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Sustainable Development Polices: Building with Natural Materials in the Children's Playgrounds

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Abstract

This study employs sustainable development in designing a playground. The research structure is based on the concept of sustainable and renewable design. The disadvantages of the current materials used for playground equipment are discussed. Natural environments and sustainable development are also investigated to provide a new direction for industries engaged in designing playgrounds. The environmental context is expressed in different playground design process examples. Thus, this study explains that the character and image of green manufacturing can be established through new environmental effects. We can also regard natural environmental choice that can promote an eco-friendly spirit in future industry.

Keywords: Children's Playground, Sustainable Development, Natural Environment, Children's play spaces, Environmental Politics

1. Introduction

Children's playgrounds are often constructed using various types of plastic or metal materials that are readily available. However, harmful substances such as heavy metals and plasticizers are often present when using these traditional materials to construct playgrounds (Table 1). The decision of the kinds of products available on playgrounds is an important issue. What kinds of activities are currently attractive to children on playgrounds? What is the future direction of the playground industry? How should this industry stay abreast of advancements in renewable environment and find its own new directions and markets? These are important business related issues in the field of education. Children playing on playgrounds constructed using traditional materials such as plastic and metal are exposed to potential health risks, including exposure to heavy metals, such as iron, zinc, copper, manganese, cadmium, and lead (Wong & Mak, 2010). Field designers can either continue using plastic or metal materials that harm the environment and endanger the health of children, or they can adopt sustainable development (SD) materials to build green, environment friendly playgrounds.

Table 1. Metal and plastic air emission levels (International Finance Corporation, 2007)

Pollutants	Units	Guideline Value
VOCs-surface cleaning	mg/Nm ³	20-75 ⁽¹⁾
VOCs-metal and plastic coating	80	100 (up to 15 ton/y solvent consumption); 75 (more than 15 today solvent consumption); 50(drying processes)

<u>Volatile Halogenated Hydrocarbons -</u>	mg/Nm ³	20
<u>Metal surface treatments</u>		
Particulate Matter – metal surface treatments	mg/Nm ³	5
Particulate Matter – plastic surface treatments	mg/Nm ³	3
Hydrogen Chloride	mg/Nm ³	10
Nitrogen Oxides ⁽³⁾	mg/Nm ³	350
Ammonia	mg/Nm ³	50

This study devotes more attention to the five senses experience that are genuinely educational in addition to protecting children from injury and making playgrounds look attractive. In addition, the study case supports the five sense experience as well as changing color and media transmitting functions through SD material utilization. The huge potential market of playgrounds has attracted a lot of attention among investors. In the general SD context of moving towards sustainable production and consumption, environmental issues should be managed throughout all stages of the product life-cycle. This can minimize the overall negative environmental effects of products and their manufacturing. Environmental concerns such as performance, quality, and safety must be integrated with product development (European Commission 2013). Therefore, friendly and educational playgrounds are likely to become a part of the recreation world for children. Especially, playing without fear or tears provides many benefits to a child's development (Thompson, Donna, Hudson, Susan, Olsen & Heather, 2007).

SD thinking about product development involves ecological standards and regulations. It seems necessary to reconsider or redefine towards an ecological friendly nature for playgrounds. This study proposes a new playground design idea to integrate a sustainable view to facilitate 'happy-health-safe design'. From the viewpoint of a product life-cycle, companies should also implement eco-efficiency policies, as these can have immediately positive effects on industries by reducing energy and resource consumption.

1.1 Purposes and methods

SD is based on obligations to nature and the requirements of human welfare (Dobson 1996). Modern playgrounds generally include many structures for playing and education that are constructed with many different equipment. Modern playgrounds often provide recreational equipment to help children develop their physical coordination and flexibility as well as offering recreation and enjoyment (Busuttill and Keeling 2008). A playground also exhibits the local community's perception of life and display a child's emotional perception. As expected, this kind of development is in resonance design. The concept of SD is required to analyze which innovations have the greatest impact on playground design, to explore how to consolidate environmental effects through the use of fluted core board (e.g., Re-board, X-board, and D-board approaches; Figure 1), and to establish a user experience model in line with user demands and concepts of interactive design. A successful playground designer seeks solutions for functional issues when working on a design and considers it useful to convey certain connotations outside expected functions by applying the Re-board (Figure 2) approach as well as other techniques to create a playground with a removable and reusable structure.

Re-board material (Figure 3) can be easily customized to allow the removal of plastic and metal materials to provide a green, safe, and sustainable material for building new playgrounds. The paper has the following three purposes: (1) To discuss the advantages of playgrounds developed through SD; (2) To understand the advantages of using Re-board as a renewable material and discuss the challenging issues of adopting traditional materials and ecological perspectives; (3) To provide insight into a strategic design model for playgrounds and education by applying a sustainable environment.

The five senses comprise the physiological capacity of a child and allow interaction, perception, and recognition in ecological environments. The senses and their operation have been studied in a variety of fields. Cognitive psychology investigates how people perceive, process, etc. Playgrounds have specific sensory systems, dedicated to the five senses experience, including sight (ophthalmoception), hearing (audioception), taste (gustaoception), smell (olfacoception or olfactoception), and touch (tactioception). Cognition usually refers to visual views of the psychology of children, such as visual stimulants, sound

effects, and light interaction. Kail and Cavanaugh (2008) pointed out that convergent thinking is often associated with creativity and integration with incoming information to form new and more complex concepts. In this study, the interaction, recognition, and environmental communication are the main elements of playgrounds and for education. We also provide a new perspective for designing playgrounds by considering the five senses experience to enhance learning.

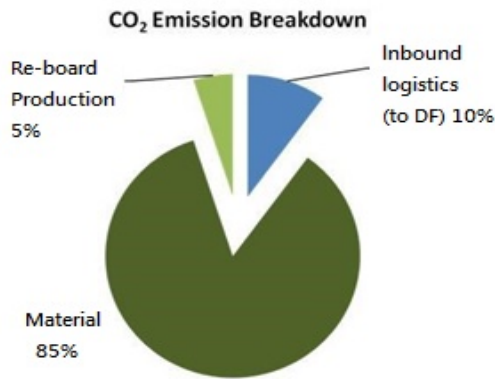


Figure 1. SD of the Re-board (AimCulture Co., Ltd)



Figure 2. Re-board Structure (AimCulture Co., Ltd)

Surface of Re-board

- Planar flatness
- Re-Board has one of the whitest surface, which is good for paint. Even though the surface are not as smooth, but it allows the ink to stay better.
- Can be digitally printed or finished with decorative laminates for stunning, high-impact results.
- Specially designed to prevent tearing caused by shear forces

Printable Surface	Whiteness 130 CIE
Opacity	92 ISO%
Gloss Hunter	35%
Brightness	98 D65%
Smoothness	2PP-10 um

Figure 3. Re-board Structure (AimCulture Co., Ltd)



Figure 4. Re-board five senses application

2. Literature Review

SD can potentially be kept up well into the future without causing harmful repercussions. Recycling technology and an advanced five senses experience approach will change the face of design in the next century. In fact, it is also important to consider the child’s needs and how to create a harm free environment through playground design. Playground design will be developed worldwide through various cultures, technologies, and ways of thinking; design will also turn from the tangible to the intangible and from practical product design to greater concern for the five senses experience in product design. Re-board (Figure(s)1–3) can be used in new product design. It can be kept in place all year long and serve as an ancillary tool for engineering in the exhibit manufacturing processes, new recycling prototypes, and five senses experience (Figure(s) 4–7). Another question has to do with how visual stimulation develops brains. While a child grows, the brain receives input from all five senses. This is why visual stimulation is crucial to a child’s growth and health (Ask Dr Sears 2013). Thus, a playground provides continuous visual input and the visual part of the child’s brain thrives and develops. This study considers how to achieve the best visual stimulation for children in a safe way. A playground is designed with happy-health-safe- sustainable development.



Figure 5. Re-board customizable application (AimCulture Co., Ltd)



Figure 6. Five senses experience (I)



Figure 7. Five senses experience (II)

Re-board has high rigidity in spite of its light construction. If you increase the area of contact, it can bear more weight. This material is made out of water-based adhesives so that it can be recycled as paper in normal waste paper streams. It also offers stability, strength, and retention of fixings such as screws, and enables rapid cutting of shapes to produce 3D objects as well as allowing for the production of curves and clean edges. Therefore, we can produce weight bearing sign displays, furniture, exhibition booths, and temporary stores with Re-board (NSK Corp. 2014).

Re-board has led to some futuristic re-thinking of the possibilities of creating renewable materials; Re-board is an eco-friendly paperboard with a unique engineered fluted core that challenges traditional methods and is also eco-sensitive. The paper-based sandwich board is capable of replacing medium density fiberboard (MDF). Re-board provides protection for children under different environmental conditions. Thus, this material protects the environment and can be recycled immediately after use

(Repro Arts 2014). In recent years, many countries have encouraged the use of more sustainable, eco-friendly materials as opposed to plastics, MDF, and chipboard. We can explore new materials and offer creative ways to integrate SD and ecological design in playground design. New materials satisfy the needs of playgrounds and result in less pollution than traditional materials such as plastic and metal materials (Table 1).

Printing or decorative lamination on Re-board creates amazing effects. When compared to traditional materials, considering a full project, Re-board is usually a more cost effective form of material utilization (Table 2). Re-board originated under the following 3R framework: reduce, reuse, and recycle. Following the 3Rs, unique 3C concepts were introduced at the Taiwan Meetings, Incentives, Conferencing, and Exhibitions [MICE], including construction, creativity, and content. Light yet strong structures can be assembled/disassembled with ease to lower construction costs. Meanwhile, designers are now free to use their creativity through printing technologies and various decoration methods. Then, with the help of digital technologies and equipment, the contents on display can be duplicated or transferred instantly (Taiwan Green Exhibitions 2012).

Table 2. Comparison of Re-board, metal, plastic (International Finance Corporation [IFC], 2007)

items	Re-board	Metal	Plastic
Safety	H	L	M
Pollution	L	H	M
Aesthetics	H	L	M
Learning	H	L	M
Cycle time	H	M	L
Operation	H	L	M
Colorful	H	L	M
Cost	L	H	M

Re-board is the eco-friendliest material and is the first board in the world to meet CEPI and ISO 14040 guidelines (Eco Rock 2013). The Executive Yuan (2013) pointed out that Taiwan has worked diligently to promote the 3R philosophy to achieve significant progress in minimizing waste and expanding recycling programs. Dryzek (1997) has argued that the discourse of SD is connected to society, nature, and economies and their relationships.

Demand for such a product has increased due to the rapid development of large-scale exhibitions, exhibition displays, and cardboard cut-outs. However, since exhibitions tend to only last a few days, the waste from advertisements made of foam board, PVC, plastic, and other materials has led to an environmental issues. By using recycled Re-board, an extra step toward protecting the environment is taken. Thus, the development of renewable material is an increasingly important issue for developing and developed countries. Figure 8 lists and compares Taiwan's energy supply and consumption in 2011 and 2012. It shows increases of consumption of 3.4% for petroleum, 0.1% for renewables, 0.2% for nuclear, and 0.7% for natural gas, and a decrease of 4% in coal consumption. We believe that new playgrounds can be integrated into indoor spaces in the future to promote SD and reduce energy pollution, especially in Asian weather. In Taiwan, the government constructs sound regulatory incentives for create a high quality environment and support industries via domestic green energy demand, select key industries, integrate and utilize existing industrial advantages to promote cross-industry integration, establish new green energy industry chain from parts to system, and form green energy industrial ecological system with global competitiveness in order to explore global green energy business opportunities (Bureau of Energy, 2017).

The study of playground design includes material utilization and the five senses experience approach. Children develop through experiences in which their five senses are used. Developing a child's attention using the five senses experience and the discussion of this process increases understanding and communication about information and things around them. Like other skills that children learn, listening takes practice (Simon, 2015). Sensory play provides children with sensory experiences that strengthen their cognitive skills. This is why it is important to give children plenty of opportunities to use their senses as they explore and interact with the environment (Amber & Demand, 2015). Thus, developing good

playgrounds helps children obtain important information from environmental communication. The five senses experience design covers the identification of functions, equipment, sense of touch, the body and its uses, and sensory manifestations. The Children's Geographies by Horton and Kraftl (2005, 2006a, 2006b) and Horton et al. (2008) have pointed out that the body would get the most attention. They stated that: A closer apprehension of the bodily details of children's lives—as well as wider conceptualisations of bodies and embodiments.

Interactive design approaches include expression through color, material, and visual style for the body's attention. Unlike other types of design, playground design calls for a strategy to integrate the concepts of needs to stimulate the five senses experience and provide fun from the playground business. As mentioned above, Re-board has many interesting properties, but is currently used primarily for exhibitions. In fact, Re-board can be used as a construction material and as a means of vision communication. It offers strength and excellent printing properties. Therefore, we combine the material design approach with this special Re-board material for playground design. In Taiwan, the top policy is to develop knowledge-based industry with low energy intensity so that the share of emerging industries in the total production value of the manufacturing industry can be increased from 4% in 2008 to 30% in 2020 (Bureau of Energy, 2014). Especially, the health risks of being exposed to traditional materials really (metal, plastic....etc). Human exposure occurs through all environmental media. Infants are more susceptible to the adverse effects of exposure. Increasing attention is now being paid to the mental development of children exposed to heavy metals (Simeonov, Kochubovski & Simeonova, 2011). Toxic substances contained inside of artificial turf, who's utility has recently been increasing, and its negative effect on children's health are on the rise as a social issue (Kim, Yang, Yeo, Shin & Lim, 2012).

The below table help inform designers and aid decision-making. The values are relative: 1 is low and 7 is high (Table 3). (Thompson, 2013)

Table 3. Comparison of Pulp, Paper, Board, Steel, Bio-based Plastic (Thompson, 2013)

Essential information	Pulp, Paper, Board	Steel	Bio-based Plastic
Availability	5	3	3
Durability	6	7	5
Recyclability	7	7	1
Biodegradability	7	2	6
Energy	3	4	3
Resources	3	5	3
Pollution	3	5	3
Waste	2	6	2

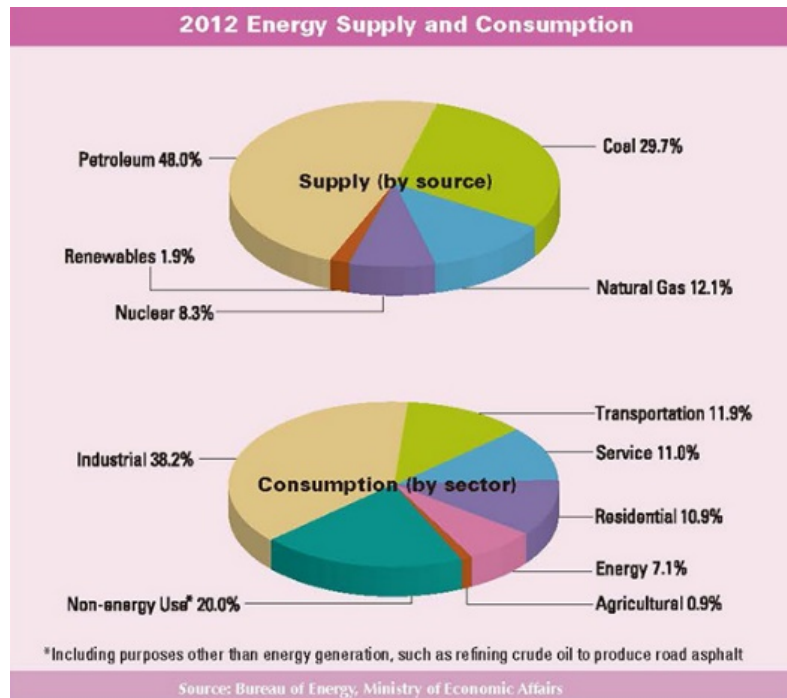


Figure 8. 2012 energy supply and consumption in Taiwan (Ministry of Economic Affairs)

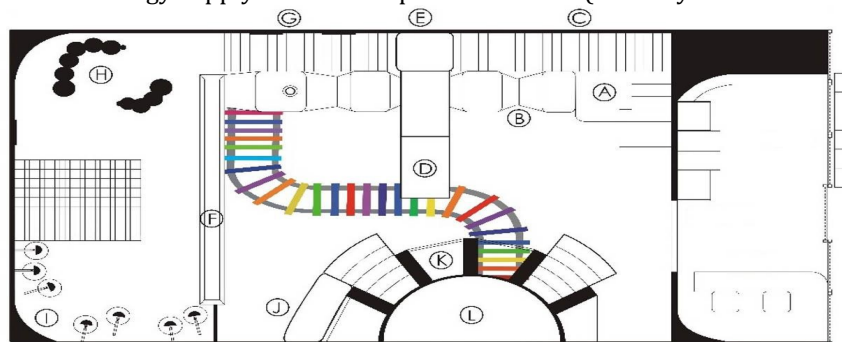


Figure 9. The child playground filed design stages

3. Research Analysis

The Environmental Protection Administration Green Mark Program encourages manufacturers to produce and consumers to purchase products that are recyclable and have a low environmental impact. This paper explores this kind of product through subjective testing. The mock construction site used here is relevant to the overall sensations for the five senses experience. This study further investigates the quality of known materials to promote fun play and exploration of the five senses experience sequences. The focus group method is used to study 20 preschoolers (10 boys and 10 girls) aged between 2 and 6-year-olds. We also conducted in-depth interviews with 10 kindergarten principals (42 to 65-year-old) (Table 4).

Table 4. Interview questionnaire

Researcher's analysis of children's playgrounds	
1	Trying not to offer judgments
2	Usually do something other than playing
3	Usually does something that makes them feel happy or homelike
4	The kind of field that is the best choice
5	Letting the child know how they are playing on the playground
6	Helps the child understand their actions and learn

3.1 Principles of application of child playground design

Play is natural and spontaneous for children. As children grow, play becomes more organized and activity oriented, i.e., running, jumping, and playing with toys, among others (Chetna, 2001). Another important issue is that play must take place in the context of playground safety. Children play games or participate in organized sports or recreational activities where they follow certain rules. The playground in this study is designed so that organized play can take place indoors (Figure 9). We apply the tenon and migration methods in playground design with age appropriate equipment for preschoolers of 2-6 years of age (preoperational stage), including the following items: (1) stepped area; (2) ramp area; (3) pattern learning area; (4) slide area; (5) tunnel area; (6) bean shape climbing area; (7) media education learning area; (8) horizontal bar climbing area; (9) spring bounce area; (10) flag stage area; (11) teaching mapping area; and (12) winner stage area (refer the ASTM F1487).

3.2 Stage for Playground Design

This study employs a domain and migratory playground structure. The opposing traits in the playground space domain constituent elements, such as high — low, dynamic — static, light — dark, wide — narrow, open — closed, and soft — hard, among others. We place a strong emphasis on creative wisdom in playground design to produce an innovative and creative model. Material utilization is also used to convey the cultural communication elements in toy design as well as to reflect new thinking about future playgrounds.

These natural environments can help us investigate playgrounds and also increase the cultural connotation of a product to meet the sensory demands of users, affect social and economic performance, and reshape a sense of value towards playground aesthetics. In order to create a safe, friendly, and positive environment, this study proposes a four-stage refer the in-depth interview (Table 5) for playground design as follows.

(a) Material characteristics: SD should be implemented in a practical environment and created by Re-board to arouse resonance among the children.

(b) Cultural codes (symbol): The performance of a symbol is closely related to learning (knowledge, code, text, and number). It takes a sharp sense of perception for the child to get a grasp of the material utilization, which is also an important element of sensory satisfaction.

(c) Story patterns: Regardless of the mode or expression or application of cultural and emotional materials, the purpose of the integration of culture and story is to make the material surface design more feasible.

(d) Value significance: In addition to reflecting the character of a brand, the value of the SD of the brand serves to convince consumers and improve business image.

Of particular relevance to education are values such as promoting SD, cultural codes, aesthetics, physical, mental and social well-being, and maturing to a responsible member of society. David (1998) mentioned that the point of SD is that future generations should have similar access to fecundity and beauty as well as to use this kind of access indefinitely to derive material advantages. SD can be seen as the most effective way by which society can confront the challenges of the future. Of course, in its broadest sense, SD must be a vital part of all efforts to imagine and create new relations among people and to foster greater respect for the needs of the environmental communication.

Table 5. In-depth interview with a kindergarten principal

Transcription of interviewer's questions and interviewee's answers	
I: This idea of letting the child play on the playground...it sounds like it's a problem for some of them. What field of design do you use to assure children's safety?	R: Well, usually I hope they do it by themselves: 'How do you feel that went?' And I see how they like to play
I: How do they play?	R: For example: swing, slide, seesaw, jungle gym, roundabout, jogging trail, cycling track, model toy pool, etc., colorful space, safest-material and visual styleladder...light field
I: Can you tell me a bit more about what happens to our brains when we play and how it	

makes us happier?

R: When I feel like that I just tell them how to play, you know, then try and say something about different ways to play. You know try and be positive...

I: Do you ever try anything else . . . other questions?

R: Yeah, you know, get them to think about what influence they may or may not have had (facilitating kids' safest-playing); and sometimes that works really well. It gets them thinking. You know and when they remember that they realize the effect it would have. So that was good (facilitating kids' self-understanding; valuing kids' safest-playing)

4. Discussion

According to our vision of a better playground, we want to offer kids some valuable educational information, not just play structures. We refer to these spaces ecological schoolyards, which are environments that combine diverse ecosystems with various play environments and learning experiences (Shanti 2011). In more environmental communication, it is less about who is the strongest and the fastest and more about using imagination. This changes the dynamics of who is in charge. Moreover, there is less conflict because the children will not get bored. Thus, SD thinking is used to develop the following suggestions:

(a) Manufacture safe equipment with social value is good for playgrounds.

(b) Discourage the production of toys that are not beneficial to children and the environment.

(c) Visualize and recognize play in all its forms and disseminate its value to parents and teachers and spot talent among children for various creative endeavors.

In this study, a social vision model (Figure 10) is proposed to improve the manufacturing process using a new and renewable material. Moreover, the vision model is introduced to guide the management and policy for sustainable manufacturing. As a result, the social vision model can also be used as an effective and feasible tool for playground designers. It ensures that the play equipment and indoor space are safe and takes social and environmental responsibility into account. We maybe not identify what the product wasn't get the greatest solution of any materials. But the design mission is to translate observation into insights and insights into products that will improve lives for SD.

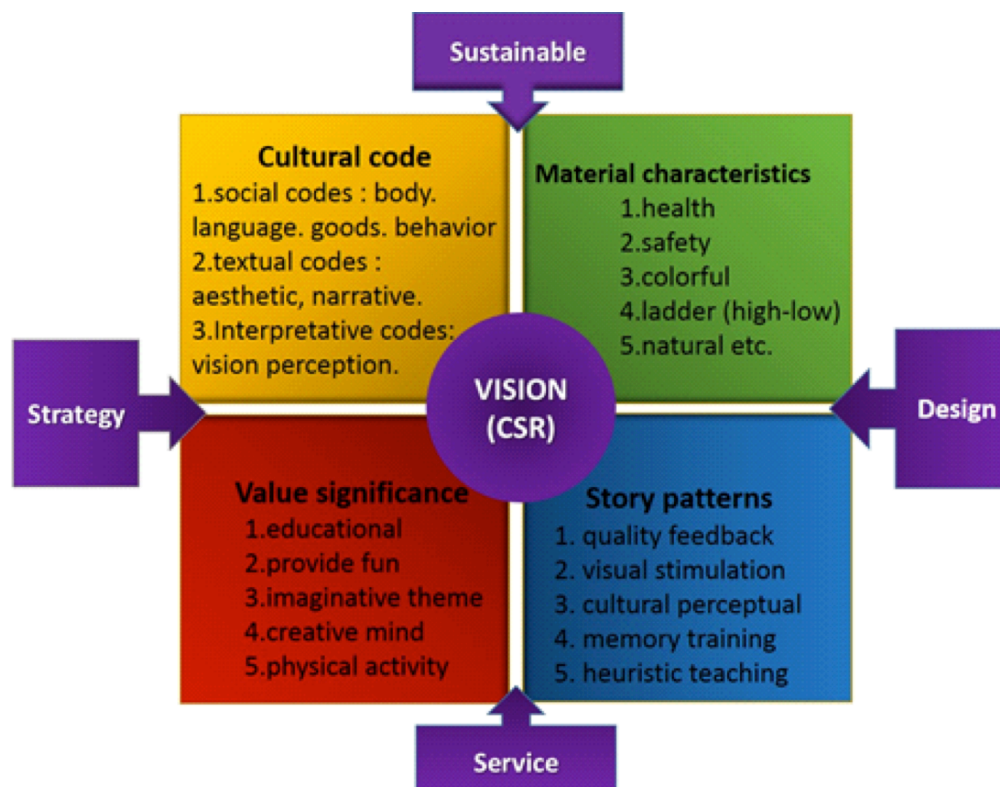


Figure 10. A social vision model of the child playgrounds child playground bSustainable Development Polices

5. Conclusion

The concept of SD is pervasive and applies in all value levels. In addition, material utilization is used to convey the cultural communication elements in toy design as well as to reflect new thinking for crowded environments. The materials will help our search for new design elements for products and also increase the cultural connotation of a product to meet the sensory demands of users, affect physical and psychological performance, and reshape a sense for playground aesthetics. In other words, the environmental effects of different playground types have become a unique way to recover playground material utilization. It is also important to note that the eco-material for a playground is innovative. Moreover, we would welcome more comprehensive thinking to better understand educative communication practices. This study explains that the character and image of a brand can be established through new environmental communication and mitigation of environmental pollutants through the expression of material contexts in different playground design process examples. The findings of this study contribute to the development of social polices for diversified development of children and the active expansion of SD research related to the development of children's environments by promoting benevolence and charity. Furthermore, our findings will promote green growth in the future development of pluralistic playgrounds.

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