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### ARCHITECTURAL DESIGN STRATEGIES OF SENSORY INTEGRATION THROUGH SPACES FOR AUTISTIC CHILDREN

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#### *Abstract*

Autism Spectrum Disorder (ASD) can be identified among children that have difficulties in social interaction and communication, and also have a repetitive and limited behavioural pattern and interests. ASD also can be recognized on as a diverse way of being within the world where tactile encounter, cognitive handling, and discernment, social needs, and interface veer from neurotypical desires. The means in designing for ASD children appears to surround sensory environment issue and the behaviour of the autistic children. Review of literature on autism and design theories by designers in architectural intervention, sensory integration facilities or spaces such as sensory garden and farm, playscape, threshold, sensory gym, etc. considers as a driving factor in design strategies for autism centre which based on the children's sensory quality and their sensory needs. The aim is to identify the design strategy of sensory integration spaces or activities through literature review and case studies. The study was carried out by direct observations, semi-structured interviews, and some research visits. Wide-Range research was accomplished on the adaptation of autism institution design strategies and sensory integration of spaces as the key study. This study is crucial to integrate summarize architectural design strategy with sensory integration through activities and spaces for providing a better environment for autism facilities.

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**Keywords:** Autism, design strategies, sensory integration, architecture facilities.



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## 1. Introduction

Autism Spectrum Disorder (ASD) refers as permanent neurodevelopmental disorder for children that have difficulties in social interaction and communication, and also have a repetitive and limited behavioural pattern and interests. (Nelson et al., 2016). ASD It is a severe disorder that will affect your daily activities in terms of socialization, communication, flexibility in thinking and behaviour (Gopal & Raghavan, 2018).

Between 1994 to 2013, there was five autism spectrum diagnoses in the fourth version of the official Diagnostic Manual (Wolff, 2004) which are Asperger syndrome, Pervasive Developmental Disorder Not Otherwise Specified (PDD-NOS), Autistic Disorder, Childhood Disintegrative Syndrome and Rett Syndrome. Meanwhile in 2013, the fifth version of the Diagnostic Manual later categorized in one "autism spectrum disorder." Everyone with an autism diagnosis, no matter what his or her symptoms, is now lumped under that single diagnosis (Razzaghi, 2014).

ASD covers a large spectrum of skills, symptoms, and range of impairment due to their different way of seeing the world and processing information (Sthapak, 2017). Based on studies, problems that will be faced by the children with ASD are having difficulties in establishing their hearing, communicating and language skills (Ghazali, Md Sakip, & Samsuddin, 2018a). They will express themselves in another way with unexpected behaviours, for example: injuring themselves, being aggressive and had a bad temper that difficult to control them. According to (Fernandes, De La Higuera Amato, Cardoso, Navas, & Molini-Avejonas, 2016), autism is a formative incapacity developmental and many people on the spectrum have difficulty processing everyday sensory information; Sight, Sound, Smell, Taste, and Touch.

According to Saxena and Chahrour, (2017), there are three levels of autism to differentiate which are Mild symptoms, Moderate symptoms and Severe symptoms. Usually, the level of autism is determined by the abilities of social communication and the restricted or repetitive behaviours of individuals with autism (Ghazali, Sakip, & Samsuddin, 2018b). There are two types of senses of autism which are hypersensitive (over-developed) and hyposensitive (under-developed) as shown in Table 1. Both will results in the perception of physical pain, occasionally, stress and anxiety (Scott, 2009).

**Table 01.** Characteristics of Hypo and Hypersensitive

Hyposensitive	Hypersensitive
<ul style="list-style-type: none"> <li>▪ Only hear sounds in one ear, the other ear having partial hearing or even none at all</li> <li>▪ Might enjoy crowded and noisy places</li> <li>▪ Like to bang doors or objects together, or even speak in loud tones to seek the sensation</li> </ul>	<ul style="list-style-type: none"> <li>▪ Be able to hear conversations in the distance</li> <li>▪ Have a inability to cut out sounds such as background noise which leads to difficulties concentrating</li> <li>▪ Sound can become distorted</li> </ul>

A suitable interior and exterior environments that help children with autism can be designed by architects (Leestma, 2015). They can use the space comfortably and appropriately. One of the current design criteria concepts - ASPECTSS has been introduced by research including use of transition spaces between zoning, sensory zoning, and visual clues for enhancing way finding and adoption of escape spaces (Mostafa, 2014).

## 2. Problem Statement

According to a study done by Autism and Development Disabilities Monitoring (ADDM) Network based in United States Centers for Disease Control and Prevention (CDC), in the year of 2014, the occurrence of autism has raised from 1 in 110 in 2006 to about 1 in every 59 (CDC, 2018). Meanwhile, in Malaysia, the Ministry of Health reported that 1 in every 600 children in Malaysia is autistic (MOH) in 2004. The Department of Statistics reports 508,700 births in 2017. If one out of 600 children is autistic, then a total of 848 children were born with autism that year. Using the US calculation, the number of children with autism raises rapidly a total of 8622. In Malaysia, limitations of social understanding lead to social discrimination and isolation. Lacking activity space and facilities and properly built environment with for early autism are showed (Ghazali et al., 2018b). Hence, the enhancement of facilities and properly built environment for early autism are needed to optimize their quality of life and further develop their physical, social, communicate emotional, intellectual, and spiritual health and wellbeing. There are still lacking schools that cater for the children with autism due to many parents whose children are on the ASD are searching for the programs (Abdun-nur, 2015)..

## 3. Research Questions

In order to understand the design element for ASD facilities, a few research questions have been developed.

- What is the relationship between Autism and Architecture in terms of design strategy with sensory integration?
- What are the architectural design strategies with sensory integration through activities or spaces for providing a better environment for autism facilities?

## 4. Purpose of the Study

The aim of this study is to identify architectural design strategy with sensory integration through activities and spaces for providing a better environment for autism facilities in Malaysia. Below are the specific objectives based on the research question arising:

- To understand the behaviour of the autistic individual and design strategies through their sensory sensitivities.
- To integrate summarize architectural design strategies with sensory integration through activities or spaces for providing a better environment for autism facilities.

## 5. Research Methods

Firstly, this paper will describe the definition of autism and understand the behaviour of the autistic individual through sensory sensitivities as a kick start by using exploratory studies. Descriptive studies will be involved after that to define the relationship between design strategy and sensory integration in terms of architecture for the autistic individual. There is a total of two case studies have been chosen for this paper to support the research methodology and data collection. The analytical studies

are carried out through the data collection by using two types of qualitative research methods which are direct observation and semi-structured interviews. The two institutions that selected for the case study is based on the principle of their architecture zoning/spaces which comprising of design strategies and sensory integration. Table 2 shows the spaces of both institutions. Data is gathered in the form of descriptive observational studies and semi-structured interviews from each case study.

**Table 02.** List of zoning/spaces of case studies.

Institution	Outdoor zone/space	Indoor zone/space
Permata Kurnia, Sentul	<ul style="list-style-type: none"> <li>• Stimulating playground</li> <li>• Swimming pool</li> <li>• Sensory Garden</li> </ul>	<ul style="list-style-type: none"> <li>• Sensory Gymnasium</li> <li>• Music Therapy Room</li> <li>• Sensory room</li> </ul>
Lighthouse Academy, Penang	<ul style="list-style-type: none"> <li>• Sensory courtyard</li> <li>• Swimming pool</li> <li>• Sensory Pathway</li> </ul>	<ul style="list-style-type: none"> <li>• Sensory Room with Gym</li> <li>• Music and Performance Hall</li> </ul>

### 5.1. Data Collection from Literature Review

Literature Review provides the definition, characteristics, level, and types of autism. Furthermore, the sensory stimulation towards the individual with autism is discussed. The relationship between autism and built environment and architectural design strategies and criteria which conducted from the previous researches will be discussed. Sensory Integration and design are also discussed.

### 5.2. Data Collection from Case Studies - Permata Kurnia at Sentul

Permata Kurnia is one of the biggest autisms centres in Malaysia that providing early intervention services and preschool education to children with autism as well as support services to families and communities. In December 2015, Permata Kurnia began its operations in Sentul, Kuala Lumpur and total have a 2.4 acre of land area for the centre. Permata Kurnia is a state-of-the-art facility and a convenient environment for both children with autism and their families. Permata Kurnia provides comprehensive and structured autism services in line with the needs and values of Malaysia. This integrated approach is essential in helping children with autism lead fulfilling lives like their peers. The aim of Permata Kurnia initiation is to promote and create awareness of ASD. Permata Kurnia currently has approximately 400 students, 60 teachers and therapists, and 30 assistant staffs. Basically, al the range of ages of the children in Permata Kurnia was from two until six years old. Figure 1 and 2 shows the existing condition of outdoor area and indoor spaces in Permata Kurnia.



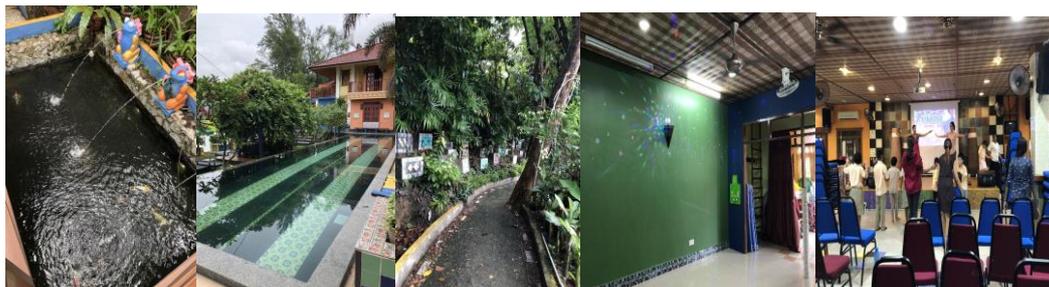
**Figure 01.** Outdoor area: Playground, Pool, Sensory Garden and Mini Petting Zoo



**Figure 02.** Indoor spaces: Sensory Gym, Music Room and Sensory Room

### 5.3. Observation Studies from Case Study 2 – Lighthouse Academy at Penang

Lighthouse Academy is a learning centre for kids of preschool, primary and secondary mainstream, A-levels and with special needs, learning disabilities and from underprivileged families. The centre now has a total of 120 students, aged between three until twenty-one years old while there are 40 students are from special education. Figure 3 shows the main area/spaces in Lighthouse Academy, Penang.



**Figure 03.** Courtyard, Pool, Sensory Pathway, Sensory Room with Gym, Music and Performance Hall.

### 5.4. Data Collection from Semi-Structured Interviews

A semi-structured interview is conducted with the professional teacher, interventionist, head of special education and head of principle to gauge their knowledge and familiarity in the field of autism, architecture design strategies and sensory integration. Table 3 below indicates the semi-structured interview questions to the respective respondents.

**Table 03.** Semi-structured Interview Questions

<b>Question 1:</b> In your opinion, what are the architect's spaces that can help children with autism spectrum for the institution?
<b>Question 2:</b> Other than classroom for academy education, what are the important sensory friendly spaces that are lacking for children with autism spectrum disorder?
<b>Question 3:</b> How to design ASD-friendly playground for kids with Autism Spectrum Disorder?
<b>Question 4:</b> Base on your experience, how swimming therapy can help children with autism?
<b>Question 5:</b> What's about creating an ASD-friendly sensory garden for children and what to include it?
<b>Question 6:</b> How sensory gymnasium helps kids on the autism spectrum?
<b>Question 7:</b> In your opinion, how does music therapy help autism?
<b>Question 8:</b> What are the design strategies of sensory room and what to include it for kids with autism?

## 6. Findings

### 6.1. Sensory Integration Design

According to Ghazali, Sensory Integration Difficulty or Sensory Processing Disorder means that the environment provides a large impact on a pupil with sensory sensitivity (Ghazali et al., 2018a). It is important to consider the needs of children with neurological disorders when designing children’s spaces and environment (Paron-Wildes, 2005). The sensory design is design for living including five senses which are how space sounds, feels, looks, functions, and smell. All these senses will affect each other as well which possibly overwhelming on their life (Fernandes et al., 2016). A few spaces and environment such as Sensory Gym, Sensory Garden, Playground, Sensory Room, etc. have been studied that can help the autistic children improve their sensory functions and avoid sensory overstimulated (Gopal & Raghavan, 2018). Table 4 summarizes the sensory integration design spaces and facilities.

**Table 04.** Sensory Integration Design Spaces and Facilities

<b>Architecture Spaces</b>
<p><b>Sensory Gym</b>                      The benefit of the sensory gym is to build their gross motor play and coordination. Meanwhile, it helps the children to improve their sensory functions reduce sensory over-stimulated concurrently due to the specially designed and unique equipment in the sensory gym (Ismael, Lawson, &amp; Hartwell, 2018). Gross motor play is the primary sensory input for children with autism when occupying the sensory gym (Walker, 2015).</p>
<p><b>Sensory Garden</b>                      A sensory garden is a safe and simulation environment that allows children to explore their senses without feeling overload from them (Lipscomb, Bd+c, &amp; Stewart, 2014). For the visual part, the colour usually came from stones, gravel, plants, and bricks. Hence, colour balancing is important and need to take care when too many types and sharp colours have been introducing into this space (Hussein, 2012).</p>
<p><b>Playground</b>                      The playground is the spaces that allow children with autism to socialize and integrated easily with other children. It can overcome and support the children with the sensory issue in social and communication skills. Chimes and drums can be introduced in the playground and let the children have opportunities to play music and generate different kinds of rhythms and sounds Sachs, Vincenta, May, Vincenta, &amp; Sachs, 2010). For the touch senses, different kind of objects, shapes, surfaces, and pressures can be developed and manipulate through water tables, sandpit or even climbing the structure. Lastly, a quiet, calm or resting areas shouldn’t be missed out which children can gather, regroup or overstimulated (Walker, 2015). This is to avoid children won’t completely leave the playground when they need to rest.</p>
<p><b>Sensory Room</b>                      A sensory room is a unique room that developed for the individuals with autism that have sensory difficulties such as sight, hearing, touch, smell and sound. This place where can let the children feel safe, relax and relieve stress, but also able to stimulate and develop their sensory skills who have sensory integration disorder (Atari, 2014). Soft carpets or other materials can be introduced in the sensory room for the floor finishes to avoid any injured possibilities and have an acoustic effect for the room (N Young &amp; Furgal, 2016). This can help them to focus more and generate their creativity.</p>

### 6.2. Observation Studies from Case Study 1 – Permata Kurnia at Sentul

Table 5 summarize the observation during case study to Permata Kurnia in Sentul based on outdoor zone/space. Meanwhile, Table 6 summarized the architecture spaces with sensory integration of Permata Kurnia.

**Table 05.** Summary of observation for Case Study 1

Outdoor zone/space	Stimulating Playground	A covered play structure that allows children to do several activities such as climbing, sliding, crawling and running. All the equipment has been placed on a rubber surface floor finishes, this is to prevent any injuries when children accidentally fall down.
	Swimming Pool	The pool comes with two different depths which is 1.2 metres and 0.6 metres deep. All the children are having a swimming class twice per week. Total seven children will be lead and guided by three swimming instructors in every each lesson.
	Sensory Garden	The sandpit area that can help the children with autism practising their motor skills. Next is the water play area that allows children to enhance eye-hand coordination and social interaction skills. They also offered children to have interaction with animals through mini petting zoo.
Indoor zone/space	Sensory Gymnasium	Total has two sensory gyms which located at ground and first floor. They provide lots of sensory equipment for the children. All the rooms are using visual cues with the colour plane on the floor.
	Music Therapy Room	The whole room surrounded with acoustic materials for the wall finishes and tinted window to avoid direct distraction or noise from outside.
	Sensory Room	An individual sensory room was provided which let the children calm down when they are sensory overload or overwhelmed. The whole room surrounded by the soft carpet on the floor and wall finishes, is to prevent children from injuring themselves by knocking to the wall.

**Table 06.** Summary of Permata Kurnia Architecture Spaces with Sensory Integration

Architecture Spaces	Sight	Taste	Auditory	Smell	Touch
Stimulating Playground	Brightly colour playground and gym equipment, landscape	-	Sound of equipment	Natural plants and flowers	The texture of playground equipment, floor finishes, gym equipment
Swimming pool	Pastel blue colour of tiles finishes	Water	Sound of water and outdoor landscape	Smell from water, flowers and plants surrounding the pool	Texture of water and material finishes
Sensory Garden	Colours from flowers, plants, animals, sand and water	-	Sound of water, sound from animals	Smell from water, sand, animals, flowers and plants	Texture from sand, water and floor finishes, tactile experience with animals
Sensory Gymnasium	Colours of equipment, lighting, wall and floor finishes	-	Sound of gym equipment	-	Tactile wall with texture equipment, soft materials finishes
Music Therapy Room	Colours of music instruments, furniture, lighting, wall, floor finishes	-	Sound of music instruments, acoustic room	-	Acoustic wall with texture, music instruments, soft materials finishes
Sensory Room	Pastel muted colour of wall ad flooring, fluorescent lighting	-	Acoustic room, sound from play equipment and trampoline	-	Tactile wall with texture, soft carpeted, play equipment

### 6.3. Observation Studies from Case Study 2 – Lighthouse Academy at Penang

Table 7 summarize the observation during case study to Lighthouse Academy in Penang based on outdoor zone/space. Meanwhile, Table 8 summarized the architecture spaces with sensory integration of Lighthouse Academy.

**Table 07.** Summary of observation for Case Study 2

Outdoor zone/space	Sensory Courtyard	Fish feeding session at the mini pond and a sensory courtyard with turf and pathway that currently sharing the facilities with the resort.
	Swimming Pool	A long linear swimming pool provided for the children. According to the interview, they mentioned children will have 2 swimming session per week.
	Sensory Pathway	Sensory pathway with several texture hardscape and trees to explore
Indoor zone/space	Sensory Room with Gymnasium	Their sensory room is combined with gymnasium as well due to space limitation.
	Music and Performance Hall	Having sung and dancing session together at the performance hall.

**Table 08.** Summary of Lighthouse Academy Architecture Spaces with Sensory Integration

Architecture Spaces	Sight	Taste	Auditory	Smell	Touch
Sensory Courtyard	Colours and pattern of floor finishes, views from sea, landscape and animals	-	Sound from the sea and fish pond	Natural plants and flowers, smell from sea	The texture of floor finishes, hardscape, plants and timber furniture
Swimming pool	Pastel green colour of tiles finishes	Water	Sound of water and outdoor landscape	Smell from landscape	Texture of water and material finishes
Sensory Pathway	Colours from flowers, plants, and hardscape	-	Sound from trees	Smell from flowers and plants	Texture from floor finishes, plants
Sensory Room with Gymnasium	Colours of equipment, movable LED lighting, wall and floor finishes	-	Sound of gym equipment	-	Tactile wall with texture equipment, soft materials finishes
Music with Performance Hall	Colours of music instruments, furniture, lighting, wall, floor finishes	-	Sound of music instruments	-	Music instruments

### 6.4. Data Collection from Semi-Structured Interviews

Based on the semi-structured interview conducted with the professional teacher, interventionist, head of special education and head of principle from respective autism centre, Table 9 summarized the outcomes.

**Table 09.** Overall Analysis from Interviews

<p><b>Question 1</b>                  Indoor spaces such as academy education, music room, sensory room, a sensory gym is important for children with autism. Outdoor spaces such as swimming pool, sensory garden and playground need to be provided as well to balance the activities for the children.</p>
<p><b>Question 2</b>                  Academy education is just part of the strategies for helping children with autism, facilities and activities need to be included as well.</p>
<p><b>Question 3</b>                  Playground plays an important role for children with autism. The calm area is the special elements that needed for autism if compare to the conventional playground. Autism playground needs more equipment that involved in physical and body strength such as swing, climbing and crawling.</p>
<p><b>Question 4</b>                  Swimming lesson is one of their compulsory activities every week and the children are really enjoyed to swim. All the respondents have mentioned swimming can helps to calm down the children with autism and improve their body strength and motor skills.</p>
<p><b>Question 5</b>                  Sand and water play need to be designed in the sensory garden which can slave the touch and visual sensory. Next will be the interaction and social skills can get from the animal patting zoning area. Last, several plants, coloured flowers, and fruits can help the children in terms sensory of visual, smell, sound, taste and touch.</p>
<p><b>Question 6</b>                  A good sensory gym needs to include several design strategies such as a climbing wall, soft materials for floor finishes, pasted colour and sensory equipment.</p>
<p><b>Question 7</b>                  Music therapy shows that are an important teaching process for children with autism. But is better to provide a music room that has an acoustic solution to prevent the children from getting distracted by the noise from outside.</p>
<p><b>Question 8</b>                  The main design strategies for the sensory room are the soft materials and lighting. These two elements will directly affect the children behaviour. Other than that, a quiet area or a tent is needed as well for children to stay when they are overwhelmed.</p>

## 7. Conclusion

In order to design autism facilities for children with autism, architects must distinguish the sensory environment. Many individuals with autism sensitive to a variety of sensory stimuli over sensitive can lead to a chaotic and some cases startling encounter at the extreme end. Therefore, architects should subdue environmental stimuli and create predictable and well-organized spaces. Academy education is not the only way for child development in autism. The opportunities for sensory integration through activities and spaces are even more important for children with physical limitations and sensory processing disorders which can develop children’s lifelong physical, cognitive, emotional and social benefits. Based on both case studies, there are still got improvements can be done for upgrading their facilities for providing a better environment for children with autism. In Malaysia, there's still a lack of autism centres with design strategy with sensory integration and autism-friendly appropriate facilities or environment for them. It is acknowledged that the availability of resources and facilities for children with autism is very much lacking or in conducive thus highlighting the need for a comprehensive autism centre in our efforts to establish such a centre visits to known autism establishments locally and internationally were carried out to learn the best practices in autism. There are several architecture design strategies can be concluded that translating Autism issues into the appropriate architectural environment with sensory integration for architects during designing the autism facilities for the children:

1. Consideration of the surrounding context, the neighbours and external influences as noise, sound, light, and smell. This is very important as these children are highly sensitive to the senses.
2. Transpose spaces into zoning which are a high stimulus, low stimulus, buffer zone, and outdoor zone.
3. Create a multi-level play area to increase social interaction
4. Use muted pastel colours to reduce over-stimulation and visual confusion. From the wall, flooring, ceiling, even furniture, the colour chosen plays an important role for the children.
5. Employ monochromatic interior colours to reduce sensory overload and glaring contrast, strong colours are only for educational objects.
6. Use natural and low volatile organic compound materials to reduce harmful gasses and odours and sensory overload.

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