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Assessing the Quality of the Educational Environment in China-Iraq Agreement Schools: An Applied Study of A18 and B18 School Models in Al-Karkh First Directorate of Education

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ABSTRACT

This study assesses the quality of the educational environment in a sample of schools implemented under the China-Iraq Agreement in Al-Karkh First Directorate of Education. It examines the relationship between the quantitative response to the shortage of school buildings and the quality of the learning environments produced by replicated school models. The research adopts a descriptive, analytical and comparative methodology. It first analyzes the A18 and B18 models, and then evaluates 15 implemented schools using a criteria-based assessment matrix consisting of 20 sub-indicators distributed across seven axes: site capacity and density, classrooms and learning spaces, circulation and safety, water, sanitation and hygiene (WASH), outdoor spaces, greenery and shade, and indoor environmental quality. The matrix is grounded in Iraqi and international references, including UNICEF Child-Friendly Schools, WHO/UNICEF WASH, INEE Minimum Standards and Building Bulletin 103. The results show that the highest score was 67.5/100 and the sample average was 53.82/100; no school reached good or high compliance levels. The descriptive and correlation analyses indicate that the decline in educational environmental quality is mainly associated with operational density, pressure on sanitation facilities, limited yards, and weak greenery and shade. The study concludes that school models should be developed from fixed, repetitive prototypes into adaptable design systems responsive to site conditions, density and climate

1. Introduction

Educational systems depend on adequate school infrastructure. The quality of education is not determined solely by the curricula and teaching staff, but also shaped by the quality of the surrounding physical learning environment. A school should not be understood as a neutral container, where students passively occupy classrooms and receive instruction; but rather as an educational, social and health-supportive learning environment that provides safety but also comfort, circulation, sanitation, recreational space, universal accessibility and climate adaptability. This is in accordance with the Child-Friendly School concept — defining schools as a safe, healthy, inclusive, and supportive environment for all children, rather

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than merely a building that contains classrooms. [1]

Schools constructed in Iraq under the China–Iraq Agreement have become a large-scale response for a government facing shortages of school buildings and pressures caused by overcrowding due to double or triple shifts. But quantitative expansion does not eliminate the need for architectural and planning evaluation of the project. Constructing a large number of schools does not guarantee achieving the goal of quality learning environments. This becomes particularly significant when we draw on standardized repeated school models like A18 and B18. Replicating standard school prototypes can accelerate project implementation, but it also risks transferring design weaknesses from one site to another.

The standardized school prototype approach itself can increase classroom capacity, however spatial, functional, and operational gaps may remain in schoolyards, provision of sanitary facilities, universal accessibility for all students regardless of ability or status including landscape provision, shading, and climatic response. Similarly, a single prototype can also yield different results when applied to sites with different areas, orientations and patterns of use. This means that a school cannot be judged by the plan alone; rather the plan needs to be linked to site conditions and operational data as well.

This study evaluates the extent to which a sample of schools from the China–Iraq Agreement within the Al-Karkh First Directorate of Education meet learning environment design criteria. This is based on an examination of the A18 and B18 models combined with a criteria-based assessment applied to 15 schools under implementation. The study contributes to developing a replicable diagnostic tool to identify design and operational gaps, which can inform the development of future Iraqi school prototypes.

2. Theoretical and Normative Framework

2.1 The school as an integrated learning environment

Contemporary literature understands the school as an integrated learning environment composed of classrooms, laboratories, yards, internal circulation, sanitation facilities, entrances, waiting areas, play spaces, and internal and external environmental components. From this perspective, the yard is not a leftover site area but an educational, social and health-related space. Likewise, sanitation facilities are not a secondary service annex, but an essential condition for health, dignity and continuity of school operation.

The UNICEF Child-Friendly Schools framework provides an appropriate basis for this study because it links the school building with children's rights and daily needs. The framework does not prescribe a single design solution for all contexts, but emphasizes principles such as inclusion, safety, health, gender sensitivity and effective learning, while allowing these principles to be adapted to local conditions [1].

2.2 International and local standards guiding the assessment matrix

The study relies on a composite normative package rather than on a single standard. UNICEF standards provide the general rights-based and environmental framework for child-friendly schools, while WHO/UNICEF WASH guidelines provide a basis for evaluating drinking water, sanitation, handwashing, hygiene, gender separation and accessible facilities [2]. INEE Minimum Standards emphasize that learning environments should be safe, contextually relevant and accessible, while ensuring protection and accountability in the delivery of education [3].

In terms of area requirements, Building Bulletin 103 provides an explicit international reference for estimating classroom, learning-space and yard areas. It indicates that typical classrooms in mainstream schools are generally between 55 and 62 m² for 30 students at basic levels, equivalent to approximately 1.83 to 2.07 m² per student [4]. By comparison, the classroom area in the A18 and B18 models is approximately 49.2 m². This area may be acceptable at low operational densities, but it becomes weak when student numbers per classroom increase.

At the local level, recent Iraqi studies and local standards indicate that school design standards in Iraq are not fully unified and are issued by multiple authorities, which makes them in need of development and comparison with international standards, especially regarding yards, sustainability, indoor environmental quality and outdoor spaces [5], [6]. This study therefore treats Iraqi standards as a necessary local baseline, but links them to international frameworks that are applicable to field assessment.

2.3 Previous studies and the research gap

The contemporary literature has addressed school-building quality from multiple perspectives, including educational space adequacy, functional performance, indoor environment, sanitation services, outdoor yards and post-occupancy evaluation. This literature confirms that schools cannot be evaluated only by the number of classrooms or built area, but by the capacity of the building and site to support learning, health, safety, circulation, comfort and outdoor activities. This is particularly relevant for repeated school models: repetition may accelerate construction, but it can also transfer fixed design problems to different contexts if the model is not adaptable to density, site and climate [1], [3], [4].

In the Iraqi context, the study conducted by Kazem and Al-Kazzaz [5] is one of the most relevant studies to this research. It found significant shortcomings in Iraqi school design standards when compared with several international standards related to sustainability, safety, flexibility and comfort and requirements for users with special needs. It also revealed that local standards tend to focus on spatial dimensions, spatial distribution and number of spaces rather than long-term environmental and operational performance. This is consistent with the logic of the present study, because the assessment of China-Iraq Agreement schools should be based not only on formal compliance with standards, but also adherence to student density requirements, schoolyards, sanitation facilities and circulation efficiency.

Building on this literature, Rajab and Breesam [7] provide recent Iraqi evidence for the need to incorporate sustainability standards in school design. The study investigated the most important criteria for sustainable school design in Iraq including energy, water, indoor environmental quality, waste management, materials and resources and sustainable sites. The emphasis on sustainable sites, indoor environmental quality and water as key assessment dimensions corresponds to the assessment dimensions of the present study, such as schoolyard provision, green coverage, shaded outdoor spaces, student density and adequacy of sanitary facilities.

Post-occupancy studies additionally show that school performance is more accurately assessed after occupancy rather than through pre-occupancy drawings alone. For example, Ahmed et al. [8] used post-occupancy evaluation in three schools in the UK and examined building services and indoor environmental parameters such as temperature, lighting and ventilation and HVAC systems. Shehata et al. [9] provide a multidimensional model for measuring the post-occupancy performance of primary school buildings, linking functional and environmental factors to site context, spatial arrangement, classrooms and learning spaces. These works demonstrate the methodological link between the standardized model and operational reality after use.

With regard to indoor environmental quality, integrated studies on thermal comfort, air quality, lighting and acoustics are required for classrooms. Baba et al. [10] examined post-occupancy evaluation of indoor environmental quality in Palestinian schools and Di Loreto et al. [12] showed that field assessment of indoor environmental quality is necessary to evaluate thermal comfort conditions, indoor air quality, acoustics and lighting. As such, indoor environmental indicators are used as preliminary architectural indicators based on the available data used in the present study, not as a substitute for detailed field measurements.

Research on classroom design also indicates that the built environment of the classroom forms part of the learning experience. Barrett et al. [11] found a link between classroom design and pupil learning performance, while Andrew Hargreaves argued that seven factors—light, flexibility, complexity, connection and choice—shape the learning environment [12]. This reinforces the use of classroom area per student and students per classroom as indicators in the assessment matrix, since the classroom is not merely a measured floor area, but rather a learning environment defined by density, daylighting conditions, thermal/visual comfort and spatial organization.

In the WASH axis, WHO/UNICEF references emphasize that toilets, water and handwashing in schools are essential educational and health conditions, not secondary service elements. WHO/UNICEF guidelines provide indicative ratios of approximately one toilet for every 25 girls and one toilet for every 50 boys. Poague et al. [13] and WHO/UNICEF JMP [14] also confirm that water, sanitation and hygiene in schools remain major issues for monitoring and are linked to daily school health and the Sustainable Development Goals [2], [13], [14].

For yards and greenery, recent studies show that schoolyards are not leftover spaces but part of learning, health and well-being. Ly and Vella-Brodrick [15] show that school-led nature interventions, such as outdoor learning, school gardens and green spaces, can improve children’s and adolescents’ mental, physical and social well-being. Bikomeye et al. [16] show that schoolyard greening can support physical activity and socio-emotional health, while Raney et al. [17] indicate that play-zone diversity and nature-based design features are associated with more diverse play behaviors during recess. These findings support the indicators used in this study: yard area per student, diversity of outdoor spaces, greenery, shade and heat-island mitigation.

Based on the above, the research gap is that most previous studies address Iraqi school standards in general, post-occupancy evaluation, indoor environmental quality, yards and greenery, or WASH separately. They do not provide an integrated applied evaluation of the A18 and B18 models after implementation within one administrative context. This study therefore links the standard design model, actual operational data, yard area, sanitation adequacy, classroom density, greenery and shade through a practical assessment matrix that can be replicated in other Iraqi schools.

3. Methodology

3.1 Research method and sample

The research adopts a descriptive, analytical and comparative methodology. The subject does not merely require describing implemented school buildings; it requires analyzing the relationship between the standard design model and actual site and operational conditions. The sample consists of 15 implemented schools within Al-Karkh First Directorate of Education, distributed between the A18 and B18 models, with differences in student numbers, yard area, urban, peri-urban and rural location, gender and operational density.

The sample was purposively selected because architectural plans [18] and basic operational data [19] were available, and because the schools were implemented and operational within a single administrative context that allows comparison. The sample also includes variation in model type, area, student numbers and site conditions. The study does not claim to generalize its findings to all China-Iraq Agreement schools in Iraq. Rather, it provides an applied diagnosis within the limits of the sample, with the possibility of extending the tool to broader samples in future studies.

The research design consists of two levels. The first level analyzes the standard plans of the A18 and B18 models to identify fixed characteristics such as number of classrooms, classroom area, number of floors, built footprint, laboratories and multi-use halls, sanitation units, corridor and stair widths, and the absence of elevators and ramps. The second level evaluates the implemented schools through data on student numbers, yard area, model type, and the adequacy of services, outdoor spaces, greenery and shading.

3.2 Building the criteria-based assessment matrix

The assessment matrix was built to translate theoretical standards into measurable and comparable indicators. It consists of 20 sub-indicators. Each indicator is scored from 0 to 4, producing a total of 80 points, which is then converted to a 100-point equivalent for classification and comparison. The matrix evaluates seven main axes: site and school density, classrooms and learning spaces, circulation and safety, water, sanitation and hygiene, yards and outdoor activities, greenery, shade and outdoor climate, and indoor environmental quality.

The matrix is not based on impressionistic judgment. It relies on quantitative and qualitative indicators that can be derived from plans, official data and architectural observation. Quantitative indicators include classroom area per student, students per classroom, students per sanitation unit, and yard area per student. Qualitative indicators include greenery, shade, yard diversity, separation of activities from risks, ventilation, daylighting and acoustics. Appendix (1) presents the scoring limits from 0 to 4 for each indicator, the source of each indicator and the method of measurement.

The study uses equal weighting for the indicators to avoid an unsupported local weighting system and because the aim of the tool is diagnostic and comparative rather than a final ranking system. Future studies can develop the tool by assigning differential weights based on expert judgment or subsequent statistical analysis. Indoor environmental quality indicators were treated as preliminary diagnostic indicators, not as substitutes for field measurement using specialized equipment.

Table (1): Assessment matrix axes, sub-indicators and sources.

Axis	Sub-indicators	Reference standards
Site and density	1. Site area adequacy / number of students; 2. Built-to-open-space ratio	BB103 [4]; Kazem and Al-Kazzaz [5]
Classrooms and learning spaces	3. Classroom area per student; 4. Students per class; 5. Supporting learning spaces	BB103 [4]; Barrett et al. [12]
Circulation and safety	6. Corridor width; 7. Stairs, exits and emergency routes	INEE [3]; UNICEF CFS [1], [6]
Water, sanitation and hygiene (WASH)	8. Toilet adequacy; 9. Gender separation and inclusion; 10. Drinking-water points; 11. Handwashing and maintenance	WHO/UNICEF WASH [2]; Poague et al. [13]
Yards and outdoor activities	12. Yard adequacy; 13. Diversity of outdoor spaces; 14. Separation of activities from risks	UNICEF CFS [1], [6]; BB103 [4]; Raney et al. [17]
Greenery, shade and outdoor climate	15. Greenery and planting; 16. Outdoor shade; 17. Surface treatment and heat-island reduction	UNICEF CFS [1], [6]; LEED [20]; Bikomeye et al. [16]; Ly and Vella-Brodrick [15]
Indoor environmental quality	18. Ventilation; 19. Natural lighting; 20. Acoustics	BB101 [21]; BB93 [22]; Baba et al. [10]; Di Loreto et al. [11]

3.3 Validity and reliability of the assessment tool

The study relies on content validity by linking the indicators of the assessment matrix with recognized references and standards in school design and learning environments, including UNICEF Child-Friendly Schools [1], WHO/UNICEF WASH [2], INEE [3] and BB103 [4], in addition to Iraqi studies related to school standards. Each indicator was selected to correspond to a clear design or operational dimension that can be read from drawings, data or architectural observation.

Reliability was treated as preliminary procedural reliability through the standardization of equations, scoring scales and methods of calculating indicators for all schools in the sample. The study does not claim statistical reliability based on multiple assessors or inter-rater agreement. This remains an area for developing the tool in future studies.

3.4 Equations and classification

Four main equations were used in the analysis: average students per classroom = total number of students ÷ 18 classrooms; classroom area per student = 49.2 ÷ average students per classroom; students per sanitation unit = total number of students ÷ number of student sanitation units; and yard area per student = external yard area ÷ total number of students. The study uses the design capacity of 18 classrooms as a standardized comparison basis, while acknowledging that actual class distribution and shift operation may alter real classroom density. After conversion to a 100-point scale, results were classified into five categories: high compliance (85-100), good compliance (70-84), moderate compliance (55-69), weak compliance (40-54), and very low compliance (below 40).

Research ethics and data

The study does not use personal data of students or staff, and it does not include interviews or experiments involving human participants. It relies on architectural plans, aggregated operational data and architectural observations. Therefore, it does not require special ethical approval for human-subject research. School data were treated as aggregated data for architectural and planning analysis only.

4. Analysis of the A18 and B18 Models

The A18 and B18 models represent core design formulas used in the China-Iraq Agreement schools. Although they share the same number of classrooms and classroom area, the essential differences lie in the built footprint, number of floors, circulation organization and relationship between the mass and the yard. The analysis therefore focuses on the design characteristics that influence the quality of the learning environment, with reference to the renumbered figures.

4.1 Architectural analysis of the A18 model

The A18 model is based on a vertical organization of three floors and a footprint of approximately 1000 m². The ground-floor plan shows classrooms and supporting spaces arranged in a linear organization with service and administrative spaces, giving the model higher land-use efficiency, especially on small and medium-sized sites (Figure 1).

Figure (1): Ground-floor plan of the A18 model. Source: School Buildings Division, Al-Karkh First Directorate of Education [18].

The main facade presents a unified institutional language based on a prominent front mass, wide glazed openings and colored vertical elements (Figure 2). In Baghdad’s climate, however, this treatment requires careful control of orientation, shading and glazing type so that wide openings do not become a source of heat gain or glare within educational and administrative spaces.

Figure (2): Main facade of the A18 model within China-Iraq Agreement schools. Source: 964 Media [23].

The aerial view shows that the A18 model is more compact and vertically extended, leaving relatively more external space around the building (Figure 3). This efficiency is balanced by an operational issue in circulation and safety. The model has relatively wider corridors of approximately 2.75 m, which is a positive indicator for horizontal circulation at peak times. However, the stair width, approximately 1.15 m, remains a weakness when student numbers increase. The absence of elevators or ramps also weakens universal access to upper floors and makes the model less suitable for students or users with disabilities or temporary injuries.

Figure (3): Aerial view showing the vertical massing of the A18 model and its relation to the site. Source: PowerChina, “POWERCHINA completes delivery of 93 schools in Baghdad” [24].

Accordingly, the A18 model can be summarized as a land-efficient model that is relatively suitable for limited sites. However, it requires design treatment in three areas: vertical circulation, universal access, and the improvement of the external environment through planting, shading and reduction of exposed hard surfaces.

4.2 Architectural analysis of the B18 model

The B18 model is organized horizontally over two floors with a footprint of approximately 1650 m². The ground-floor plan shows classrooms and service and administrative spaces spread across a wider area, with more extended internal and external spaces (Figure 4). This organization reduces vertical circulation pressure, but increases land occupation and makes the model's success dependent on site capacity.

Figure (4): Ground-floor plan of the B18 model. Source: School Buildings Division, Al-Karkh First Directorate of Education [18].

The aerial view shows that the B18 model is lower and more horizontally spread than A18 (Figure 5). This characteristic is appropriate on large sites because it distributes movement and outdoor activities more calmly. It becomes a weakness on smaller sites, however, because the larger footprint consumes space that could otherwise be allocated to yards, greenery and shaded circulation paths.

Figure (5): Aerial view of the B18 model in Al-Karkh education sector within China-Iraq Agreement schools. Source: PowerChina, "POWERCHINA completes delivery of 93 schools in Baghdad" [24].

The internal yard in B18 appears as a hard, enclosed space surrounded by educational blocks. It can serve as an assembly or alignment area, but it is environmentally weak because of the predominance of hard surfaces and the absence of shade and greenery (Figure 6). The B18 model also provides only 9 student sanitation units compared with 12 in A18, making it more sensitive to high operational density. Therefore, B18 performs better on large sites with moderate densities and becomes weaker where site area is limited or student numbers increase.

Figure (6): Exposed internal yard in the B18 model. Source: 964 Media [23].

4.3 Analytical comparison and implications for assessment

The comparison shows that the difference between A18 and B18 goes beyond the number of classrooms or classroom area. It primarily relates to site coverage as well as circulation organization. A18 stacks functions vertically and maintains relatively more open space around the building, while B18 not only distributes functions horizontally but reduces pressure on vertical circulation. In this way, A18 is more efficient in terms of land use, while B18 provides greater circulation comfort with fewer floors and less vertical circulation.

A18 has wide corridors, but narrow stairs and many floors in terms of circulation and safety. B18 requires more site area, but it occupies more ground area and the corridors are narrower; B18 also provides wider staircases and it is organized over fewer floors. Therefore, neither model can be preferred unconditionally as performance depends on site area, student numbers, and density as well as daily school movement patterns.

Both models require further improvement in schoolyards and outdoor spaces from the perspective of the external environment. The images reveal excessive use of hard surfaces and limited shading and landscape provision. This creates a significant climatic disadvantage in Baghdad where, in a hot climate, the role of the schoolyard should function as an active climatic space and not merely a residual open space. As such, the two models should be supported by a mandatory landscape and shading plan for schoolyards, entrances, movement paths, assembly areas as well as transitional spaces.

Both models lack clearly integrated lift and ramp solutions in their prototype design, from the perspective of universal accessibility. The gap is more evident in A18 because of the presence of a third floor, but B18 also shows the same limitation. Therefore, universal access should be treated as a core design element in the development of the school prototype not as an operational afterthought.

Table (2): Brief analytical comparison between A18 and B18 models.

Indicator	A18	B18	Analytical reading
Number of classrooms	18	18	Design classroom capacity is equal.
Classroom area	49.2 m²	49.2 m²	The difference appears during operation, not in classroom area.
Number of floors	3 floors + roof	2 floors + roof	A18 is more vertical; B18 is more horizontal.
Built footprint	approx. 1000 m²	approx. 1650 m²	A18 is more efficient in land use.
Corridor width	2.75 m	2.20 m	A18 is better for horizontal circulation.
Stair width	1.15 m	1.50 m	B18 is better for vertical circulation.
Student sanitation units	12	9	A18 is better under high density.
Universal access	No elevators/ramps	No elevators/ramps	Common weakness in both models.

5. Results

5.1 Overall sample results

Applying the assessment matrix to the fifteen schools showed that overall performance falls between moderate and weak compliance levels. The highest result was 67.5/100 at Al-Furat Secondary School for Distinguished Students, while the lowest result was 43.8/100 at Al-Wataniya Preparatory School for Girls and Al-Basra Intermediate School for Girls. The sample average was 53.82/100 and the median was 55/100. No school reached good or high compliance levels; eight schools fell within the moderate compliance category and seven within the weak compliance category.

No decisive difference appeared in the final scores between the two models. The average score of A18 schools was approximately 54.11/100, compared with 53.24/100 for B18 schools. This comparison should be read descriptively within the limits of the sample, not as a decisive statistical test between the two models, because the number of schools in each model is unequal and model effects overlap with student numbers, site area and operational conditions. This means that model type alone does not explain the final result; school performance is strongly affected by operational density, yard area, greenery, shade and the condition of services after operation.

Table (3): Assessment results of the fifteen schools using the assessment matrix.

No.	School	Model	Students	m²/student in classroom	m²/student in yard	Students/sanitation unit	Score /100	Compliance
1	Al-Furat	A18	300	2.95	4.67	25.0	67.5	Moderate
2	Al-Dhad	B18	300	2.95	2.67	33.3	62.5	Moderate
3	Al-Izdihar	A18	376	2.36	1.06	31.3	60.0	Moderate
4	Aali Al-Furat	A18	384	2.31	0.91	32.0	56.2	Moderate
5	Haifa	A18	611	1.45	2.29	50.9	56.2	Moderate
6	Umm Al-Banin	A18	521	1.70	1.44	43.4	56.2	Moderate
7	Dhat Al-Nitaqayn	B18	319	2.78	1.10	35.4	56.2	Moderate
8	Noor Baghdad	A18	700	1.27	2.00	58.3	55.0	Moderate
9	Al-Hussein	B18	391	2.26	0.90	43.4	52.5	Weak
10	Al-Yemen	B18	602	1.47	0.75	66.9	51.2	Weak
11	Al-Ghazaliy	A18	683	1.30	0.88	56.9	50.0	Weak

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12	Hajar	A18	625	1.42	0.96	52.1	50.0	Weak
13	Zaha Hadid	A18	723	1.22	0.90	60.2	46.2	Weak
14	Al-Wataniya	A18	812	1.09	0.80	67.7	43.8	Weak
15	Al-Basra	B18	932	0.95	1.39	103.6	43.8	Weak

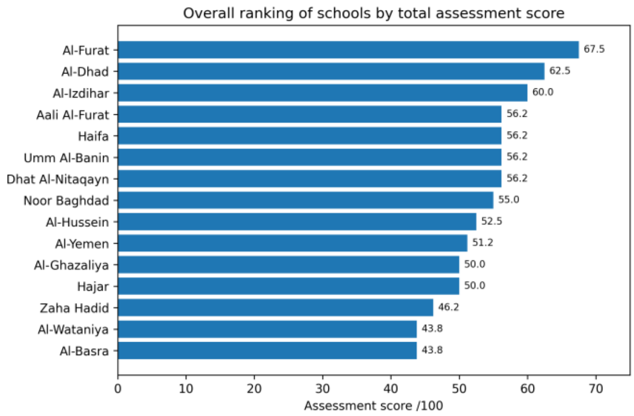

Figure (7): Overall ranking of schools by total assessment score. Source: prepared by the researcher based on assessment matrix results.

5.2 Correlation analysis of factors affecting compliance

A descriptive correlation analysis using Pearson correlation was conducted between total school scores and a set of operational and architectural variables extracted from the data table: number of students, classroom area per student, yard area per student, and students per sanitation unit. Given the limited sample size of 15 schools, the correlation coefficient is used here as a descriptive indicator of the direction and strength of relationships, not as a decisive statistical test for generalization beyond the sample.

The correlation coefficients should be read as internal explanatory indicators because some of the studied variables are already components of the total score in the assessment matrix. Therefore, these relationships are not used to prove independent causality, but to clarify the factors that contribute most to lower compliance scores within the sample.

The results show a strong inverse relationship between the number of students and the total score, with a correlation coefficient of approximately -0.85. This indicates that higher operational density is associated with a clear decline in the quality of the educational environment as measured by the matrix. A strong positive relationship also appeared between classroom area per student and total score, with a coefficient of approximately +0.84. Yard area per student showed a moderate-to-strong positive relationship with the total score, with a coefficient of approximately +0.72. Students per sanitation unit recorded a strong inverse relationship with the total score, with a coefficient of approximately -0.83.

Thus, the correlation analysis shows that gaps in the sample schools are not related to the design model alone, but to the interaction between the fixed model, actual operational density, yard area and sanitation adequacy. The same model may perform acceptably with a low number of students, but its performance declines clearly when it operates beyond its design capacity.

Table (4): Pearson correlations between operational variables and total score.

Variable	Correlation coefficient	Direction	Analytical meaning
Number of students	-0.85	Strong inverse	As student numbers rise, the compliance score declines.
Classroom area per student	+0.84	Strong positive	Increasing each student's classroom share improves educational environmental quality.
Yard area per student	+0.72	Moderate to strong positive	The yard is influential, but requires shade, greenery and organization.
Students per sanitation unit	-0.83	Strong inverse	Sanitation pressure reduces the quality of the health and learning environment.

5.3 Most recurrent gaps

The most recurrent gap in the sample is weak greenery and weak treatment of shade and the heat-island effect. Most yards appear as hard-surfaced or limited-greenery spaces, which is unsuitable for Baghdad's hot-arid climate. In such conditions, an exposed yard becomes ineffective for much of the school day. From a child-friendly school perspective, the yard should not be merely an empty area; it should be safe, shaded, playable and suitable for outdoor learning [1].

The second gap is pressure on sanitation facilities in high-density schools. Some schools reached more than 60 students per sanitation unit, and Al-Basra Intermediate School for Girls exceeded 100 students per unit. This does not align with the WASH logic, which treats water, sanitation and handwashing as requirements for daily school health and dignity rather than as secondary service annexes [2].

Finally, the third gap is in classroom area per pupil as student density increases. Providing only 49.2 m² of classroom space gives 2.95 m² per pupil in a school with 300 pupils, and only about 1.00 m² per pupil — dropping to 0.95 m² per pupil in a 932-pupil school. It demonstrates that the issue is not the plan layout itself: it is certainly in closing the gap between the designed capacity and actual operational capacity.

The fourth gap is universal accessibility. The absence of elevators and ramps in both models, particularly the three-storey A18 model, is a clear design limitation which limits full accessibility of school spaces for all users. This shortcoming cannot be resolved purely operationally, as it is an inherent design limitation within the model itself.

6. *Discussion*

The results also indicate that, within the limits of the sample, China-Iraq Agreement schools may provide an important quantitative response to the shortage of school buildings but do not yet necessarily represent integrated learning environments according to contemporary standards. The school should be assessed as an integrated spatial and functional system, not merely by the number of classrooms it has — classrooms, schoolyards, sanitary facilities, circulation, greenery, shading and indoor comfort. This is consistent with the international literature that educational quality includes safe and healthy physical environments, as well as classroom teaching[3]. The key finding is that gaps can be categorized as either fixed design gaps, or site-related and operational gaps. Fixed design gaps include the absence of elevators and ramps, number of sanitary units, stair width, and building footprint. Site-related and operational gaps include the actual schoolyard area, student numbers, green areas, roof gardens, building position and relationship with the street. This distinction is required to justify the direction of intervention: design gaps require prototype adjustment, whereas site-related gaps require better criteria for site selection, implementation and operation.

Repetition of the school prototype, however, is shown not to be inherently problematic; instead, it becomes a problem only when repeated without mechanisms for contextual adaptation and adjustment of the prototype to specific sites and densities. A repeated prototype should be flexible in schoolyard configuration, orientation, sanitation strategy, shading and productive greenery locations and entry points instead of identical copies across contexts. This conclusion is important for the Iraqi school context that rapid construction models should not be adopted without qualitative post-occupancy evaluation in response to the shortage of school buildings.

Architecturally, classroom area in the two models appears close to the minimum under moderate operation, but it is lower than BB103, which indicates 55-62 m² for 30 students [4]. Improving school quality therefore requires not only increasing classroom area, but also controlling student numbers, adding supporting learning spaces and improving the external environment so that the building does not become a block of classrooms isolated from children's daily needs.

7. Conclusions

1. Within the limits of the sample studied in Al-Karkh First Directorate of Education, China-Iraq Agreement schools provided an important quantitative response by supplying new school buildings. However, they did not achieve the same level of integrated learning-environment quality; overall sample performance remained between moderate and weak compliance, and no school reached good or high compliance levels.

2. The assessment matrix results show that school quality is not determined by the design model alone. It is affected by the interaction of several operational and site-related factors, especially student numbers, available yard area, sanitation adequacy, greenery and shade. Therefore, the school model cannot be judged by the plan alone; it must be connected to actual operating conditions.

3. The A18 model showed relatively higher land-use efficiency because of its smaller footprint and vertical organization, making it more suitable for small and medium-sized sites. However, this advantage is counterbalanced by clear challenges in vertical circulation and universal access, especially due to the number of floors, narrower stairs and absence of elevators or ramps.

4. The B18 model showed a relative advantage in reducing vertical circulation pressure because it has two floors and wider stairs. However, it consumes more land due to its larger footprint. Its performance is therefore better on large sites, whereas its efficiency declines on limited sites that need more space for yards, greenery and outdoor circulation paths.

5. Operational density is one of the most influential factors in the decline of educational environmental quality. Higher student numbers reduce each student's share of classroom and yard area and increase pressure on sanitation facilities and daily circulation. This shows that the design capacity of the model is insufficient unless actual operational capacity is controlled.

6. The WASH axis is a significant weakness in high-density schools. An increase in students per sanitation unit reduces the quality of the health and learning environment. This indicates the need to link the number of sanitation units to actual student numbers, not merely to the design number of classrooms.

7. Yards and outdoor spaces showed a recurring environmental weakness, represented by hard surfaces, limited greenery and shade, and weak heat-island treatment. In Baghdad's hot climate, the schoolyard does not perform its function simply by existing as an open area; it must become a usable educational and climatic space.

8. The study shows that repeating the school model is not a problem by itself. It becomes ineffective when applied without adaptation to site area, orientation, student density and local climate requirements. The A18 and B18 models should therefore be treated as adjustable systems rather than

fixed prototypes suitable for all sites in the same form.

9. The findings confirm the need for a post-occupancy evaluation mechanism for implemented schools. Such evaluation should not be limited to the number of schools and classrooms delivered, but should include classroom quality, yards, circulation, sanitation, greenery, shade and environmental comfort. The proposed assessment matrix can provide an initial basis for development and application to wider samples in future studies.

8. Recommendations

1. A18 and B18 should be treated as adjustable models, not as fixed design solutions applied identically to all sites. Each model should be adapted according to land area, orientation, expected student numbers and local climatic conditions.

2. Clear operational limits should be adopted for the number of students in each school and classroom. School operation should be linked to actual design capacity, because exceeding operational capacity reduces student share of classroom and yard area and increases pressure on circulation and sanitation services.

3. The A18 model should be developed by addressing vertical circulation and universal access, especially through adding ramps, elevators or alternative design solutions, and by reconsidering stair widths and evacuation routes in high-density schools.

4. The B18 model should be developed by controlling site-selection conditions. Because of its larger footprint, it is more suitable for large plots. It should not be applied to small sites unless sufficient space is available for yards, greenery and external circulation paths.

5. The number of sanitation units should be increased, or additional sanitation blocks should be added, in high-density schools. The number of units must be linked to actual student numbers rather than only to the design number of classrooms, in order to ensure an adequate health environment and reduce daily use pressure.

6. Implemented schools should be required to include an integrated planting and shading plan covering yards, entrances, assembly areas, circulation paths and waiting areas. In Baghdad’s climate, the yard cannot perform its educational and social functions if it remains a hard exposed space.

7. Exposed hard surfaces inside yards should be reduced and partly replaced with lower heat-absorbing materials, green areas, shading structures and shade trees. This would help reduce heat-island effects and improve the usability of outdoor spaces during the school day.

8. Each school should undergo post-occupancy evaluation one year after operation. This evaluation should include classroom density, yard adequacy, sanitation pressure, circulation quality, greenery, shade and environmental comfort, instead of relying only on assessment at the construction handover stage.

9. A renewed Iraqi guide for standard school design should be developed. It should integrate local requirements with international standards related to learning environments, school sanitation, safety, universal access and environmental comfort, and should become a binding reference for designing new schools or modifying existing models.

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Appendix: Detailed Tables

The detailed tables are included here to preserve the readability of the main text.

Appendix Table (1): Detailed assessment matrix used to evaluate sample schools and sources of sub-indicators.

Axis	No.	Sub-indicator	Measurement method	Reference standard / evidence type
Site and space	1	Adequacy of site area relative to student numbers	Total site area ÷ number of students, with a reading of the site's ability to accommodate classrooms, yard and services	BB103 [4]; Kazem and Al-Kazzaz [5]; site and student data
Site and space	2	Built-to-open-space ratio	Yard and open-space area ÷ site area × 100, with assessment of open-space effectiveness	BB103 [4]; UNICEF CFS [1], [6]; site plan and yard area [18], [19]
Classroom density	3	Classroom area per student	Classroom area 49.2 m² ÷ average students per class	BB103 [4]; classroom area and student numbers [18], [19]
Classroom density	4	Students per classroom	Total number of students ÷ 18 classrooms	BB103 [4]; student and classroom data [18], [19]
Learning and circulation	5	Availability of supporting learning spaces	Identification of laboratories and supporting educational and administrative spaces in plans	BB103 [4]; UNICEF CFS [1], [6]; architectural plans [18]
Learning and circulation	6	Corridor width and circulation ease	Measurement of corridor width and comparison with peak and two-way movement	INEE [3]; architectural plans [18]
Learning and circulation	7	Stairs, exits and evacuation routes	Width and number of stairs, clarity of exits and escape routes	INEE [3]; school safety principles; plan [18]
Health and inclusion	8	Adequacy of toilets	Number of students ÷ number of sanitation units	WHO/UNICEF WASH [2]; student and sanitation data [19]
Health and inclusion	9	Gender separation and inclusion	Presence of separate facilities for students and staff and their suitability for inclusion and access	WHO/UNICEF WASH [2]; UNICEF CFS [1], [6]; plan and observation [18]
Health and inclusion	10	Drinking-water points	Availability of nearby, safe and continuous water points based on data or observation	WHO/UNICEF WASH [2]; visit/administrative statement [19]
Health and inclusion	11	Handwashing and maintenance	Presence of sinks, soap, operational status and maintenance of facilities	WHO/UNICEF WASH [2]; field observation
Yards and safety	12	Schoolyard adequacy	Yard area per student and its capacity for assembly, play and dispersal	BB103 [4]; UNICEF CFS [1], [6]; yard area and student numbers [19]
Yards and safety	13	Diversity of outdoor spaces	Presence of hard yards, play areas, seating, shade and outdoor learning	UNICEF CFS [1], [6]; BB103 [4]; site plan/photos [18]
Yards and safety	14	Separation of activities from risks	Separation of play and movement from vehicles, services, generators and storage	INEE [3]; UNICEF CFS [1], [6]; site plan/observation
Greenery and climate	15	Greenery and planting	Greenery proportion and its functional effect on shade and outdoor comfort	UNICEF CFS [1], [6]; LEED Sustainable Sites [20]; photos/observation
Greenery and climate	16	Outdoor shade	Availability of shade in yards, entrances, circulation paths and waiting areas	UNICEF CFS [1], [6]; LEED Heat Island Reduction [20]; solar/photos analysis
Greenery and climate	17	Heat-island mitigation and surface treatment	Hard paving ratio and presence of light/permeable surfaces, canopies and trees	LEED Heat Island Reduction [20]; BB103 [4]; flooring type/photos
Indoor environment	18	Ventilation and air quality	Preliminary architectural reading of openings and air renewal potential; later field measurement required	BB101 [21]; architectural observation
Indoor environment	19	Daylight and glare control	Preliminary architectural reading of openings, orientation and glare; later measurement required	BB103 [4]; EN 17037 as supporting reference; observation
Indoor environment	20	Acoustics and noise control	Preliminary reading of classrooms in relation to street noise, echo and sound interference; requires reverberation/noise measurement	BB93 [22]; architectural observation

Appendix Table (2): Detailed school assessment by matrix indicators (each indicator scored from 0 to 4)

Axis	**Sub-indicator**	**Al-Hussein**	**Dhat Al-Nitaqayn**	**Al-Izdihar**	**Um Al-Banin**	**Zaha Hadid**	**Al-Basra**	**Haifa**	**Aali Al-Furat**	**Al-Yemen**	**Hajar**	**Al-Ghazaliya**	**Al-Furat**	**Noor Baghdad**	**Al-Wataniya**	**Al-Dhad**
Site and space	Site adequacy/student number	0	1	1	1	0	0	2	0	0	0	0	3	2	0	2
Site and space	Built/open-space ratio	0	1	1	1	0	1	2	0	0	0	0	3	2	0	2
Classroom density	m²/student in classroom	4	4	4	3	2	0	3	4	3	3	2	4	2	1	4
Classroom density	Students per classroom	4	4	4	4	1	0	3	4	3	3	2	4	2	0	4
Learning and circulation	Supporting learning spaces	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Learning and circulation	Corridor width and movement	3	3	4	4	4	3	4	4	3	4	4	4	4	4	3
Learning and circulation	Stairs and exits	4	4	3	3	3	4	3	3	4	3	3	3	3	3	4
Health and inclusion	Toilet adequacy	2	2	4	2	1	0	1	4	2	1	3	4	1	1	3
Health and inclusion	Gender separation and inclusion	2	2	3	3	3	3	2	3	3	3	3	3	3	3	3
Health and inclusion	Water points	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Health and inclusion	Handwashing and maintenance	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Yards and safety	Schoolyard adequacy	0	1	1	1	0	1	2	0	0	0	0	3	2	0	2
Yards and safety	Outdoor-space diversity	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Yards and safety	Activity-risk separation	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Greenery and climate	Greenery and planting	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greenery and climate	Outdoor shade	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Greenery and climate	Heat island / surfaces	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Indoor environment	Ventilation and air quality	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Indoor environment	Daylight / glare	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Indoor environment	Acoustics and noise	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Total score	Total /80	42	45	48	45	37	35	45	45	41	40	40	54	44	35	50
Total score	Percentage %	52.5	56.2	60.0	56.2	46.2	43.8	56.2	56.2	51.2	50.0	50.0	67.5	55.0	43.8	62.5
Total score	Classification	Weak	Moderate / with gaps	Moderate / with gaps	Moderate / with gaps	Weak	Weak	Moderate / with gaps	Moderate / with gaps	Weak	Weak	Weak	Moderate / with gaps	Moderate / with gaps	Weak	Moderate / with gaps