Urban Plaza as a School for Children: A Decision Support Tool for the Design of Children Inclusive Urban Plaza

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Analytical Hierarchy Process (AHP), children growth, education, public art, urban plaza.

Abstract
Urban plazas provide opportunities for children to play, learn and explore. In particular, public art in urban plazas can be a medium to absorb more children. This research has developed the Inclusive Urban Plaza Design (IUPD) assessment tool, which complies with the principles and features of urban plaza design based on the children's preferences, needs, wishes, and perceptions for their healthy growth. The AHP (Analytical Hierarchy Process) decision-making method was applied to measure the weights of the feature. AHP analysis determined that motor skills ($W_{C1.1} = 0.127$) have the highest impact on children's growth among all sub-criteria, followed by space shape and size ($W_{C2.1} = 0.100$) and cognitive development ($W_{C1.6} = 0.097$). The IUPD toolkit was implemented in Vivacity plaza in Singapore to be validated. The implementation analysis showed that Vivacity plaza was a ‘gold’ grade. It is a well-designed urban plaza that supports children's growth through interaction with various shapes, colors, textures, and materials (like sand and water) that children love. However, it needs minor improvements in terms of inventiveness and creativity ($WSM_{C1.4} = 0.65$), cognitive development ($WSM_{C1.4} = 0.57$), and time and program schedule ($WSM_{C2.7} = 0.65$). The IUPD toolkit showed to be a universal tool that can evaluate the performance of urban plazas in children's growth.

Introduction

Behaviour is a very complex issue that has different meanings for different people. Behaviour is about arguing, distracting others, or talking with others. Riddall-Leech [1] states that children’s behaviour is much about how children act in a social situation (such as saying thank you). Overall, behaviour is about everything that children say and do; meanwhile, it may impact behaviour of other children [2]. Waddell et al. [3] explain that children’s behaviour reflects their level of development and growth. Children must be shaped in the correct behaviour to make their development process smooth and accurate. Behaviourism views children as going along with the flow of their natural development [1]. Development occurs continuously, and children develop and change their behaviour according to their external environment. This theory expresses that kids can unlearn old behaviours and learn new ones if rewarded [3]. Thus, ensuring that children go through the right environment allows them to shape children with good behaviour, automatically shaping proper development and skills [4]. Most of the behaviours children display at each age and stage in their development process are entirely reasonable, while every child is unique, and they all develop at their own pace. Children go through distinct periods of development as they move from infants to young adults, and multiple brain development changes occur during each stage. The ‘ages and stages’ is used to broadly outline critical periods in the human development timeline [5]. Growth and development occur in the primary developmental domains during each stage, including physical, intellectual, language, social, and emotional [6]. However, nowadays, children have a bad lifestyle as most are obsessed with gadgets [7]. Children tend to stay indoors and live with technology, which may
influence their health, creativity, and other skills. Habibe Acar states that most children nowadays lack exposure and interaction with the outdoor environment. One of the reasons for this issue is the decrement in green spaces for children to play and enjoy [8]. Green spaces decreased due to the rapid development of our urban areas.

The urban plaza has become a place for leisure for people or families [9]. According to Remesär [9], 90% of the usage of the urban plaza is sitting, standing, walking, and combining it with reading, watching, eating, and listening. However, urban plaza nowadays becomes a place for families and children to learn and enjoy leisure. The urban plaza can play a vital role as an open space for people, especially children, with a great outdoor environment to play, learn and explore [2], [10]. It is a public space at the intersection of essential streets set aside for civic purposes and commercial activities [11], [12] and is surrounded by landscape components and green elements [9]. Public art is one of the landscape components of the urban plazas, which can display the art outside of the museum or gallery for the public, especially children [13], [14]. Public art allows artists or landscape architects to deliver their creative artworks in a public realm.

The urban open space of urban plazas is often used for public arts [12]. Public art may include a variety of artworks (including sculptures, murals, statues, or cultural events), but the main goal is to be accessible to the public [10]. Jutras and Lepage [15] state that public art can bind social, cultural, political, historical, and economic considerations. The public art decorates town plazas, shopping malls, and public buildings’ lobbies, providing physical comfort and gathering places for socializing elders and youths [16]. Public art encompasses functional objects in the landscape and expressive and decorative forms, either permanent or temporary, belonging to any established classic or contemporary artistic disciplines [17]. Besides, public art promotes or establishes identity in a space or a place. In particular, an urban plaza with public art attracts attention and interest of people, especially children, sometimes working as a playground or play area [18] where children love to explore, look and touch everything that interests them [19]. Hence, public art is hidden in urban areas, allows promoting new ways of education and exploring by children [20]. By understanding the children’s needs in public spaces, we can design urban plazas more effectively to meet these needs. Designing an urban plaza with public arts for children will benefit children in creativity, learning, and growing. Percy-Smith and Carney [21] state that art not only teaches children how to be creative but can also come with other benefits, such as learning math, reading, cognitive ability, critical thinking, verbal skill, and motor skills. Such an urban plaza can encourage children to explore their outdoor space [10]. To sum up, the deficiencies in designing an inclusive urban plaza are as follows:

- The urban plaza design has less attraction to children, while more urban open spaces are being built nowadays.
- Public art implemented in urban plazas does not sufficiently consider the children’s needs.
- Lack of outdoor exposure among children is important for a child’s development and growth.

Hence, it is important to study how public art in urban plazas can attract children to learn and play. For landscape architects and urban designers, this is a challenge to create an urban plaza with public art which can attract children and promote exploration and education. The current research aims to develop a tool for designing the inclusive urban plaza particularly for children – the inclusive urban plaza design (IUPD) assessment tool. The IUPD toolkit can comply with the principles and features of urban plaza design based on the children’s preferences, needs, wishes, and perceptions. Furthermore, the IUPD toolkit analyses the performance and capacities of the inclusive urban plaza in children’s growth and skills development. The IUPD is a performance-based decision-making toolkit that would be the most appropriate choice to assess and quantify the impact of each principle and feature of urban plaza design on children’s growth. The IUPD toolkit has applied AHP (Analytical Hierarchy Process) decision-making method since AHP is a thriving method for assessment and evaluation. AHP has high reliability and validity to support the assessment process and the intensities of urban plaza design. It can obtain an excellent approximation of values through linguistic metrics [22], [23]. Also, AHP is an applicable method for ‘performance-type problems, resource management, corporate policy and strategy, public policy, political strategy, and planning [24].

I. Materials and Methods

A. Public Art Attributes for Designing Children-Oriented Urban Plaza

This section presents a comprehensive list of public arts dimensions and features in urban plazas critical to designing an inclusive urban plaza especially for children. These attributes are grouped into two classes: C1 – public art dimensions for children development; C2 – public arts features for children development. Each class involves several sub-classes (i.e., criteria). In the next section, AHP estimates the weight of each criterion and then transfers them into the IUPD index.

- C1. Public art dimensions for children development:
  - C1.1. Motor skills: Many motions create art, such as holding a paintbrush or scribbling with a crayon. These are the essential murals to grow excellent motor skills in children [25]. According to Sawaki et al. [25], developmental milestones of motor skills include learning shapes and colors.
C1.2. Speech and language development: For children, looking at art or just talking about it provides opportunities to learn words for colours, shapes, and actions. Children can use descriptive words to discuss their creations or what feelings are elicited when they see different styles of artwork [26]. The child can both understand and use language. For example, a 12-month-old baby can learn to say his first words, a two-year-old can name parts of body, or a five-year-old can learn to say feet instead of feed [18].

C1.3. Visual earning: Drawing, sculpting, and threading beads on a string develop visual-spatial skills [27]. Children receive visual information consisting of cues from pictures or three-dimensional objects from digital media, books, and television [26]. Art education teaches students to interpret, criticize, and use visual information and make choices based on it. In addition, knowledge about visual arts, such as graphic symbolism, is crucial in helping kids become smart consumers and navigate a world filled with marketing logos [27].

C1.4. Inventiveness and creativity: When kids are encouraged to express themselves and take risks in creating thinking of art, they develop a sense of innovation that is important in their adult lives [28]. Society needs inventive people who seek new ways and improvements, not people who can only follow directions [29].

C1.5. Improved academic performance: By using public art, children can correlate art and another achievement [6]. Bullick [30] states that young people who regularly participate in the arts (three hours a day on three days each week through one full year) are four times more likely to be recognized for academic achievement, to participate in a math and science fair or to win an award for writing an essay or poem than children who do not participate.

C1.6. Cognitive development: Cognitive ability is to learn and solve problems. It might be understanding their environment with hands or eyes, or learning how to do multiplication or subtraction [10].

C1.7. Social and emotional development: The child’s ability to interact with others, including helping themselves and self-control. For example, learning to smile as a six-week-old baby is a social development milestone. For a 10-year-old boy, a social and emotional milestone might be leading and organizing a game with friends [26].

C1.8. Physical development: Physical development is often broken into two distinct sections. Excellent motor skills are the child’s ability to use small muscles. Specifically, their hands and fingers pick up small objects, hold a spoon or use a pencil to draw [5]. Gross motor development is about more important things like crawling, walking, running, and hopping [5].

C2. Public arts features for children development:

C2.1. Space shape and size: Different shapes attract children, especially the shapes that show one character. For these purposes, appropriate species selection is needed depending on the function and usage of the space and the activities that will take place (e.g., size, form, texture) [10].pace can either encourage or discourage children's desired behaviour. Children can play and work in a relaxed setting where there is sufficient space. Space must be available for the program of activities. In such spaces, adults and children should have a minimum conflict of interactions. In short, the space is aesthetically pleasing, planned, and organized, promotes good mental health, and diminishes potential problems.

C2.2. Colors: Right colours easily capture and hold a child's attention for extended periods [31]. Although colour choice is a primary factor in designing any public art, this is especially true when designing public art for children since colours make a big impression on children's young minds [31]. Acar [10] states that the popular colours among children of ages 5–8 are pinkish-purple, red, pink, lilac, and lemon yellow; 9–10 – purple, pink, red, turquoise, reddish-orange, coffee; and 11–12 – green, light blue, red, purple.

C2.3. Sounds: Children love to sing, dance, and create. If musical children can learn an instrument, they can share their love and talent with others [32]. They feel someplace is unique with interactive music played off. They will have an avenue to express themselves, challenge themselves, and ultimately understand the joy of making music. Socially, emotionally and cognitively, music enriches the lives of children.

C2.4. Water: It is a sensory extravaganza as children feel the wetness, hear the splashes and sprinkles, see the bubbles and waves, and maybe even taste a few droplets [33]. It is also a sensational learning experience for children. Acar [10] states that using water in landscape design will attract birds to come and this will also be fun learning.

C2.5. Materials: When materials are in good supply, familiar, and developmentally appropriate, children are encouraged to focus and participate in productive learning experiences.

C2.6. Adult care: Adults committed to nurturing and guiding young children create an atmosphere that fosters trust, security, safety, and comfort. An adult’s verbal and physical communication skills are critical in modeling the behaviour they wish children to learn. When children are in an environment that encourages caring and cooperative relationships,
they learn to relate positively with each other [34], [35].

C2.7. Time and program schedules: Time and program schedules, routines, and transitions serve as a framework in which children gain trust, security, and order. While these can be flexible to some degree, they must provide children with clear guidelines about what they can expect. Meeting children’s needs throughout the day requires balancing active and restful periods, individual and group activities, and child-initiated/adult-initiated content.

B. Analytical Hierarchy Process (AHP)

The research has employed the AHP method for developing the IUPD toolkit. AHP has a series of steps for this purpose. The AHP method can determine each sub-criterion’s weight, it constructs the hierarchical decomposition of the decision-making problem. As can be seen in Fig. 1, the decision model has three layers: layer one is the goal (i.e., developing the IUPD toolkit), layer two is the IUPD toolkit criteria (i.e., public art dimensions and features), and layer three the sub-criteria embedded in layer two (i.e., the list of sub-criteria investigated in phase one of the research). In Fig. 1, all sub-criteria are interconnected to observe the full co-relationship among them while indicating a hierarchical list of sub-criteria playing roles in child skills development (a list of top-influencer to the least-influencer).

In the second step, AHP has performed a series of pairwise comparisons. The experts have been involved in expert input studies to conduct pairwise comparisons. The research has invited \( k \) experts to rate \( n \) sub-criteria; the results from each expert make the direct relation of \( n \times n \) sub-criteria matrix (as \( A_{ij} \), where \( ij \) is the influential level of sub-criterion \( i \) to sub-criterion \( j \)). A questionnaire would collect the experts’ ratings based on AHP nine-point scaling (where ‘one’ indicates equal importance and ‘nine’ indicates super importance). The purposive sampling method was applied in this study to indicate the number of experts who participated in the AHP survey.

Since this is an exploratory research, the purposive sampling method was employed. Therefore, the most knowledgeable multidisciplinary experts in the field and a group of experts representing the entire society were selected [36]. According to the purposive sampling method, a series of in-depth surveys has to be performed with a few experts to get the in-depth information through the most time and cost-efficient survey. Considerable number of experts may produce the same results [37]. Therefore, during the research seven experienced experts with extensive knowledge in urban design, public health, and policy tool development were invited to participate. The experts were asked to rate the following question: ‘When considering plaza design, would you rate developing children’s motor skills (C1.1) more important than developing children’s visual learning skills (C1.3)?’

In the third step, AHP develops the sub-criteria super-matrix using Eq. (1). Let \( C_{ij} \) (\( i = 1, \ldots, n \) and \( j = 1, 2, 3, \ldots, N \)) denote the impact value of each \( j \)-th criterion (i.e., \( C_j \)). It also denotes \( W_j \) as the weight of criterion \( C_j \). Normalized weight is yielded by dividing the sum of sub-criteria entries in each criterion by the sum of all criteria weights.

![Fig. 1. AHP structure for developing the IUPD assessment tool [by authors].](image-url)
in the row (i.e., \( C_{jn} \)) to its column sum, and then sum up the normalized weight of sub-criteria equal to 1.

\[
A_{i}^{\text{AHP}} = \sum_{j=1}^{N} a_{ij} w_{j}, \quad (1)
\]

where \( i = 1, 2, 3, \ldots, M \).

In the last step, AHP normalizes the values of the super-matrix by dividing each entry of the column by the sum of that column (i.e., each entry \( C_{jn} \) of the matrix of normalization) and applying Eqs. (2) and (3). The weight vector ‘\( w \)’ (an \( m \)-dimensional column vector) of each sub-criterion has then been computed by averaging the entries of each row of the normalization matrix in Eq. (3). \( C_{ij} \) denotes the row entry in the \( j \)-th column of the normalized matrix, and \( v_{i} \) denotes the \( i \)-th element of \( v \).

\[
\frac{C_{jn}}{\sum_{i=1}^{m} C_{in}} = \frac{C_{jn}}{\sum_{i=1}^{m} C_{jn}} \quad (2)
\]

\[
W_{j} = \frac{\sum_{i=1}^{m} C_{ij}}{m} \quad (3)
\]

AHP conducts the consistency analysis to check that all comparison ratings are consistent. The consistency is accepted if the consistency ratio (CR) is equal and less than 10%. CR is a normalized value, since it is divided by CI to an arithmetic mean of random matrix consistency indexes (RI) (Eq. (4)).

\[
CR = \frac{CI}{RI} = \frac{(\lambda_{\text{max}} - n) \cdot (n - 1)}{RI}, \quad (4)
\]

where \( \lambda_{\text{max}} \) is maximum eigenvalue and \( n \) is the rating value (1 to 9).

C. Weighted Sum Method (WSM)

The IUPD toolkit should be validated; the research has implemented it in a real case (here, VivoCity in Singapore). To conduct the case study, the weighted sum method (WSM) was used for data collection and data analysis. During WSM close-group discussions were conducted with the invited experts to evaluate the case concerning each criterion. WSM applied the purposive sampling size to indicate the number of survey participants. Accordingly, the research has called the same group of experts who participated in the previous phase (i.e., tool development) to join in this phase. According to Marler and Arora [38], WSM is a trustable method that can convert multi-objective optimization into a single-objective optimization. Such a qualitative-based rating method indicates the weight of each factor interconnected with other factors in a system using Eqs. (4) and (5). The experts were asked to rate the sub-criteria based on 5-point scaling, from ‘one’ meaning weak to ‘five’ – excellent.

\[
WSM(a_{i}) = (\sum_{j=1}^{n} w_{j}) a_{ij} \quad (\text{for } i = 1, 2, 3, \ldots, m), \quad (5)
\]

where \( m \) is the number of sub-criteria rated in the rating exercise; \( w \) is the weight assigned by the expert for the sub-criterion \( j \); \( a \) is the sub-issue of discussion for sub-criterion \( i \).

\[
WSM(a) / WSM(a)_{\text{max}} = \text{Consensus in } \%, \quad (6)
\]

where \( WSM(a)_{\text{max}} \) is the maximum weight that can be assigned for the sub-criterion \( i \).

Consensus is accepted if more than 70% saturation is achieved in the experts’ input for sub-criterion \( i \).

II. Analysis

All features (i.e., criteria and sub-criteria) have been investigated in phase one and imported into the second phase of the AHP’s procedure. During AHP the required steps were conducted to determine each feature’s weight, which will formulate the index of the IUPD toolkit. For conducting and analysing the pairwise comparisons, the research has employed the SCB software. The SCB software is an outsourcing stand-alone AHP analyser software developed by SCB Associates Ltd. After completing all pairwise comparisons, AHP computed the normalized super-matrix. Using Eq. (2), the normalized weight (i.e., impact value) of all sub-criteria were calculated. According to Table 1, motor skills (\( W_{C1.1} = 0.127 \)) have the highest impact on children development in urban plazas among all sub-criteria, which is followed by space shape and size (\( W_{C1.3} = 0.100 \)). Next, cognitive development (\( W_{C1.6} = 0.097 \)) is the most effective factor, which is followed by visual learning (\( W_{C1.5} \)) and physical development (\( W_{C1.8} \)), having equal 0.098 weight. In contrast, time and program schedule (\( W_{C2.2} = 0.018 \)) and adults’ care (\( W_{C2.9} = 0.019 \)) have the lowest impact on children development skills through urban plazas presenting public arts.

Lambda is calculated as 17.23141856. Next, the consistency index \( CI \) has been calculated (\( CI = 0.1593 \)). In Table 1, \( RI = 1.58 \); then, the CR coefficient was calculated: \( CR = 0.10024 \) (<10%). According to Saaty’s [22] suggestion, the ratio was equal and less than 10% (<0.10); thus, the decision-making result was consistent enough. Next, the research has exported the outputs of the normalized matrix to the index of the IUPD toolkit. The IUPD assessment tool is a linear index that sums up all sub-criteria. Therefore, the weight of each sub-criterion has been donated as the consistent value to the corresponding sub-criterion in the index.

\[
\text{IUPD Index} = \text{Index Public Art Design Dimensions} + \text{Index Public Art Features} = \sum (a_{ij} \cdot X) + (b_{ij} \cdot Y), \quad (7)
\]

where

\( a \) – the consistent value imported from the normalized matrix for the criteria of C1 (see Table I);
b – the consistent value imported from the normalized matrix for the criteria of C2 (see Table I);
i – urban plaza with public art design principle criteria (for 1, 2, 3, ..., 8);
j – urban plaza with public art design features criteria (for 1, 2, 3, ..., 7);
X – the weight assigned by the experts in the case study for the criterion X of C1;
Y – the weight assigned by the experts in the case study for the criterion Y of C2.

III. Model Implementation and Results

As the IUPD toolkit needs validation, a site for a case study was selected. VivoCity in Singapore was chosen for this purpose (see Fig. 2). VivoCity is the largest urban shopping mall in Singapore, with a 137,000 m² area surrounded by urban area, and it can be categorized as urban oasis plaza. The mall was known as the family area and was creatively designed as an edible landscape for the community. "VivoCity draws its name from VivoCity,

<table>
<thead>
<tr>
<th>Sub-criteria</th>
<th>C1.1</th>
<th>C1.2</th>
<th>C1.3</th>
<th>C1.4</th>
<th>C1.5</th>
<th>C1.6</th>
<th>C1.7</th>
<th>C1.8</th>
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<tr>
<td>C1.1. Motor skills</td>
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<td>C1.2. Speech and language development</td>
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<td>C1.3. Visual learning</td>
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<td>C1.4. Inventiveness and creativity</td>
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<td>C1.5. Improved academic performance</td>
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<td>C2.7. Time and Program schedule</td>
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TABLE I
Normalized Super-matrix of Criteria Impacting Children Development in Urban Plaza [by authors]
a liveliness of spirit. The mall’s design draws from the qualities of the bay waters adjacent to the site: one must navigate a complex of this scale as the ocean waters flow unbroken among the spaces they occupy. VivoCity’s undulating forms give continuous curvature to the halls, facade, and roof structure, reformulating the typical hard-edged, ‘big box’ mall type” [39]. An event area is located at the center of the VivoCity used as a focal point for several types of activities and a node for the convergence of all internal paths. Its plan is divided into two zones; the first is the arrival corridor linked to a national vehicular roadway on the north edge of the site. The second zone is the destination front along the water to the south. Per local codes limiting the structure height to three levels to prevent sea views from Mt. Faber to the north, the mall was to remain low-rise [39]. An outdoor area is divided into several spaces on every level, including the first floor, second floor, and roof. The first floor has some areas of the urban plaza that create a welcoming mode for the visitor. The second-floor outdoor area is specially designed for children’s outdoor play area surrounded by cafes and retail shops. The rooftop area is an open-air deck shaped by organic forms; these are translated from the walls to the horizontal surfaces and provide topographies of landscaped gardens, observation landings, and a large shallow reflecting pool [39].

The IUPD toolkit was applied in VivoCity (see Table 2). WSM results show that VivoCity has significant strengths in terms of space shape and size (WSM C2.1 = 0.97) and sound and water equality (0.94). In addition, IUPD toolkit computation indicates that the VivoCity urban plaza has received 0.82507 scores.

\[
\begin{align*}
IUPD \text{ Index implementation} &= IUPD \text{ Index Public Art Design Dimensions} + IUPD \text{ Index Public Art Features functional} \\
IUPD \text{ Index Public Art Design Dimensions} &= (0.91 \times 0.127) + (0.85 \times 0.054) + (0.74 \times 0.096) + (0.65 \times 0.048) + (0.82 \times 0.045) + (0.57 \times 0.097) + (0.82 \times 0.052) + (0.85 \times 0.096) = 0.48014 \\
IUPDIndex \text{ Public Art Features functional} &= (0.97 \times 0.100) + (0.88 \times 0.076) + (0.94 \times 0.065) + (0.94 \times 0.036) + (0.85 \times 0.071) + (0.74 \times 0.019) + (0.65 \times 0.018) = 0.34493 \\
IUPD \text{ Index implementation} &= 0.48014 + 0.34493 = 0.82507
\end{align*}
\]

The IUPD toolkit has identified ‘gold’, ‘silver’, and ‘bronze’ grades based on the index score ranges. Grade ‘gold’ has the highest value, calculated as the maximum value, while grade ‘bronze’ has the lowest value. The following presents the IUPD maximum index (Max) calculation. In the IUPD maximum index, the weights of sub-criteria were assumed as 1. Therefore, the IUPD minimum index (Min) equals 0.2 of maximum (Max). Therefore, IUPD indicates

Fig. 2. VivoCity urban plaza in Singapore (divided zone and softscape plan in outdoor rooftop area): a) synchronized fountain in the children area on the second floor [40]; b) wading pool in the sky park of VivoCity [Source: https://sites.google.com]; c) hardscape mount for children as topography [41].
TABLE II
WSM Analysis of IUPD Model Application at VivoCity, Singapore [developed by authors]

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Sub-criteria</th>
<th>Experts Inputs</th>
<th>WSM(a)_{sub-criteria}</th>
<th>Consensus</th>
<th>*AHP weight</th>
<th>**Actual consensus</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1. Public art dimensions for children development</td>
<td>C1.1. Motor skills</td>
<td>Ex1 3 2 1 0 0 0</td>
<td>35</td>
<td>0.91</td>
<td>0.127</td>
<td>0.116</td>
</tr>
<tr>
<td></td>
<td>C1.2. Speech and language development</td>
<td>Ex2 3 2 1 0 0 0</td>
<td>35</td>
<td>0.85</td>
<td>0.054</td>
<td>0.046</td>
</tr>
<tr>
<td></td>
<td>C1.3. Visual learning</td>
<td>Ex3 4 5 3 2 1 0</td>
<td>35</td>
<td>0.74</td>
<td>0.096</td>
<td>0.071</td>
</tr>
<tr>
<td></td>
<td>C1.4. Inventiveness and creativity</td>
<td>Ex4 4 5 3 2 1 0</td>
<td>35</td>
<td>0.65</td>
<td>0.048</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>C1.5. Improved academic performance</td>
<td>Ex5 4 5 3 2 1 0</td>
<td>35</td>
<td>0.82</td>
<td>0.045</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>C1.6. Cognitive development</td>
<td>Ex6 2 3 4 5 0 0</td>
<td>35</td>
<td>0.57</td>
<td>0.097</td>
<td>0.055</td>
</tr>
<tr>
<td></td>
<td>C1.7. Social and emotional development</td>
<td>Ex7 3 4 5 0 0 0</td>
<td>35</td>
<td>0.82</td>
<td>0.052</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>C1.8. Physical development</td>
<td>Ex8 3 4 5 0 0 0</td>
<td>35</td>
<td>0.85</td>
<td>0.096</td>
<td>0.082</td>
</tr>
<tr>
<td>C2. Public arts features for children development</td>
<td>C2.1. Space shape and size</td>
<td>Ex9 4 5 3 2 1 0 0</td>
<td>35</td>
<td>0.97</td>
<td>0.100</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>C2.2. Colours</td>
<td>Ex10 4 5 3 2 1 0 0</td>
<td>35</td>
<td>0.88</td>
<td>0.076</td>
<td>0.067</td>
</tr>
<tr>
<td></td>
<td>C2.3. Sounds</td>
<td>Ex11 4 5 3 2 1 0 0</td>
<td>35</td>
<td>0.94</td>
<td>0.065</td>
<td>0.061</td>
</tr>
<tr>
<td></td>
<td>C2.4. Water</td>
<td>Ex12 4 5 3 2 1 0 0</td>
<td>35</td>
<td>0.94</td>
<td>0.036</td>
<td>0.034</td>
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<tr>
<td></td>
<td>C2.5. Materials</td>
<td>Ex13 5 4 3 2 1 0 0</td>
<td>35</td>
<td>0.85</td>
<td>0.071</td>
<td>0.060</td>
</tr>
<tr>
<td></td>
<td>C2.6. Adults’ care</td>
<td>Ex14 4 4 3 2 1 0 0</td>
<td>35</td>
<td>0.74</td>
<td>0.019</td>
<td>0.014</td>
</tr>
<tr>
<td></td>
<td>C2.7. Time and program schedule</td>
<td>Ex15 2 4 4 3 2 1 0 0</td>
<td>35</td>
<td>0.65</td>
<td>0.018</td>
<td>0.012</td>
</tr>
</tbody>
</table>

Note. Ex – expert
Consensus – the weight calculated based on Eq. (6), saturation more than 70%
** Actual consensus – the sub-criteria final weight calculated by WSM weight multiplied to ANP weight (extracted from Table 1)

that an urban plaza with less than 0.200 scores is non-certified.
IUPD Index_{\text{max}} = 1.000
IUPD Index_{\text{min}} = 1.000 \times 0.2 = 0.200

IUPD index score interpretations indicate that VivoCity has received a ‘gold’ grade; therefore, VivoCity is a well-designed urban plaza for children’s growth.

\[
0.800 \leq \text{s} \leq 1.000: \text{Gold: Well-designed urban plaza treats the children effectively.}
\]

\[
0.500 \leq \text{s} < 0.800: \text{Silver: Well-designed urban plaza treats the children effectively, but minor improvements are needed.}
\]

\[
0.200 \leq \text{s} < 0.500: \text{Bronze: An urban plaza that treats the children, but significant improvements are needed.}
\]

\[
s < 0.200: \text{Not certified: Very poor; non-efficient urban plaza for children.}
\]

IV. Discussion

Urban development has increased hard surfaces, buildings, and high rises while decreasing the soft and green spaces [10]. Hence, children have no choice rather than stay indoors due to the lack of green spaces [42]. Among the urban spaces, urban plazas can potentially provide a healthy living environment for children [43], [44]. Currently, the urban plazas have relevant contextual and functional parallels in the city [43]. The role of an urban plaza is to attract children through a variety of functions and different kinds of activities surrounding it. Francis [45] states that if the urban plaza is located near the commercial or business centre, it must be a place for all users to come and rest in an outdoor space. Similarly, the urban plaza embedded in public arts allows adults and children to enjoy leisure. Therefore, it is not surprising that many kids nowadays use urban plazas as their play areas [45]. On the other hand, public art involves various groups of people. Every public art project is an interactive process involving artists, architects, design professionals, community residents, civic leaders, politicians, approval agencies, funding agencies, and construction teams [12]. Moreover, the materials and methods of public art change to reflect our contemporary culture [46]. Professional expertise and public involvement should seek the most imaginative and productive affinity between the artist and community. Likewise, artists must show integrity, creativity, and skills.

In this context, introducing an urban plaza with public arts suitable for children allows for attracting children to urban spaces and public realms [47]. However, understanding the design requirements appropriate to
the needs of children is essential to make urban plazas function well [10]. Hence, this research has developed the IUPD toolkit to evaluate the quality and performance of urban plazas in growing children’s different skills. By applying AHP, the research indicates the weight (i.e., potential) of the children’s physical, psychological, and social development criteria. It was found that an urban plaza with public art with a suitable space shape and size can significantly grow children’s motor skills, cognitive skills, visual learning, and physical skills. Therefore, the zoning system of the urban plaza must be clear based on its significant functions, characters, facilities, and activities to support children’s skills development. However, it needs to consider every part of the zone in the urban plaza, whether it is for active or passive use [48]. It avoids any confusion among users regarding space utilization, ages, and type of activities. Proper zoning division can increase the possibility of full space utilization for users to recognize easier the spaces they would like to go. Indeed, urban plaza space shape and size impact significantly the development of children’s motor skills. Furthermore, the circulation must cover all sides of the urban plaza. This ensures that children can enjoy all spaces and feel not bored in the urban plaza.

On the other hand, the width of the pathway should be as comprehensive as possible, with a minimum requirement of two meters in width. Furthermore, the pathway should be designed with efficient space, such as a separate circulation system. The complete plaza should be organized in the right way where the circulation should be incorporated into all spaces; hence space should provide a boundary to make children feel like they are entering a children’s world or space. Still, all spaces need to be open for adult observation. Besides, urban plaza design should encourage children to stay longer rather than pass by the place. To create an outdoor space for children, urban plaza should consider a program or activity for children to play. Through this tool, both the success of the urban plaza and children’s outdoor exposure can be achieved. Moreover, educational activities in the urban plaza for children are important and can be organized differently.

To validate the IUPD toolkit, the researchers have implemented it at VivoCity urban plaza in Singapore. As can be seen in Table 2, VivoCity has received 75% saturation for most of the criteria. In particular, VivoCity has a well-designed spatial organization of the entrance area, well-functioning activity area, passive and leisure area, art and culture performance area, and indoor and eating area. Also, the hardscape elements of the Vivacity can admirably attract children by their shape, colours, texture, and materials (like sand or water) that children love. However, some criteria gained less than 75% saturation: inventiveness and creativity (WSM_c14 = 0.65), cognitive development (WSM_c14 = 0.57), and time and program schedule (WSM_c27 = 0.65). In this regard, the experts have expressed the following recommendations and corrective actions to VivoCity urban plaza:

- Provide a child-centred, recollective, and inviting plaza.
- Create spaces with mixed-use for children of different ages, where children love to socialize with different ages, groups, and cultures.
- Creative activity (like drawing mural) can be included with something that children can mold or draw.
- Propose a program or activity that stimulates the five senses.
- Sand is an element for exploration, so raised sandboxes might be installed to promote different skills.
- Propose natural planting that gives a positive emotion and sense of place. However, avoid planting of dangerous, poisonous, thorny, and allergic species.
- Select plants for play, enclosure, identity, movement, climbing, education, accessibility, integrations, landmarks, seasonal change, and climate modification.

Conclusions

Children are the new generation that needs to be given attention to. To develop an outdoor space that attracts children, it is important to know their interests. Children like places where they feel joy and happiness, so incorporating the educational component into a play and joy environment allows reaching various objectives. This is an excellent way to trend good behaviour in early-stage and educate them in the process of social, cognitive, language, and physical development. It is a good way to support informal educational activities. Children can fully use outdoor space if the design reaches their needs.

A decrease in green space nowadays should not be an excuse to limit children learning in an outdoor environment. Urban plazas can work as a solution, which offers a place for leisure and learning outdoors. Notably, public art in urban plazas can solve the issues of the outdoor environment for children nowadays. A well-targeted public art design in the urban plaza promotes the quality of urban space among children and exposes them to a pleasant outdoor environment. Within a plaza where the physical environment and its elements are well planned, the environment also encourages an outdoor learning and so supports children’s development process.

Importance of designing an inclusive urban plaza where children can enjoy public arts has encouraged the development of the IUPD assessment tool. The IUPD assessment tool consists of fifteen design sub-criteria embedded into two criteria: C1 – public art dimensions and C2 – public arts features. By employing the AHP method, the weights of all sub-criteria have been measured. AHP analysis shows that motor skills are the most critical factor in children’s development at urban plazas among all sub-criteria. In addition, space shape and size and
cognitive development are the practical factors. The IUPD tool is a decision support tool that urban designers and landscape planners can apply to measure and quantify the capacities of urban plazas in child skill development. The validation of the IUPD tool at VivoCity urban plaza in Singapore has shown that the VivoCity urban plaza meets the requirements for children's growth considerably. However, the VivoCity should be improved according to certain criteria (such as inventiveness and creativity, cognitive development, and program schedule) to reach the maximum score.

Based on assessment by the IUPD tool, public art in urban plazas proves to be a successful outdoor space for children. The group of experts has finally verified the IUPD tool and confirmed its usability and applicability by urban professionals and consultants. Furthermore, they expressed that it can be used worldwide. In future, the IUPD tool has room for a couple of other data analysis methods (such as SEM – structural equation modelling), GIS (Geographic Information System), SNA (social network analysis), etc.) to increase its power and certainty in assessment practices. Also, the web-based version of the IUPD tool can be developed to make it more accessible for its global users.

REFERENCES
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