV who control the space (agents). Space syntax methods are not employed widely in educational buildings. Some studies used a "convex map" (hierarchical depth of spaces) to analyse the intelligibility of areas and students' activities (Kishimoto and Taguchi, 2014). Others developed a new model of "convex map" to align learning settings and the needs of school users (Heitor and Pinto, 2012). Others proposed a theoretical framework by using visual maps to identify different types of learning (Sailer, 2015) or to analyse students' socialisation (Fouad and Sailer, 2017). One PhD study used axial mapping to study the effect of spatial design on students' interaction (Pasalar, 2004). These studies agreed that space syntax could be a powerful tool in the programming process as a discussion medium between architects and non-designers.

3 METHODS

Three primary schools for boys in Riyadh were selected for observation, socio-spatial analysis, interviews with principals and teachers, and a questionnaire for parents. The schools' sites varied, whereas the buildings' layouts were standardised, representing the most recent prototype Tatweer Building Company implemented since 2013 (TBC, 2017).

Table 1 provides an overview of the three schools. Central Region PS was built in 2016 in a wealthy district part of Riyadh's recent urban sprawl. The sites of the other two schools were in more established zones with a lower socioeconomic status of their communities. West Valley PS was built in 2018, whereas Desert PS was built in 2015.

Table 1: Overview of the case study schools

School pseudonym	Built	Grades	Site area	Outdoor	Classrooms	Teachers	Staff	Students
Central Region PS	2016	1 – 6	7833 m^2	5075 m^2	28	36	4	634
Desert PS	2015	1 – 6	5060 m^2	1180 m^2	28	32	4	*559 – 740
West Valley PS	2018	4 – 6	9146 m^2	6400 m^2	28	*9 – 24	*2 – 4	*161 – 168

Note. Site area, outdoor area, and classrooms are based on the provided facilities, not the actual use.
*Denotes inconsistent data provided by participants.

Although the number of classrooms was the same, the difference was apparent in the number of students. West Valley PS served fewer educational levels (grades 4 to 6), which was reflected in the small number of students and teachers compared with the other two schools. The essential activities are observed during school recess. Each observed school had an individual 45-minute break that split the school day. The regular school day took place between 7 am and 1 pm, but some schools had reduced loads, causing dismissal as early as 11.30 am on some days. Recess started typically after two or three classes, at about 9 am. The observation during the break time allowed documenting and mapping unstructured moments.

Three spatial mapping methods were used: behavioural mapping, circulation patterns and floor plan annotations (Sanoff, 1991; Zeisel, 2006). Choosing these methods is to link the written observation notes with people's geographic locations to investigate their relations. Behavioural mapping visualises the positions of school users at specific periods. Circulation patterns illustrate the movement flows of students and staff to explore the school management protocols spatially. Floor plan annotations provide commentary on the observed activities such as playing or doing collaborative work and spotting human behaviours of the school community that are associated with their perception of the built environment and interaction with it. A time interval between five and fifteen minutes for recording was considered appropriate, given the differences in scale in each schoolyard.

The observational activities were also triangulated with space syntax analysis (Hillier and Hanson, 1984; Hillier, 1996). I use depthmapx software to generate "Visibility Graph Analysis" (VGA) (Turner *et al.*, 2001) and isovist maps (Benedikt, 1979). These maps can offer other dimensions for meaning-making when studied in parallel with other forms of representations (Zeisel, 2006; Al-Sayed, 2018). VGA heat maps demonstrate a gradation of colours from the most visible areas to the most invisible areas by connecting “all the inter-visible points in a human-scale grid” (Turner *et al.*, 2001; Al-Sayed, 2018:29). VGA deals only with the floor plans (spatial arrangements) but not how subjects and agents organise themselves spatially. Therefore, the fields of vision (isovist) are employed to observe and record the locations of agents who control the school spaces. Isovist can shadow the visible areas from identified points or paths (Benedikt, 1979) by shading schoolyard spaces that teachers, staff, and CCTV organise themselves spatially to cover visually. There is not a scientific standard for the maximum visibility distance of isovist. I adopt Lonergan & Hedley's (2016) approach, which suggests a visibility range with a maximum radius of 225 m. That means observers can cover visually all exposed schoolyard spaces from any point in the three schools.

4 FINDINGS: SOCIO-SPATIAL PATTERNS

Key socio-spatial patterns that emerged from analysing schoolyards are related to site size and distribution of buildings, boundary conditions, recess routine and system of control, weather protection and exposure to sunlight, outdoor sitting options, eating activity, and space utilisation. These patterns are presented below after the spatial analysis.

4.1 Spatial analysis

The behavioural analysis combines behavioural mapping, horizontal circulation patterns and floor plan annotations during recess (see Figure 1). The maps capture three periods: the transition from the educational building to the outdoor grounds, activities during recess, and the transition from the schoolyard back into classrooms. Figure 1 shows only an example of activities during recess in Central Region PS. The site plans also show an architectural section of the ground level to discuss the indoor-outdoor relationships and circulation flow.

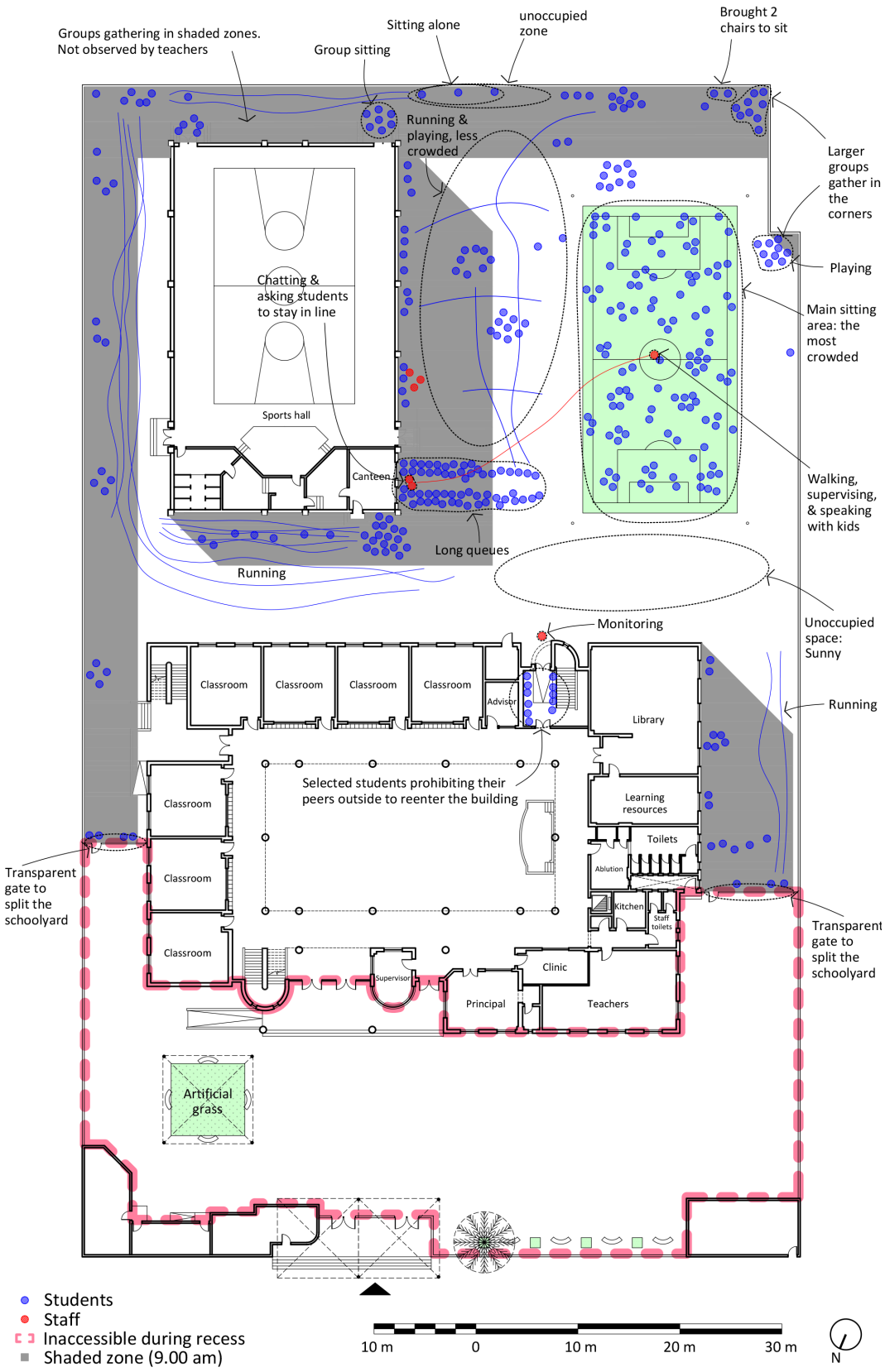

Figure 1: Example of behavioural analysis at Central Region PS during recess from 9.00 to 9.25 am. Original source: Anteet (2022).

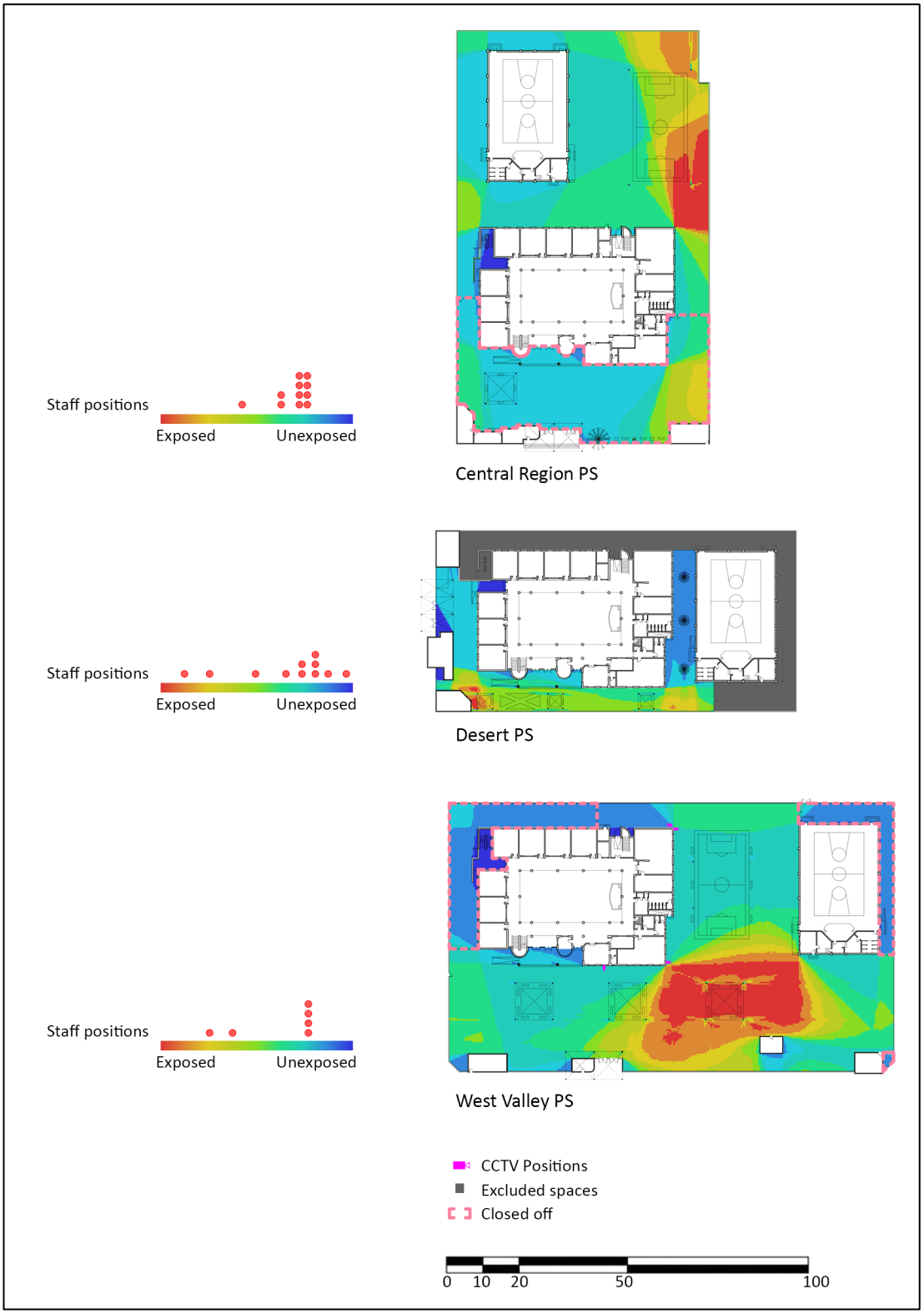

Figure 2: VGA in the three schoolyards.
Original source: Anteet (2022b).

Figure 3: Isovist analysis in the three schoolyards.
Original source: Anteet (2022b).

The maps are not only snapshots but to reveal patterns of congregation areas and socio-spatial encounters. The blue colour refers to students, and the red indicates staff members or teachers. For example, each blue dot represents the location of one student at a specific recorded moment when the student is almost not moving. The blue line indicates the movement patterns of students. The VGA and isovist representations for the three schools follow the behavioural analysis plan (Figure 2 and Figure 3).

4.2 Site size and distribution of buildings

The outdoor functions included a soccer field (in two schools), sports hall, gatekeeper room, a few sitting areas, open-to-sky spaces, and some palm trees. As shown in the maps, Desert PS had the smallest school site and largest student population, while West Valley PS had the largest school site and the smallest student population. The schoolyards varied based on the site area, while the school building took a fixed footprint of approximately 2,000 m^2 for each of the three storeys. That had created an inconsistency between the number of students occupying classrooms and facilities, and the provided outdoor functions, as outlined below:

- Central Region PS: 5075 m^2 outdoor space for 634 students (8.0 m^2/student).
- Desert PS: 1180 m^2 outdoor space for 559 students (2.1 m^2/student).
- West Valley PS: 6400 m^2 outdoor space for 191 students (33.5 m^2/student).

The outdoor design issues were apparent in the distribution of buildings. The active zones at schoolyards appeared not to be designed purposefully. Central Region PS's active zone was oriented southeast, Desert PS's yard was oriented southwest, and West Valley PS's campus faced east, west, and south (as shown in the maps). The distribution of buildings is considered a critical issue, given the desert climate that requires shading and environmental control.

4.3 Boundary conditions

The educational building and outdoor yard had well-defined boundaries. For the schoolyard, a sharp territorial edge was represented by the surrounding solid wall of 3-5 m height and a singular access point from the street and parking area. This entrance was used by both the school community and visitors and was usually controlled by a gatekeeper. A teacher found the flow of movement "hard to manage", especially when it is dismissal time.

For the access of the educational building, there was almost no sequence of transitional spaces. The building doors played a crucial role in access control by allowing people's entry or leaving them exposed. Building access during recess was managed by staff members and chosen students who enforced the system by enabling or prohibiting their peers from entering or exiting the building. The principal room's location helped them gaze indoors more than outdoors as the windows were sometimes frosted, and CCTV screens were the alternative. However, the principals tended to keep their rooms' doors open to monitor the movement at the ground level.

The single entrance between the principal's room and the supervisor room seemed to be provided by designers for affording the option of extra surveillance.

4.4 Recess routine and system of control

Recess started and ended with a ringing bell. Older students took the upper levels and used the stairs to go outdoors with minimised accessibility to the ground level. Younger children (grades one and two) typically took the ground floor classrooms. They left their classes five minutes earlier than their older peers to avoid congestion at the canteen. Once the bell rings, all children jostled to run outdoors. Some students went directly to the canteen to buy snacks, while others sat or played outside. The schools prohibited children from spending their break time indoors without an excuse. One reason is the open foyer that distributed the noise echoing throughout the entire building.

Children could move around the schoolyard during the break and choose what to do. Five to seven staff and teachers were on duty at each school, keeping their eyes on students to resolve any disputes or manage their accessibility and queuing. Students tended to form groups at the corners, or edges, instead of fully exposed spaces. The heat map at Desert PS suggests that many schoolyard spaces were unexposed (Figure 2) but were fully monitored by the staff (Figure 3). Apart from Desert Ps, which was smaller and easier to watch, the heat maps at the other two schools (Figure 2) show that the more exposed zones (in red colour) were less populated by students. The CCTV at West Valley PS was an active surveillance technology, but its existence did not replace the positions of staff on duty. The isovist maps (Figure 3) suggest that observers organised themselves to cover most of the accessible spaces for students at school grounds, except the southeast zones of Central PS, where buildings concealed them. The staff at Central Region PS were less dedicated to monitoring the hidden spots. Figure 3 shows that unobserved areas around the sports hall made them suitable for bullying and abusive behaviour amongst students. It is worth mentioning that this school did not have CCTV, but that did not affect the number of staff outdoors compared to the other two schools.

When children returned to classes, they left the schoolyard unesthetic and full of rubbish, expecting the cleaner to do his job. Such a situation indicates a lack of self-organisation and a lack of responsibility. It adds more contradictions about the school regime, which appears to be disciplinary, but it is legitimated for students to throw rubbish in schools and not treat them as their own homes.

4.5 Weather protection and exposure to sunlight

The desert climate in Riyadh is a challenge for architects. One of the outlined challenges is balancing exposing students to sunlight and protecting them from extreme hot or cold weather. The designers expressed awareness about these issues and interest in making future schools more comfortable for students. However, the observation of schools showed a lack of shading devices to tackle the outdoor environment. The schoolyards were fully exposed. The only sunshades

provided were a few canopies distributed over seats and artificial grass. The only canopy zone at Central Region PS was not even accessible during the break time (Figure 1) because its location represented a challenge for the staff to monitor students during recess.

In general, as shown in the maps, students' positions suggest that they tended to congregate in the edges of the schoolyard spaces. Such spaces offered more shadow on the hotter days. When the schoolyard at Central Region PS was observed on a sunny day, students followed the shaded areas cast from surrounding structures, which determined their activity zones (Figure 1).

4.6 Outdoor sitting options

In addition to the effect of shadow, the limited furniture for sitting made those edges preferred spots for children to distance themselves from the traffic and their peers playing and running. Those children who wanted to sit for eating or chatting found themselves sitting on the pavement, on steps around the buildings, or artificial grass in the soccer field. Four to eight seats were only provided under the canopies or around the soccer field. They could accommodate only a tiny fraction of the total number of students and forced them to sit too close to each other. Some students brought classroom chairs to personalise their own spaces.

Greenery was almost completely missing in the schools. The site plans show that there were only four palm trees in all three schools. An entire zone was vacated at Desert PS as children were not allowed to enter the area because of the risk of branches falling from trees. The palm trees near the school gate at Central Region PS shows a lack of maintenance and care about the natural environment as a fallen tree was abandoned. The school administrations did not take steps to protect the available trees or use natural settings to stimulate students' learning.

4.7 Eating activity

Sitting and eating are two associated activities. Each visited school had a canteen that served students snacks, which they ordered and paid for through small windows. However, not providing an eating place remained a critical issue. The spatial analysis shows the long queues of students in front of the canteen windows. A teacher or two took the role of keeping children in the line. Physical proximity seemed a challenge for teachers to control. Queueing did not consider the personal space for each student. A parent raised their concern about crowding, suggesting "making lanes for the student to buy from the canteen and preventing physical stickiness in the purchase and respect for students' privacy and not to deal with these practices in careless ways by teachers".

4.8 Space utilisation

One of the salient issues in the site plans is the outdoor space with limited programmed functions (see Figure 4). At West Valley PS, the total outdoor space is 6400 m^2. 13.31% of which were closed areas with locked gates by the school. When I asked the principal about the reason for closing these spaces, he said, "we had to choose between two unwanted options". The first one is

not having steel gates, which means students will access the spaces, but they cannot be monitored because the surveillance cameras do not cover them (see Figure 3). The other option is closing them, and they will consequently trap students if they use the adjacent stairs in case of an emergency evacuation. He chose the second option because the school did not want these spaces to become places for inappropriate behaviour. That suggests the high importance and prioritisation for surveillance over primary safety measures.

Figure 4: The schoolyard at West Valley PS.

Figure 2 and Figure 3 illustrate these invisible spaces using space syntax analysis. The school staff dealt with these spaces as hidden zones and took action to change the given zones to meet their needs. They added transparent gates and kept them locked during the school day. In this case, the school leader at West Valley PS had the power and capacity to reduce space efficiency and control access. Although students' access to such spaces was controlled, these underutilised spaces were somehow mistreated. They were shifted to trash collection areas, and some walls were sprayed.

At Central Region PS, the school added transparent gates to segregate the outdoor zone at the south from the northern area (Figure 1). Unlike West Valley PS, the north side was used by students, but only when they entered the school in the morning or left in the afternoon. That space is 1697 m^2, making 33.44% of total school grounds unexploited during recess.

5 DISCUSSION

5.1 Discipline, control, and spatial agency

The tension between discipline and autonomy in schools was witnessed in the maps. In terms of surveillance and control, the open-plan schoolyards exposed students and helped teachers monitor and control them. As surveillance was a priority in the design guidelines (Deputy Ministry for Buildings, n.d.), the school leadership strived to close off those areas that could not be observed to minimise inappropriate behaviour. CCTV added another technology for surveillance. The space syntax analysis in schoolyards showed that settings around the building edges were less exposed to teachers and staff. They afforded privacy for students who wanted to form personal space.

Nevertheless, CCTV was "disciplinary technology" (Foucault, 1977) regardless of whether it worked. The staff also effectively used CCTV to settle disputes and respond to parents' complaints if their children were abused. It can be noted that the physical school structure has been perceived as a defence line. There is also an apprehension that students would climb the wall and escape from school if they had the chance, although using technology such as CCTV cameras can reduce potential risks for students.

The findings and spatial analysis brought to light the geography of students and teachers concerning social and pedagogical practices under the school power regime. The issue of "geographical awareness" between people's "spatial ability" and/or their "spatial knowledge" (Tuan, 1976:268) was evident in the ways principals, teachers, and students had spatial agency in school spaces. The strict timetable, structured school day, and control of spaces limit the possibilities for acting beyond "moral geography" (Fielding, 2000). Indirect rules dictated the movement of students at the schoolyard. Closing off areas kept students visually exposed and narrowed their options of spatial affordances—a "spatial strategy" (Sack, 1986:1). This territorial control is a form of social power normalised by humans—not explicitly enforced or aggressive (Sack, 1986).

The connection between students and the outer community was blocked visually and physically. The schoolyard functions were hidden from the street behind the solid walls, segregating the school as a gated community. The grounds remained private for the school community during the school day except when parents entered or exited the school in the morning or at school dismissal. During the recess, some zones were "prescriptive spaces" (Thomson, 2005), such as the soccer field, which was designed for the specific function of playing football. Its function sometimes shifted to sitting and eating space where children found the artificial grass soft compared to the cement pavement.

The concept of proxemics (Hall, 1966) expands the discussion of teacher and student geography. The issue of physical and social proxemics was witnessed in the students' queues. Students were likely to keep a small distance (15 to 46 cm) when they queued in front of the canteen window. Such distance is considered by Hall (1966) a "far phase intimate distance", which Americans find uncomfortable physically and visually. However, Hall (1966) claims that Middle Eastern individuals do not mind being touched by strangers in public spaces. In the schoolyards, the staff behaviour aligned with Hall's proposal as they did not take action to ask students to respect the personal space of each other.

These discussed issues represent socio-spatial tensions between discipline and agency and control and self-organisation. Some signs and forces connote evidence of a controlling system such as gates, walls, fences, queues, and being seen versus unseen. They did not differ much between the

three schools, but socio-spatial patterns exist. Students prefer grass over cement pavement, shade to sunlight, informal time to formal academic activities. Complex forces are affecting the behaviour of individuals and social groupings. The schools' regimes can be both strict and permissive. There is a sense of a controlling regime. There must be doors, fences, CCTV, gatekeepers, and other controlling measures to prevent something unwanted. However, discipline was sometimes in competition with ill-discipline rather than the agency. The measures helped the schools' systems to avoid worse than throwing rubbish at schoolyard from happening. The recess seemed a form of release for students to let off steam with no structure and rules before returning to their "cells" (classrooms) (Nair, 2014).

5.2 Flexibility: form, function, time, and movement

Significant changes to the architectural space ("transformability") (Woodman, 2016) were witnessed for constraining outdoor spaces. Adding gates to close off large zones on campus was not a direct change to the space layout but a form of management and control to exclude areas rather than reconfiguring them. From the principals' perspectives, they did not use their "power over" (Dovey, 1999) students to control their access possibilities, but that was positive conduct of social power (Sack, 1986) to protect them from being abused in unmonitored spaces.

The outdoor functions for students during recess were primarily eating, playing, and sitting individually or in groups. The steps on the buildings' edges afforded (Gibson, 1979) sitting (frequent "adaptation") (Woodman, 2016) as a replacement for the unprovided furniture (such as seats) or natural settings (such as grass). The steps were not designed for this purpose, but the function occurred spontaneously and was predictable because of the lack of other sitting options. Pawlowski et al. (2019) highlighted such misalignment between design and use. They found that children created their own play spaces in schoolyards more than using spaces designed for play. They suggested designing spaces with affordances (Gibson, 1979) that enable students to perceive spatial potentials to form their own play spaces (Pawlowski *et al.*, 2019).

Minimal outdoor furniture and flat topography raise the question of whether it is intentional to keep outdoor spaces minimally programmed (or "polyvalent") (Hertzberger, 2014) to welcome unexpected changes. Apart from the soccer field and small shaded zones, the whole ground is covered with durable cement pavement but not suitable for playing, eating, sitting, or specific pedagogical activities. Furthermore, the schools with smaller yards were congested with students and provided fewer options for outdoor activities. Therefore, the outdoor school areas missed defined functions and "in-between spaces" (Aminpour *et al.*, 2020) that can welcome undefined functions in the brief.

The initiative by 'Green Schoolyards America' (Danks, 2014) is an example of recent efforts to utilise public school grounds. Replacing paved or asphalted school grounds with well-designed green spaces is essential for children's welfare as part of their "hidden curriculum" (Titman, 1994; Danks, 2014). Such programs promote students' well-being, sociality, and self-esteem

(Pernille and Wistoft, 2018). However, teachers need to be prepared for such initiatives. A study in the United States schools suggests that limited numbers of teachers took advantage of outdoor spaces (Feille and Nettles, 2019). Teachers in the Netherlands also reported barriers to adopting a natural schoolyard environment for educational purposes (van Dijk-Wesselius *et al.*, 2020). Still, studies on schoolyards and outdoor settings remain an overlooked domain (Armitage, 2005; Aminpour *et al.*, 2020) worth further research.

Overall, the structured school day (time) and structured learning activities (functions) in schoolyards (spaces) constrained flexibility. Schoolyard spaces could afford more diversity in size and scale, valued at primary schools (Gross and Murphy, 1968; Tanner, 2000) to facilitate meeting the curricular and pedagogical changes.

6 CONCLUSIONS

The study interrogated the relationship between design and use in three schoolyards in Riyadh. Spatial analysis was supported by the perspectives of participants and observational notes. Behavioural analysis of movement, positions, and behaviour is an invaluable contribution to interpreting findings. Such methods were the essence of some studies (for example, Pasalar, 2003; Woodman, 2016) at different scales of school spaces. Future studies can benefit from using a similar technique. When triangulated with observation, space syntax (VGA and isovist) offered a rich visual communication output through analysis of visibility in the schools. The relevance of the produced maps aligns with Sailer's (2015) argument that analysing spatially the pedagogical functions should expand beyond classrooms.

Producing the VGA and isovist maps offered a piece of evidence and a window of meanings on how school spaces are designed, perceived, and used. Their data provide architects, clients, and policymakers a platform to facilitate their discussion and decision-making. Therefore, space syntax is considered an effective tool for fostering evidence-based design. Focusing on the produced maps as the data on their own can be the primary benefit of the analysis. Definite numerical data can be constraining (Pafka *et al.*, 2018), given that social behaviour cannot be decidedly predictable. Still, technology development holds the potential to consider buildings as real three-dimensional objects rather than flat horizontal plans. The VGA maps depicted many unexposed spaces in the three different school sites. However, most of them seemed easy to be monitored by the staff or CCTV (see isovist maps) as such spaces were open with minimal hidden corners or physical barriers. However, the isovist tool has the limitation of not considering the distance and height of physical barriers in the analysis. Distant areas will not be as clearly visible as closer areas.

Someone can argue that space syntax does not add value because architects are expected to be aware of visibility, surveillance, and control issues as they design. As much as this statement is hoped to be accurate, the competencies of architects are not the only and most important factor. Not every architect has the same perception of human behaviour during the design stage,

especially when the designer is immersed in other creativity constraints such as budget and accommodation of spaces. A recent study adds that educators can have a more in-depth perception of the physical learning environment affordances than architects (Young *et al.*, 2019). Plus, such maps are useful for architects and more critical for other stakeholders, especially those who demand evidence to make decisions.

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