10 FINGERS MODEL FOR INCLUSIVE DESIGN: TOWARDS ACCESSIBLE COMMUNITIES FOR ALL

Torpong Selanon[1]
Kanit Sunchatvirul[2]
Issararat Kruahongs[3]

Office of the National Broadcasting and Telecommunications Commission,
Bangkok 10400 Thailand[1] to [3]
Corresponding Email: torpong.s@nbtc.go.th

Abstract

Inclusive design is a crucial concept for creating an equitable and accessible society for all. This article presents the "10 Fingers Model" for inclusive design. The model uses the 10 fingers as symbols representing key components to consider in the design process. The model comprises 5 physical environment components and 5 human-centered technology components. 5 physical environment components include urban design, landscape design, architectural design, interior design, and product design components; and five human-centered technology components consist of users, skills, smart devices, software applications, and connectivity. This study was based on a review of relevant literature published between 2000 and 2023. The findings revealed that inclusive design positively impacts quality of life, economy, social participation, innovation, and the environment. It enhances the lives of the elderly and disabled, creates new business opportunities, promotes social inclusion, stimulates innovation, and supports sustainable development. However, implementing this concept in Thailand still faces challenges. Recommendations include raising awareness, developing personal skills, improving policies and laws, and promoting collaboration among various sectors to create an inclusive society for all in Thai society.

Keywords: inclusive design, 10 Fingers Model, equity, accessibility, Thai society

1. Introduction

Inclusive design has gained significant attention over the past decade, focusing on creating products, services, and environments that can be used by all groups without requiring special modifications or adaptations. This concept has its roots in the disability rights movement of the 1960s-1970s and has continued to evolve to the present day (Welch & Jones, 2001).

In an increasingly diverse society in terms of age, gender, physical ability, and culture, design that considers the needs of different users has become critically important. This is particularly relevant in the context of Thailand, which is entering a full-fledged aging society and experiencing increased awareness of the rights and equality of all groups. "Inclusive design" has become a crucial concept in creating an equitable and accessible society for everyone. Furthermore, new technologies and

innovations have opened opportunities to design diverse solutions that respond to different needs (Persson et al., 2015).

The "10 Fingers Model" is a conceptual framework that the authors have integrated and built upon from inclusive design concepts, presenting a holistic view of inclusive design. Using all ten fingers as symbols representing key components in the design process, it is divided into two main parts: the right hand representing the physical environment and the left hand representing human-centered technology. This concept aims to create understanding that is easy to grasp and remember for those involved in the design process, whether they are designers, policymakers, or general users.

The dissemination of the 10 Fingers Model for inclusive design has gained broader recognition in Thailand and internationally. The concept was presented in a lecture titled "Digital Inclusion, How?" to students in the Advanced Certificate Program in Broadcasting and Telecommunications Regulation and Development at the Office of the National Broadcasting and Telecommunications Commission (NBTC) on June 20, 2024. The presentation offered a holistic perspective that connects the physical and digital worlds, reflecting the importance of non-discriminatory design in all aspects of daily life and aligning with the Internet of Things (IoT) concept to create an equitable and accessible society for all.

Subsequently, the 10 Fingers Model for inclusive design was presented at the 17th International Convention on Rehabilitation Engineering and Assistive Technology (i-CREATe 2024), held between August 23-26, 2024, in Shanghai, China. The presentation, titled "Digital Fusion for Inclusive Nursing: Building an Accessible Future," under the theme "Application of Digital Fusion in Intelligent Nursing," as shown in Figure 2, explained the application of this concept in hospital design, medical equipment, and medical information technology systems. Key points presented included the integration of digital technology with healthcare and creating accessible environments for all patients and medical personnel through the use of digital technology and modern technologies such as Artificial Intelligence (AI) to enhance healthcare accessibility and inclusivity for everyone. The application of the 10 Fingers Model in these various contexts demonstrates the flexibility and adaptability of the concept across different fields.

At the ITU Digital Skills Forum 2024, held between September 17-19, 2024, in Manama, Kingdom of Bahrain, the author had the opportunity to present Thailand's digital skills development vision at an international level. As one of the panelists in the session "High-level dialogue on key issues related to digital transformation and the digital skills gap," as shown in Figure 3, the presentation emphasized the importance of digital skills development in driving the economy, along with introducing key initiatives of the National Broadcasting and Telecommunications Commission (NBTC) aimed at reducing inequality and creating opportunities for everyone in the digital era. The 10 Fingers Model for inclusive design was presented for the first time on the International Telecommunication Union's (ITU) international platform, focusing on creating an inclusive and equitable society that considers the needs of all social groups.

The presentation of this concept not only reflects Thailand's commitment to being a leader in inclusive digital development but also demonstrates a vision for creating an equitable society in the digital age. It emphasized that as various services are becoming digital, digital skills have become essential in daily life. However, not everyone is ready to cope with this change, especially vulnerable groups such as people with disabilities, the elderly, and rural populations. Inclusive design is therefore crucial in creating an equitable and happy society. The 10 Fingers Model presented covers

both physical and digital design, and considers the relationship between people, machines, and the environment to create a society that leaves no one behind.

Creating opportunities for access to technology and digital skills development is key to reducing social and economic inequalities. Thailand aims to promote comprehensive digital skills development, including addressing challenges and lessons learned, which can guide other countries in developing inclusive and sustainable digital policies. This reinforces Thailand's role as a leader in digital development in the Asia region.

2. Objectives

2.1 To study and compile concepts, principles, and components of inclusive design in global and Thai contexts.

2.2 To present and analyze the 10 Fingers Model for inclusive design in creating an accessible society for all.

2.3 To propose policy recommendations for promoting and developing inclusive design in Thailand to reduce inequality and create an equitable society.

3. Methodology

This study employs a documentary research approach, conducted according to the following steps:

3.1 Data collection: Researching and gathering information related to the 10 Fingers Model for inclusive design, including current approaches to solving digital inequality. The scope of data sources was defined from academic documents and articles both domestic and international, published between 2000-2023, covering the fields of design, architecture, information technology, and public policy.

3.2 Data analysis: The collected data was subjected to content analysis, categorizing and classifying information according to the components of the 10 Fingers Model, analyzing relationships and connections between various components, and assessing the appropriateness of application in the Thai context.

3.3 Data synthesis: The analysis results were synthesized to develop policy recommendations for promoting inclusive design in Thailand, taking into account relevant social, cultural, and environmental factors.

3.4 Reliability verification: Using triangulation methods by comparing data from various sources to confirm the accuracy and reliability of the information.

4. Results

4.1 Basic Principles of Inclusive Design

4.1.1 Definition and Importance

Inclusive design is a concept that focuses on designing products, services, and environments that can be used by all groups without requiring special modifications or adaptations. The concept is based on the principle that human diversity is normal and should be accepted from the outset in the design process. This concept not only considers accessibility but also takes into account the diverse needs, backgrounds, and experiences of users. Inclusive design is important in both the physical and digital worlds, focusing on creating friendly and accessible environments for everyone, whether in building design, public spaces, or applications and websites. This concept helps promote social participation and reduce inequality between different groups of people.

Inclusive design is particularly important in today's society for the following reasons:

4.1.1.1 Responding to social diversity: There is increasing diversity in age, gender, ethnicity, culture, and physical abilities.

4.1.1.2 Accommodating demographic changes: With rapidly aging populations worldwide, there is a need to consider designs suitable for older adults.

4.1.1.3 Promoting equality: There is greater awareness of the rights and equality of all groups, leading to the promotion of relevant laws and policies.

4.1.1.4 Utilizing technology: New technologies and innovations open up opportunities for diverse designs that respond to different needs.

4.1.2 Key Principles of Inclusive Design

Inclusive design has the following key principles (Clarkson et al., 2003; Steinfeld & Maisel, 2012):

4.1.2.1 Equitable use: Designing for use by all groups equally, without

Discrimination.

4.1.2.2 Flexibility in use: Accommodating a wide range of individual preferences and abilities.

4.1.2.3 Simple and intuitive use: Designing for ease of understanding, regardless of the user's experience, knowledge, language skills, or current concentration level.

4.1.2.4 Perceptible information: Communicating necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

4.1.2.5 Tolerance for error: Minimizing hazards and adverse consequences of accidental or unintended actions.

4.1.2.6 Low physical effort: Allowing efficient and comfortable use with minimum fatigue.

4.1.2.7 Size and space for approach and use: Providing appropriate size and space for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.

Additionally, Microsoft's Inclusive Design Manual (Microsoft, 2016) suggests that effective inclusive design has three key components:

1) Recognize exclusion: Understand and acknowledge biases that can lead to excluding certain groups from design.

2) Learn from diversity: Incorporate diverse perspectives into the design process.

3) Solve for one, extend to many: Design features with specific groups in mind, then expand the scope to benefit others.

Inclusive design differs from universal design or design for all in that inclusive design emphasizes creating diverse solutions to meet the different needs of users, while universal design focuses on a single solution that works for everyone. Inclusive design is thus more flexible and adaptable, especially in the context of digital products that can be more easily customized than physical products.

4.1.3 Benefits of Inclusive Design

Inclusive design offers several benefits, including:

4.1.3.1 Increasing accessibility and social participation for everyone, especially the elderly and people with disabilities.

4.1.3.2 Reducing inequality and promoting social equity.

4.1.3.3 Improving quality of life and well-being for all population groups.

4.1.3.4 Creating business opportunities by expanding the customer base to include more diverse user groups.

4.1.3.5 Reducing long-term costs by decreasing the need for specific adaptations or designs.

4.1.3.6 Promoting innovation and creativity in design.

4.1.3.7 Building a positive image for organizations as socially responsible.

4.1.3.8 Helping to enhance overall user experience, allowing everyone to access and use digital products effectively.

4.1.3.9 Creating competitive advantage; positioning oneself as a leader in accessibility and inclusion can enhance brand reputation and attract loyal customers.

4.1.3.10 Ensuring compliance with accessibility standards and legal requirements, as many countries have laws mandating digital accessibility, and non-compliance may have legal consequences.

It is evident that the concept of inclusive design is crucial in creating a fair and inclusive society for everyone. This is especially important in the context of Thailand, which is entering a fully-fledged aging society. Applying inclusive design principles will help accommodate the changing needs of the population and effectively promote the quality of life for the elderly and people with disabilities. Moreover, from an economic perspective, inclusive design opens opportunities for Thai entrepreneurs to develop products and services that respond to the diverse needs of consumers, which can help increase competitiveness in the global market. However, the widespread adoption of this global concept in Thailand requires cooperation from all sectors, including government, private sector, and civil society, in raising awareness and seriously pushing for policies.

4.2 The 10 Fingers Model for Inclusive Design

4.2.1 Origin and Main Concepts

The 10 Fingers Model for inclusive design is a conceptual framework developed to present a holistic view of inclusive design across all dimensions of life. It uses all ten fingers as symbols representing key components to consider in the design process. This concept aims to create an understanding that is easy to grasp and remember for those involved in the design process, whether they are designers, policymakers, or general users.

The main concepts of the 10 Fingers Model include:

1) Viewing design in all dimensions, covering everything from the physical environment to humans to the digital world.

2) Interconnection between components: All elements are interrelated and impact each other

3) Integration of concepts from various disciplines, drawing on knowledge and expertise from fields such as architecture, engineering, psychology, sociology, and information technology to create inclusive and effective design.

4) Focus on user experience: Considering the needs, abilities, and limitations of diverse users at every stage of design.

5) Creating an inclusive society: The ultimate goal is to create a society where everyone can participate and access opportunities equally.

.2.2 Components of the 10 Fingers Model

The components of the 10 Fingers Model can be divided into two main parts: those related to the physical environment and those related to human-centered technology. They are represented by fingers on the right and left hands for easy recall, with each finger representing a key component in inclusive design as follows:

Right Hand – Physical Environment

1) Thumb represents Urban Design

2) Index finger represents Landscape Design

3) Middle finger represents Architectural Design

4) Ring finger represents Interior Design

5) Little finger represents Product Design

Left Hand – Human-Centered Technology

6) Thumb represents Users

7) Index finger represents Skills

8) Middle finger represents Smart Devices

9) Ring finger represents Software applications

10) Little finger represents Connectivity

4.2.3 Interconnections Between Components

The uniqueness of the 10 Fingers Model lies in its recognition of the relationships and connections between various components. Important connections include:

4.2.3.1 Urban design and connectivity: Urban planning must consider communication and technology infrastructure to ensure all citizens can access information and services universally.

4.2.3.2 Architectural design and smart devices: Modern buildings must support the use of smart devices, such as automated building control systems or navigation systems for the visually impaired.

4.2.3.3 Product design and people's skills: Products must be designed in accordance with the diverse skills and abilities of users to ensure efficient usage.

4.2.3.4 Software applications and interior design: Interior space design must consider the use of various applications, such as the placement of device charging points or the design of workspaces that support remote meetings.

4.2.3.5 Users and physical environment: Environmental design must consider the diversity of users in terms of age, physical ability, and culture.

The 10 Fingers Model presents a comprehensive and interconnected view of inclusive design, which is particularly important in the context of Thailand, which is facing rapid social and technological

changes. Considering all 10 components in an integrated manner will help develop cities, environments, and products in Thailand that can more effectively respond to the needs of all citizen groups.

For example, in developing mass transit systems in Bangkok, using the 10 Fingers Model would help designers consider both physical infrastructure, such as train stations accessible to wheelchair users, and information technology systems, such as easy-to-use map and timetable applications for the elderly, simultaneously. This would lead to a more inclusive and efficient transportation system for all citizen groups.

Ref: NEC (2024)

However, implementing this model in Thailand may require adaptation to local social and cultural contexts, such as emphasizing the design of public spaces that accommodate Thai cultural activities and traditions, or developing applications that support various local languages, to ensure that inclusive design truly meets the needs of Thai society.

4.3 Details of the Components of the 10 Fingers Model

4.3.1 Urban Design (Right Thumb)

Urban design according to inclusive design principles focuses on creating public spaces that facilitate use by all groups, including people with disabilities, the elderly, or families with young children. Key approaches include (Persson et al., 2015; Steinfeld & Maisel, 2012):

4.3.1.1 Accessibility and mobility: Designing sidewalks with sufficient width, smooth non-slip surfaces, and tactile paving for the visually impaired. Installing traffic signals with both audio and visual cues, setting appropriate crossing times for the elderly.

4.3.1.2 Public spaces and facilities: Providing accessible public toilets with grab bars and sufficient space for wheelchairs. Installing large, clear information signs with Braille information.

4.3.1.3 Participatory planning: Opening opportunities for community involvement in the design process to ensure urban environments reflect the needs of all residents.

Inclusive urban design not only helps promote accessibility for all but also supports human capital development through access to education, healthcare, and employment. It also opens up marketing and employment opportunities and strengthens social connections. Data from the World Bank (2020) shows interesting examples of inclusive urban design, such as the case study of Yokohama, Japan, which developed the Yokohama City Sketch Workshop method to involve citizens in urban planning and design. This method has been applied in other cities like Panama City and Barranquilla, where activities are organized for citizens to visit different areas of the city and brainstorm on how to improve these areas.

Studies have found that inclusive urban design not only makes cities accessible to everyone but also promotes long-term sustainability and resilience of cities, especially in emergency situations such as the COVID-19 pandemic. Well-designed cities can adapt more quickly to crises by converting public spaces into temporary health service points or improving public transportation systems to be safer. Moreover, inclusive urban design aligns with the United Nations Sustainable Development Goals, particularly Goal 11 on sustainable cities and communities (UN, 2015), which aims to make cities safe, resilient, and sustainable for all.

However, implementing inclusive design principles in urban design still faces several challenges, such as policy and regulatory barriers, funding limitations, and the need for specialized knowledge in inclusive design. Overcoming these challenges requires cooperation from government, private sector, civil society, international organizations, and stakeholder representative organizations. Raising awareness and understanding about inclusive design among policymakers and urban planners is a crucial first step in overcoming these obstacles.

4.3.2 Landscape Design (Right Index Finger)

Landscape design according to inclusive design principles aims to create environments that are both functional and aesthetically pleasing for all user groups. Key considerations include:

4.3.2.1 Selection of diverse plant species: Using native plants and low-maintenance species. Employing bright, colorful flowers and fragrant plants. Planting at various levels so wheelchair users can touch and appreciate plants at eye level.

4.3.2.2 Sensory gardens: Incorporating elements that stimulate various senses, such as using fragrant plants and walkways with different tactile surfaces. Using small waterfalls or fountains to create a relaxing atmosphere.

4.3.2.3 Seating that accommodates all users: Designing seating areas that support users with mobility limitations, such as benches with backrests and armrests, and providing seating at different heights.

Inclusive landscape design also promotes social participation and well-being, especially for the elderly and people with disabilities. Accessible green spaces increase opportunities for physical activity and social interaction. However, inclusive landscape design still faces challenges in balancing natural beauty with accessibility, as well as managing budget constraints and maintenance issues. Careful planning and involvement of all stakeholders in the design process are necessary.

4.3.3 Architectural Design (Right Middle Finger)

Architectural design plays a crucial role in creating buildings that everyone can access and use. Key approaches include (Persson et al., 2015; Steinfeld & Maisel, 2012):

4.3.3.1 Barrier-free entrances: Designing ground-level entrances or ramps with a slope not exceeding 1:12. Installing automatic doors or easily operable doors.

4.3.3.2 Flexible spaces: Designing multipurpose rooms that can be adjusted in size and layout. Using easily movable furniture.

4.3.3.3 Clear signage: Installing signs that are easy to read and understand, using symbols and Braille.

A good example of inclusive architectural design can be found in public buildings in Japan, which are designed to be accessible to everyone. For instance, train stations in Tokyo have elevators and ramps for wheelchair users, guidance systems for the visually impaired, and accessible toilets for all.

In Thailand, there have been efforts to promote inclusive architectural design, as evidenced by the Persons with Disabilities Quality of Life Promotion Act, B.E. 2550 (2007), which requires public buildings to provide facilities for people with disabilities, and the Ministerial Regulation on Accessibility for People with Disabilities or Mobility Impairments and the Elderly, B.E. 2548 (2005),

which specifies details of facilities that must be provided in public buildings (Suthida Unjit, 2019).

However, inclusive architectural design still faces challenges in balancing aesthetic beauty with accessibility, as well as managing budget constraints and legal requirements. It is necessary to integrate inclusive design concepts into the design process from the beginning and create a shared understanding among architects, building users, and all stakeholders.

4.3.4 Interior Design (Right Ring Finger)

Interior design according to inclusive design principles focuses on creating spaces that are comfortable and functional for all users. Key considerations include (Persson et al., 2015; Steinfeld & Maisel, 2012):

4.3.4.1 Adjustable fixtures: Installing counters and sinks that can be adjusted in height. Using work desks with adjustable heights.

4.3.4.2 Lighting considerations: Using natural light and adjustable artificial lighting. Installing lighting systems that can adjust brightness and color temperature.

4.3.4.3 Clutter-free layout: Designing open floor plans. Arranging furniture with adequate spacing.

In Thailand, there have been efforts to promote inclusive interior design, especially in residential homes for the elderly, such as designing bathrooms without thresholds, with non-slip floors and grab bars (Suthida Unjit, 2019).

However, inclusive interior design still faces challenges in balancing aesthetics with functionality, as well as managing users' beliefs and cultural practices. For instance, in the case of Thai elderly who believe in Feng Shui, which may conflict with some inclusive design principles (Suthida Unjit, 2019).

4.3.5 Product Design (Right Little Finger)

Product design according to inclusive design principles aims to create objects that are easy to use and accessible for diverse people. Key approaches include (Persson et al., 2015; Steinfeld & Maisel, 2012):

4.3.5.1 Ergonomic tools: Designing tools and equipment that are convenient for users with different levels of strength and dexterity. Ergonomically designed handles help reduce fatigue and injuries from repetitive use.

4.3.5.2 Universal controls: Using control systems that are easy to understand and use. Employing universal symbols.

4.3.5.3 Sustainable materials: Using materials that are not only accessible but also environmentally friendly, such as recycled or biodegradable materials.

In Thailand, there have been efforts to promote inclusive product design, especially for the elderly and people with disabilities. For example, the National Innovation Agency (Public Organization) supports the development of products and services that respond to the needs of the elderly (Suthida Unjit, 2019). However, inclusive product design still faces challenges in balancing functionality with aesthetics, as well as managing potentially higher production costs due to more complex designs. Continuous research and development are necessary, as well as raising consumer awareness about the importance of inclusive products.

The integration of universal design, inclusive design, and design for all concepts into various aspects of design is not only beneficial for people with disabilities and the elderly but for everyone in society. It has been found that "what is necessary for some groups to use a product often makes it more efficient for most people" (Suthida Unjit, 2019).

4.3.6 Users (Left Thumb)

Inclusive design emphasizes the diversity of users, recognizing that each user has different abilities and limitations, which may arise from permanent disabilities, age-related conditions, or temporary limitations (Microsoft 2016; Microsoft, 2023). Key considerations include:

4.3.6.1 Physical disabilities: Designs must consider supporting various technologies and assistive devices, such as screen readers for those with visual impairments, captions or sign language for those with hearing impairments, and input devices like switches or joysticks for those with mobility limitations.

4.3.6.2 Cognitive and learning differences: Users may have differences in perception and learning, affecting how they process information and interact with user interfaces. For example, users with autism may be more sensitive to sensory inputs and require simpler, less cluttered interfaces.

4.3.6.3 Cultural and linguistic differences: Inclusive design must consider cultural and linguistic differences, such as using universally understood symbols and supporting multilingual display and input.

Considering user diversity in design not only makes products or services accessible to everyone but also increases market opportunities and business potential. A study by Accenture (2018) found that companies with good diversity and inclusion practices are more likely to be innovative and perform twice as well as their competitors.

4.3.7 Skills (Left Index Finger)

Inclusive design not only focuses on creating accessibility but also emphasizes empowering users by providing tools and interfaces that align with diverse learning models and individual abilities (Microsoft, 2016; Microsoft, 2023). Key considerations include:

4.3.7.1 Supporting diverse learning models: Presenting information in text, audio, and visual formats to support those who learn through reading, listening, and seeing. Including interactive and hands-on experiences for kinesthetic learners.

4.3.7.2 Supporting learning and skill development: Providing guidance and assistance during use, allowing users to learn and practice new skills. Offering constructive feedback to promote progress in usage.

4.3.7.3 Customization based on ability levels: Designing simple interfaces for beginners but allowing expansion of advanced features for more experienced users. Presenting intelligent recommendation systems that adapt to each user's behavior.

4.3.7.4 Promoting collaboration and knowledge sharing: Creating spaces or platforms that encourage knowledge and experience exchange. Designing features that support real-time collaboration.

Considering the diverse skills and abilities of users in design not only helps make products or services accessible to everyone but also promotes lifelong learning and continuous skill development, which is crucial in an era of rapid technological change.

4.3.8 Smart Devices (Left Middle Finger)

Smart devices are crucial in creating accessible and user-friendly environments for all groups. Designing smart devices according to inclusive design principles should consider the following issues:

4.3.8.1 Physically accessible design: Using large, clearly tactile control buttons. Designing shapes that are easy to hold for those with hand mobility limitations. Using non-slip and durable materials.

4.3.8.2 Customizable user interfaces: Providing options to adjust font size, color, and contrast. Supporting voice and gesture control. Using themes and display modes suitable for different environments and times (Apple, 2023).

4.3.8.3 Connectivity with accessories and assistive technologies: Supporting various connection standards. Developing open interfaces for accessory developers.

Supporting standard communication protocols for assistive technologies (Apple, 2023).

4.3.8.4 Security and privacy: Using diverse and accessible authentication systems. Providing security and privacy information in easily understandable formats. Designing clear and easily controllable privacy settings (Apple, 2023).

Designing smart devices according to inclusive design principles not only helps all user groups access and use technology effectively but can also create innovations beneficial for general users. Pullin's (2009) study shows that designing for users with special needs often leads to innovations useful for everyone, such as the development of voice messaging systems that started from the needs of the hearing impaired but have become widely used technology today.

4.3.9 Software Applications (Left Ring Finger)

Software applications are crucial in creating accessible and efficient user experiences for all user groups. Designing applications according to inclusive design principles should consider the following issues:

4.3.9.1 Accessible user interface design: Using consistent and predictable structures and layouts. Using appropriate colors and contrasts. Using easily understandable icons and symbols with clear meanings. Designing controls of appropriate size for use on touch devices (Microsoft, 2016; Microsoft, 2023).

4.3.9.2 Supporting assistive technologies: Supporting use with screen readers. Using appropriate HTML structures for keyboard navigation. Providing alternative descriptions for non-text content such as images and videos (Google, 2023).

4.3.9.3 Customization and configuration: Providing options to customize the interface, such as font size, color, and layout. Allowing customization of shortcuts and automation according to user needs. Storing and synchronizing settings across devices (Microsoft, 2023).

4.3.9.4 Responsive design: Using flexible and scalable layouts according to screen size. Adapting display and functionality to suit each device type. Supporting both portrait and landscape modes (LePage & Andrew, 2019).

Designing software applications according to inclusive design principles not only helps all user groups access and use them effectively but can also create better user experiences in general.

4.3.10 Connectivity (Left Little Finger)

Connectivity is a crucial factor that links the physical world and personal

experiences. In the context of inclusive design, it covers the ways users can access information and services through various devices and platforms (Microsoft, 2023). Key considerations include:

4.3.10.1 Connectivity between diverse devices: Responsive design to support different screen sizes. Synchronization of data and settings across devices. Supporting continuity of work across devices (Apple, 2023).

4.3.10.2 Supporting various assistive technologies: Using accepted accessibility standards such as WCAG (Web Content Accessibility Guidelines). Testing compatibility with various assistive technologies. Providing options to customize connectivity to suit individual user needs (W3C Web Accessibility Initiative, 2020).

4.3.10.3 Social connectivity: Remote meeting platforms and social media designed to allow all user groups to access and participate equally, especially those with hearing and visual impairments. For example, Zoom has important accessibility features such as auto-captioning for the hearing impaired and screen readers for the visually impaired (Zoom, 2023).

4.3.10.4 Public service connectivity: Developing online government service platforms accessible from all devices. Users can make appointments and track service status in real-time. Additionally, developing applications for reporting community issues and tracking resolutions efficiently. Examples in European countries show the development of platforms focused on accessibility for all, to increase efficiency in digital government services and enhance citizen participation (European Commission, 2023).

4.3.10.5 Workplace connectivity: Developing collaborative work platforms that support remote access and diverse devices. Creating document and information management systems accessible to all user groups. Developing communication tools that support text-to-speech and speech-to-text conversion, such as auto-captioning and live captions in Zoom, which help convert speech to text, allowing users to access conversations and remote meetings efficiently from various devices (Zoom, 2023).

Designing inclusive connectivity is crucial in creating an equitable and accessible digital society for everyone. Considering how users with different abilities and needs can interact with technology and access various services efficiently will help reduce the digital divide and promote social participation.

4.4 Impact and Importance of Inclusive Design

4.4.1 Impact of Inclusive Design

Inclusive design has impacts and importance in multiple dimensions, affecting people's quality of life, economy, society, and environment, as follows:

4.4.1.1 Impact on quality of life: Inclusive design helps improve the quality of life for all groups, especially people with disabilities and the elderly. A study by Carnemolla and Bridge (2019) found that home improvements based on inclusive design principles can reduce caregiver burden by up to 40% and significantly increase caregiver job satisfaction. It also increases independence and confidence in daily living for the elderly and people with disabilities (Mackelprang & Salsgiver, 2016).

4.4.1.2 Economic impact: Inclusive design not only benefits users but also creates new business opportunities. A study by Accenture (2018) found that companies with good diversity and inclusion practices are more likely to innovate and perform twice as well as their competitors. Meanwhile, Erlandson (2007) points out that using these principles can increase market share by up to 25% by responding to the needs of a more diverse consumer base.

4.4.1.3 Impact on social participation: Inclusive design promotes social participation for everyone, especially groups often excluded from society. Bayor et al. (2019) found that using accessible social media platforms can support the development of social and digital skills in adults with intellectual disabilities, resulting in increased opportunities to create and maintain social relationships. This is a crucial factor in reducing isolation and promoting social participation. Moreover, the development of accessible online government services can significantly increase citizen participation in democratic processes. Providing inclusive services tailored to different contexts is a key factor in promoting citizen participation.

4.4.1.4 Impact on innovation: Design that considers user diversity often leads to innovations beneficial for everyone. Pullin (2009) demonstrates that designing for users with special needs often leads to innovations useful for everyone, such as the development of voice messaging systems that started from the needs of the hearing impaired but have become widely used technology today.

4.4.1.5 Environmental impact: Inclusive design can also promote environmental sustainability. Rossi et al. (2016) found that using environmentally friendly materials in product manufacturing can increase consumer satisfaction by more than 30% and create a positive brand image. Additionally, Cooper (2010) found that designing

easily repairable products according to inclusive design principles can extend product lifespan by an average of 2-3 years, significantly reducing electronic waste.

4.4.2 Importance of Inclusive Design in Creating an Inclusive and Sustainable Society

4.4.2.1 Creating an equitable society: Inclusive design is an important tool in creating an equitable and fair society by reducing barriers and increasing access opportunities for everyone (Clarkson et al., 2003).

4.4.2.2 Accommodating demographic changes: In societies entering an aging population, inclusive design is crucial in accommodating the changing needs of the population (World Economic Forum, 2020).

4.4.2.3 Promoting innovation and business competitiveness: Inclusive design not only benefits users but also creates new business opportunities and promotes business competitiveness (Microsoft, 2016).

4.4.2.4 Supporting sustainable development: Inclusive design aligns with the United Nations Sustainable Development Goals, particularly Goal 10 on reducing inequalities and Goal 11 on sustainable cities and communities (UN, 2015).

4.4.2.5 Increasing efficiency and quality of products and services: Design according to inclusive design principles often leads to higher quality products and services for all users (Steinfeld & Maisel, 2012).

Finally, systematic measurement and evaluation are important in tracking progress and improving the implementation of inclusive design in Thailand. Appropriate indicators for the country's context should be developed, with regular reporting to ensure continuous improvement. Effective implementation of inclusive design in Thailand will help create an equitable and accessible society for all, promote sustainable economic and social development, and improve the quality of life for all population groups, aligning with the country's long-term development goals.

4.5 Relevant Laws and Policies

4.5.1 The Constitution of the Kingdom of Thailand B.E. 2560 (2017) promotes equality and protection of rights for all people, including people with disabilities and the elderly.

4.5.2 The National Digital Economy and Society Development Policy and Plan, which is the main master plan for digital economy and society development in Thailand for a 20-year period (2018-2037). It aims to drive the country towards a sustainable digital economy and society. One of the key strategies is Strategy 3: Building a

Quality Digital Society, which focuses on using digital technology to create an inclusive and equitable society. In particular, it emphasizes developing people with disabilities to be able to access and benefit from various government services through digital technology, promoting the participation of all groups in the digital society and helping to reduce social inequality (Office of the National Digital Economy and Society Commission, 2018).

4.5.3 Persons with Disabilities Empowerment Act, B.E. 2550 (2007) emphasizes creating a friendly environment and supporting people with disabilities. Section 20(6) stipulates the rights of persons with disabilities to access and utilize facilities, with the state playing a crucial role in providing assistance in welfare and such support.

4.5.4 Ministerial Regulation on Prescribing Criteria for Access to and Utilization of Information, Communication, and Telecommunication Services for Persons with Disabilities, B.E. 2554 (2011), issued under the Persons with Disabilities Empowerment Act, B.E. 2550 (2007). This regulation aims to create equality in access to information and technological services for people with disabilities in Thai society. It requires government agencies and private entities receiving state funding to provide information and services in formats accessible to people with disabilities. It also mandates the Office of the Permanent Secretary of the Ministry of Information and Communication Technology to provide or lend technology to people with disabilities and arrange training for people with disabilities and caregivers to enhance skills in accessing information and various services free of charge.

4.5.5 Ministerial Regulation Prescribing Facilities in Buildings for Persons with Disabilities or Mobility Impairment and the Elderly B.E. 2548 (2005) and B.E. 2555 (2012) sets standards for building design and facilities to accommodate the use by persons with disabilities and the elderly.

4.6 Obstacles and Challenges in Promoting Inclusive Access to Physical Environment and Digital Technology

Obstacles and challenges in promoting inclusive access to physical environment and digital technology include:

4.6.1 Limited knowledge and understanding: Stakeholders involved in urban community design and development still have insufficient understanding of the inclusive design concept.

4.6.2 Lack of strict law enforcement and follow-up: Although there are clear laws,

enforcement in many areas remains lax. For instance, with ministerial regulations concerning facilities in buildings for the elderly and persons with disabilities, it is found that construction in many areas does not strictly comply with the requirements, resulting in discontinuity and lack of comprehensiveness.

4.6.3 Budget and resource issues: Many agencies, especially local authorities, face financial and resource constraints, making it impossible to develop facilities comprehensively.

4.6.4 Participation of all sectors: Designing an environment friendly to everyone requires a participatory process from all sectors, which has not yet fully occurred in many areas.

4.6.5 Limitations in internet access for vulnerable groups, which is the main channel for accessing information and various services.

4.6.6 Lack of standards in developing websites and applications to be accessible for people with disabilities.

4.6.7 Law enforcement may not cover all private entities, as the ministerial regulation specifies only "agencies receiving budget support from the state," and the policy of lending equipment may not fully meet the needs of people with disabilities as equipment must be returned when due (Ministerial Regulation on Prescribing Criteria for Access to and Utilization of Information, Communication, Telecommunication Services, Information and Communication Technology, Assistive Technology for Communication, and Public Media Services for Persons with Disabilities, B.E. 2554 (2011), 2011).

5. Conclusion

Inclusive design has significant positive impacts on quality of life, economy, social participation, innovation, and the environment. Moreover, it is important in creating an equitable society, accommodating demographic changes, promoting business competitiveness, supporting sustainable development, and increasing the efficiency of products and services.

In the context of Thailand, while there has been progress in implementing inclusive design in many sectors, challenges remain in expanding its application throughout the country, especially in rural areas and small towns. Raising awareness and educating designers, policymakers, and the general public is crucial in driving concrete change in Thai society. The implementation of inclusive design principles in Thailand must also consider cultural factors and local environments, such as designing with consideration for Thai elderly people's beliefs in Feng Shui or developing applications that support local languages and languages of neighboring countries to reach more diverse user groups.

Furthermore, promoting inclusive design in Thailand should focus on building cooperation between government, private sector, and civil society to develop solutions that effectively respond to the needs of diverse users. Developing skills and expertise of Thai designers and developers in inclusive design is another important issue that should be promoted.

In terms of policy, reviewing and improving laws and standards related to accessible design for all should be carried out continuously to align with technological changes and evolving user needs. Additionally, creating tax incentives or benefits for organizations implementing inclusive design could be another approach to promote the widespread adoption of this concept.

This article has presented the "10 Fingers Model" for inclusive design, which is a holistic view of inclusive design covering both physical and digital dimensions, aligning with the needs of an era facing demographic and technological changes. Applying this concept in the design of urban communities, buildings, products, and services will help create environments conducive to the lives of all groups, leading to an equitable and accessible society for everyone.

In the context of Thailand, promoting inclusive design is particularly important in accommodating an aging society and sustainable development. However, the widespread implementation of this concept still faces challenges, especially in terms of understanding, social acceptance, and limitations in resources and policies.

The analysis indicates that raising awareness and educating designers, policymakers, and the general public is crucial in driving concrete change. Moreover, integrating this concept into educational curricula in design and architecture will help create a new generation of designers who understand and recognize the importance of inclusive design.

Promoting inclusive design is not only ethically correct but also a smart business decision as it helps expand the customer base, increase user satisfaction, and create a positive image for organizations. Investing in inclusive design is thus an investment for a sustainable and equitable future.

6. Recommendations

Based on the study and analysis of the inclusive design concept along with the 10 Fingers Model, the following recommendations are made:

6.1 Recommendations for Future Research

Further studies should be conducted on the following issues:

6.1.1 Quantitative research should be conducted to assess the impact of inclusive design in Thailand using concrete indicators such as access rates to public services, user satisfaction levels, and economic returns.

6.1.2 Comparative studies of inclusive design policies and practices between Thailand and other ASEAN countries should be conducted to exchange lessons and best practices.

6.1.3 Participatory action research should be conducted to develop inclusive design models appropriate for local community contexts in Thailand.

6.1.4 Studies on the impact of inclusive design on smart city development in Thailand and approaches to integrate this concept into urban development policies should be conducted.

6.1.5 Economic cost-benefit analysis of long-term investment in inclusive design should be conducted to create incentives for private and public sectors to implement this concept.

6.1.6 In-depth studies on the development of inclusive design curricula in Thai educational institutions should be conducted to prepare personnel to meet future needs.

6.1.7 Further studies using quantitative data and field research should be conducted, which could be topics for future research.

6.2 Policy Recommendations for Digital Communications

6.2.1 Awareness Creation and Education

6.2.1.1 Campaigns should be conducted to raise awareness about the importance of inclusive design.

6.2.1.2 Inclusive design curricula should be incorporated into both vocational and higher education systems.

6.2.2 Policy and Legal Development

6.2.2.1 Laws and regulations related to building design, public spaces, and products should be updated to align with inclusive design principles.

6.2.2.2 Inclusive design standards should be established for both public and private sector projects.

6.2.3 Law Enforcement and Evaluation

Systematic monitoring and evaluation approaches should be developed, including supporting local agencies in creating collaborative networks to ensure that facility design complies with laws and responds to the needs of all groups, especially the

elderly and people with disabilities.

6.2.4 Promotion of Research and Development

6.2.4.1 Budget should be allocated to support research and development of innovations in inclusive design.

6.2.4.2 Collaboration between government, private sector, and educational institutions should be promoted to develop solutions that respond to the needs of Thai society.

6.2.5 Economic Incentives

6.2.5.1 Tax benefits should be provided to organizations that implement inclusive design principles in developing products and services.

6.2.5.2 Small and medium-sized enterprises should be supported in improving their products and services to be more accessible.

6.2.6 Infrastructure Development

6.2.6.1 Investment should be made in improving public infrastructure to be accessible for everyone, especially in rural areas and small cities.

6.2.6.2 Accessible and interconnected public transportation systems should be developed nationwide.

6.2.7 Usage Skill Development

Online learning platforms should be developed for training in information and communication technology use for vulnerable groups such as the elderly, people with disabilities, caregivers, and related individuals.

6.2.8 Promotion of Community Participation

6.2.8.1 Community participation in the design and development process of public projects should be supported.

6.2.8.2 Advisory committees on inclusive design should be established at local and national levels.

6.2.9 Development of Monitoring and Evaluation Systems

6.2.9.1 Indicators and monitoring systems should be developed to evaluate the implementation of inclusive design principles at the national level.

6.2.9.2 Annual reports on progress in creating an accessible society for all should be prepared.

6.2.10 Law Enforcement and Follow-up

Systematic monitoring and evaluation approaches should be developed, including supporting local agencies in creating collaborative networks to ensure that facility design complies with laws and responds to the needs of all groups, especially the elderly and people with disabilities.

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