



Architectural Space and School Violence: A Space Syntax and CPTED Analysis of Ourtal Bachir Middle School, Batna, Algeria

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Abstract:

The present study aims to analyze the link between urban space and school violence in educational institutions in Algeria, through a case study of Ourtal Bachir Middle School in the city of Batna. The study proceeds from the hypothesis that the school space affects students' behavior and social interactions, by influencing their sense of belonging and security. The research relied on the Space Syntax methodology established by Hillier (1984), supported by the principles of Crime Prevention Through Environmental Design (CPTED) approach, using specialized digital tools such as: ArchiCAD software for drawing architectural plans and DepthmapX for visual supervision and spatial integration analysis. Results indicate persistent deficits in school space quality. The outsider analysis reveals insufficient transitional space lacking a welcoming identity. The insider analysis reveals a significant contrast between highly integrated spaces, which are prone to crowding and spatial friction, and low-integration spaces, which constitute potential zones of visual isolation. These data indicate that the current spatial configuration fails to satisfy social sustainability standards and the principles of Crime Prevention Through Environmental Design (CPTED). Consequently, a comprehensive redesign is required to promote natural surveillance, visual integration, and psychological comfort for students. The paper recommends incorporating CPTED principles and social sustainability into the reconstruction of Algerian schools, and using spatial-analysis tools as scientific instruments to guide educational and architectural policies towards a safe school environment.

Keywords: Architectural Space, School Violence, Space Syntax, CPTED (Crime Prevention Through Environmental Design), Social Sustainability.

1.0 Introduction:

School violence is a complex educational phenomenon because of its negative impact on the educational environment and the psychological and social equilibrium of students. It encompasses more than isolated individual behavior; rather, it results from the interaction of multiple factors that intersect within the institutional educational space (Debarbieux, 2006; Furlong & Morrison, 2000). Literature indicates that schools are social spaces where behavioral patterns—including violent behavior—are reproduced (Gottfredson, 2001; Bradshaw et al., 2014).

From a critical sociological perspective, school violence can be explained by the structures of power and control embedded in the physical environment. Foucault (1977), in *Discipline and Punish: The Birth of the Prison* argues that institutional spaces such as schools are not neutral; rather, they exercise forms of discipline and surveillance that reshape behavior through subtle mechanisms. This implies that the organization of classrooms, seating arrangements, systems of monitoring, and even the design of school buildings contribute to the production of behavioral patterns that may incline toward either conformity or resistance, including violent behavior. Building on this perspective, recent studies support the argument, showing that the spatial organization of educational institutions influences the control of behaviors. (Woolner et al., 2012; Gislason, 2010).

Within the framework of Social Learning Theory, Bandura (1977) argues that aggressive behavior is acquired through observation and imitation, as individuals learn from the behavioral models around them. Several subsequent studies have supported this argument, showing that repeated exposure to violence within the school environment produces "aggressive cognitive scripts" that guide students' responses in social situations (Huesmann, 1988; Anderson & Bushman, 2002).

Recent research has also shown that bullying and school violence contribute to the establishment of negative cognitive and behavioral patterns among adolescents (Espelage & Hong, 2020; UNESCO, 2019). Thus, the school environment not only contains violence but also contributes to its reproduction through mechanisms of daily interaction.

General Strain Theory proposed by Agnew (1992), views violence as a response to the pressures and frustrations that students face, especially when they perceive injustice or discrimination within the educational institution. Empirical studies have shown that feelings of school injustice are associated with higher rates of aggressive behavior among students (Kupchik & Ellis, 2008; James et al., 2015). Recent research has confirmed that psychological and social pressures, such as discrimination or inadequate school support, are among the most prominent factors that fuel aggressive behavior (Turanovic et al., 2022; Bradshaw et al., 2014; Peguero, 2012). This highlights the role of school policies and organizational justice in regulating and directing behavior toward positive adaptation rather than aggression.

Conversely, school environment studies show that the educational setting is a crucial factor in explaining aggressive behavior. Unsupportive conditions—such as overcrowding, poor social relationships, and a lack of perceived security—are associated with higher rates of student violence (Steffgen et al., 2013; Wang et al., 2013). Mayer and Leone (1999) also suggest that excessive control and punitive measures can be counterproductive, reinforcing students' resistance and increasing the likelihood of aggressive behavior. Recent research supports this view, indicating that a positive school climate acts as a protective factor against aggressive behaviors (Bear et al., 2015; Cornell & Huang, 2016; Thapa et al., 2013).

In the context of social interaction, peer groups are a key factor shaping student behavior. However, association with deviant groups predisposes students to adopt violent behaviors (Gottfredson, 2001; Thornberry et al., 2003). Research has found that the “social normalization of violence” within these groups makes aggressive behavior acceptable, and sometimes even rewarded, which reinforces its persistence and spread within the school environment (Espelage and Swearer 2003). Later studies support this proposition, confirming that peer pressure is one of the most prominent determinants of aggressive behavior in adolescence (Dishion & Tipsord, 2011; Salmivalli, 2010).

School violence is not confined to physical acts; it also includes verbal abuse and symbolic violence, which are widespread and harm pupils' mental health (Olweus, 1993; Infante & Wigley, 1986). Studies show that constant exposure to these forms of violence can lead to psychological and behavioral disorders, including anxiety, depression, and impaired school adjustment (Nansel et al., 2001; Arseneault et al., 2010). Later research confirms that psychological and verbal violence have long-term implications for mental health and educational attainment (Modecki et al., 2014; Kowalski et al., 2014). This highlights that school violence is multidimensional and that its non-physical forms may be more harmful in the long term.

The physical school environment plays a direct role in shaping interaction patterns. Research indicates that overcrowding and poorly designed spaces increase the likelihood of friction and conflict among students (Maxwell, 2016; Astor et al., 2009). These findings align with environmental theories that assert human behavior is shaped through continuous interaction with place and setting (Bronfenbrenner, 1979). Subsequent research supports this view, confirming that the quality of a school's architectural design is a crucial factor in enhancing safety or, conversely, in facilitating abusive behavior (Barrett et al., 2019; Gislason, 2010; Woolner et al., 2012).

Recent analyses find that school violence is a multi-level phenomenon involving interactions among individual (personality), social (peers), and institutional (policies and physical space) factors (Bradshaw et al., 2014; Turanovic et al., 2022). This perspective confirms that the school is not a neutral context; rather, it is an active agent in producing and reshaping student behavior, whether through regulatory policies or the design of educational spaces (Astor & Benbenishty, 2019; Cornell & Huang, 2016).

According to the foregoing, violence within the school environment helps reshape student behavior through different interlinked mechanisms:

- **Observational learning and reproduction:** Students acquire abusive behaviors from surrounding patterns (Bandura, 1977; Hong & Espelage, 2012).
- **Response to pressures and frustrations:** Violence is a reaction to psychological pressure and to the recurring perception of injustice within the educational institution (Bandura, 1977; Hong & Espelage, 2012).
- **Interaction with the school environment and physical space:** Non-supportive environments and poor architectural design may increase the probability of abusive behavior (Steffgen et al., 2013; Maxwell, 2016; Barrett et al., 2019).
- **Peer-group influence:** Peer groups contribute to the normalization of violence, making it an acceptable behavior within the school (Thornberry et al., 2003; Salmivalli, 2010).

In this context, the relationship between the architectural environment and human behavior is emphasized, particularly adolescent behavior within the school. The architectural design of educational institutions is not limited to providing functional spaces for learning; its impact also extends to students' psychological and social conditions, which are directly reflected in their behavior. Studies indicate that architectural elements — including classrooms, courtyards, corridors, and even interior fittings such as furniture, colors, or lighting — can act as catalysts for positive or negative behavior. Environmental psychology and architectural research have confirmed that the physical environment and human behavior are closely related. Well-designed spaces enhance feelings of security, comfort, and belonging, while poor design contributes to stress, anxiety, and aggressive behavior.

UNESCO's guide Stopping Violence in Schools: A Guide for Teachers (2009) addresses school violence as a multidimensional educational issue that directly affects education quality, the school environment, and students' psychological health. The guide offers a comprehensive definition of school violence, including physical, verbal, and psychological acts, as well as more complex forms such as sexual violence, cyberbullying, and gender-based violence. Furthermore, UNESCO states that these practices are not limited to interactions among students; they involve other actors within the educational institution, which calls for a systematic, school-wide intervention. The guide highlights the absence of clear rules of conduct, poor communication between teachers and students, and the spillover effects of societal violence among the most prominent factors contributing to the spread of violence. It notes that the psychological and social consequences include anxiety, depression, isolation, and a decline in academic performance, making prevention both an educational and a humanitarian imperative (UNESCO, 2009; WHO, 2020). However, the UNESCO report (2009) does not explicitly discuss the relationship between architectural design and school violence; its content clearly highlights the importance of the school environment in shaping student behavior. This connection allows us to relate the report's findings to the field of educational

architecture, where thoughtful design of learning spaces can reduce opportunities for negative interactions and foster a sense of safety and belonging. This approach aligns with calls for a comprehensive strategy to reduce violence in schools by combining educational policies with sustainable spatial planning.

A recent UNESCO report entitled “**Behind the Numbers: Ending School Violence and Bullying (2019)**” states that school violence and bullying are widespread worldwide: approximately 32% of students reported experiencing some form of bullying in the month prior to the survey. The 13- to 15-year-old age group is the most vulnerable to these practices, as the data showed that nearly half of adolescents in this age group have experienced repeated bullying—whether physical, verbal, psychological, or online. The report also indicated that verbal bullying is the most common form, followed by physical bullying, while cyberbullying is seeing a marked increase with the spread of smartphones and social media. The report also demonstrated pronounced differences by gender: boys are more likely to experience physical violence, while girls face higher rates of gender-based violence (UNESCO, 2019; Modecki et al., 2014; Kowalski et al., 2014).

The UNESCO report (2019) noted that bullying and school violence have long-term effects on psychological health and educational attainment. Data show that students who frequently experience violence are more likely to drop out, perform poorly academically, and develop anxiety and depressive disorders. In addition, the report revealed that these effects are not limited only to victims; they also include bullies, who are likely to face future issues with social adaptation and have a higher probability of engaging in deviant behaviors (UNESCO, 2019; Arseneault et al., 2010; Nansel et al., 2001). Evidence from recent studies supports this view, confirming that school violence contributes to the weakening of students’ psychological and social capital (Modecki et al., 2014; Kowalski et al., 2014; Espelage & Hong, 2020). In light of the previous data, it can be noted that violence within schools is not merely a reflection of external factors; rather, it is the product of a complex interaction between educational policies, the school climate, and the architecture of the educational institution. Thus, well-designed educational spaces reduce opportunities for negative friction, promote positive interaction, and foster a sense of security, while inappropriate design can create environments conducive to violence and disorder (Barrett et al., 2019; Maxwell, 2016; Gislason, 2010).

Within the theoretical framework of the study, architectural space is considered one of the influencing factors within the school environment. The literature confirms that the spatial environment is not neutral; rather, it contributes to shaping patterns of movement, social interactions, and feelings of security and belonging (Maxwell, 2016; Evans, 2006). In this context, the Space Syntax approach, developed by Hillier and Hanson (1984), represents both a quantitative and qualitative approach to studying the relationship between spatial structure and social behavior. This theory is based on the hypothesis that the spatial layout of buildings shapes possibilities for interaction, influencing opportunities for natural

observation or isolation, which is reflected in student behavior, including manifestations of violence or aggression (Bafna, 2003; Karimi, 2012; Psarra, 2019).

This methodology also aligns with the principles of Crime Prevention Through Environmental Design (CPTED), which confirm that architectural design can serve as a preventive tool to limit deviant behavior by enhancing natural surveillance, controlling access, and ensuring that spaces are open, visible, and accessible to the wider community (Cozens & Love, 2015; Armitage, 2018; Saville & Cleveland, 2013; Vagi et al., 2018). Recent studies have shown that integrating CPTED principles into school design can reduce rates of violence and enhance students' feelings of security and belonging (Atlas, 2013; Fisher & Nasar, 1992; Jeffery, 1971).

Combining both Space Syntax and CPTED provides a comprehensive theoretical framework for understanding how school urban architecture can contribute to creating a safe, integrated, and interactive environment. This integration paves the way for a shift toward an analytical methodology that relies on digital tools such as ArchiCAD and DepthmapX to test these hypotheses in the field.

2.0 Methodology of the analytical study:

Building on the theoretical framework presented above regarding school violence and its relationship with architectural space, this research employed an analytical study approach to assess the hypothesis in the field using both quantitative and qualitative tools, according to the following sequence:

2.1 Architectural analysis:

- ArchiCAD software was used to draw the architectural plans, document the distribution of classroom spaces, corridors, and courtyards, and analyze the functional relationships within the school.
- DepthmapX software was used to analyze visual oversight according to Space Syntax approach in order to identify isolated zones or areas without surveillance.

Visual documentation was also conducted through photographs of the school spaces to support the architectural analysis and visually identify critical points.

2.2 The Space Syntax approach:

- The research employed the Space Syntax approach, developed by Hillier and Hanson (1984), based on the hypothesis that space is not neutral; rather, it influences movement patterns, social interaction, and the sense of security
- DepthmapX version 0.8.0 software was used for two types of analysis:
 - **Visibility Graph Analysis:** Measuring visual fields inside the spaces and determining visually controlled and isolated zones.
 - **Axial Map Analysis:** Measuring the degree of spatial connectivity between paths and corridors and identifying the axes that are most integrated for movement and social interaction.

2.3 Procedures

Developing the architectural plan in DXF format after simplifying it from secondary elements.

- Importing the file into DepthmapX with the following settings:
 - Unit of measurement: meters
 - VGA grid: spacing = 0.5 m.
 - Automatic drawing of axes to cover all main paths, and exporting the results in CSV format for numerical data and PNG format for color maps.

2.4 The analysis indicators:

- **Integration:** Reflecting the extent to which a particular space is connected to the rest of the spaces.
- **Choice:** The probability of users passing through a specific space.
- **Connectivity:** The numbers of spaces directly connected to a special space.
- **Mean Depth:** It measures how isolated or difficult to access a space is.
- **Visual integration:** The clarity of space from other points, related with sense of security and natural observation.

2.5 Methodical observation:

- Because of the data type (map pictures), visual reading was relied upon, supported by standard values from the Attribute Properties.
- It is proposed to conduct a follow-up study using the original CSV files to verify the results.
- It should be emphasized that spatial analysis does not definitively explain human behavior; rather, it identifies spatial possibilities that may facilitate or hinder certain behavioral patterns. School violence is influenced by multiple factors, including psychological, social, and educational ones, while architectural design is a facilitating factor rather than a direct cause.

3.0 RESULTS AND DISCUSSIONS

3.1 Analysis of Ourtal Bachir Middle School:

Localization map:



Map 01: Site plan of Ourtal Bachir Middle School

A) Analysis of exterior threshold spaces-pre-entry-:

The exterior space of the educational institution, particularly the pre-entry zone, constitutes a highly significant functional architectural element. In architectural literature, it is known as a transition space. It is expected to play a pivotal role in welcoming students and psychologically preparing them for the transition from the public sphere to the private educational setting, through the provision of a comfortable, safe, and clearly legible environment with an architectural identity that reflects the institution's character.

However, the field survey conducted around Oortal Bachir Middle School reveals an almost complete absence of the essential components of a well-designed transition space. The area located in front of the students' main entrance is not functionally prepared to receive students before entry, as it lacks seating elements, gathering areas, green spaces, and shade—features that are considered essential for supporting psychological well-being and reducing stress and friction among students during peak hours.



Figure 01: An unorganized gathering of students in an isolated, weakly supervised corner of the institution's exterior space.

Source: By author, 2025



Figure 02: The exterior space in front of the institution's entrance and the absence of comfortable transitional spaces.

Source: By author, 2025

The ground surface of the space is also unorganized, and neighbors for parking cars use the sidewalk adjacent to the institution, which obstructs students' movement and reduces the safe area allocated to them, thereby depriving the space of its primary function as a preparatory transitional zone.



Figure 04: The encroachment of vehicles onto the sidewalk and the resulting transformation of the transitional space surrounding the institution from its original function.

Source: By author, 2025

The principal entrance does not reflect the principles of educational architecture; rather, it conveys a negative architectural image, more akin to a prison entrance than a school entrance. This is due to the barbed wire installed directly above the gate, which serves as a visual element symbolizing fear, violence, and overprotection, and contradicts the principles of humanistic educational design, which should express openness, welcome, and safety. Furthermore, the lack of clear architectural elements at the entrance (whether through spatial gradation, shadow, or a symbolically significant gate) makes the experience of arriving at the school harsh and unattractive.



Figure 05: The situation at the educational principal entrance, the absence of architectural installation, and the barbed wire installed directly above the gate

Source: By author, 2025

The architectural landscape is compounded when we notice the classroom windows located in the exterior facade closed by thick iron sheets, obscuring visibility and preventing the entry of natural light and ventilation, negatively affecting the quality of the indoor environment and reducing the sense of security and belonging. This type of rigid closure reveals a defensive approach to environmental

discourse, viewing students as potential threats rather than as users whose comfort should be prioritized. It also contributes to a sense of isolation and detachment from the urban environment, and completely contradicts the standards of humanistic schools based on visual transparency and biophilia.



Figure 06: The installation of steel sheets over classroom windows, thereby eliminating visual permeability and restricting environmental interaction with the surrounding environment.

Source: By author, 2025

It is also worth noting that iron bars that form a solid barrier separating this section from the direct urban surroundings surround the western side of the institution— where the administration entrance is located—. This fencing has resulted in the complete appropriation of the public sidewalk, effectively transforming it into a private interior space belonging to the institution, which contradicts the principle of respect for public property and undermines the visual and functional integration between the school and its urban fabric.



Figure 07: The entrance of administration to the institution is surrounded by a closed iron structure that isolates the green space from the surrounding urban fabric.

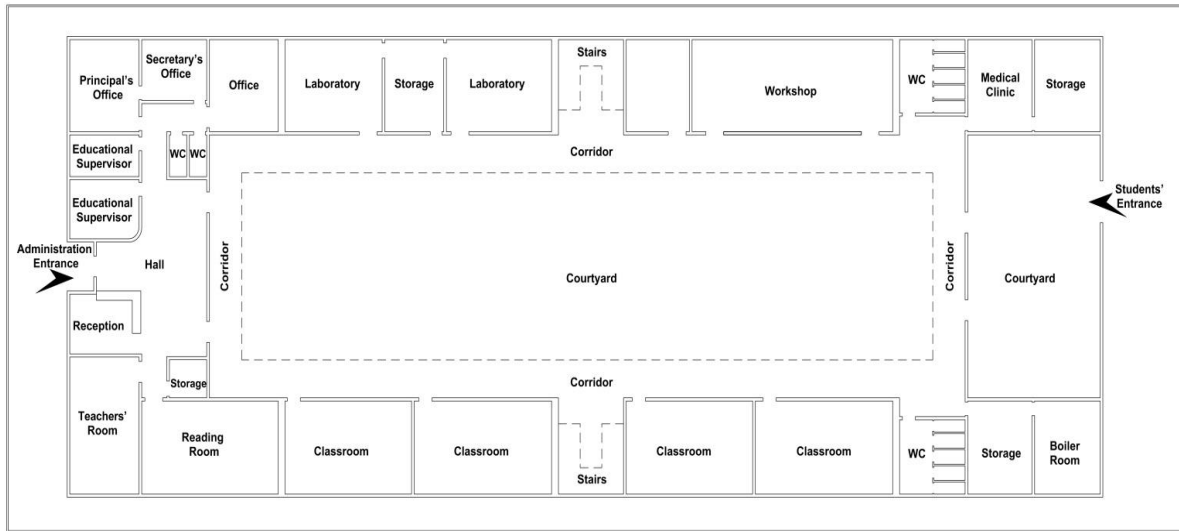
Source: By author, 2025

Although this enclosure created an internal courtyard featuring trees and landscaped green areas, the space remains entirely unused by students and teachers. Despite its environmental value, its function is limited exclusively to serving as a circulation area for staff accessing the administrative offices. Thus, the garden shifts from being a visual and environmental asset integrated into the daily educational experience to a closed and isolated space that is functionally marginalized and deprived of any social or educational role.

In fact, this type of excessive fencing reflects a defensive design philosophy that enhances the separation between the administration and students instead of promoting positive communication and interaction. It eliminates the possibility of using green spaces as calming and stress-reducing elements within the school environment, despite the fact that these elements have been proven to be closely linked to improving mood and behavior according to the principles of biophilic design. In addition, separating the green space behind an iron fence causes the overall landscape of the administration facade to resemble a "security zone" rather than the front of an educational institution, which negatively affects the school's visual identity and weakens the welcoming character that should distinguish the official entrances of educational institutions.

B) Analysis of Interior Spaces

The following plan represents the architectural plan of the school's ground floor, which was imported into the software DepthmapX after being simplified and prepared according to the recommendations of the Space Syntax approach. This process involved removing all unnecessary details, such as doors, windows, and secondary structural elements, while relying solely on walls and main pathways to ensure a clear reading of the spatial composition and structure. The plan includes a set of main functional spaces as follows: Entrances (the administration entrance and the student entrance), the corridors surrounding the central courtyard, classrooms, the teachers' lounge, the reading room, the workshop, administrative offices, supervisors' offices, storage rooms, the medical clinic, and restroom facilities. This plan has been adopted as the basis for the following morphological analysis, as it represents the actual movement network within the building. It reveals the spatial relationships that influence student behavior and the levels of school organization.



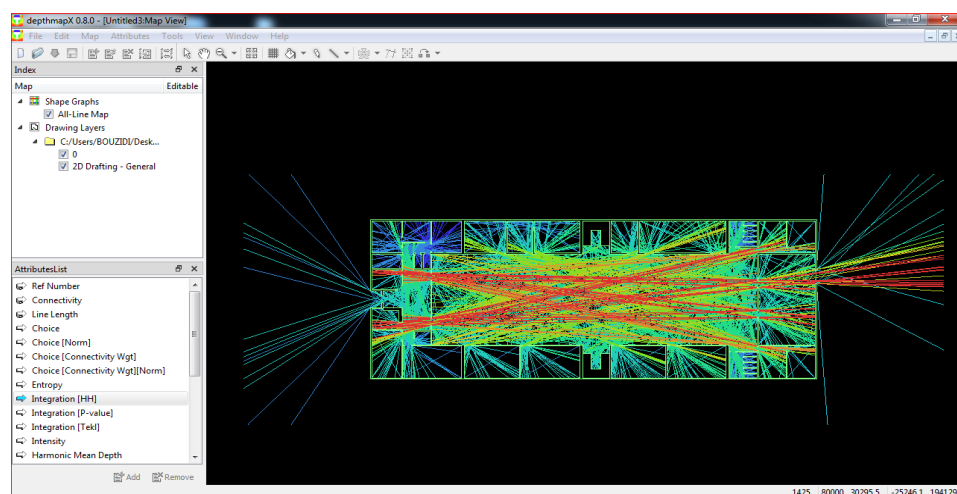
Plan 01: Ground floor plan of Oortal Bachir Middle School (Input model into DepthmapX software).

Source: By author, based on the original project plans

B-1- Indicator One:

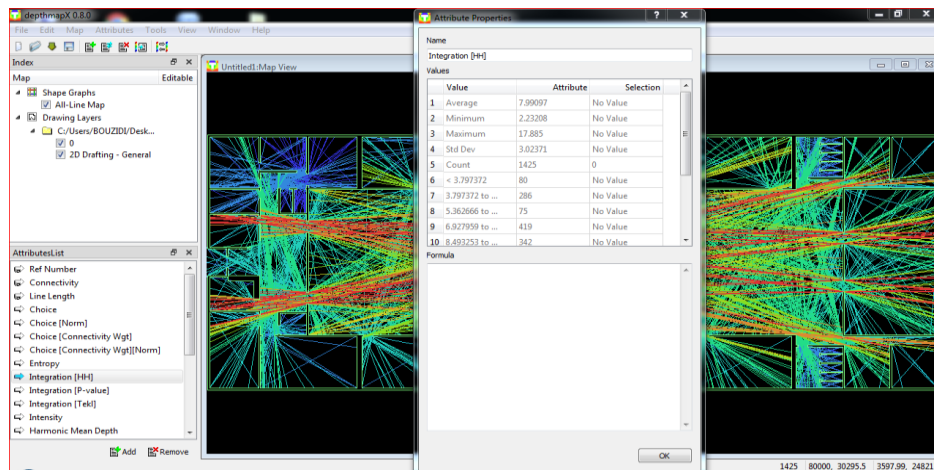
Spatial Integration in Oortal Bachir Middle School:

In the following map, we will present the first indicator, spatial integration, showing the distribution of integration levels within the movement network on the school's ground floor, based on the axial-line model used in DepthmapX. This indicator represents the degree of ease in reaching different spaces and their level of connectivity with the other parts of the building, which allows the identification of the main movement axes in comparison with isolated or peripheral areas. The following map represents a major step in understanding the impact of the spatial configuration on student behavior and the daily patterns of school use.



**Map 02: Spatial Integration map for the ground floor of Ourtal
Bachir Middle School**

**Source: By author, 2025 using DepthmapX based on the original
round floor plan**



**Map 03: Attribute Properties map for the outputs of spatial
integration analysis**

**Source: By author, 2025, using DepthmapX based on the original
round floor plan**

B-1-1 Interpretation of Statistical Values (Attribute Properties)

According to the maps:

Indicator	Value
Average	7.99
Minimum	2.23
Maximum	17.88
Standard Deviation	3.02
Count of studied lines/segments	1425

Table 01: Table of spatial integration (HH) indicator values extracted from the axial lines model

Source: By author 2025, using DepthmapX Software

The significance of values:

- The maximum value of 17.88 indicates highly integrated lines, most often located around the central courtyard.

- The minimum value of 2.23 refers to isolated lines, probably found in the storage rooms, the clinic, the enclosed offices, and the service rooms.
- The average integration value of 7.99 is relatively high, which shows that the school is not spatially isolated, but rather characterized by corridors that ensure good connectivity between spaces.

B-1-2-Color Reading of the High-Integration Zone (Red and Yellow)

The red/yellow zone in the Space Integration map includes:

The central courtyard, which extends lengthwise across the middle school, it means that: The natural movement of students tends to converge along this axis; this space forms the backbone of the school, and consequently, the likelihood of overcrowding and disturbances is higher in this area, which requires visual organization and an educational presence.

- From the perspective of Crime Prevention Through Environmental Design (CPTED), this corridor is considered a suitable space for natural surveillance if it is transparently reinforced.



Figure 08: The Central Longitudinal Courtyard in Oortal Bachir Middle school

Source: By author, 2025

B-1-3- Reading of the Medium-Integration Zone (light green):

It includes secondary corridors, facades adjacent to departments, entrances to classrooms, this indicates: Moderate movement, good visual clarity, no significant isolation, and these spaces represent functional communication areas without being main axes.

- **A logical flow and progression of movement from the main courtyard towards the classrooms**

B-1-4- Low Integration Zone (Blue):

It includes spaces such as Storage rooms, restrooms, side offices, clinic, small rooms, service rooms, staircases

Analysis: These low-integration areas are often:

- They have poor visual visibility. -They are potential locations for unseen behaviors or minor acts of aggression. -They therefore require stronger surveillance, transparency, or movement redirection. They are spatially isolated from the flow of movement.
- They have a higher potential for aggressive or destructive behavior because of the absence of natural passage.
- Restrooms, in particular, appear in blue, indicating low integration and thus low natural surveillance.
- **From a CPTED perspective, these spaces are potential risk areas and should be designed to support: clearer sightlines at entrances, good lighting, and natural movement through path redirection where necessary.**

B-1-5- Architectural analysis:

The central longitudinal courtyard is the most integrated space, which leads to: the concentration of movement within it, greater friction between students, and a possible increase in annoying or abusive behaviors during breaks.

- At the same time, this space offers a strong opportunity for natural surveillance if the corridor is visible from the administration area, supervisors' offices, and department entrances.

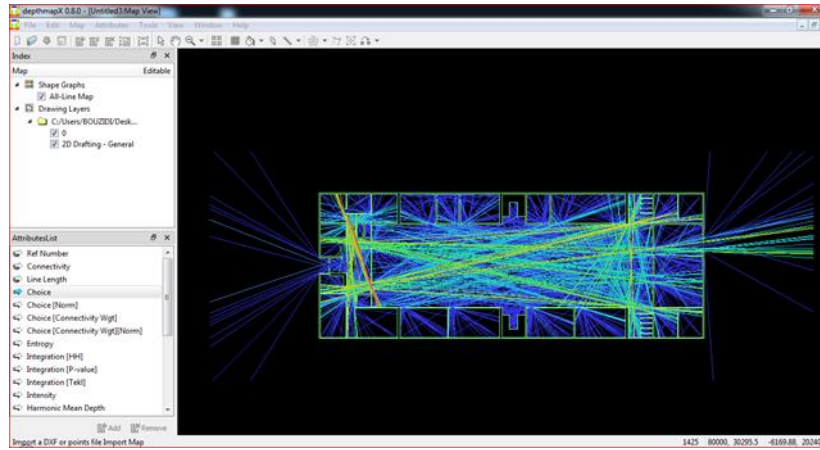
Low integration zone (Blue): These spaces require reconsideration, as they are “deep” spaces that are difficult to monitor and may be used as hiding areas or for unregulated behavior. It is therefore recommended to improve sight lines, lighting, and levels of pedestrian movement.

B-1-6- Overview:

The results of the Space Integration indicator show that the central courtyard is the most integrated space within the school and constitutes the main axis of movement, making it an important point for understanding student behavior and circulation. In contrast, storage rooms, restrooms, and adjacent offices show low levels of integration, which makes them isolated spaces and more vulnerable to the absence of natural oversight. These findings provide a basic framework for identifying potential congestion areas and behavioral vulnerabilities within the school, in line with CPTED principles that promote natural surveillance.

B-2-Indicator Two:

The choice within Oortal Bachir Middle school:



Map 04: The Choice Indicator Map for the Ground Floor of Ourtal Bachir Middle School

Source: By author, 2025, using DepthmapX based on the original round floor plan

B-2-1- Color reading of the Choice Indicator Map:

Red / Yellow colors: highest Choice values, Green / Cyan colors: medium values, Dark blue: very low values.

This corresponds to the numerical classification in the Attribute Properties of the Choice index

Category	Numeric range	Meaning
Very low	0 – 1735	Few-used lines
Medium	1735 – 3471	Secondary to medium traffic routes
High	3471 – 5207	Important paths
Very high	+5207 to 17357	Critical paths with intensive use

Table 02: Choice Indicator Value Table from the Axial Line Model

Source: By author 2025, using DepthmapX Software

B-2-2- The spatial distribution of the choice indicator value within the school:

B-2-2-1-The Long Central Corridor (Courtyard):

It appears in yellow/green, with some orange areas in the center. This means that the circulation paths surrounding the courtyard function as the main channels for student movement between classrooms. This corridor is the backbone of movement within the school, receiving the highest volume of student flow during breaks, at the beginning of the school day, and at dismissal.

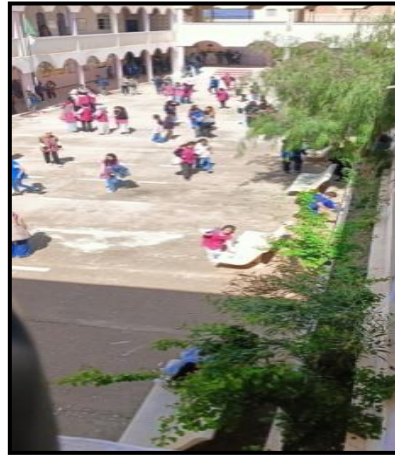


Figure 09, 10, and 11: Students' movement in the central courtyard

Source: By author, 2025

B-2-2-2- Intersection Points Between corridors (Especially at the courtyard Entrances):

The highest values of the choice indicator show yellow to orange colors. These points represent major movement nodes.

Implication: Potential for crowding and friction. Critical transition areas that must be controlled in terms of both design and behavior.

B-2-2-3- Classroom corridors on the south side

Medium to low values (Green- Blue): Lower movement than in the central corridor **Implication:** These corridors are less exposed to violence because they do not receive a large flow of movement, but they may experience some isolation in certain areas, especially near the restrooms.

B-2-2-4- Administrative Entrance Area (West):

Relatively low values (blue-green), limited movement, and staff-oriented.

Implication: A stable area, not a point of behavioral tension.

B-2-2-5- Students Entrance (East):

Higher colors than the administrative area (green-yellow): A very common route as it is a main daily entrance.

Implication: Entry and exit points are always prone to violence due to heavy traffic and a lack of complete control.

B-2-2-6 Restrooms (South- East):

The lowest value, shown in dark blue, is isolated and not intersected by major paths.

Serious implication: This is an area of weak surveillance and highly susceptible to aggressive behavior.

B-2-3 Behavioral-functional interpretation of the "Choice" indicator:

B-2-3-1 Areas with a high Choice (central corridors and intersected nodes):

It represents critical paths, highest student movement volume, points of friction, especially during breaks, movement between classes, and entry and exit.

Potential behavioral effects: Increased likelihood of pushing and shoving and conflicts, increased noise, difficulty in controlling behavior.

Design recommendations: It is recommended to introduce waiting and traffic-control areas before intersections, position supervision points at these locations, enlarge certain spaces, and improve lighting and ventilation.

B-2-3-2- Areas with a medium Choice (departments' corridors):

Characteristics: Movement directed only towards departments, less crowded, becomes sensitive when students leave all at once.

Recommendations: Maintain good visual clarity, avoid sharp corners or bottlenecks, and distribute departments so that students are not concentrated in one area.

B-2-3-3- Areas with Very Low Choice (Restrooms + Storage rooms):

These are dangerous because: Lowly active areas, poorly supervised, and offer both spatial and apparent isolation.

Indications of violence: Potential for bullying, small, unseen groups, and disruptive behavior.

Recommendations: Improve visibility, avoid overlapping spaces, add lighting, and conduct regular surveillance.

B-2-3-4- Overview of the Choice Indicator Analysis:

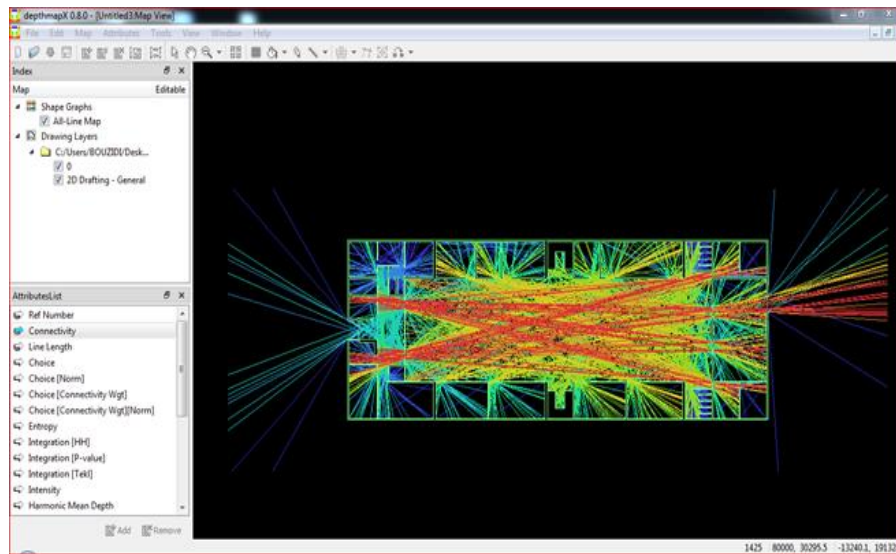
The space	Choice level	Behavioral Implication	Recommendations
Central courtyard	High	Heavy movement + potential for friction	Expansion + movement organization
Corridors intersections	Very high	Tension points	Dedicated surveillance and expansion
Departments' corridors	Medium	Regular movement	Improve visibility
Students Entry	Medium- High	Daily overcrowding	Organization of entry points
Administration	Low	Stable	No major risks
Restrooms	Very low	Most hidden points of violence	Surveillance + Lightning + Opening the view

Table 03: Table of Choice indicator analysis

Source: By author, 2025

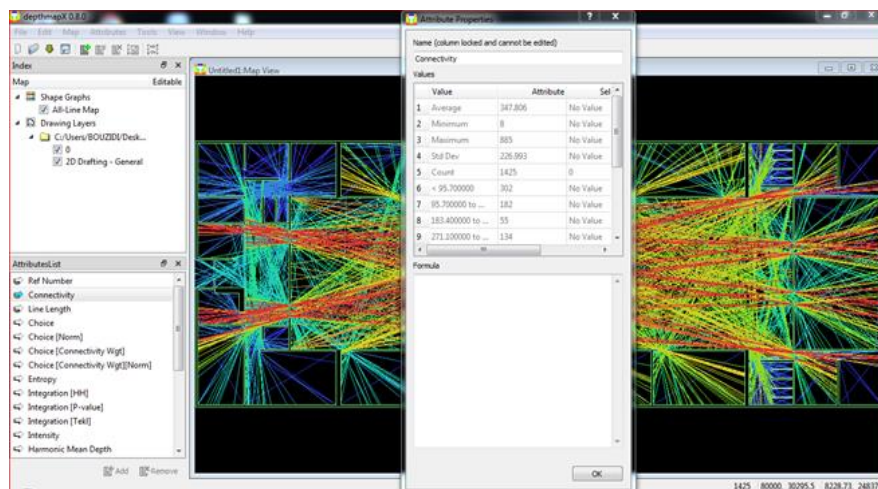
B-3- Indicator Three: Connectivity within Oortal Bachir Middle school:

Connectivity refers to the number of spaces that are directly accessible from a given space without passing through another space.



Map 06: The connectivity indicator map of Oortal Bachir Middle school ground floor

Source: By author, 2025, using DepthmapX based on the original ground floor plan



Map 07: Attribute Properties Map of the choice Analysis Outputs

Source: By author, 2025, using DepthmapX based on the original ground floor plan

B-3-1. Color Map Reading in DepthmapX:

- Red/ Orange = very high connectivity.

It is located in the main central corridor, i.e. the passage surrounding the courtyard, on both its upper and lower sides, the movement axes connecting the students' entrance to the interior space (the

courtyard), and, to a lesser extent, the movement axis at the administrative entrance. These areas display dense red and orange lines.

- Yellow/Green = Medium Connectivity.

It is located in secondary corridors leading to classrooms, access paths to the workshop, clinic, restrooms, and storage rooms, and internal administrative corridors.

- Blue/Sky Blue = Poor connectivity.

Appearing in: Building corners, isolated administrative offices (Director's office, Principal's office, and Bursar's office), peripheral classrooms far from the central axis, and restrooms and storage rooms (especially those on the west side).

B-3-2- Reading connectivity values from Attribute Properties:

- Minimum = 8 ← Minimal connectivity (closed rooms/corners).
- Maximum = 885 ← highest connectivity, corresponding to the central corridor.
- Average = 347.8 ← moderate.
- Standard deviation = approximately 227 ← indicates significant differences in connectivity across the school.

Classified distribution in DepthmapX:

- Below 95.7: very weak connectivity (302 lines).
- 95.7–183.4: weak connectivity (182 lines).
- 183.4–271.1: moderate connectivity (55 lines).
- 271.1–885: high connectivity (134 lines).

Nearly half of the network, or more, has weak connectivity, shown in blue/cyan, which indicates a large number of functionally isolated spaces.

B-3-3- Spatial Analysis – Significance of the Connectivity Indicator in the middle School:

B-3-3-1- Central Corridor (Highest Connectivity): It constitutes the primary movement axis; almost all paths intersect there, making it the most likely point of overcrowding.

According to CPTED perspective: It is an ideal location for natural surveillance, but it is also prone to overcrowding and student friction, especially during arrival, departure, and break times.

B-3-3-2. Corridors Leading to Classrooms (Moderate Connectivity):

- Nearly unidirectional movement.
- They do not form movement nodes, so they are less congested.
- They can be used as quiet transitional spaces.

However: Toilet entrances may become points of aggressive behavior due to weak connectivity and the absence of supervision.

B-3-3-3. Administrative Spaces (Low Connectivity): They are isolated from student movement. This facilitates administrative work, but it reduces the effectiveness of behavioral supervision.

B-3-3-4. Eastern and Western Peripheral Corners (Very Weak Connectivity): These are critical points in the design, as they may be used for unmonitored activities such as fights or small gatherings.

B-3-4. Behavioral Interpretation – Potential for Increased Violence:

B-3-4-1. At the intersection of corridors near the students’ entrance (very high connectivity):

- Severe congestion creates a high risk of friction, so it is recommended to reshape the circulation route or expand the node.

B-3-4-2. In front of the restrooms (low connectivity + poor visibility):

- This is a behaviorally risky area according to most CPTED studies, so its visual transparency or supervision should be strengthened.

B-3-4-3. Isolated administrative offices: The administrative space does not participate in monitoring the corridor, which weakens the school’s “natural authority.”

B-3-4-4. Peripheral corridors far from the courtyard: Their low connectivity makes them “hidden” areas within the network, making them prone to negative behavior or aggressive gatherings.

B-3-5. Overview of the Connectivity Analysis:

B-3-5-1-The spaces with the highest connectivity:

The space	Level	Spatial interpretation	Behavioral interpretation
The corridor surrounding the courtyard	Very high	Main artery of movement	Congestion – friction – need for supervision
Students’ entrance axis	High	Main gathering point	Tension during entry/exit

Table 04: The spaces with the highest connectivity in Ourtal Bachir Middle School

Source: By author, 2025

B-3-5-2- The spaces with medium connectivity in the Middle School

The space	Level	Observation
Departments’ corridors	Medium	Less movement – suitable for tranquility

Table 05: The spaces with medium connectivity in Ourtal Bachir Middle School

Source: By author, 2025

B-3-5-3- The spaces with poor connectivity:

The space	Level	Risks
Restrooms+ Storage rooms	Very weak	Poor vision – potential aggressive behaviors
Peripheral corridors	Weak	Functional isolation

Table 06: The spaces with poor connectivity in Ourtal Bachir Middle School

Source: By author, 2025

According to this analysis, spaces with poor connectivity require a series of architectural interventions aimed at enhancing visual and movement connections within the network. The most significant of these include:

- Replace the solid walls surrounding the peripheral corridors with sound- and heat-insulating glass walls to increase natural surveillance without compromising functional privacy.
- Enlarge door openings and increase transparency at side entrances to improve visual perception from highly connected corridors toward low-connectivity spaces.
- Redirect some movement paths by opening short passages or new crossing points that link quiet areas to central corridors, without disrupting the overall flow of the system.
- Strengthen natural and artificial lighting in low-connectivity spaces to improve spatial perception and reduce hiding places.

These findings indicate the need to balance spatial connectivity, ensuring that central corridors remain effective in directing movement while integrating peripheral areas into the visual and circulation network. Such an approach can enhance school safety and improve the quality of instruction in accordance with the preventive principles of CPTED.

B-3-6- The configurational relationship between spatial connectivity and integration properties according to the Space Syntax approach:

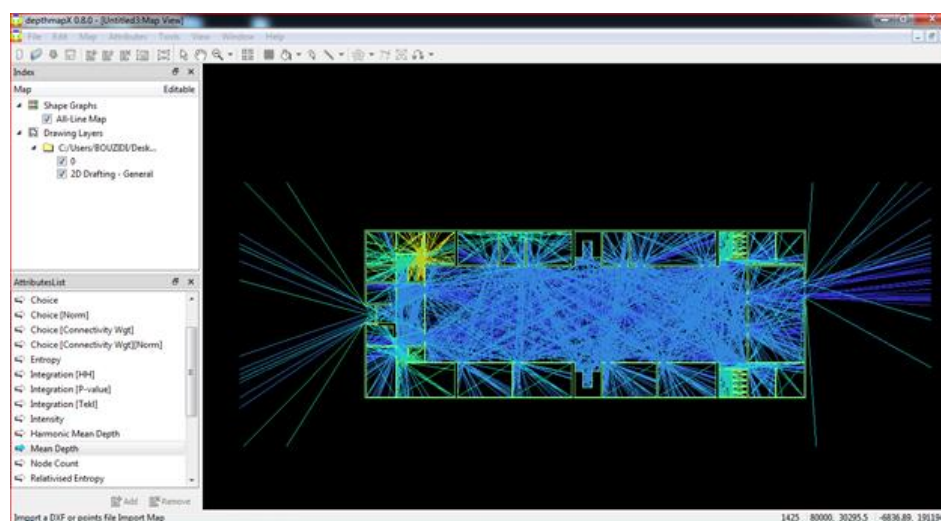
The spatial analysis shows that the highest levels of connectivity in the central corridors contribute directly to increasing the overall integration values of the internal structure. The indicator recorded an average of 7.99, a level that reflects the efficiency of spatial connections. Furthermore, the range of values, from a minimum of 2.23 to a maximum of 17.88, confirms a clear divergence between the most integrated and the least integrated paths. This variation is related to degrees of connectivity: lines with strong lateral relationships tend to occupy the highest integration values, while lines with weak connectivity tend toward the minimum. This is consistent with the standard deviation (3.02), which reflects a considerable degree of dispersion within the linear network of 1,425 lines.

These results reveal that enhancing integration is not achieved solely by increasing the number of connected lines, but also by improving the quality of visual openings and movement pathways. Accordingly, a set of architectural solutions can be adopted. Notable examples include replacing some solid

walls with insulating glass walls to expand the field of vision without compromising sound and heat insulation, as well as widening the central corridors to increase capacity and improve traffic flow. This would raise communication levels, thereby improving the actual integration values within the space, and positively affecting ease of movement while reducing congestion.

B-4-Indicator Four: Mean Depth within Ourtal Bachir Middle School:

The mean depth indicator represents a key indicator in spatial composition analysis according to the Space Syntax approach. It is used to measure the “depth” of each point within the system, that is, the number of spatial steps separating it from the rest of the spaces. The greater the depth value, the more detached the space becomes from the main pathways, and the lower the likelihood of regular passage or visibility within it. As a result, it becomes less central to movement and more susceptible to isolation.



Map 08: The Mean Depth indicator map of Ourtal Bachir ground floor

Source: By authors, 2025, using DepthmapX software based on the original ground floor plan

The results extracted from DepthmapX show that the mean value of the Mean Depth indicator in this spatial model is 2.15, with values ranging from a minimum of 1.44 to a maximum of 4.53. This variation suggests that the institution contains both highly open spaces and spaces with greater spatial depth, reflecting a clear disparity in the distribution of movement within the school.

The color map shows that the spaces near the administration entrance and the central courtyard tend to appear in yellow and green tones, indicating low depth values and, therefore, a direct connection to the main corridors and daily student movement. In contrast, some spaces such as storage rooms, restrooms, and side offices appear in dark blue, confirming their greater depth and their functional and visual separation from the main circulation structure of the school.

This pattern has important behavioral implications. Spaces with high depth are usually low-traffic and weakly supervised areas, which makes them more vulnerable to negative behaviors outside the view of supervisors, such as vandalism, harassment, or conflicts between students. These spaces also represent

visual pockets lacking transparency, which conflicts with CPTED principles that emphasize reducing isolation and strengthening natural surveillance within educational institutions.

On the other hand, this distribution reveals a problem in the overall spatial organization of the institution. While student activity is concentrated in a limited area with low depth, namely the central courtyard, several educational or service spaces remain completely isolated in terms of accessibility. This may reinforce the imbalance in school use and create narrow circulation paths around certain zones, increasing the likelihood of friction and congestion during entry and exit periods.

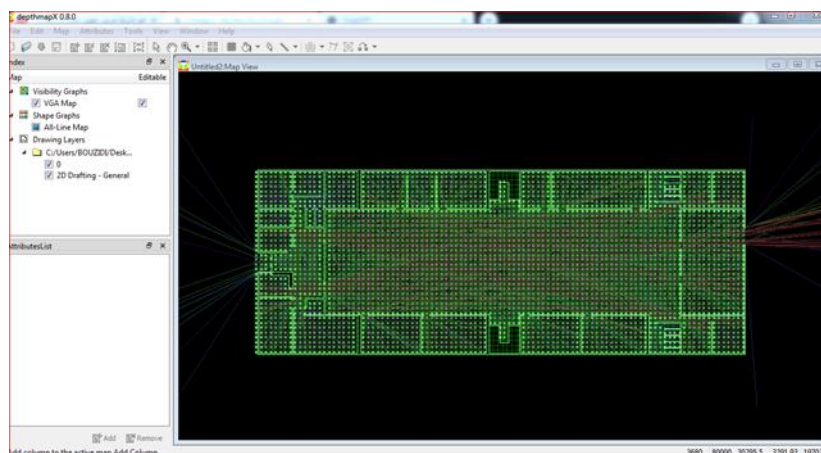
The interpretation of the Mean Depth values shows that the school suffers from an unbalanced spatial gradation, where some spaces enjoy high accessibility while others remain highly isolated and poorly supervised. This configuration highlights the importance of reconsidering spatial connectivity, especially between service spaces and the main corridors, in line with the architectural principles of school safety and social sustainability.

B-5 indicator Five: Visual Integration (VGA)

Within Oortal Bachir Middle School:

The color map produced by the Visibility Graph Analysis (VGA) shows a chromatic gradation that reflects variations in visual integration across the spaces making up the school plan.

This gradation reveals a transition from warm colors to cool colors, indicating differences in visibility levels and visual exposure among the various spaces.



Map 10: The visual integration map within Oortal Bachir Middle school

Source: By author, 2025, using DepthmapX software

The central courtyard zone records the highest visual integration values, as shown by the dominance of warm colors ranging from yellow to red. This indicates a high level of mutual visibility and a broad field of visual supervision. It can therefore be considered the visual heart of the educational institution, as it allows continuous natural surveillance that helps reduce violent behavior and strengthen the sense of safety within the school environment.

By contrast, the corridor surrounding the courtyard appears in medium tones tending toward green, reflecting a moderate level of visual integration. This color representation confirms the transitional role of the corridor as an element that organizes both movement and visual connection at the same time, maintaining visual contact with the courtyard while preserving its function as a distributive space. Classrooms, on the other hand, are generally represented by relatively cooler colors, indicating lower visual integration compared with shared spaces. This condition reflects a deliberate balance between the requirements of educational privacy and the need for a minimum level of visual oversight, allowing behavior to be regulated without compromising the pedagogical function.

Secondary spaces such as storage rooms, sanitary facilities, and some peripheral corners appear in cool colors ranging from blue to violet, which indicates weak visibility and limited visual connection. These areas are behaviorally sensitive, given their potential use for undesirable practices, which makes it necessary to address them through design within a preventive framework aimed at reducing violence in the school environment.

Overall, the VGA color map confirms that the distribution of visual integration levels within the plan follows a design logic based on enhancing visual openness in collective spaces while regulating visibility in private functional spaces. This balance highlights the crucial role of architectural design in guiding behavior, supporting a safe educational environment, and limiting manifestations of violence in the school setting.

C) Conclusion of Oortal Bachir Middle School Analysis:

Reading the built environment of this middle school, whether through its exterior setting or its internal configuration, reveals a clear weakness in spatial quality from both an educational and behavioral perspective. The external analysis shows a fragile transitional space, lacking a welcoming identity and conveying a defensive visual message that negatively affects the experience of arrival. Meanwhile, the internal analysis based on Space Syntax indicators highlights a significant contrast between highly integrated spaces, which are exposed to congestion and friction, and low-integration spaces, which represent potential zones of visual isolation. Accordingly, the current spatial composition does not meet the requirements of social sustainability or the principles of CPTED. It therefore calls for a comprehensive rethinking that strengthens natural surveillance, visual integration, and psychological comfort, while improving the student's experience within a safe and effective school environment.

Conclusion:

The current spatial composition of Oortal Bachir Middle School does not meet the requirements of social sustainability or the principles of CPTED, as it promotes isolation and lacks a welcoming identity. This situation negatively affects students' experience and increases the likelihood of aggressive behaviors. Thus, a complete rethinking of the architectural design is a prerequisite for building a safe, inclusive, and effective school environment.

Architectural Guidelines

- Redesign the external transitional space:

Introduce welcoming elements such as green areas, signage, and seating zones to strengthen a positive visual identity.

- Improve the internal integration of spaces:

- Reorient some corridors and classrooms toward the central courtyard.

- Add glazed openings to enhance visual integration between classrooms and courtyards.

- Strengthen natural surveillance:

- Design open corridors with clear sightlines.

- Reduce isolated points that weaken educational supervision.

- Apply CPTED principles: Natural surveillance. Access control. Territorial reinforcement.

- Psychological and environmental comfort:

Introduce green spaces and natural shade. Improve lighting and ventilation quality inside classrooms.

- Future methodological recommendation:

- Rely on the original CSV files from DepthmapX to verify the results more accurately.

- Conduct comparative studies with other schools to generalize the findings.

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