Sustainability via Adaptability:
Learning from the Traditional Thai House's Built-for-Change Architecture
สรรค์สร้างสำหรับปรับเปลี่ยน:
ความยั่งยืนผ่านความสามารถในการปรับตัวของเรือนไทย

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Abstract

Adaptive reuse plays an important role in safeguarding the traditional Thai house, or *Ruen Thai*, by appropriately converting the time-honored architectural fabrics to efficiently fulfill new requirements and ensure their practicality and compatibility with today's context. This paper studies converted traditional Thai houses, and addresses embedded adaptive qualities that facilitate physical and functional modifications. The qualities not only contribute to the conservation of *Ruen Thai*, but their potential applications in contemporary designs can also encourage environmentally sustainability. Revealed through structures undergone adaptive reuse procedure, the adaptability is articulated via five key attributes: the prefabricated structure that allows dismantling, relocation and reassembly of components; the modularity and neutrality of house units that retain the compound integrity; the interconnectivity of the central terrace that accommodates an addition of house units; the use of a single room for a single function that provides flexibility of conversions; and, the potential unoccupied areas on the ground floor, the veranda and the terrace that can be enclosed for additional functional spaces. The built-for-change qualities enhance the architecture's performance and prolonging its operational lifetime, while acknowledging creative changes. At the same time, the adaptability allows a reuse of existing resources and a reduction of extra consumptions and investments needed for new constructions.

บทคัดย่อ

การดัดแปลงเพื่อประโยชน์ใช้สอยแบบใหม่มีบทบาทสำคัญในการอนุรักษ์เรือนไทยเพื่อให้ดำรงอยู่สืบไป โดยการปรับอาคารเก่าที่ยังทรงคุณค่านั้นให้เกิดประโยชน์ใช้สอยตอบรับกับบริบทแวดล้อมและความต้องการที่เปลี่ยนแปลงไป บทความนี้วิเคราะห์กรณีศึกษาเรือนไทยเก่าที่ถูกดัดแปลงประโยชน์ใช้สอย พบว่า คุณสมบัติในการปรับเปลี่ยนได้และการรองรับการเปลี่ยนแปลงภายนอก ซึ่งมีอยู่แล้วในสถาปัตยกรรมของเรือนไทย มีส่วนสนับสนุนให้เกิดการดัดแปลงได้โดยง่าย และมีประสิทธิภาพบนรากฐานของการเคารพอัตลักษณ์ดั้งเดิมของสถาปัตยกรรม ซึ่งไม่เพียงแต่เอื้อต่อการอนุรักษ์อาคารเท่านั้น แต่มีศักยภาพที่จะนำไปประยุกต์ใช้เพื่อการให้เกิดความยั่งยืนทางสภาพแวดล้อม ความสามารถในการปรับเปลี่ยนของเรือนไทยแสดงออกผ่านคุณสมบัติ 5 ประการหลัก อันประกอบด้วย โครงสร้างที่สามารถถอดรื้อ ย้ายที่ตั้งและปลูกขึ้นใหม่ได้ ความเป็นอันหนึ่งอันเดียวกันของหมู่เรือนจากการใช้ระบบพิกัดและรูปลักษณ์กลมกลืนของแต่ละเรือน การเชื่อมโยงพื้นที่ต่างๆ ด้วยชาน ซึ่งรองรับการขยายตัวของครอบครัวและบ้านโดยการเพิ่มจำนวนเรือน การแยกการใช้สอยของแต่ละ

เรือนออกจากกันในลักษณะ 1 ห้องต่อ 1 การใช้สอยหลัก และพื้นที่กึ่งโล่งที่สามารถปิดล้อมเพื่อการใช้งานที่เหมาะสม ได้แก่ พื้นที่บริเวณใต้ถุนเรือน ระเบียงและชานเรือน คุณสมบัติการสรรค์สร้างเพื่อปรับเปลี่ยนจากองค์ประกอบเหล่านี้ ช่วยเพิ่มประสิทธิภาพและช่วยยืดอายุการใช้งานของอาคารด้วยการเปิดรับการเปลี่ยนแปลงอย่างสร้างสรรค์ และเอื้อให้เกิดการใช้สอยทรัพยากรที่มีอยู่แล้วอย่างยั่งยืน เพื่อทดแทนการบริโภคและการลงทุนจากการก่อสร้างอาคารใหม่

Keywords (คำสำคัญ)

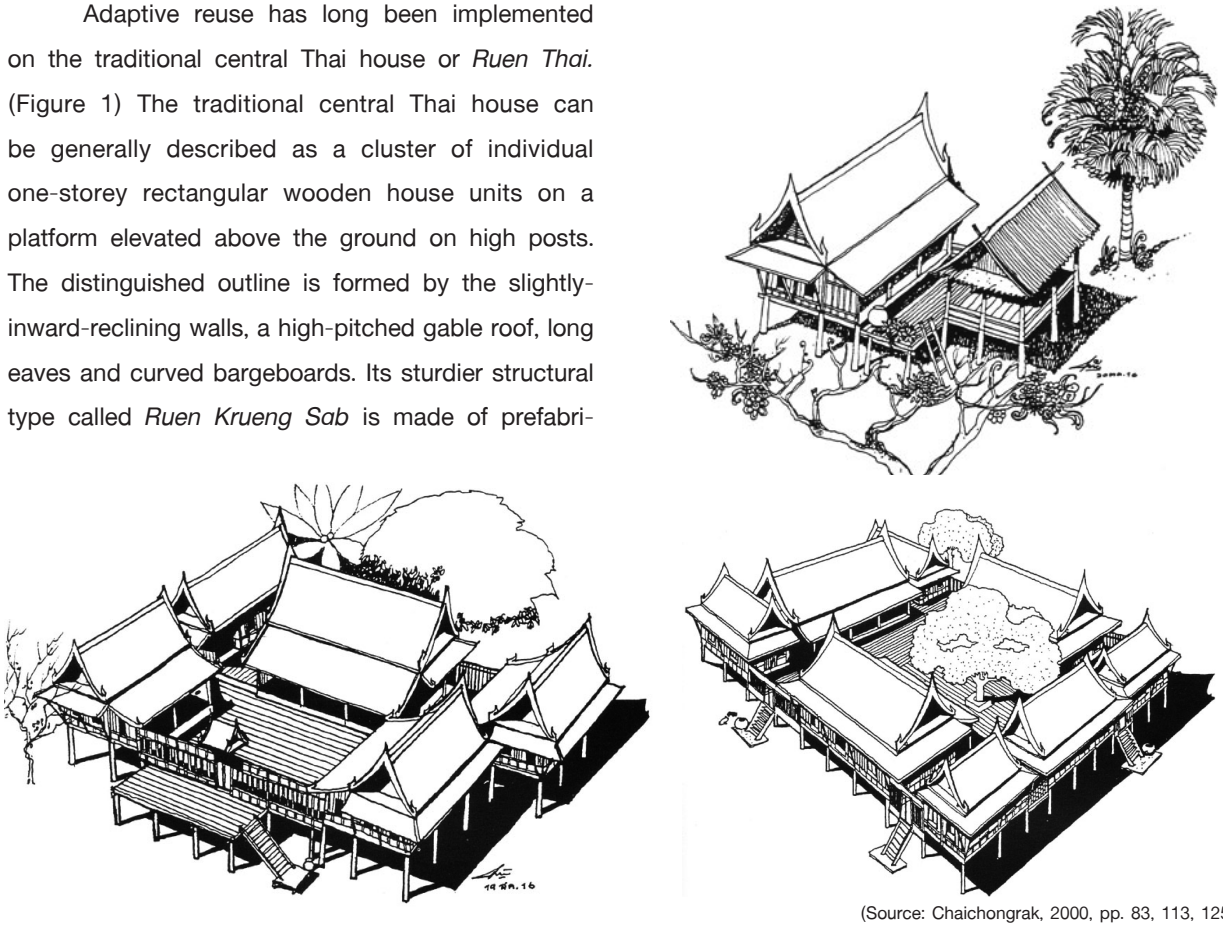
Adaptability (ความสามารถในการปรับตัว)
Adaptive Reuse (การปรับประโยชน์ใช้สอย)
Built for Change (การสร้างเพื่อรองรับการเปลี่ยนแปลง)
Sustainability (ความยั่งยืน)
Architectural Conservation (การอนุรักษ์สถาปัตยกรรม)
Traditional Thai House (เรือนไทย)

1. Introduction: The Scenario

Adaptive reuse or adaptive use refers to an intervention in which old buildings are protected by adapting them to fit changing requirements in response to users, functions, contexts and related criteria. Inactive roles are updated in the process by means of functional conversion. At the same time, varying physical modifications conformable to the new uses are frequently introduced. Benefits of the treatment not only contributes to historic preservation, but also environmental sustainability for re-utilization of existing structures and reduced consumption of resources otherwise required to build an entirely new building to serve equivalent purposes. Economic and social aspects of sustainability, although not usually emphasized, are consequently promoted by the practice through the maintained way of life and urban dynamicity.

Adaptive reuse has long been implemented on the traditional central Thai house or *Ruen Thai.* (Figure 1) The traditional central Thai house can be generally described as a cluster of individual one-storey rectangular wooden house units on a platform elevated above the ground on high posts. The distinguished outline is formed by the slightly-inward-reclining walls, a high-pitched gable roof, long eaves and curved bargeboards. Its sturdier structural type called *Ruen Krueng Sab* is made of prefabricated hardwood components specially shaped to fit with adjacent members at joints that can be dismantled and reassembled when needed. Domestic spaces flow from the inner room and the attached semi-outdoor verandah of each house unit to the more public central terrace which connects house units together. The bigger family size, the larger the house cluster becomes by adding more house units. Also, the larger and the more elegant house, the wealthier and higher ranked owner it identifies.

Past applications of adapted Thai houses were usually resulted from the needs to relocate and repurpose the architecture, in particular to serve house expansion for family's changing situations and requirements. However, modern applications mainly aim to resolve *inconvenient* characteristics that challenge contemporary requirements, while they indirectly articulate cultural identities and address the Thai house's gradual decline that may eventually



(Source: Chaichongrak, 2000, pp. 83, 113, 125)

Figure 1. Various compound arrangements of the Thai house: from a single-family house (upper right) and a larger-family clustered house (lower right) and the wealthy family 'Ruen Khahabodi' compound.

lead to the risk of extinction (Rujivacharajul, 1999; Pansoonthorn,1990, pp. F1, F3). Through these practices, extensive design alternatives of building configurations and functional adaptations based on the original architecture have emerged, yet certain shared characteristics of the varied interpretations can be observed. Most often than not, the physical qualities of the Thai house architecture have facilitated the modifications one way or another. This scenario has formed a hypothesis about the nature of the Thai house in that its adaptability promotes functional conversion and eventually contributes to the sustainability of the architecture.

2. Research Objectives and Methods

This paper is established on one of the principal investigations and findings from a research study, "Dismantle, Reassemble, and Modify: an Adaptive Reuse of the Traditional Thai House" (Ramasoot, 2008). which investigated the role of adaptive reuse as a potential means to prolong the life of the traditional Thai house in the central region of Thailand. The paper aims to address the linkage between adaptability and environmental sustainability, using the traditional Thai house and its adaptive qualities as a model. It essentially raises a question: *what* are the original qualities of the traditional Thai house that encourage its adaptability? Research data was collected from general studies and surveys of at least 15 converted traditional central Thai houses, and primarily via detailed examinations and a comparative analysis of three main case studies. The case studies were selected from the hardwood *Ruen Krueng Sab* traditional Thai houses in Bangkok and its vicinity that are still in use, are over fifty years old and have undergone functional conversions and physical modifications. Data collection was based on survey, observation of physical conditions and user behaviors, interviews with house owners, users and architects, and literature review. The case studies share a comparable scale but are diverse in history, acquisition, purpose and physical conditions, especially levels of adaptation, as follows (Table 1, Figure 2):

Table 1. Comparison of converted traditional Thai house case studies.

	M.R. Kukrit Pramoj's House	**Nipa Krupaisarn's House**	**Ruen Mallika Restaurant**
origin of old house structures	5 Thai house units from Bangkok & Ayutthaya	5 Thai house units from Samutprakarn	1 on-site & 1 house unit from Ayutthaya
new structures	2 Thai house units	n/a	a concrete kitchen structure & toilets
acquisition of Thai house unit	purchase in different occasions	family inheritance	with land lease & purchase
functional conversion(s)	contemporary house / house museum / office	contemporary house	Thai restaurant

Figure 2. M.R. Kukrit Pramoj's house (left), Nipa Krupaisarn's Baan Boran house (middle), and Ruen Mallika restaurant (right).

1) *M.R. Kukrit Pramoj's residence a.k.a. the House in Soi Suan Plu, Bangkok:* a house complex consisting of three old house units of different ages from Bangkok and Ayutthaya and two new units rebuilt and built in the site during 1960-1981, with occasional modifications afterwards until a major transformation and conversion into M.R. Kukrit's house museum following his death in 1995.

2) *Nipa Krupaisarn's "Baan Boran" house, Samut Prakarn*: a two-unit compound has been reassembled and modified in 1993 from Nipa's great grandparents' five-unit house originally built in 1892 on another site, with several alterations to serve contemporary needs including untraditionally enclosed ground floor and additional interior staircase that bonds the two units together.

3) *Ruen Mallika restaurant, Bangkok:* an upscale Thai restaurant in which dining spaces are distributed in the pre-existing 150-year-old traditional Thai house; restaurant facility additions consisting of a separate old Thai house relocated from Ayutthaya now functioned as a reception hall and souvenir shop, a one-story plain concrete box of the kitchen and a new masonry toilet structure attached to the main house.

This paper will review the implementation of adaptive reuse and the concept of built-for-change architecture in general. The two approaches are connected and contribute to environmental sustainability. The paper later identifies the emerging pattern of adaptability in the converted traditional Thai house revealed in the research study. These adaptable architectural qualities not only facilitate adaptive reuse of the traditional architecture for historic and cultural purposes, but show potential in application in other contemporary designs towards sustainability of the architecture through adaptability as well.

3. Sustainability through Adaptive Reuse and Built-for-Change Concepts

Acknowledging building life cycle is a fundamental principle of sustainable architectural design. The basic method entails the understanding of building growth and decline after they are built, and the efficient use of existing resources, either materials or entire structures. In a correlated effort to prepare for the predictable and unexpected changes in advance, designing flexible or adaptable architecture addresses the happenings by facilitating modifications and encouraging active uses.

Adaptation is a common form of transformations that reflects cultural changes and human nature's achievements to increase freedom from the limitations of his habitat (Cohen, 1968, pp. 40-41). Building adaptation, commonly known today as Adaptive Use or Adaptive Reuse, are essentially part of the history of architecture and civilization (Fitch, 1995, p. 165; Vale, B. & Vale, R., 1991, pp. 107-127). Architects modify, transform or convert architecture at varying levels as if it is a palimpsest that has been erased and built over with layers of newer forms and stories but ultimately marries memory and anticipation, as well as time and space (Robert, 1989, p. 6). Building adaptation regardless of level suggests growth and changes of its users, functions, contexts and conditions. It seeks out for opportunities to recreate extant architectural fabrics and facilitate utilization of space beyond existing boundaries of original designs and enables individualization and optimal performance to fulfill current and future requirements. The so-called divergent treatment promotes a balanced integration of conservation and development through transformations based on an appropriate functional application different from its original use (Horayangura, 2009, pp. 3-21). Among its most difficult challenge is to retain building integrity of meaning and value that is expressed through style, workmanship, setting or location, materials, building type or function and continuity (Murtagh, 1997, pp. 116-124).

In general, needs for building recycling has initially emerged from its economic and functional benefit to save budget for new investment by making use of existing structures. It was until after World War

II when the labor-intensive remodeling of obsolete buildings was considered costlier than starting over with new up-to-date construction. As romantic concepts in historic preservation of built heritage emerged in the nineteenth century, old buildings were protected especially for irreplaceable actual fabrics, authenticity and nostalgic memory of the past. From there, approaches in historic preservation developed and expanded. Old structures have gradually been realized to encompass not only historic and artistic significance but also structural, economical, scenographical and sentimental value (Fitch, 1995, p.165). Presently, adaptive reuse is extensively employed to bring "dead" and "obsolete" structures back to life through physical alternations and introduction of active uses. Examples vary in levels of significance from national monuments to even ordinary, plain old buildings. Preservation strategies in many countries including the United States promote economic viability of adaptive reuse projects through additional benefits of tax credits, special ordinances, financial loans or grants, and other local and state incentives, which successfully stimulate private investment on the practice (Gause, 1996). In contrast to its original cost reduction objective, it is found that overall cost of repurposing of obsolete buildings today may not be necessarily lower than regular constructions despite generally less capital to start projects. The cost depends largely on the old structure's condition as well as current economic condition and cycles of real estate values (Fitch, 1995, pp. 165-183; Bloszies, 2012, pp. 29-32). Certain studies have also noted the higher labor employment per structure in adaptive reuse projects than that of new construction projects due to work complication (Fitch, 1995, p. 179).

Nevertheless, building reuse today is exercised no longer for financial feasibility, historic and artistic/architectural purposes alone. Its current concept and practice also concern environmental sustainability benefits for both the specific building and its urban context. In terms of individual benefit, environmental sustainability is achieved from reduced energy consumption through recycled materials and resources, shorter construction period, less use of heavy machinery and frequently the thoughtful structures that were originally designed to use natural light and ventilation. (Fitch, 1995, p. 179). Reduce, recycle and reuse has been among major ecological design principles, owing primarily to resource conservation and consequently to reduced environmental impact and minimized energy consumption otherwise required to produce, transport, construct, install and maintain new materials as well as disposal of waste (Zeiher, 1996, pp. 123-127). Reusing existing buildings which involves reuse of space and materials appears to be the most radical opportunity for multi-dimensional utilization of old materials and conserve embodied energy, from recycled and reused deconstructed materials, to building parts and entire structure. In terms of urban sustainability, adaptive reuse of extant structure generates larger impact by maintaining urban dynamism. Following the Smart Growth concept that encourages high density, mixed-use urban developments within existing framework instead of city expansion, utilizing existing fabrics provokes control of urban sprawl and promotes liveliness of the city (Bloszies, 2012, pp. 34-35). A good mixture of buildings from different ages and conditions offer visual, social, economic and commercial diversity and dynamicity to a city (Jacobs, 1992, pp. 186-189). Rehabilitation of old buildings in rundown area not only saves the neighborhood by reviving it, but it also frequently draws commercial value, work and life to its residents.

In order to achieve new requirements, adaptive reuse treats existing buildings through the interplay of functional conversion and physical modifications. However, for historically-significant buildings, wrong choice of interventions may radically harm or alter original fabrics which are pertinent to overall qualities along the process. In the worst case scenario, this may lead to a permanent loss of the building's historical essence inhabited in the irreplaceable patina of age (Murtagh, 1997, pp. 116-124). For

regular buildings, difficulty to alter structure, space and elements may prevent the reuse of obsolete buildings or diminish their efficiency. Here, the built-for-change design approach emerges to address and facilitate transformations over the building life. In contrast with built-to-last approach where constructions are aimed toward permanence, durability and perfection, built-for-change approach conforms to the insight that changes in built environment are typical and unavoidable. Therefore, possible damages to original structures caused by varying degrees of physical modifications can be avoided. To acknowledge building changes as well as avoid drastic modifications and waste from demolition and construction, adaptation-friendly or adaptive building design pays attention to holistic building design fundamentals to allow flexibility and adaptability from process, budget, technology, configuration, spatial arrangements to material selection and structure. Among design methods to let buildings learn over time are avoidance of short-term aesthetic fashion, choice of technology that blends with buildings, flexible spatial arrangement, use of adaptable and recyclable timber frame structure, and configurations based on simple composition of rectangles while allowing complications to gradually develop with time.

In addition, in parallel to Built-for-Change approach, Design for Disassembly (DfD) also addresses ecological life cycle of products where repair, recycle and refurbishment are necessary at later phases. Independence and exchangeability of building parts play a major role as indicators of disassembly which could be achieved through design provision for physical connections, assembly sequences, joinery techniques and the geometry of components (Yeang & Spector, 2011). Modular design, open and dynamic building reconfigurable configurations and easily disassembled parts are among techniques that lead to transformable buildings in which structural and spatial systems contribute to physical and functional conversion. Dependence between function and physical configuration must be reduced while their flexibility must be addressed to allow different arrangements in response to changing functional requirements.

4. The Adaptable Nature of the Thai House

"Architecture that is designed for adaptation recognizes that the future is not finite, that change is inevitable, but that a framework is an important element in allowing that change to happen" (Kronenburg, 2007, p. 115).

An adaptive reuse of the traditional central Thai house extends existing margins that shape domestic uses and lifestyles through its functional and physical modifications. With respect to celebrated architectural essences, the practice demonstrates measures implemented to encourage the Thai house's survival through demolition and even extinction, largely generated by doubts in its practicality and maintenance in today's context (Ramasoot, 2009, pp. 219-237). The traditional Thai house is known for its flexible structure and configurations that allow modifications to comply with expansion of stem family, relocation and changing conditions. Some adaptations occurred by tradition, in that many old houses were dismantled and donated to Buddhist monasteries to use for any religious purposes after the decease of their original house owners, either as a merit making act toward the late owners or simply because the houses were no longer in use. The extensive adaptive reuse practice and involved modifications endorses *adaptability* and the "built for change" quality incorporated in the architecture's distinctive physical qualities in the beginning.

Recurring patterns of functional and spatial modifications can be observed regardless of their varying levels of interventions, ranging from homes for contemporary ways of life to non-residential and public facilities. The Thai house's characteristics correspond with a description of an adaptive or design-for-disassembly building in that it begins with a simple, conventional form and becomes more

unique and radical over time due to growth, changes and customizations (Brand, 1994, p. 190). The architecture directly responds to Thailand's geographical, climatic, social and cultural factors rather than deeply taking root in the so-called styles and external values. Types of classic house compounds and standard architectural characteristics can be summarized as basic traditions to conform with, yet neither pattern is rigid and obligatory as strict rules (Chaichongrak et al., 2002, pp. 24-63). This approach encourages adaptations and layers of interpretations which consequently enable a conservation of the old artifact.

Most adaptive implementations of the traditional Thai house can be accomplished successfully in terms of original qualities of the building itself. Such traits establish a foundation for adaptability via certain building components, spatial and functional characteristics, as well as physical conditions. The flexibility incorporated within these elements opens access to the traditional architecture, and allows a smooth integration between old and new parts. This adaptable nature upon which adaptive designs usually are based is articulated in five key attributes: 1) the prefabricated structure, 2) the modularity and neutrality of house units, 3) the central terrace, 4) the use of a single room for a single function, and, 5) potential spaces available for infills and modifications, as follows:

4.1 Prefabricated Structure

The ready-made Ruen Krueng Sab structure of the traditional Thai house reflects traditions, construction methods as well as artistic factors of the old Thai society (Piromya et al., 1995, pp. 59-60). The hardwood structure enables dismantling, relocation and reassembly of building components required in the adaptation process. In addition to a general adaptive reuse which normally involves a functional conversion and interior modifications at varying levels, the flexible structure allows further alterations which include relocation and a reorganization of the architecture. Its building components are preassembled in set, before the prefabricated kits of parts are transported and put together on site with the structural frames. Wooden members of the Thai house are fit together by varying types of interlocking joints and firmly secured in place by wooden pegs. By not using nails or glues in the component installation, the construction is not permanently fixed. As a result, the buildings can be pulled down without damaging the members and their joinery. The relatively-lightweight parts are dismantled and stored in large sets, which facilitates their transportation and accelerates their reconstruction on a new site. In the past, reasons for house relocation ranged from flood, other natural disasters, relocation of the family's agricultural site, and family matters such as marriage. Relocation of the Thai house compound is an opportunity for today's Thai house to be constructed on a better site, with a more appropriate size, shape and environment, for the benefit of the architecture and its particular function. Moreover, the traditional Thai house's pre-assembled sets of small members make it possible to recycle certain building components which are still in good condition, and to use them as a part of a different house compound. That is, a mix-and-match of architectural parts from different sources, or a combination of old and new components, can be done in order to utilize the materials to their fullest capability.

4.2 Modularity and Neutrality of Units

The traditional Thai house's uniformity through modularity and neutrality facilitates the architecture's adaptive reuse, be it an addition to a new house unit in an existing traditional Thai house compound, an adaptation of an existing house unit, or a new compound formation of individual house units acquired from different places. The modularity is portrayed via its standardized exterior features and a module within an individual house unit. Each rectangular unit is composed of a multiplication of rooms *(Hong)*, or post bays on the long side of the structure. The structure's modular system is strictly reflected via the façade and interior space treatments. Window or door

openings on the long sides are placed at the middle of each room's wall panel, while the short sides of the structure have two windows on either side of the post plinth *(Sao Dung)* which supports the ridge beam at the middle of the bay. A partition of interior space, if required, is usually lined between two posts to comply with the existing structural system, openings and exterior appearance. Although dimensions of the structure and its components can slightly vary in different house units, and there are minor variations in exterior treatments, the modularity maintains an accord within a single house and between different units.

The neutral quality in the agreeable appearance of house units involves resemblance, accompaniment and harmony among the different structures, which consequently generates physical unity of the compound (Figure 3). Regardless of the minor physical variations among house units in size, proportion, decorative ornaments and other architectural details, the designs of the houses are established on the same basis by sharing similar essential forms, components, physical characteristics and materials. While some house units are emphasized thanks to their placement, elaborate details and nature of functions, all structures do not contrast one another in terms of distinctive or uncorresponding manners.

Figure 3. Main floor plan of M.R. Kukrit Pramoj's house shows modularity of house units.

The combination of modularity and neutrality in the Thai house makes most changes made to an existing house compound uniform with the remaining structures in the cluster. The modular system and the neutral appearance homogenize the modifications and other original components, despite dissimilarities in details. House units acquired from different sources with different sizes and ages can be juxtaposed without major contrast, which would otherwise diminish overall physical harmony. Special qualities also facilitate the organization of the house compound by allowing a variation of compound planning according to site constraints and the functional conversion. Standardized Thai house units naturally balance themselves when composed together due to their conformed appearances.

4.3 The Connecting Element: The Central Terrace

A component that establishes distinctive sensations, including encloseness, spatial hierarchy and relationship with nature, the central outdoor terrace, or *Charn,* generally occupies at least forty percent of the entire compound space and is considered an essential feature of the classical Thai house (Chaichongrak, Nil-athi, Panin & Posayanonda, 2002, p. 30). It has not only a practical use as a multi-purpose area for both informal and formal activities, but also an architectural role as a link that draws separate components of the cluster together into one compound. The central terrace's capability as a connecting element greatly facilitates compound expansion, as it links the clustered house physically and functionally (Figure 4). In terms of physical connection, the house units are arranged at cardinal directions around the terrace, with their entrances facing the open space. The terrace then serves as a spacious outdoor corridor that provides access to each house and gives circulation between any pair of house units. Regarding functional connection, it unites different uses of individual house units. At the same time, the terrace acts as a transitional space that balances the varying levels of privacy and security of the units.

Figure 4. The central terrace of M.R. Kukrit Pramoj's house unifies the multi-unit compound.

Reciprocating compound formation, a traditional house expansion following family growth can simply be executed by constructing a new bedroom unit and connecting it to the existing compound by the terrace. A single-unit house is turned into a multi-unit clustered residence, while ensuring adequate privacy and appropriate proximity of extended family members. Similar practice is applicable to house compound development and reorganization when it comes to adaptive reuse. Functional conversion of each house unit can be carried out without an effect on others or the overall functional framework of the complex, thanks to the connection maintained by the terrace. Additions of house units can be done extensively to the degree that the terrace can accommodate. In some cases, where the site is limited, a raised wooden corridor is used as a linear connecting element in place of the terrace, in order to link additional house units with existing ones, or to connect an isolated house unit or a compound to another compound. This potential for relatively-unrestricted expansion of the clustered traditional Thai house provides flexible usable spaces, which consequently encourage a variation of possible adaptive uses.

4.4 Single Room - Single Function

The utilization of an individual house unit for a single function is a unique characteristic of a traditional central Thai house that greatly encourages and facilitates compound additions and adaptations. Each individual house unit usually performs one main use, while each function is generally fulfilled in a single house unit. Additionally, increasing usable spaces for similar functions can be executed by multiplying house units, although each structure's practical performance is generally independent. Therefore, the function of the house unit is designated and spelled out, and its functionality is complete in itself, such as, a parent's bedroom, a children's bedroom, a living room, a Buddha room and a kitchen. Some house units may be multi-functional, in that the space can be informally adapted for another use at a different time of the day. For example, the bedroom unit in a small house compound may have a second function as a daytime sitting room, once the mattress and bedding gear are put aside or stored in the closet. However, the main function of the certain house is in general self-sustaining rather than dependent on another. Its particular utilization can usually be achieved within itself, while sometimes supported by neighboring house units in terms of supplemented uses. For this reason, additions and adaptations of a house unit can be carried out without any significant effect on the practicality of the remaining structures in the same house compound, as well as the circulation and the overall functional relationship among the house units. Addition of a new Thai house unit in a compound does not necessarily have a consequence for others. A new house unit may be added to an existing compound to support additional functional and spatial requirements of an adaptive use, while the functions of the existing units can continue to operate without being diminished in terms of practicality and accessibility.

4.5 Potential Unoccupied Spaces for Expansion

Unoccupied spaces in various locations in the traditional Thai house compound promote its adaptive reuse in terms of being partitioned, enclosed and modified to support particular functional and spatial requirements. In contrast to most buildings in which

planning was originally designed to be as inclusive as possible, or in a complete state without room for future infills, there are *blank* versatile areas at various parts of the Thai house, namely, the veranda, the terrace and the ground floor area (Figure 5). The spaces are ready to be developed from their original roles to complement the main functions in the house units as auxiliary, transitional, communal, storage or multi-purpose areas. These spaces present alternatives for compound adaptations to support its adaptive reuse, rather than addition of new house units, which require additional built spaces on the property, or repartitioning existing rooms, which results in each divided space's smaller size and possibly less practical room proportion. Compound development by exploiting these available spaces is also creative in terms of utilizing existing structural components. It thus tends to require modest additional materials and construction. It has less effect on the architectural totality of the house compound because additions do not compromise the visible outline.

Figure 5. The adaptive design of Nipa Krupaisarn's house encloses its ground floor area and veranda with transparent walls, and utilizes the spaces to serve contemporary living.

A) Veranda – The semi-enclosed veranda of the traditional central Thai house functions as a transitional space between the communal central terrace and the private inner room of the house unit. It signifies increasing levels of privacy in the compound, while providing a sheltered informal sitting space in front of the room. The case studies and several examples of adapted houses studied in the research have shown the verandas' capability to be partially or entirely enclosed for use, especially for functions pertinent to the utilization of the inner room of the particular house units, thanks to their convenient location. The 1.5-2.5-meter wide space is found fitting for various auxiliary functions. When the unit is used as a living quarter, its veranda is often enclosed and converted into a dressing room, a bathroom, a storage room, a sitting room, or an antechamber to the inner bedroom. The veranda compartment often complies with the original structural framework by partitioning between post grids to accommodate structural modification and preserve the exterior features. Access to the adaptively partitioned space is either from the inner room, or from the other section of the veranda which still remains as an entrance hall to the unit.

B) Central terrace – The central open terrace of the traditional Thai house not only enables house expansion by combining new additions to the old compound, but presents a space for distinct separate infills. Its availability and advantageous location between house units enable compound development without expanding the built space of the property. That is, the expansion is carried out within the existing compound, instead of spreading it out. Possible alternatives for adaptations include an expansion of an existing unit by an addition of room (post bay), a connection of two existing house units by enclosing the terrace in between, and an addition of a new structure in the available terrace space. Functional independence of the infill capability

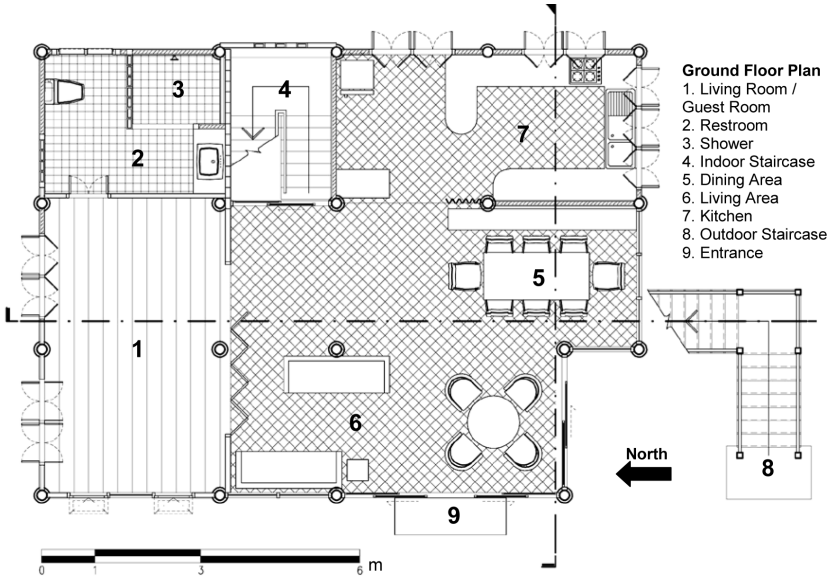


Figure 6. The enclosed ground floor of Nipa Krupaisarn's house is linked to the upper, traditionally main level by an interior staircase.

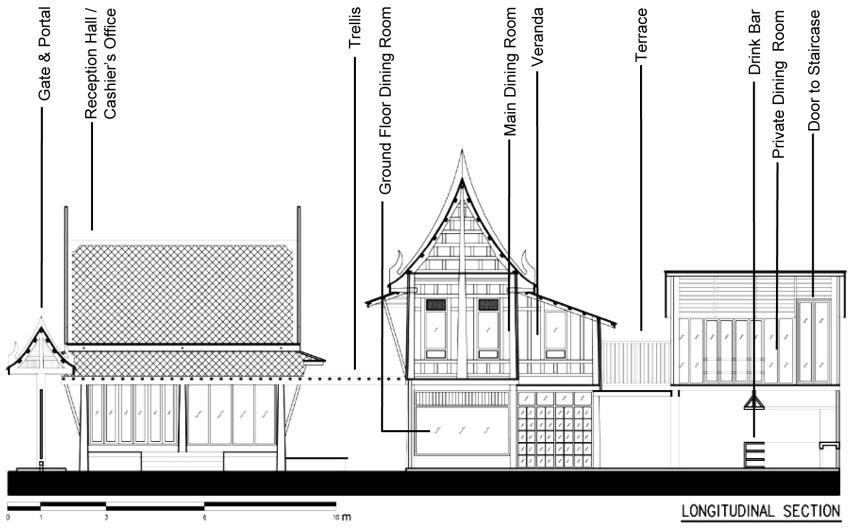


Figure 7. Ruen Mallika Restaurant makes use of its ground floor area as a dining room and drink bar that connects to the outdoor seating space.

notwithstanding, adaptation of the open terrace could affect the old compound to some extent. It therefore requires design consideration so as to respect the traditional essences of the architecture, in terms of form, planning and functional cohesiveness of the compound (Figure 6).

C) Ground floor area – The ground floor area is considered the primary space of the traditional Thai house with the most potential for additions and modifications, thanks to its accessibility and spaciousness. The availability of the ground floor area results from the elevation of the main floor from the ground to increase privacy and security, as well as in response to climatic and geographical. The adaptability and the multi-function quality of the space were originally demonstrated in its classical uses. While the ground floor area was traditionally open, it might be allocated as a cage for livestock and poultry, used to store agricultural equipment and supplies, or to informally accommodate daytime activities and women's handicrafts. This unoccupied space has a floor area equal to the main raised floor, thus doubling the compound's usable space (Figure 7). Its convenient, accessible location is fitting for public and auxiliary

functions, such as a living room or a bedroom for physically-challenged persons, to support principal residential uses on the main elevated floor. Moreover, the ground floor space is structurally practical for addition of functions that involve complicated installation of utility and mechanical systems, for instance, a kitchen and a bathroom. Due to the varying proportion of the Thai house, an elevation of the entire house structure may be required, in order to increase headroom of the ground floor area.

5. Conclusion

Adaptive reuse protects old buildings and prolongs its life by updating original use to fit changing needs. It promotes environmental sustainability by utilizing existing structures while reducing extra resource consumption for new materials and energy. At the same time, the intervention indirectly draws economic and social sustainability benefits for individual buildings and their urban context. Physical modifications, either minor or major, are frequently required during the functional revision in order to optimize the structure. Buildings with certain characteristics, such as simple form composed of rectangles, flexible spatial arrangement and modular structures, may facilitate wider alternatives of alterations, while preventing design complications and risk of possible harm to original structures and their value. Built-for-change and design-for-disassembly architecture therefore addresses changes commonly occur with most buildings over their life and explores sustainability through the adaptability of the structures. Case studies of the traditional Thai house converted for contemporary uses reveal patterns of building alterations made possible by the Thai house's five adaptable qualities -- prefabricated structure, modularity and neutrality, interconnectivity via the central terrace, single room for a single function and potential spaces available for infills and modifications. Such adaptability facilitates adaptive reuse and related alterations without compromising the traditional architecture. It confirms a potential and appropriateness of adaptive reuse as an optional means to prolong the life and optimize the revised management of the artifact. The built-for-change structure of the Thai house acknowledges development, allows interpretation and accepts modifications, while its original architectural essences and representations are respected and retained. In addition, the findings on the adaptable natures interestingly suggest a sustainable concept embedded in the Thai house design. The attributes encourage environment responsibility and efficient consumption of resources by revising, reusing and recycling process by means of the traditional Thai house's adaptable structure.

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