

Guidelines for Healthy Housing Development for All

Trirat Jarutach

Center of Excellence in Universal Design, Faculty of Architecture, Chulalongkorn University, Bangkok, Thailand

Corresponding author e-mail: curu.calendar@gmail.com

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Abstract

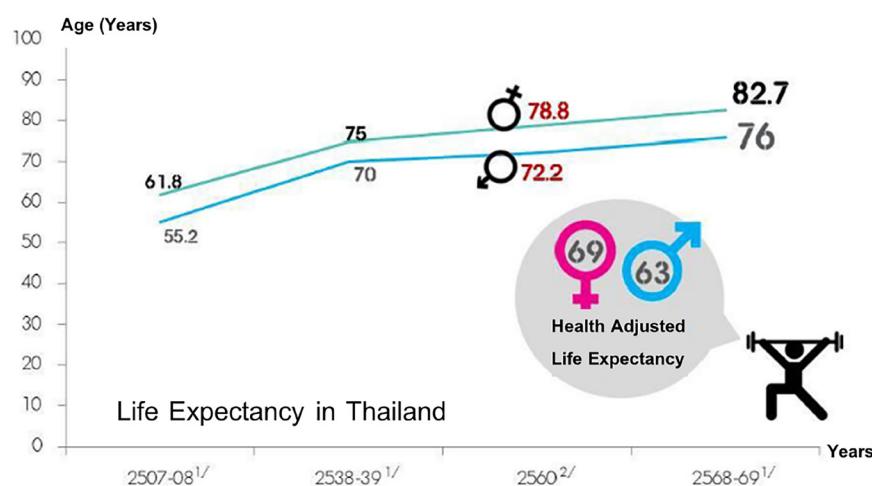
Good health and well-being are some of the most significant trends in the contemporary world. Because of the coronavirus (COVID-19) pandemic, Thai people have healthier lifestyles, more concerned about their health, and consequently, change their behaviours to adapt to the 'new normal' ways of living. According to the result of an opinion survey by Suan Dusit Poll, 45.39% have changed their attention to healthcare by exercising, eating more healthy products, and emphasising housing and health education, and criteria for evaluating residential buildings have been established. The research study shows that the assessment criteria such as LEED and BREEAM mainly focus on energy and resource efficiency to reduce environmental impacts. At the same time, WELL and CASBEE tools are primarily occupant-oriented and include universal design principles. All of these aim for improving residents' quality of life. The analysis of factors for healthy housing development indicates that residents were satisfied with eight essential factors such as location, lighting, materials, water quality, comfort, sound, air quality and energy conservation. Among these aspects, comfort and sound are the most critical factors. The results highlight the emphasis of project developers and architects. In the context of Thailand, the SOOK Building Standard by Thai Green Building Institute (TGBI) is a criterion used to evaluate both residential and other types of buildings. The objective of this research is to produce building evaluation criteria for residential and other building types. Consequently, future studies are recommended to study the physical characteristics and satisfaction of residents within a project with a healthy home concept, particularly in the projects that have received a certificate of building assessment criteria.

Keywords

Healthy Housing development; Universal design; new normal; assessment criteria; well-being; Guidelines for Healthy Housing Development for All¹

1. Rationale and importance

Health and well-being form parts of the new mega trends. (Sigh, 2012). With reference to Health at a Glance Thailand, it was reported that health related behaviors of Thai people have been on an improving trend, in line with Health Adjusted Life Expectancy. Coupled with the Coronavirus disease (COVID-19) pandemic, people became more health conscious and their behaviors have shifted which is believed to adapt to the new normal. In the latest Suandusit Poll by Suandusit University, public opinions of the sampled populations regarding Thailand's new normal revealed that 45.39% became more health conscious as they exercised more often, selected food products that offer more health benefits, and consulted with their doctors on a regular basis. (Suandusit Poll, 2020).



Source: https://www.researchgate.net/figure/Life-Expectancy-of-Thai-Populations_fig1_366967905

Figure 1 Life Expectancy of Thai Populations.

Thai populations' life expectancy increased by 4 months each year. Thai people have an expected life expectancy of 4.4 months per year (Thailand Development Research Institute, 2019) and there is an increase in life expectancy. As a result of technological developments and more advanced medical knowledge. (Figure 1). The female population tended to live longer than their male counterparts. The increasing trend of life expectancy resulted due to more knowledge, better work-life condition, better income that allowed them to do more activities and better health conditions for the elderly. With reference to a survey in 2018 by Healthy Living Index Thailand, Thailand's score was 67 points out of a full hundred (American International Assurance, 2018) indicating that Thai people tended to be more health conscious and wanted to have a better living standard. Not only the elderly, but also others across all age groups have become more health conscious and tried to prevent themselves from getting ill. This was different from healthcare practice in the past that focused only on treatments of the diagnosed disease. From the Health Promotion forum organized by the World Health Organization (WHO), it was stated that "residence" was the predecessor of good health.

In many countries, as importance of residence in relation to health condition was recognized, studies were conducted, policies were made, as well as assessment criteria for residential buildings were developed to promote good health from healthy residential conditions. Examples included Home for Health from a research by The Harvard T.H. Chan School of Public Health; WELL Building Standard (WELL) from collaboration between U.S. Green Building Council and International WELL Building Institute; Green Building Standard by Leader in Energy and Environmental Design (LEED) developed by U.S. Green Building Council; Living Building Challenge

(LBC); assessment criteria for sustainable development first published in 2006 under the supervision of International Living Future Institute, Green Mark; and Singapore's Green Building Standard developed and supervised by Building and Construction Authority (BCA). In the context of Thailand, the SOOK Building Standard by Thai Green Building Institute (TGBI) is a criterion used to evaluate both residential and other types of buildings.

This research, therefore, focuses on studying residential design conditions and analyze Thailand's housing development guidelines for good health. It is hoped that this research would be applied as guidelines for residential design for health and could help promote good health for all Thai people.

2. Key questions

- 2.1 What are the components of a healthy residential design for all?
- 2.2 How to apply the principles of healthy residential design for all to Thailand's residential development?
- 2.3 What are the limitations on Thailand's development of healthy residential design for all?

3. Objectives

- 3.1 To study information, standards, and criteria of healthy residential design of other countries
- 3.2 To study and analyze the key factors impacting development of healthy residential design for all
- 3.3 To provide guidelines for development of healthy residential design for all in Thailand

4. Scope of the research

4.1 Scope of the content

Study of policies of standards and building assessment criteria for healthy residence including Home for Health, WELL (Multi-Family Residential), LEED (for Home), Living Building Challenge 3.0, and Green Mark Residential.

4.2 Scope areas

A study of residential projects was conducted that assessed buildings that promoted health., which included four projects in Thailand with complete construction and moved-in residents (two low-rise and two high-rise projects). This is to obtain information to be compared and analyzed for further application in Thailand as well as for the development of healthy residential design guidelines.

a. Low-rise residential projects with home-for-health concept. The projects offered health centers on the premises and already had their residents moved in. The case studies selected included Jirung Residences and Nusa Chevani Pattaya as shown in Table 1.

Table 1 Case studies of low-rise residential projects.

Project name	Jirung Residences 	Nusa Chevani Pattaya 
Concept	Thailand's first residential community with a holistic view of healthy living offering a complete suite of health promoting components for the sustainable wellbeing of its residents. The project is within a pure natural environment and provides a full range of health and recreational facilities for individual's and their family's health.	A perfection of residential community for healthy living with a comprehensive health center within the project to provide individuals with health advice, plus emergency medical services via the best technology.
Building type	Stand-alone	Stand-alone
Developer	Good4u Company Limited	Nusasiri Public Company Limited
Status	Ready for move-in	Ready for move-in

b. High-rise residential projects with home-for-health concept. Two residential condominium buildings in Thailand with health promotion characteristics were selected as case studies included the Jin Wellbeing County in Pathum Thani and the KnightsBridge the Ocean Sriracha in Chonburi as shown in Table 2

Table 2 Case studies of high-rise residential projects.

Project name	Jin Wellbeing County 	KnightsBridge the Ocean Sriracha 
Concept	The project targets those with the mindset of today's generation to enjoy a good quality of life for at least 30 years after retirement without being dependent on anyone by living in the place designed to provide utmost safety with a team of physicians and medical staff on call. The place also offers rehabilitation activities to maintain good health, as well as heart and soul that they can always feel happy and valued.	The project of a luxurious 36-story condominium with health promoting concept located upon a hill that offers a splendid view of surrounding natural beauty all around. With a mountain behind and a sea view at its front, the location is the pride of its owner as it is claimed to have the most prestigious facilities with the highest potential for opportunities brought by Thailand's EEC initiatives.
Building type	Five 7-story buildings; a total of 494 units. Construction plan was divided into 4 phases. Currently, only Phase 1 of six 7-story buildings has been completed. There are 19 units per story. The provided facilities included a health center, a park, and areas for activities There were already residents in the project.	A 36-story building with a total of 722 units. The project highlights health promoting concepts by adding green spaces on the 1st, 4th, 12th, 18th, 24th, 30th and 35th floors for its residents to relax. Facilities provided include shops, kids club, library, golf simulator, home theater, fitness center, swimming pool, Tatami room, On-sen room, and a steam sauna.
Developer	Thonburi Healthcare Group Public Company Limited	Origin Property Public Company Limited

Table 2 Case studies of high-rise residential projects. (continue)

Status	Ready for move-in by December 2018 (Cluster 2)	Ready for move-in by December 2018
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5. Expected merits

1. To provide guidelines for government and public entities adopting home for health policies. This should also help improve people's quality of life.
2. To provide guidelines for developers to further develop healthy residential designs for people living in Thailand
3. To provide material information as reference for researchers to further study and add on new knowledge.

6. Relevant concepts and theories

6.1 WELL Multifamily Residential (United States of America)

WELL Building Standard was established as a cooperation between U.S. Green Building Council and International WELL Building Institute. Stemming from medical research, WELL was intended to be used as building assessment criteria which focused on the health and wellness of building occupants. WELL Building Standard Version 1 had been implemented since October 2014 as a performance-based assessment considering areas impacting health and wellbeing of occupants, from designing to construction. (Thuwawong, 2017). WELL Multifamily Residential (Table 3) assesses seven areas as follows:

- a. Air: purified, low in carbon dioxide, free of PM2.5, and has proper level of humidity for living
- b. Water: clean and safe, proper treatment equipment, no lead or any other toxin in drinking water
- c. Nourishment: availability of foods which are fresh, toxin-free, properly prepared, and nutritious
- d. Light: Not only quantity but also quality of light such as glares and color
- e. Fitness: Availability and adequacy of spaces that promote physical movement of building occupants
- f. Comfort: Proper ergonomics, temperature, reduction of sound or other disturbances, comfortable for all (Universal design)
- g. Mind: pleasant place, feel close to nature, cool and calm atmosphere

Table 3 WELL Multifamily Residential Certification Matrix.

WELL Building Standard	
Project:	
Location:	
Project Type:	Multifamily Residential
Date:	

Certification Matrix



AIR		
Y	?	N
<input checked="" type="checkbox"/>		1 Air Quality Standards*
<input checked="" type="checkbox"/>		2 Smoking Ban*
<input checked="" type="checkbox"/>		3 Ventilation Effectiveness
<input checked="" type="checkbox"/>		4 VOC Reduction
<input checked="" type="checkbox"/>		5 Air Filtration*
<input checked="" type="checkbox"/>		6 Microbe And Mold Control*
<input checked="" type="checkbox"/>		7 Construction Pollution Management
<input checked="" type="checkbox"/>		8 Healthy Entrance*
<input checked="" type="checkbox"/>		9 Cleaning Protocol
<input checked="" type="checkbox"/>		10 Pesticide Management
<input checked="" type="checkbox"/>		11 Fundamental Material Safety
<input checked="" type="checkbox"/>		12 Moisture Management
<input checked="" type="checkbox"/>		13 Air Flush
<input checked="" type="checkbox"/>		14 Air Infiltration Management
<input checked="" type="checkbox"/>		15 Increased Ventilation
<input checked="" type="checkbox"/>		16 Humidity Control*
<input checked="" type="checkbox"/>	17 Direct Source Ventilation*	
	18 Air Quality Monitoring And Feedback*	
<input checked="" type="checkbox"/>		19 Operable Windows*
<input checked="" type="checkbox"/>		20 Outdoor Air Systems
<input checked="" type="checkbox"/>		21 Displacement Ventilation
<input checked="" type="checkbox"/>		22 Pest Control*
<input checked="" type="checkbox"/>		23 Advanced Air Purification*
<input checked="" type="checkbox"/>		24 Combustion Minimization*
<input checked="" type="checkbox"/>		25 Toxic Material Reduction
<input checked="" type="checkbox"/>		26 Enhanced Material Safety
<input checked="" type="checkbox"/>		27 Antimicrobial Activity For Surfaces
<input checked="" type="checkbox"/>		28 Cleanable Environment*
<input checked="" type="checkbox"/>		29 Cleaning Equipment*
<input checked="" type="checkbox"/>	P9 Advanced Cleaning	
0	0	0
TOTAL		

Y		?		N		TOTAL	
		n/a	38	<i>Fruits And Vegetables*</i>			
		o	39	<i>Processed Foods*</i>			
		o	40	<i>Food Allergies*</i>			
		o	41	<i>Hand Washing*</i>			
		o	42	<i>Food Contamination*</i>			
		P	43	<i>Artificial Ingredients*</i>			
		P	44	<i>Nutritional Information*</i>			
		o	45	<i>Food Advertising*</i>			
		n/a	46	<i>Safe Food Preparation Materials*</i>			
		n/a	47	<i>Serving Sizes*</i>			
		n/a	48	<i>Special Diets</i>			
		n/a	49	<i>Responsible Food Production</i>			
		o	50	<i>Food Storage*</i>			
		o	51	<i>Food Production*</i>			
		n/a	52	<i>Mindful Eating</i>			
		o	53	<i>Food Environment</i>			
		n/a	57	<i>Strategic Dining Design</i>			

LIGHT	
Y	?
<input type="radio"/>	53 Visual Lighting Design*
<input type="radio"/>	54 Gradian Lighting Design*
<input type="radio"/>	55 Electric Light Glare Control
n/a	56 Solar Glare Control*
n/a	57 Low-Glare Workstation Design*
<input type="radio"/>	58 Color Quality
<input type="radio"/>	59 Surface Design
<input type="radio"/>	60 Automated Shading And Dimming Control
<input type="radio"/>	61 Right To Light*
<input type="radio"/>	62 Daylight Modeling
<input type="radio"/>	63 Daylighting Penetration*
<input type="radio"/>	64 Light at Night
<input type="radio"/>	65 Gradian Emulation

FITNESS			
Y	?	N	
		<input checked="" type="checkbox"/>	64 Interior Fitness Circulation*
n/a		<input type="checkbox"/>	65 Activity Incentive Programs
n/a		<input type="checkbox"/>	66 Structured Fitness Opportunities
		<input checked="" type="checkbox"/>	67 Exterior Active Design*
		<input checked="" type="checkbox"/>	68 Physical Activity Spaces
		<input checked="" type="checkbox"/>	69 Active Transportation Support*
		<input checked="" type="checkbox"/>	70 Fitness Equipment*
n/a		<input checked="" type="checkbox"/>	71 Active Furnishings*
n/a		<input checked="" type="checkbox"/>	78 Injury Prevention

COMFORT			
Y	?	N	
n/a	72	Accessible Design	Universal design
n/a	73	Ergonomics Visual And Physical	
o	74	Exterior Noise Intrusion*	
o	75	Internally Generated Noise*	
P	76	Thermal Comfort*	
n/a	77	Olfactory Comfort	
n/a	78	Reverberation Time*	
n/a	79	Sound Masking*	
n/a	80	Sound Reducing Surfaces	
o	81	Sound Barriers	
n/a	82	Individual Thermal Control*	
o	83	Radiant Thermal Comfort	
o	84	Impact Reducing Flooring	
0	0	0	TOTAL

MIND			
Y	?	N	P
			84 Health And Wellness Awareness*
			85 Integrative Design
		N/B	86 Post-Occupancy Surveys
			87 Beauty And Design I*
		P	88 Biophilia I - Qualitative*
			89 Adaptable Spaces*
		N/B	90 Healthy Sleep Policy
			91 Business Travel
		N/B	92 Building Health Policy
			93 Workplace Family Support
		N/B	94 Self-Monitoring
			95 Stress And Addiction Treatment
		N/B	96 Altruism
		O	97 Material Transparency*
		N/B	98 Organizational Transparency*
			99 Beauty And Design II*
		O	100 Biophilia II - Quantitative*
		P	105 Health Through Housing Equity
		N/B	106 Education Space Provisions
		O	101 Innovation Feature I
		O	102 Innovation Feature II
		O	103 Innovation Feature III
		O	104 Innovation Feature IV
		O	105 Innovation Feature V
A	B	C	TOTAL

SUMMARY			
Y	?	N	
0	0	0	Preconditions (28 possible)
0	0	0	Optimizations (48 possible)
0	0	0	n/a Optimizations targeted
0	0	0	Innovations targeted
0	0	0	Total Optimizations

Source: https://a.storyblok.com/f/52232/x/9d1643a09c/multi_family_residential_q4_2020.xlsx, 2020

6.2 Leadership in Energy and Environmental Design (LEED) (United States of America)

LEED is a green building certification program developed by U.S. Green Building Council. LEED is currently used worldwide and recognized in standard design and construction for green buildings across business sectors. To register for LEED certification program, a special consultant is required to assist with designing and the documentation of energy saving and environmental friendliness standards of the building, as well as registration with U.S. Green Building Council (as shown in Table 4).

Table 4 LEED v4 for Homes and Multifamily.

LEED v4 for Building Design and Construction: Homes and Multifamily Lowrise			
Project Checklist			
 Y ? N			Integrative Process
 Credit			2
0 0 0	Location and Transportation	15	Required
 Y	Preq: Floodplain Avoidance		
PERFORMANCE PATH			
 Credit	LEED for Neighborhood Development Location	15	
PRESCRIPTIVE PATH			
 Credit	Site Selection	8	
 Credit	Compact Development	3	
 Credit	Community Resources	2	
 Credit	Access to Transit	2	
0 0 0	Sustainable Sites	7	
 Y	Preq: Construction Activity Pollution Prevention	Required	
 Y	Preq: No Invasive Plants	Required	
 Credit	Heat Island Reduction	2	
 Credit	Rainwater Management	3	
 Credit	Non-Toxic Pest Control	2	
0 0 0	Water Efficiency	12	
 Y	Preq: Water Metering	Required	
PERFORMANCE PATH			
 Credit	Total Water Use	12	
PRESCRIPTIVE PATH			
 Credit	Indoor Water Use	6	
 Credit	Outdoor Water Use	4	
0 0 0	Energy and Atmosphere	38	
 Y	Preq: Minimum Energy Performance	Required	
 Y	Preq: Energy Metering	Required	
 Y	Preq: Education of the Homeowner, Tenant or Building Manager	Required	
PERFORMANCE PATH			
 Credit	Annual Energy Use	29	
BOTH PATHS			
 Credit	Efficient Hot Water Distribution System	5	
 Credit	Advanced Utility Tracking	2	
 Credit	Active Solar Ready Design	1	
 Credit	HVAC Start-Up Credentialing	1	
PRESCRIPTIVE PATH			
 Credit	Home Size	Required	
 Credit	Building Orientation for Passive Solar		
 Credit	Air Infiltration	3	
 Credit	Envelope Insulation	2	
 Credit	Windows	3	
 Credit	Space Heating & Cooling Equipment	4	
0 0 0	EA PRESCRIPTIVE PATH (continued)	10	
 Credit	Heating & Cooling Distribution Systems	3	
 Credit	Efficient Domestic Hot Water Equipment	3	
 Credit	Lighting	2	
 Credit	High Efficiency Appliances	2	
 Credit	Renewable Energy	4	
0 0 0	Materials and Resources	10	
 Y	Preq: Certified Tropical Wood	Required	
 Y	Preq: Durability Management	Required	
 Credit	Durability Management Verification	1	
 Credit	Environmentally Preferable Products	4	
 Credit	Construction Waste Management	3	
 Credit	Material Efficient Framing	2	
0 0 0	Indoor Environmental Quality	16	
 Y	Preq: Ventilation	Required	
 Y	Preq: Combustion Venting	Required	
 Y	Preq: Garage Pollutant Protection	Required	
 Y	Preq: Radon-Resistant Construction	Required	
 Y	Preq: Air Filtering	Required	
 Y	Preq: Environmental Tobacco Smoke	Required	
 Y	Preq: Compartmentalization	Required	
 Y	Preq: Enhanced Ventilation	3	
 Credit	Containment Control	2	
 Credit	Balancing of Heating and Cooling Distribution Systems	3	
 Credit	Enhanced Compartmentalization	1	
 Credit	Enhanced Combustion Venting	2	
 Credit	Enhanced Garage Pollutant Protection	2	
 Credit	Low Emitting Products	3	
0 0 0	Innovation	6	
 Y	Preq: Preliminary Rating	Required	
 Credit	Innovation	5	
 Credit	LEED AP Homes	1	
0 0 0	Regional Priority	4	
 Credit	Regional Priority: Specific Credit	1	
 Credit	Regional Priority: Specific Credit	1	
 Credit	Regional Priority: Specific Credit	1	
 Credit	Regional Priority: Specific Credit	1	
0 0 0	TOTALS	Possible Points: 110	
Certified: 40 to 49 points, Silver: 50 to 59 points, Gold: 60 to 79 points, Platinum: 80 to 110			

Source: <https://www.usgbc.org/resources/checklist-leed-v4-building-design-and-construction,2016>

6.3 Building Research Establishment Environmental Assessment Method (BREEAM)

Building Research Establishment Environmental Assessment Method (BREEAM) is an assessment method established by UK's Building Research Establishment (BRE) aiming to reduce the negative effects of construction and development cycle of buildings on the environment. It provides recognition and trust, which increases attractiveness and value of the certified buildings to help all stakeholders successfully adopt sustainable solutions. The criteria involves a holistic wellbeing of occupants. In the section "My Home", majority of criteria center around comfort zone. An assessment tool of Home Quality Mark (HQM) is provided.

Home Quality Mark is divided into three parts with 11 topics as follows:

1. Our Surroundings: Select the right location/ neighborhood that would allow good quality of living
 1. Transport and Movement
 2. Outdoors
 3. Safety and Resilience
2. My Home: the design for comfort, health, efficiency, which minimizes environmental impacts
 1. Comfort Universal design
 2. Energy and Cost
 3. Materials
 4. Space
 5. Water
3. Knowledge Sharing: promote understanding and cooperation between designers, contractors, clients,

and occupants

1. Home Delivery
2. User Experience
3. Future Learning

6.4 Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)

Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) is an assessment method established by Japan Sustainable Building Consortium (JSBC) aiming to evaluate and rate environmental performance of buildings and the built environment including interior features. The assessment criteria's primary focus is on the health and wellbeing of occupants, while other environmental practices come second. A house assessment tool of "CASBEE for Home" was also provided.

CASBEE for Home (Detached House) is divided into two parts as follows:

1. Q (Quality): Building Environmental Quality and Performance

1.1) Q1 - Indoor Environment

1.2) Q2 - Quality of Service

1.3) Q3 - Outdoor Environment on Site

2. L (Loadings): Building Environmental Loadings

Competency index indicating the building's ability to reuse the resources consumed within the construction system. Environmental impacts are assessed to quantify the loads that construction of the building put upon its community and the city.

Table 5 Comparison of LEED, WELL, BREEAM, CASBEE.

Assessment name	Tools	Objectives	Institutes	Country
 LEED (Leadership in Energy and Environmental Design)	LEED v4 for Homes and Multifamily	To increase buildings' resource efficiency and reduce negative impacts on environment and sanitation of residents/ occupants	U.S. Green Building Council (USGBC) Universal design	United States
 WELL Building Standard	WELL Multi-Family Residential	To improve well-being and living quality of occupants	IWBI (International WELL Building Institute) Universal design	United States
 BREEAM (Building Research Establishment Environmental Assessment Method)	Home Quality Mark	To prevent impacts on environments caused by buildings' cycle, offering acknowledgement, credibility for attractiveness and added values	BRE Building Research Establishment	United Kingdom
 CASBEE (Comprehensive Assessment System for Building Environmental Efficiency)	CASBEE for Home (Detached House)	To assess and rate environmental performance of buildings and their interiors	Japan Sustainable Building Consortium (JSBC)	Japan

Source: <http://cuir.car.chula.ac.th/handle/123456789/55747,2016>

From the literature review of the four assessment methods of LEED, WELL, BREEAM and CASBEE as

shown in Table 5, the comparison shows the different focus of each method. LEED and CASBEE mainly focus on resources and energy efficiency as well as environmental impact minimization with some assessment criteria that benefits the health of occupants. As for WELL and BREEAM, their assessment criteria center around people and incorporate the universal design features as shown in Table 6.

Table 6 Analysis of contributive factors of for healthy residence from guidebooks and building assessment methods.

No.	Factors	Assessment methods			
		WELL	LEED	BREEAM	CASBEE
1	Air quality	/	/	/	/
2	Water quality	/	/	/	/
3	Light	/	/		/
4	Comfort Zone	/	/	/	/
5	Materials	/	/	/	/
6	Noise	/	/		/
7	Energy conservation		/	/	/
8	Location		/	/	/
9	Emotions	/			
10	Social	/			
11	Foods	/			
12	Physical movements	/		/	
13	Innovation and technology		/		
14	Universal design	/		/	

6.5 Homes for Health: 36 Expert Tips to Make Your Home a Healthier Home

As we spend 65% of our life living in our houses and one third of our lifetime in our bedrooms, the Homes for Health report was set out by Harvard T.H. Chan School of Public Health with enthusiastic collaboration to conduct research on healthy indoor environments. Here are 36 tips from experts that can be used to make a Healthier Home (Allen & Spengler, 2019) as summarized below (Figure 2).

WHOLE HOME	BEDROOM	LIVING ROOM	KITCHEN	BATHROOM	BASEMENT	OUTSIDE
1. Trust Your Senses						
2. Kick your shoes off at the door	7. Train your brain and make this the sleeproom	12. Vacuum. Regularly. With HEPA.	17. Cook with the exhaust hood on (and vented outdoors)	22. Control moisture by exhausting air outdoors	27. Measure and control radon	32. Ditch the pesticides and herbicides
3. Bring in fresh air	8. Black out the room (and 'blue-out' your lights)	13. Don't smoke indoors (better yet, don't smoke at all)	18. Keep a fire extinguisher within easy reach	23. Limit the use of air fresheners	28. Do not disturb signs of asbestos	33. Beware of air from attached garages
4. Install detectors for smoke and 'the silent killer'	9. Treat the air (and yourself)	14. Stamp out the candles and incense	19. Filter your drinking water where necessary	24. Detoxify cleaners and personal care products	29. Dehumidify and inspect for signs of water issues	34. Secure the perimeter
5. (Re)connect with nature and natural light indoors	10. Keep your cool at night	15. Choose furniture and carpets without harmful chemicals	20. Control pests using IPM, not more pesticides	25. Skip the antimicrobials	30. Choose a hard floor	35. Tighten up your envelope
6. Get the lead out (for homes built before 1980)	11. Block out the noise	16. Properly vent fireplaces and woodstoves	21. Choose glassware and cast iron or ceramic cookware	26. Prevent slips, trips and falls with handrails and non-slip mats	31. Solve the solvent storage issue	36. Be resilient
Universal design						

Source: <https://homes.forhealth.org/36-expert-tips-for-a-healthier-home/2021>

Figure 2 Homes for Health: 36 Expert Tips to Make Your Home a Healthier Home.

The 36 tips cover all areas of the house, each highly practical in comparison to the assessment standards (WELL, LEED, BREEAM, CASBEE) as the research speaks directly to the public and aims for application at their homes. Among the tips, one provides a recommendation to prevent slips, trips, and falls with handrails and non-slip mats (Tip no. 26) and another recommends securing the perimeter (Tip no. 34). These two are in line with the universal design principles. Therefore, the 36 tips had incorporated the universal design principles which can be used as practical guidelines for everyone to make their homes safer and healthier.

Findings

6.6 Key contributing factors of healthy homes and universal design

There are eight key factors were shared as conducive to healthy residences and can be divided into two groups. Group 1 consists of four factors shared by all the four assessment methods, including air quality, water quality, thermal comfort, and materials. Group 2 consists of four factors shared by three of the assessment methods, including light, sound, energy efficiency, and location. These eight factors involve the areas of design, architecture, and engineering that facilitate improvement of occupants' quality of life. For any project seeking certification, certain additional areas will need to be focused as per the assessment method criteria.

For example, to be LEED Certified, the additional area of sustainability is to be addressed and for WELL's certification, areas of emotion, social, foods, and physical movement are to be taken into consideration. There are two factors of physical movement and universal design that directly address and contribute to living quality of residents keeping the "person" in the center, which become a new trend of development.

6.7 Acknowledgement and recognition

According to the research of Boonnorn (2021) who studied and analysed the factors affecting the development of healthy homes, it was found that from the eight key factors, residents cared the most about location, light, materials, water quality, thermal comfort, and sound, which are in line with the areas developers and architects recognized as important. These physical components can be felt by everyone and directly affect the occupants. As for air quality and energy efficiency, it is the main factor of the project overview. (Table 7)

Table 7 Level of satisfaction and importance of factors contributing to healthy home project development.

		Residents	Developers	Architects
No.	Factors	Satisfaction level	Importance level	Importance level
1	LOCATION & SITE SELECTION	High	High	Highest
2	LIGHT	High	High	High
3	MATERIALS	High	Highest	Highest
4	WATER	High	High	High
5	THERMAL COMFORT	High	Highest	High
6	SOUND	High	Highest	High
7	AIR	Fairly high	High	Fairly high
8	ENERGY EFFICIENCY	Fairly high	High	Fairly high

6.8 Contributing factors of home for health development and residents' awareness

According to the research of Pajitpithak (2021) who analysed the factors contributing to healthy home project development, We can analyze from the self-assessment table, both the factors that contribute to the healthy condominium. (Case studies of Knightsbridge and Jin Wellbeing). From the study of opportunities and limitations of low-rise residential development under the wellbeing concept, the case studies of Jirung Residences and Nusa Chevani reveal that projects with a clear concept of health and wellbeing would attract the health-conscious target group. Use of these project areas and facilities This allows the target audience to achieve more healthy goals. For the projects with a wellbeing concept but did not have a specific target group, such as the elderly, being open to all age groups, might not see a change in the self-evaluation of health as shown in Table 8.

Table 8 Self-evaluation of health after move-in.

	Knightsbridge (N=151)	Jin Wellbeing (N=19)	Jirung Residences (N=10)	Nusa Chevani (N=10)
Improved	42%	74%	60%	43%
Unchanged	58%	26%	10%	14%

7. Recommendations as guidelines for Thailand's housing development for health

Two recommendations can be proposed as follows:

7.1 Application of WELL's building assessment criteria for the health-conscious target group

WELL's assessment focuses mainly on occupants' wellbeing and provides clear and tangible index and criteria so that it can add value to projects for developers, as well as confidence for buyers or residents. The assessment criteria, therefore, should help create business opportunities contributing to better product designs that meet the needs of the health-conscious target group, which comes with the new mega trend of health and wellbeing.

7.2 Choice of well-being materials (RISC Well-Being, 2021)

The factor of materials is high on the scale of residents' satisfaction level as well as on the developers' importance level. From the case studies, four recommendations regarding choices of materials for wellbeing are proposed as follows:

- 1) Health & safety materials: free from toxic substances, chemicals or radiation that could cause cancer and respiratory diseases, including those with anti-dust accumulation quality for less allergy.
- 2) Energy saving materials: heat insulating wall or glass would help save energy.
- 3) Recycled & upcycled materials: making up new objects out of cleaned waste materials and recycling process helps to reduce waste and landfill, while adding value to the waste materials.
- 4) Sustainable & eco-friendly materials: the durable substitutes of natural materials to reduce devastation of natural resources

Examples of "Well-Being Materials":

- Turning UHT milk cartons into durable, flexible roofs that can shield rain and sun whilst reflecting UV light.
- Turning plastic bottles into fiber for the manufacturing of carpets, pillowcases, sofa covers, bags, or face masks incorporating AVA (Anti-Viral Allergy Free) technology to enhance the prevention against RNA viruses of COVID, MERS, and SARS.
- Substitutes of wood board free from real wood and plastic made from natural raw materials such as rice hulls, salt, and oil offering higher quality than typical wooden panels which can be recycled.
- Biodegradable asphalt tiles made from natural raw materials, free from PVC and can be recycled.

8. Discussions

The WELL assessment criteria focus mainly on the well-being of residents, which is in line with the needs of the health-conscious target group. Developers have already completed some standard site development work, such as safety, therefore, it is likely for development projects in Thailand to get certified for well-being. This tendency is also supported by research, whereby most developers commented that it is highly feasible (Akaramanee, 2018). However, getting certified could become a limitation in terms of investment as developers could have additional expenses from the process of designing, construction, and obtaining certification, which could impact sale strategies for projects aimed to be affordable for the middle-high income group. However, there are many factors contributing to well-being, including physical and emotional.

At present Certified there are no single-house projects in Thailand which are certified by the WELL Building Standard. There were two condominium projects of NIL SATHORN 12 and The Residence, One Bangkok with pre-certified status. The first and only WELL Building Standard certified building in Thailand is an office building, the Research & Innovation for Sustainability Center (“RISC”) by MQDC. RISC’s New & Existing Interiors Project is the first “Gold” class in Southeast Asia certified by International WELL Building Institute (IWBI), a certifying body providing building standards that aims to promote health and wellness in buildings, either in work-related or other activities. The assessment covers seven areas including 1) Air: good air quality within buildings 2) Water: clean water for drinking and utilizing 3) Nourishment: promoting healthy choices of foods 4) Fitness: promoting physical movement during the day 5) Light: designed to match with circadian clock of human body 6) Comfort: promoting comfortable environment 7) Mind: incorporating nature into daily life (RISC Well-Being, 2021).

As the WELL assessment criteria focus mainly on the well-being of the occupants, the process would help educate and encourage stakeholders, developers and occupants, to improve the spaces and communities to become “healthier” compared to the prior stage which did not guarantee good health for the occupants. The assessment might not be fully applicable to Thailand as each residential environment of assessment should be weighed in accordance to each country’s context. by Thai Green Building Institute (“TGBI”) (Thai Green Building Institute, 2020) In the context of Thailand, the SOOK Building Standard by Thai Green Building Institute (TGBI) is a criterion used to evaluate both residential and other types of buildings. It was developed from research studies in the field of building for various well-being and WELL assessment criteria are being studied for further development of assessment guidelines for both residential and non-residential projects in Thailand. There are four levels of achievements ranging from PLATINUM (75 points or higher), GOLD (65 – 74 points), SILVER (55 – 64 points), and CERTIFIED (45 – 54 points). The assessment criteria consist of five modules, a total of 110 points.

- Outdoor & Neighborhood (ON): 13 points
- Architectural Design (AD): 42 points, 1 mandatory item
- Interior Design & Materials (IM): 15 points, 1 mandatory item
- Environmental System & Engineering (EE): 30 points, 1 mandatory item
- SOOK Innovation (SI): 10 points

9. Recommendations on further studies

1. Though the study of physical conditions and residents’ satisfaction levels was conducted at residential projects with well-being concepts, these did not register for certification. For further research, therefore, it is suggested that certified projects should be surveyed for a study of impacts on residents’ health.
2. At present, there are a large number of innovations for health such as building materials, furniture, ventilation and sanitation systems, home automation, etc., which could be studied further.

Author Contributions

Conceptualization, methodology, formal analysis, investigation, data curation, writing-original draft preparation, review and editing, visualization, project administration, and funding acquisition by T.J.. The author has read and agreed to the published version of the manuscript

Remark

¹ With reference to the research of Healthy Housing development guideline for all, June 2021.

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