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DECODING SPATIAL LAYOUT PATTERNS OF TRADITIONAL HOUSES IN URBAN KAMPUNG SETTLEMENTS

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Abstract. Understanding and identifying the spatial layout patterns of traditional houses is a pivotal feature for preserving and enhancing the cultural heritage of twelve houses which have been an object to be studied. This research investigates a comprehensive study to understand a particular architectural plan in a participative community of design processing on decoding spatial layout patterns through a generative Justified Plan Graph (g-JPG) as a grammatical spatial approach. This research examines the grammar using the rule-based spatial structure of traditional housing in three urban kampung in Indonesia. This method applies three procedures, such as collecting data, extracting jpg grammar, and formulating jpg grammar. Regarding the investigated result, indigenous and non-indigenous dwellers have mostly constructed the spatial configuration axially and created a spatial penetration or intersectional space on movement by generating and distancing social concept long models in their traditional houses. Another finding is that the houses' spatial layouts are integrated as spacious hall-centred, representing a rule-structure and form-based. It is found that this study can serve as a valuable resource for architects and researchers who are interested in preserving and revitalizing the architectural identity of traditional housing.

Keywords: justified plan graph, spatial pattern, traditional houses.

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1. Introduction

Kampungs or kampongs are one unique feature of urban settlements in Indonesia that have a valuable history and cultural significance. They are characterized by a close-knit community in urban villages, a noticeable architectural style, and a unique socio-cultural identity. This characteristic is known as an autonomous community model (Funo et al., 2002). Regarding architectural style, kampungs have traditional housings which have been constructed by expression of community characteristics. It usually classifies into locations, communities, or income groups which show the categories such as urban kampung, fringe kampung, rural (Funo et al., 2002). The recognizing environmental of kampung settlements figures with narrow paths or alleys to socialize as public space that constructs function, building meaning, order, organisation, cultural notions (Krier, 2010). In Indonesia, urban kampung has a distinctive milieu feature and depicts a setting process of daily activities and fundamental needs into spatial interaction. It reflects the concept of co-habitation space as a spirit and soul interaction between community and culture that can be presented from strong value a kampung has (Prayitno, 2017). Several urban kampungs consist of traditional houses that hold significant cultural and historical value as reflecting the architectural heritage of the region. It is a representative of traditional settlements which have highly history, culture, and tourism values. In addition, the spatial layout plan of traditional houses presents the experience of characteristics and development style of an urban environment that gives a sense of place, community, and identity. These give positive contribution to the cities in land use density, street configuration (Kim & Sohn, 2002) and social interaction in urban morphology (Can & Heath, 2016). Despite this value, some urban kampungs are vulnerable of changing and devastation, not only erodes the cultural identity but also diminishes the understanding of the socio-spatial dynamics that are formed by communities.

Since the proliferation of population, urbanization, and modernization affect the significant challenges to the existences of traditional houses in kampungs, it gives a pressure to transform into other modernization houses and settlements. This transformation makes the changing on spatial rules or architectural plans in a distinction kampung towards in declining and disappearance of the traditional dwelling units in Indonesia. This highlights an idea to preserve and conserve the traditional houses in urban kampung through decoding its spatial characteristics. Therefore, this is a main idea to identify a set of rules for architectural layout plans in unplanned settlements

(kampung) that were built by communities. Then, the finding these rules can be used for further design to generate new shapes regarding an adaptation and transformation of settlements issues.

Previous research has studied spatial language of traditional houses and justified plan graph. Using case studies, researchers have investigated the architectural language of the people and also the social and cultural in vernacular settlements that impact from a specific place (Brown & Maudlin, 2012) then leads to a sense of belonging. Other studies also found a typology of configurational space in Korean housings (Byun & Choi, 2016), identifying spatial design patterns through a justified plan graph in Glenn Murcutt's designs (Lee et al., 2018a), spatial configuration of houses layouts and transformation in Biskra City (Barkat et al., 2020), spatial configuration on users' social interaction in mass houses in Algeria (Zerouati & Bellal, 2020), transformation and changes of house in Istanbul through space syntax (Agirbas, 2020), characteristics renovation of traditional settlement based on space syntax in China, (Chu & Wu, 2022), decoding socio-spatial in syntactical analysis of a rural settlement in Algeria (Djezzar & Bada, 2023), and syntactic analysis of traditional houses in urban kampung (Asriana et al., 2024). It depicts a distinctive milieu feature with significance cultural and historical value that reflect vernacular and social or public settlement patterns. Understanding this patten can define possibilities in the relationship between human and space, shared and distributed space, and different space utilization privately, individually, collectively, or publicly (Jorge-Huertas & Jorge-Moreno, 2024). The established study has focused on the houses designed by designers and transformation of spatial configurations in traditional or social houses. However, only little is known about comparing a distinctive community as visitor (non-native dwellers) and native dwellers in urban kampung, especially in Indonesia. Therefore, this research will decode the spatial layout patterns of traditional houses in three different *kampung* communities, namely *Kampung Al Munawar 13 Ulu* (Arabic community), *Kampung Kapiten 7 Ulu* (Chinese community), and *Kampung Songket 30–32 Ilir* (Palembangnese community). By comparing and analysing the spatial layout patterns in these kampungs, the study will reveal how communities shape the value of social behaviours, activities, room functions, and cultural practices in their dwellings, then affect spatial distribution and movement flow of occupants in the houses.

The investigation of decoding spatial layout through grammatical approach could define a logical order in design process to understand spatial typologies and social relations syntactically in traditional housings. This study adopted graph theory in architecture through mapping nodes and edges to various spatial features, then set out to interpretation in a combination of mathematical analysis, observation of human behaviour, social structures, and building types (Dawes & Ostwald, 2013). The spatial arrangement and distribution depict how physical are placed and related to each other to understand of integrated, segregated, connected, or disconnected spaces (Nes & Yamu, 2021). This kind of *"hidden order"* of spatial arrangement in built environment (Hillier, 1996b). The syntax and grammar, respectively, in design could reflect its socio-spatial and formal properties to understand a particular assessment of architectural styles (Lee et al., 2013). In terms of this understanding, the unique characteristic of kampungs might be started analysing the information of spatial layouts and social composition existing. This investigation offers an opportunity to learn how the communities express a rule of its traditional houses intangibly with its culture and social aspects.

Regarding all mentioned above, this study aims to deconstruct *"the hidden law"* of urban kampung in social relation and topologies. This will encourage to the importance of preserving this architectural heritage contribution to the knowledge in learning and understanding from communities' preferences. They involve spatial order and spatial organization in topology traditional houses, associated with a place which shows the orientation of human activity in a place (Sari et al., 2020) in urban kampungs. This approach might adopt a justified grammatical approach to analyse the spatial configuration that will unravel the basic principles and design grammar to present layout, organization, and typology. Afterwards, this analysis seeks to pinpoint typical ways in which different room functions and domestic activities are configured in people's homes (Hanson 1999), movement flow (Hillier, 2019; Mahfoud et al., 2022), and spatial distribution (Hacini et al., 2022).

The experiment of deconstruction on spatial rules delivers information about architectural typologies in urban kampung and offers lesson-learnt from communities for designing human-centric culturally. By understanding the geometrical and spatial structure inherent the designs settlement in urban kampung lead to derive a prototypical design of kampung style. This will be easier in architectural process to compose the elements, spatial relations and transformation based on the formal terms of urban kampung in Indonesia. In terms of this, the finding can recognise and respect the spatial logic how the communities intervene their space into the needs and social cohesions. This will be insights for future knowledge and practice in urban planning, architectural preservation, and revitalization efforts to ensure the sustainability and continuity value of cultural traditions in contextual contemporary terms. Those results will be following further new design and transformation in relevant rules through studying of traditional houses layouts in urban kampung.

2. Spatial layout design in architectural plan style

The pattern of spatial design in architectural plan of traditional houses has been recognized as the basis method of analysis of settlement forms. Applying the generative syntax method is to establish the spatial order description, the type concepts dealing and the spatial quantity in

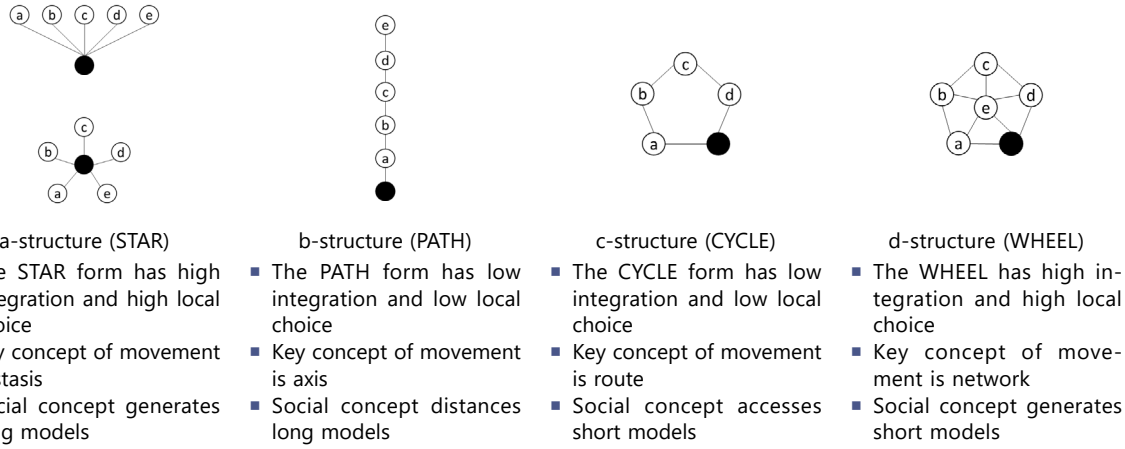


Figure 1. The emergence of comparing space types; structures, movement concepts, and social concepts

determining the relation (Hanson, 1999a). The settlement forms can be represented in architectural record with an extremely impressive variety in accommodated activities in the houses which have different cultures and historical periods. The basic needs activities in kampungs consist of living, cooking, gathering, sleeping, bathing, eating, trading, or religious activities, and the like. In terms of spatial pattern activities, it defines what space there are, how they are connected and separated. It helps designers or architects to understand the unexpurgated or true design intention and production (Pressman, 2012). Those could be explored by space syntax theory through grammatical approach to generate the rule-based design and it may arise independently a logical sequence procedure (Stiny, 1990). Additionally, the potential exploration through computational tools in identifying and studying architectural design patterns allow to understand adaptation rules (Yoas & Muslimin, 2023) and enable researchers to unfold the hidden pattern, especially in the spatiality of traditional architectural plans. This hidden pattern forms homogenous organization and an important place for social life of residents (Ayyıldız & Durak, 2024).

Spatial design refers to the concept of space types which generate structure types (Figure 1) and describe how every space in graph relates to the rule system which forms a part (Hillier, 2019). Every space type has meaning, especially in the syntactic sense of spatializing concepts and reinforcing expression. Hillier (2019) highlighted that there are four space types; a-structure (STAR), b-structure (PATH), c-structure (CYCLE), and d-structure (WHEEL), where these features of a-structure and b-structure can be called no-rings or acyclic forms, while c-structure and d-structure are rings form or cyclic forms. These space types express their meaning in the spatial concept and social concept (Figure 1) through finding their way and creating their movement. Therefore, the combination between variety activities, spatial design, and space types will reveal how the layouts create in forming integration, generating movement routes, and accessing social structures.

3. Generative Justified Plan Graph (g-JPG) as grammatical approach

The Justified Plan Graph (JPG) grammatical approach commences with an architectural plan (Turner et al., 2001) to records an overall building footprint, such as, shape, location, relative size, and orientation of rooms (Ostwald, 2011). This approach has formed by two key conceptual operations, such as configuring functional zones (nodes) and their connectivity (links). The former identifies a significant spatial grouping and defining as nodes that traditionally focus on identifying room functions or convex spaces, while the latter defines the connectivity or relationship between these nodes. That combination expressed in a graph which creates a type of JPG, then extends to a type of spatial relationship about permeability and integration sequences. It relates to space syntax theory to identify the number of syntactic relations between a particular space and object. Moreover, it defines the quantity of space that means size of objects. This JPG also is a technique to represent spatial configuration of house plans which provide a graphical and mathematical model analysis (Barkat et al., 2021).

The Justified Plan Graph (JPG) grammar usually consists of vertices (links) and edges (joints) with the structural and functional relations for generating designs (Lee et al., 2018b). It defines the information of relationship between the structural and functional terms that generate the planar mechanism (Grasl, 2012; Krstic, 1999). This approach usually presents in the processing design model which apply bubble diagram and adjacency matrixes to ascertain the formula basic of spatial-functional relationships in a planar plan (Balmer & Swisher, 2019). The spatial function allows to consider two types, namely the relation between inhabitants and between inhabitants and visitors (Hillier, 1984; Lee et al., 2018b). These forms arrangement normally will encounter the integration and depth the spatial layout in relation to other space that also contain activities and socially constructed. This also will be as references to

repetition and imitation of buildings to guide conservation effectively. However, there is a little known for comprehensive studies that specifically associate with spatial patterns within urban kampungs context. Hence, the importance of understanding the historical, social, and built environment highlight a rule how it might have been or could be orderly generated.

Identifying JPG grammar is a study of mathematic structures between rooms and to generate it, each room is illustrated by a circle (node), while doors are connection, and between the rooms are depicted by lines (edges). JPG grammar has functional sectors graph and adjacency (Table 1) is followed by Total Depth (*TD*), Mean Depth (*MD*), Relative Asymmetry (*RA*), Integration (*i*) and Control Values (*CV*) (Hillier, 1984; Lee et al., 2018b). The number of nodes and links has different spatial relationship and the syntactic values that derive the graph grammatically.

Depth refers to the number overlapping lines that can be crossed to move from space to others. The minimum number of steps means the amount of integration, while the maximum number means separation (isolation). The levels of depth show the distribution of nodes to represent the building spaces through a dendritic shape. It can organise and control the visitor's penetration into the home which make logical potential terminal space, bi-permeable spaces in sequence or intersection space as the locus for occupation on movement (Hanson, 1999b). The least integrated is deeper form (linear form), while the more integral is less deep (tree form) (Figure 2). Some studies also highlighted that a high depth value indicates low accessibility in the space and refers to strong privacy and closeness of the space (Alitajer & Molavi Nojoumi, 2016).

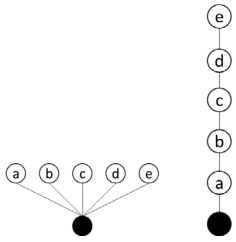


Figure 2. The less integrated is the deeper form (linear form; b), and the most integrated is the less deep (tree form; a)

Mean Depth (*MDn*) can calculate the index to average relative depth value to measure the degree of symmetry of total spaces as if it identifies the number of visual movements steps that space moves away to the entirely space system. It is calculated how many spaces it is away from the original space (Hillier & Hanson, 1984).

$$MD = \frac{TD}{(K-1)}. \quad (1)$$

Total Depth (*TDn*) is defined the sum of the topological depth paths connections between all pairs of nodes. In practical terms, it indicates a distance between room and other rooms in a layout plan.

$$TD = (0 \times n_x) + (1 \times n_x) + (2 \times n_x) + \ldots + (X \times n_x). \quad (2)$$

Integration (*i*) measures the distance value from any space of origin to all others in a system or how close the origin space is to all other spaces. This value can be calculated based on the number of steps to reach every room to other rooms in a system. The fewer the steps required to traverse every room in the building, it means the higher the integration. Integration also depicts the colour codes, where the red denotes more integration rooms and blue indicates more segregated rooms. In term of this, it enables to define the relationships between each room to all others.

$$i = \frac{1}{RA}. \quad (3)$$

Relative Asymmetry (*RA*) identifies how deep is from points, the least depth existing when all spaces are directly connected to the original space, and the most when all spaces are arranged in a unilinear sequence away from the original space (Hillier & Hanson, 1984).

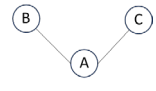
$$RA = 2 \times \left(\frac{MD-1}{K-2} \right). \quad (4)$$

Control Value (*CV*) is a measure the choice degree of each space as a space to move. If spaces have a control value greater than 1, it shows strong control and vice versa. It also defines the degree to which a space controls access that tend to be potential attraction (Hillier, 1996a).

4. Spatial distribution through movement

The structure of this spatial configuration referred to the natural movement which influences the flow of human movement in the spatial configuration of traditional housings, built environment, and other scales as pedestrian centric (Asriana & Indraprastha, 2016). Previous research on spatial movement and space syntax indicate that the spatial configuration mostly shapes the spatial patterns of

Table 1. Two key concepts in JPG grammar; node and link

	Node	Link
Definition	Spatial convex (sectors)	Spatial connection (Adjancensy)
Description	A = room 1; B = room 2; C = room 3	(A, B), (A, C)
Graph		

human activities (Hillier et al., 1993; Sharmin & Kamruzzaman, 2018). This approach also could be used to re-evaluating design strategy in urban tourism (Asriana et al., 2017) and urban spaces through spatial cognition by using agent-based simulation (Esposito et al., 2020). The spatially more integrated in spatial structure types, the higher the flow of movement and the more attractive the rooms for the activities (Hillier et al., 1993; Yamu et al., 2021), and the orientation of spatial configuration also become attraction that influence social attraction in agent-based simulation (Esposito et al., 2020). Space syntax theories and methods could imply the pedestrian movement patterns. The spatial movement distribution rises linearly with accessibility, it refers to the integration. It identifies as a set of networks in unobstructed movement (Hillier, 1996a). The flow movement on networks established the connections idea between spatial interaction and the flow of information prediction (Batty, 2022), where this pedestrian flow rate depends on the development density (Ahmed et al., 2014) and on the degree of integration (Penn et al., 1998).

Regarding this case study, the traditional houses' layouts will impact how the spaces are used in these kampungs by dwellers. It could reveal the dwellers' movement trajectories, routing network (Thiraponghaiboon & Hanna, 2019), and destination through computational-based analysis to identify the node and core activities (Asriana, 2021). Those performed activities can be linked to form predictable relation. Thus, it can validate the sensing of four spatial structures types and its expression to the traditional houses in urban kampung.

5. Methodology

Exploring the spatial layout patterns in traditional houses through Justified Plan Graph (JPG) is to understand how the participative communities established and expressed their rule-spatial system in early stage of design processing. The involvement community could reveal the importance of engaging decision making in design processing and recognize their valuable knowledge, culture, and tradition in forming their houses, because they know well what they need and preferences of spatial uses in human settlements. This affects the spatial rules between social and form concept in traditional houses. Dealing with this objective question, the research investigation focuses on the origin of spatial form pattern rules and generate orders logically in traditional dwellings through a Justified Plan Graph (JPG) grammar approach. The findings of this spatial configuration will reveal the basic rule-spatial form in layout organization. This study can serve a valuable resource for architects and researchers who are interested in preserving and revitalizing the architectural identity of traditional houses.

The JPG grammatical approach as methodology will be used in kampung in Palembang with three stages to identify and analyse spatial design patterns from Space Syntax theory in urban kampungs (Figure 3). The following steps outline are collecting data, extracting information, and formulating JPG grammar approach. This analysis can visually analyse the graph a series of qualitative spatial configuration features in depth, permeability, and spatial hierarchy

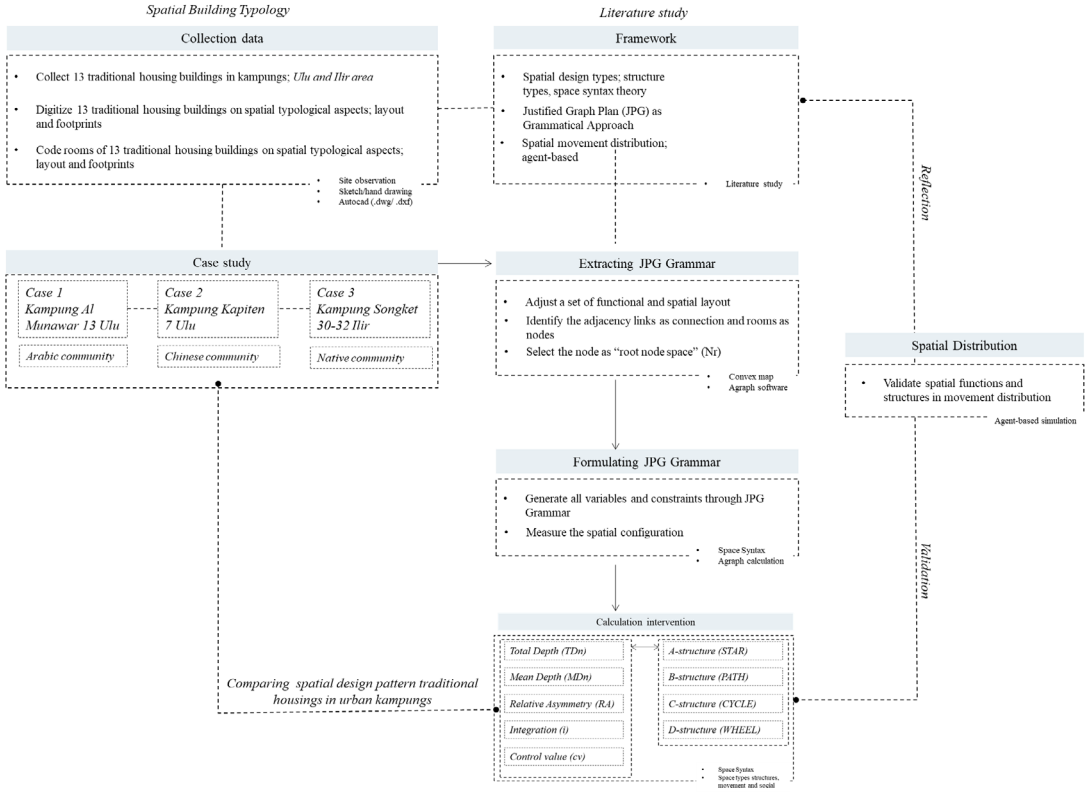


Figure 3. The corpus idea of methodology

(Elizondo, 2022) through space syntax measurement. Afterwards, this JPG approach define how communities' involvement in design processing and spatial decision to configurate spaces in traditional dwellings socially and culturally.

5.1. Selected case study

The selected 12 traditional houses in three urban kampungs as a case study is situated in South Sumatra, Palembang (Figure 4). This object study is selected in accordance with different characteristics and locations. Majorly, Palembang has several urban kampungs that appear to be historical witness the city growth. It shows characteristics that urban kampung is historically located and known for the riverfront kampung. This area is divided by Musi River, the northern part was called by "Ilir area" for indigenous residents and southern part was called by "Ulu area" for visitors. This system has been established since the Sultanate era and the Dutch colonized Palembang and it is still used by Palembang officials until now. During throughout periods, the officials could recognize the native and non-native folks, also control the settlements development of visitors. It influenced the architectural building style, socio-culture, and place identity. This study compares and the relationship of hidden order of spatial layout organization in three popular kampung between indigenous dwellers in *Ilir* area and visitors in *Ulu* area, namely *Kampung Al Munawar 13 Ulu*, *Kampung Kapiten 7 Ulu*, and *Kampung Songket 30–32 Ilir*.

Figure 4. The location of selected case study

The population vastly growth causes modernization in core of kampungs development, especially in peripheral which are inappropriate context. The development without well controlling or setting in kampungs leads to slums, irregular, unhealthy, and uncomforted settlements. This leads to devastation of traditional houses in urban kampungs. This study might highlight to have preservation and conservation, especially in learning how communities have established and maintain spatial configuration and pattern in design processing. This phenomenon evaluates around five main traditional buildings which have a significant core value in *Kampung Al Munawar 13 Ulu*, four buildings in *Kampung Kapiten 7 Ulu*, and three buildings in *Kampung Songket 30–32 Ilir*.

5.1.1. Kampung Al Munawar 13 Ulu

Kampung Al Munawar 13 Ulu has been historically known for Arabian kampung who spread Muslim religion in Palembang in the 18th century. During the Sultanate periods, traders or visitors were merely allowed to live and stay in Ulu area, because the Ilir area only for the Sultanate Palace and indigenous Palembang inheritance. This regulation influenced the housing typologies between visitor and native folks. The main spatial characteristic shows the assimilation traditional house between Arabic and Palembang style *"Limasan or Rumah Limas"*. Arabic communities built their house in similar look with native houses. For instance, some façade houses also oriented to the Musi River, others to the alleys. Generally, the Arabic houses in *Kampung Al-Munawar 13 Ulu* are also one-storeyed or two-storeyed building with long halls and a number of bedrooms.

The observed housings in *Kampung Al – Munawar 13 Ulu* depicts a significance representation value of history and socio-culture of Arabic folks in this kampung. These are representative and known as core area of this kampung (Figure 5); (1) *Rumah Batu*, (2) *Rumah Darat*, (3) *Rumah Tinggi*, (4) *Rumah Kembar Darat*, (5) *Rumah Kembar Laut*, and (6) *Rumah Kaca*. However, this investigation is not

Figure 5. The existing condition and selected traditional housings as a case study in Kampung Al Munawar 13 Ulu

including the *Rumah Kaca* since this building is a school typology instead of others dwelling typology. Those five buildings create a cluster configuration with open spaces as its façade orientation, exclude *Rumah Kembar Laut* that its façade orientation to the riverfront. Typically, Arabic traditional housings in the *Kampung Al Munawar 13 Ulu* have front and back terrace, stair, living room, bedroom, hall, kitchen, foyer, dining room, and toilet. The rooms and activities of male and female dwellers or guests are separated and limited by walls and doors in this house. This is kind of boundaries are always maintained by Muslim religion to limit the visual privacy of residents with non-mahram guests.

5.1.2. Kampung Kapiten 7 Ulu

Kampung Kapiten 7 Ulu is typically Chinese kampung, it has been historically known for Chinese people, captain or *"Kapiten"*, who visited this area for trading. This is located in front of the Musi River and some facades orient to the river, other to the alleys. There are five building that will be representative to this study (Figure 6), such as (a) *Rumah Abu*, (b) *Rumah Kapiten*, (c) *Rumah Selir Kapiten*, (d) *Rumah Kerabat Kapiten*, and (e) *Rumah Mayor*. The *Rumah Abu* and *Rumah Kapiten* are linked together so that the spatial simulation will be calculated as one building. Also, this were built by a leader and worship from Chinese inhabitant as residential and praying function.

5.1.3. Kampung 30–32 Ilir

Kampung Songket 30–32 Ilir is well known for traditional weaving *"Songket"* craft centre which is located in *Jalan Ki Gede Ing Suro*, Palembang. This kampung shows typically Palembang settlements, where the traditional housings in this kampung are oriented to the riverfront, Musi River. The housings are stilt houses which have one storey or two storeys' buildings with consisting of commercial area for residential area and *Songket* production workshop or store.

There are three observed housings in *Kampung Songket 30–32 Ilir* (Figure 7) that depicts a significance representation value of history and socio-culture of native folks Palembang in this kampung. These will be three representative and known buildings, such as (1) *Rumah Limas*, (2) *Rumah*

Figure 6. The existing condition and selected traditional housings as a case study in Kampung Kapiten 7 Ulu

Figure 7. The existing condition and selected traditional housings as a case study in Kampung Songket 30–32 Ilir

Table 2. The observable attributes

Observable attributes	Kampung Al Munawar 13 Ulu	Kampung Kapiten 7 Ulu	Kampung Songket 30–32 Ilir
Physical character	Informal settlements of Arabic communities	Informal settlements of Chinese communities	Informal settlements Palembang (native) communities
Location	Ulu area	Ulu area	Ilir area
Topographic setting	Riverfront area, Musi River	Riverfront area, Musi River	Riverfront area, Musi River
Social characters	Arabic dwellers	Chinese dwellers	Palembang dwellers
Traditional housings	▪ *Rumah Batu* ▪ *Rumah Darat* ▪ *Rumah Kembar Laut* ▪ *Rumah Kembar Darat* ▪ *Rumah Tinggi*	▪ *Rumah Abu+ Rumah Kapiten* ▪ *Rumah Selir Kapiten* (*now-Rumah Pak Iskandar*) ▪ *Rumah Kerabat Kapiten* (*now Rumah Pak Gempita*) ▪ *Rumah Mayor*	▪ *Rumah Limas* ▪ *Rumah Gudang 1* ▪ *Rumah Gudang 2* (*Rumah Pak Kms. Ali*)

Gudang 1, and (3) *Rumah Gudang 2-Kemas Ali*. Typically, the native traditional housings in the *Kampung Songket 30–32 Ilir* have front and back terrace, stair, living room, bedroom, hall, kitchen, foyer, dining room, toilet, *Songket* workshop, storage, and store. The rooms and activities for this housing are not only for residential but also for economic activities to trade and create traditional weaving.

Regarding the provided observation data, it can be classified the observable attributes (Table 2) in three different locations of kampungs, such as physical characters, location, topographic setting, social characters and the traditional houses in urban kampung. Based on physical characters, it can be seen that all the traditional houses have a similar in architectural elements especially in roofs, called *"limasan"*, and huge buildings.

5.2. Collecting data

Data collection plays an important role in an understanding the spatial design pattern dan architectural plans style in urban kampung of Indonesia. It shows a distinctive space and style that reflects the local and historical context in three different kampungs. This section collects the relevant data through observation on the spatial layout of urban kampungs, such as building footprints and related to the historical information that provide insights overall the spatial configuration. The processed is supplied by site visits and interviews with the dwellers (Figure 8).

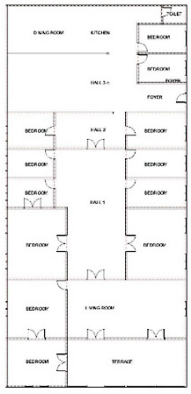
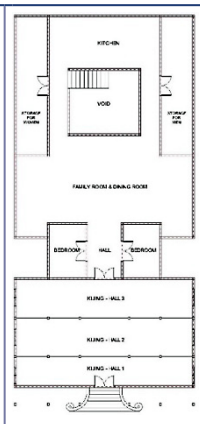
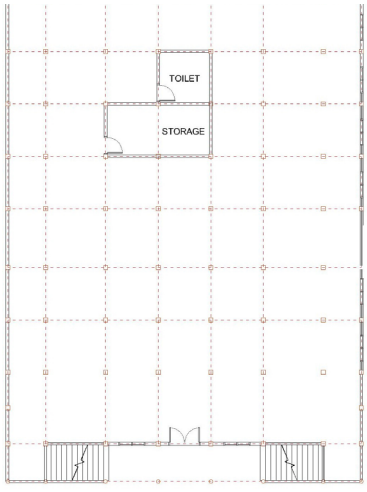
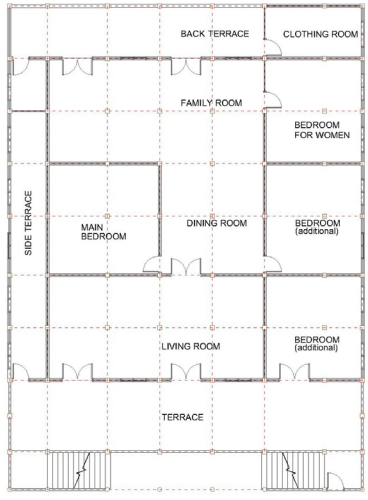
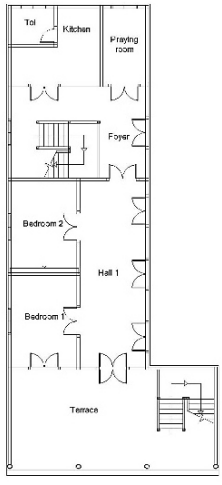
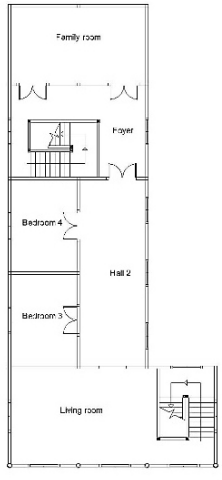
The collected data is a diverse range of architectural plans from different urban kampungs in Palembang, South Sumatera; *Kampung Arab Al Munawar 13 Ulu*, *Kampung Kapiten 7 Ulu*, *and Kampung Songket 30–32 Ilir*. These plans might include hand-drawn sketches, then the observed data might digitize the building layout footprints, doorways, and decode the room codes (Table 3) to generate formulating JPG grammar. This will be a comprehensive dataset to assure and understand the architectural style of spatial organization in traditional buildings of Palembang's kampungs. Every house has different name, rooms, function, position and connection of each space that has changed the family concepts and the changes of with lifestyle or needs.

5.3. Extracting JPG grammar

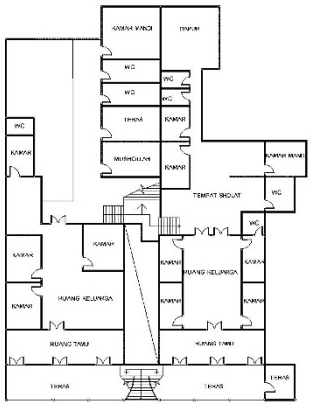
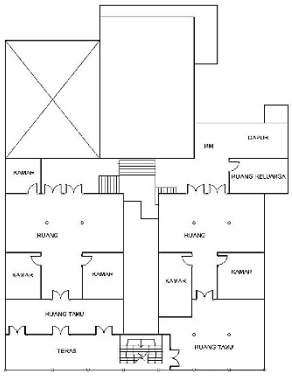
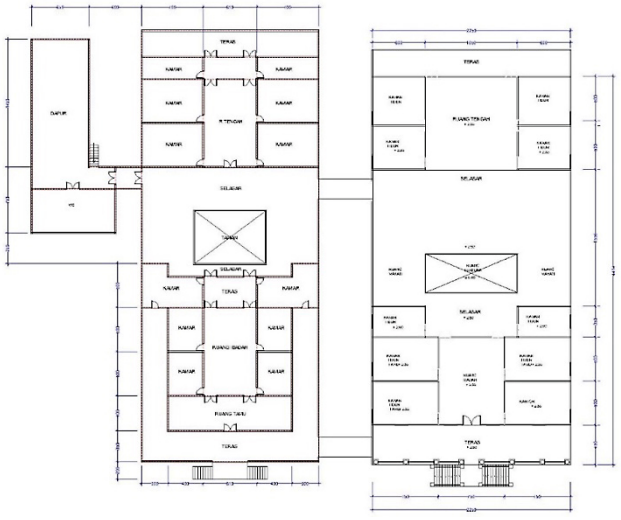
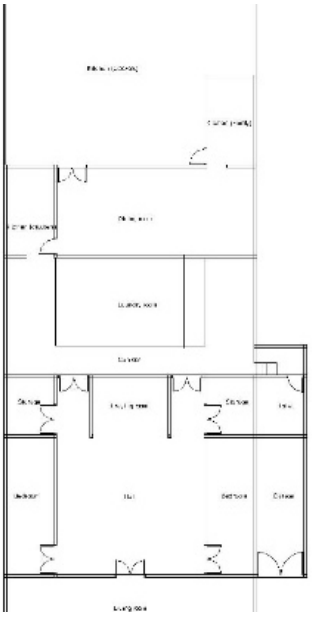
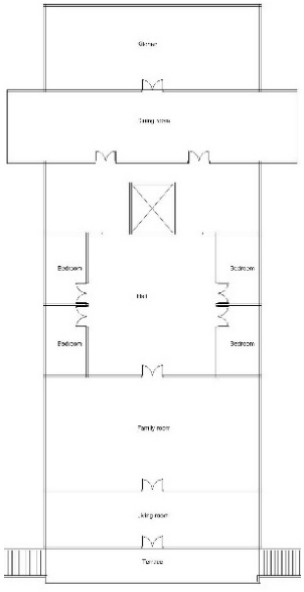
Extracting data for Justified Plan Graph (JPG) grammar defines the nodes and links. The former is spatial rooms, and the latter is doors rooms. Those can be shown in convex break-up space analysis technique (Kishimoto & Taguchi, 2014) to analyse zones visually through a justified permeability graph (Hanson, 1998). The collection dataset might proceed with extracting relevant information, this technique follows four steps: (a) identify the set of functional and spatial rooms as sectors, (b) identify the adjacency links as connection, (c) set the root as regarded root node space (example X^r) to generate and calculate the depth, connectivity, and integration (Table 4). These nodes configure of transit zone between interior and exterior area. This represents as root node space in Terrace (Te) for *Kampung Al Munawar 13*, *Kampung Kapiten 7 Ulu*, and *Kampung Songket 30–32 Ilir*. The root node space index will be value 0 (zero) that defines as starting point of

Figure 8. Collection data process

Table 3. The spatial layout organizations, footprints, and rooms code of traditional houses in Kampung Al Munawar 13 Ulu, Kampung Kapiten 7 Ulu, and Kampung Songket 30–32 Ilir

<table>
<tr><td colspan="4">Kampung Al Munawar</td></tr>
<tr><td colspan="2">1. Rumah Batu
This building has one storey with 20 rooms types;
■ Terrace (Te)
■ Living room (Lr)
■ Bedroom (Br)
■ Hall (H)
■ Kitchen (Ki)
■ Foyer (Fo)
■ Dining room (Dr)
■ Toilet (Toi)</td><td> 
Ground floor</td><td>2. Rumah Darat
This house has one storey with 10 rooms types;
■ Hall (H)
■ Bedroom (Br)
■ Family room (Fr)
■ Dining room (Dr)
■ Kitchen (Ki)
■ Storage for women (St. Wm)
■ Storage for men (St. M)</td><td> 
Ground floor</td></tr>
<tr><td colspan="2">3. Rumah Tinggi
This house has two storeys with 13 rooms types;
■ Terrace (Te)
■ Living room (Lr)
■ Bedroom (Br)
■ Dining room (Dr)
■ Family room (Fr)
■ Clothing room (Cr)
■ Side Terrace (Te.S)
■ Back Terrace (Te.B)
■ Toilet (Toi)
■ Storage (St)</td><td> 
Ground floor</td><td> 
First floor</td></tr>
<tr><td colspan="2">4. Rumah Kembar Darat
This house has two storeys with 14 rooms types;
■ Terrace (Te)
■ Hall (H)
■ Living room (Lr)
■ Family room (Fr)
■ Bedroom (Br)
■ Foyer (Fo)
■ Praying room (Pr)
■ Kitchen (Ki)
■ Toilet (Toi)</td><td> 
Ground floor</td><td> 
First floor</td></tr>
</table>

Continue of Table 3

5. Rumah Kembar Laut This house has two storeys with 13 rooms types; ■ Terrace (Te) ■ Living room (Lr) ■ Bedroom (Br) ■ Dining room (Dr) ■ Family room (Fr) ■ Clothing room (Cr) ■ Side Terrace (Te.S) ■ Back Terrace (Te.B) ■ Toilet (Toi) ■ Storage (St)	 Ground floor	 First floor
Kampung Kapiten 7 Ulu		
6. Rumah Abu This house has one storey with 24 rooms types; ■ Stair (St) ■ Corridor (Co) ■ Guest room (Gr) ■ Terrace (Te) ■ Praying room (Pr) ■ Foyer (Fo) ■ Bedroom (Br) ■ Inner court (Ic) ■ Terrace Inner (Te.i) ■ Hall (H) ■ Kitchen (Ki) ■ Toilet (Toi)	***Rumah Kapiten*** This house has one storey with 18 rooms types; ■ Stair (St) ■ Terrace (Te) ■ Praying room (Pr) ■ Workshop/Office Kapiten (Wo) ■ Bedroom (Br) ■ Corridor (Co) ■ Dining room (Dr) ■ Hall (H) ■ Terrace Back (Te.b)	
7. Rumah Selir Kapitan (now Rumah Pak Gempita) This house has one storey with 17 rooms types; ■ Balcony (Ba) ■ Garage (Ga) ■ Terrace (Te) ■ Living room (Lr) ■ Praying room (Pr) ■ Hall Praying room (Hpr) ■ Bedroom (Br) ■ Dining room (Dr) ■ Storage (St) ■ Laundry room (Lau) ■ Toilet (Toi) ■ Kitchen for family (Ki.F) ■ Kitchen for crackers (Ki.C)		***8. Rumah Mayor*** This house has one storey with 10 rooms; ■ Terrace (Te) ■ Living room (Lr) ■ Family room (Fr) ■ Hall (H) ■ Bedroom (Br) ■ Dining room (Dr) ■ Kitchen (Ki)	

End of Table 3

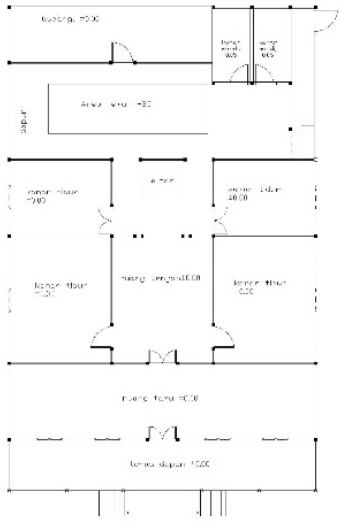
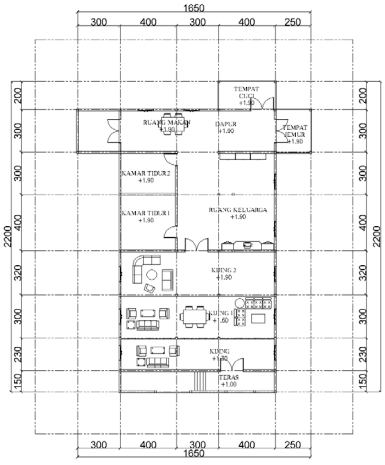
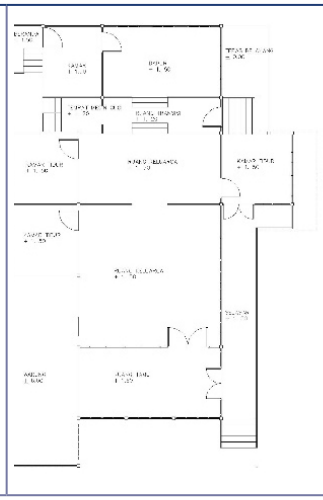
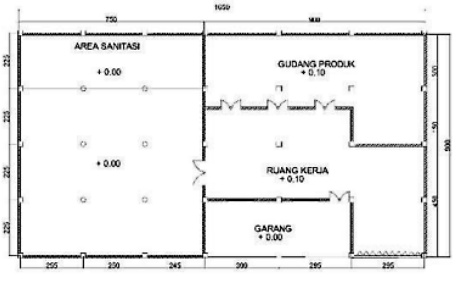
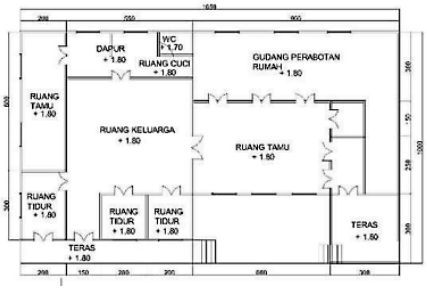
9. Rumah Kerabat Kapiten (now Rumah Pak Iskandar) This house has one storey with 17 rooms types; ■ Balcony (Ba) ■ Terrace (Te) ■ Living room (Lr) ■ Praying room (Pr) ■ Hall (H) ■ Bedroom (Br) ■ Dining room (Dr) ■ Laundry room (Lau) ■ Toilet (Toi) ■ Kitchen (Ki) ■ Storage (St)		
Kampung Songket 32 Ilir		
10. Rumah Limas This house one storeyed with 13 rooms; ■ Terrace (Te) ■ Hall (H) ■ Family room (Fr) ■ Bedroom (Br) ■ Foyer (Fo) ■ Dining room (Dr) ■ Kitchen (Ki) ■ Toilet (Toi) ■ Laundry room (Lar) ■ Drying room (Dry)		***11. Rumah Gudang 1*** This house one storeyed with 14 rooms; ■ Outside (O) ■ Terrace (Te) ■ Small store (Ss) ■ Living room (Lr) ■ Family room (Fr) ■ Bedroom (Br) ■ Laundry room (Lau) ■ Inner court (Ic) ■ Kitchen (Ki) ■ Balcony (Ba) ■ Terrace back (Te.b) 
12. Rumah Gudang 2 (Kemas M. Ali) This house two storeyed with 19 rooms; ■ Outside (O) ■ Terrace (Te) ■ Foyer (Fo) ■ Living room (Lr) ■ Furniture Storage (Fs) ■ Family room (Fr) ■ Bedroom (Br) ■ Kitchen (Ki) ■ Laundry room (Lau) ■ Toilet (Toi) ■ Workshop area (Wa) ■ Product Storage (Ps) ■ Sanitation room (Sr)	 Ground floor	 First floor

Table 4. Root node space (X^r)

No.	Traditional housings	Rooms as root node space	Code (X^r)
Kampung Al Munawar 13 Ulu			
1	*Rumah Batu*	0 = Terrace	Te^r
2	*Rumah Darat*	0 = Terrace/Stair	Te/St^r
3	*Rumah Tinggi*	0 = Outside/Stair	Os/St^r
4	*Rumah Kembar Darat*	0 = Outside/Stair	Os/St^r
5	*Rumah Kembar Laut*	0 = Terrace/Stair	Te/St^r
Kampung Kapiten 7 Ulu			
1	*Rumah Abu + Rumah Kapiten + Rumah Pembantu Kapiten*	0 = Stair	St^r
2	*Rumah Selir Kapiten* (*Now Rumah Pak Iskandar*)	0 = Balcony/Stair	Ba/St^r
3	*Rumah Mayor Letnan Tjia Kiam Boh*	0 = Terrace	Te^r
4	*Rumah Kerabat Kapiten* (*Now – Rumah Pak Gempita*)	0 = Outside/Stair	Os^r
Kampung Songket 30–32 Ilir			
1	*Rumah Limas*	0 = Stair	Sta^r
2	*Rumah Gudang 1*	0 = Outside Terrace	Ot^r
3	*Rumah Gudang 2* (*Rumah Pak Kms. M. Ali*)	0 = Terrace	Te^r

changing or steps to move to other rooms and depicts a transitional space between outdoor and indoor. The position of root node space (0) also will control movement to and from the rooms in the building and all the movement flow depends on this decision (Alexander et al., 1977). This stage will result the numerical data of structure patterns. Then, it highlights the syntax style that could reinterpret the design layout that are built or created by communities in these kampungs.

5.4. Formulating JPG grammar

A Justified Plan Graph (JPG) is one of techniques to read the spatial distribution and relations. This graph representation recognizes the emergent shape and the development of parameter shape grammars (Benrós et al., 2014; Eilouti & Hamamieh Al Shaar, 2012). It is also symbol of vertex and edge to code a spatial programming grammar which describe an invariable sequence of architectural design process. Incorporating graph and shape rules set a sequence of functions and spatial arrangement parallelly (Muslimin, 2023). This approach can be employed to represent and analyse the spatial configuration in a traditional dwelling. In terms of the chosen case study, it can clearly derive relationship between how people from "*Ulu* and *Ilir*" area could organise their lives and shape spaces for their activities and needs as well as interpretation of dwellers in traditional housings in urban kampung, Palembang.

This graph utilizes JPG grammar rules to define and reflect nodes and links (by edges or lines). The former represents different and various rooms (by a circle), while the latter shows the spatial connection in the spatial configuration. This graph also identifies and visualizes the syntactical order and pattern of traditional buildings in Ulu and Ilir area. The graph depicts how the traditional houses are experienced starting from the outside, stairs or terraces, represented as a circle with (r) code (=root node). Every line shows the connectivity and direction of change within room, it explains in a simple way the relationship between space and human activities. This also identifies the way of thinking about architectural spatial pattern in reconceptualization in terms of functional zones and the relationship determination. The five categories measurement of this spatial configuration as followed by Total Depth (*TDn*), Mean Depth (*MDn*), Relative Asymmetry (*RA*), Integration (*i*), and Control Value (*CV*). This JPG plan applied a set of rules and syntactical rules (Table 5). This applied rule will generate the following rules are applied.

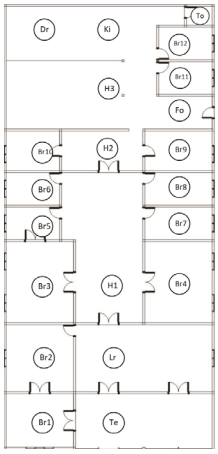
Table 5. The sequence of applied rules for JPG Plan

Step 1: node	Every room define each node
Step 2: corelink	Every node links to other nodes
Step 3: root node	Root node is selected to define the transitional space between outdoor and indoor
Step 4: calculation	The calculation results Total Depth (*TDn*), Mean Depth (*MDn*), Relative Asymmetry (*RA*), Integration (*i*), and Control Value (*CV*)

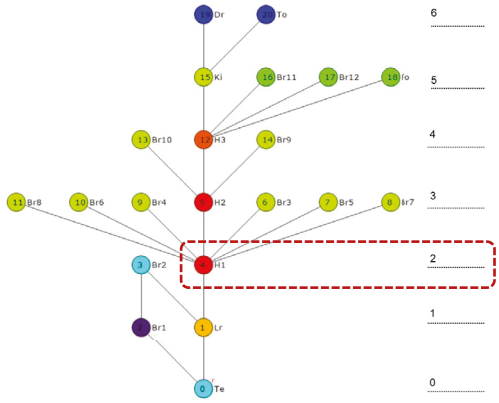
5.4.1. Kampung Al Munawar 13 Ulu

The five observed traditional houses in this kampung are more than 400 years old in still good condition. This kampung is a tourist destination and retain the originality. Following this, these traditional dwellings were constructed through the involvement of Arabic communities to understand the conceptual reasoning in terms of the architectural design process from local communities and the intangible preservation of traditional housing spatial characteristics within this kampung.

a. Rumah Batu



JPG Grammar Results



	Room names	TDn	MDn	RA	i	CV
0	Te	66	3,47	0,27	3,63	0,83
1	Lr	50	2,63	0,18	5,51	1,12
2	Br1	82	4,31	0,36	2,71	1
3	Br2	66	3,47	0,27	3,63	0,83
4	H1	38	2	0,11	9	6,58
5	H2	40	2,1	0,12	8,14	2,37
6	Br3	56	2,94	0,21	4,62	0,12
7	Br5	56	2,94	0,21	4,62	0,12
8	Br7	56	2,94	0,21	4,62	0,12
9	Br4	56	2,94	0,21	4,62	0,12
10	Br6	56	2,94	0,21	4,62	0,12
11	Br8	56	2,94	0,21	4,62	0,12
12	H3	48	2,52	0,16	5,89	2,58
13	Br10	58	3,05	0,22	4,38	0,25
14	Br9	58	3,05	0,22	4,38	0,25
15	Ki	62	3,26	0,25	3,97	2,25
16	Br11	66	3,47	0,27	3,63	0,25
17	Br12	66	3,47	0,27	3,63	0,25
18	Dr	80	4,21	0,35	2,8	0,33
19	To	80	4,21	0,35	2,8	0,33
	Min	38	2	0,11	2,71	0,12
	Mean	59,8	3,14	0,23	4,59	1
	Max	82	4,31	0,36	9	6,58

Figure 9. Spatial configuration and relationship determination Rumah Batu

Rumah Batu house has 20 rooms with 6 step depths that represent the amount of integration (Figure 9). The root node space is Terrace (Te^r) and the level of depth shows that how the building spaces are distributed by nodes. In this house, the spatial structure depth has combination between linear form and tree form. Hall 1 (H1) depicts the minimum score of TDn, MDn, and RA at 38, 2, and 0,11 respectively than other rooms and the highest score for integration (*i*) and control value (*cv*). H1 in the second steps depth also depicts red colour code that defines this room is more integrated rooms.

In addition, this house shows the combination between *a-structure* (*STAR*), *b-structure* (*PATH*), and *c-structure* (*CYCLE*), namely; *a-structure* (H1, H2, Br3, Br4, Br5, Br6, Br7, Br8), (H2, H3, Br9, Br10), (H3, Ki, Br11, Br12, Fo), (Ki, Dr, To), *b-structure* (Te, Lr, H1, H2, H3, Ki, Dr), and *c-structure* (Te, Lr, Br2, Br1). Te (0), Lr (1), Br1(2), Br2 (3) generates a distributed system route that is a ring-form. Those depicts a significant result for features (Te^r), Lr, Br1, and Br2 which determine features loops or call ring-shaped to describe the permeability of the configuration.

Regarding this result, H1 (Hall 1) in this house is more public, more integrated, more visual movements axis way, more connected, and more control related to move from space to others (See red dashed border in Figure 9). This room is as a spatial penetration or intersection space on movement with distancing social concept long models.

Rumah Darat has 10 rooms with 6 step depths (Figure 10), where the root node space is Stair (Te/Sr^r). The level of depth spatial layout shows that how the building spaces are distributed on linear and tree-from combination. Hall (H4) shows minimum index for TDn, MDn, and RA, where the features present at 19, 1.9, and 0.2, respectively. H4 also depicts the highest integration (*i*) index at 5.50. H4 in the fourth steps depth also depicts red colour code that defines this room is more integrated rooms. Meanwhile, there is an opposite condition that Terrace/Stairs (Te) is the highest index at 43.00 for TDn, 4.3 for MDn, and 0.73 for RA, but this feature presents the lowest integration (*i*) at 1.36. On the other hand, Family room (Fr) and Dining room (Dr) define the biggest index of control value (*cv*) at 3.25. The step depth depicts the combination of two space types structures; *a-structure* (H4, Br1, Fr & Dr, Br2), (Fr&Dr, Ki, St-Wm, St-M) and *b-structure* (Te, H1, H2, H3, H4, Fr&Dr, Ki).

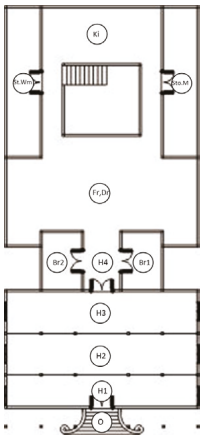
Regarding this result, the spatial organization layout of *Rumah Darat* has linear form distribution axially that shows lack of integration and connectivity (more private). H4 (See red dashed border in Figure 10) has a role as spatial penetration or intersection space on movement with distancing social concept long models.

Rumah Tinggi has 2 floors with 23 rooms with 5 step depth (Figure 11) that represent the combination of spatial configuration on linear and tree-form. The root node is Terrace (Te^r) and the level of depth shows that how the spatial layout in this house is distributed on the combination of linear and tree-form. Terrace Side (Te.s) and Bedroom (Br1) depict the highest index of TDn, MDn, and RA, where these features are at 96, 4.17, and 0.28, respectively. Stair Up (Su) is in the third step depths and also depicts red colour code that defines this room is more integrated rooms. Moreover, Stair Up (Su) also has the highest index for integration (*i*) and control value (*cv*) at 7.22 and 6.75.

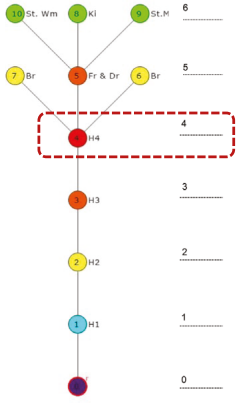
The step depth describes 4 types structures; *a-structure* (Te, St, H), (Fo, Su, Sto, Ic), (Su, Pr, Dr, Ki, To1, To2, Lau), (Te.f, Br1, Lr, Te.s), (Lr, Br2, H1, Br3, Br4), (H1, Te.b, To3, Cl.r); *b-structure* (Te, H, Fo, Su, Pr), (St, Te.f, Lr, H1, To3); and *c-structure* (Te, H, Fo, Su, Te.b, H1, Lr, Te.f, St). In term of this result, *Su* (See red dashed border in Figure 11) is as spatial penetration or intersection space on movement route steadily with accessing social concept long models.

Rumah Kembar Darat also has 2 storeys building with 15 rooms and 5 step depth (Figure 12). This simulation makes a root node space is Outside/Stairs (O^r). The spatial organization shows that this layout presents the combination between a ring-form and tree-form. There is a

b. Rumah Darat



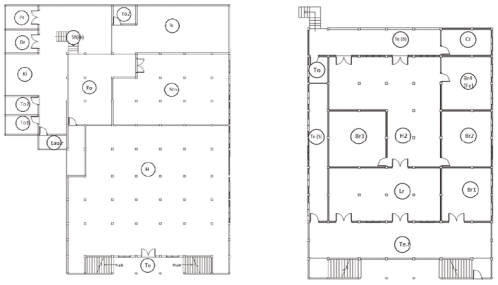
JPG Grammar Results



	Room Codes	TDn	MDn	RA	i	CV
0	O/St	43	4,3	0,73	1,36	0,5
1	H1	34	3,4	0,53	1,87	1,5
2	H2	27	2,7	0,37	2,64	1
3	H3	22	2,2	0,26	3,75	0,75
4	H4	19	1,9	0,2	5	2,75
5	Fr & Dr	22	2,2	0,26	3,75	3,25
6	Br	28	2,8	0,4	2,5	0,25
7	Br	28	2,8	0,4	2,5	0,25
8	Ki	31	3,1	0,46	2,14	0,25
9	St.M	31	3,1	0,46	2,14	0,25
10	St. Wm	31	3,1	0,46	2,14	0,25
	Min	19	1,9	0,2	1,36	0,25
	Mean	**28,72**	**2,87**	**0,41**	**2,71**	**1**
	Max	43	4,3	0,73	5	3,25

Figure 10. Spatial configuration and relationship determination Rumah Darat

c. Rumah Tinggi



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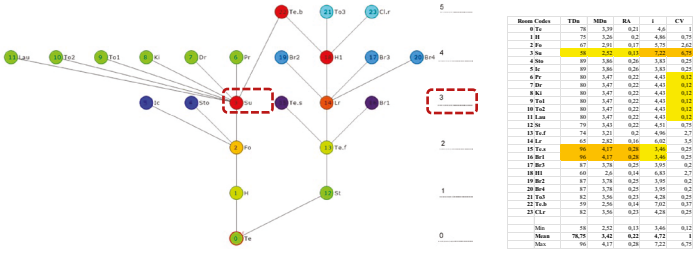
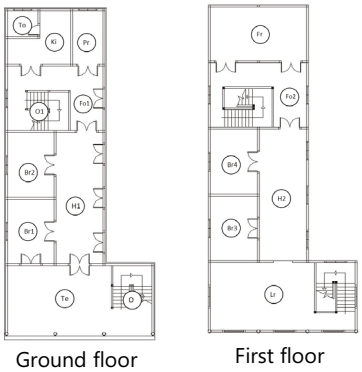


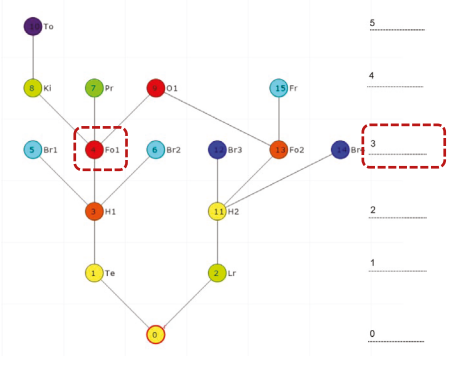
Figure 11. Spatial configuration and relationship determination Rumah Tinggi

d. Rumah Kembar Darat



Ground floor First floor

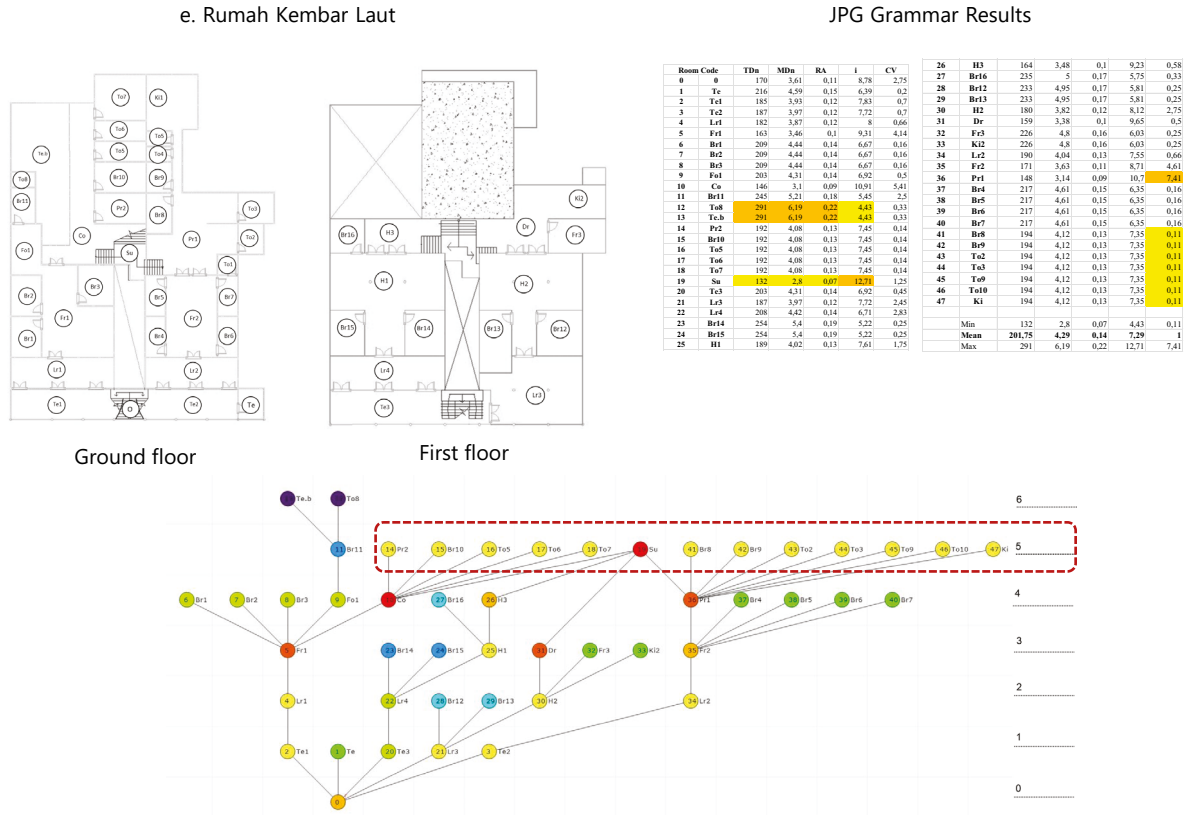
JPG Grammar Results



	Room Codes	TDn	MDn	RA	i	CV
0	0	45	3	0,28	3,5	1
1	Te	43	2,86	0,26	3,75	0,75
2	Lr	47	3,13	0,3	3,28	0,75
3	H1	39	2,6	0,22	4,37	2,75
4	Fo1	35	2,33	0,19	5,25	2,25
5	Br1	53	3,53	0,36	2,76	0,25
6	Br2	53	3,53	0,36	2,76	0,25
7	Pr	49	3,26	0,32	3,08	0,25
8	Ki	47	3,13	0,3	3,28	1,25
9	O1	37	2,46	0,2	4,77	0,58
10	To	61	4,06	0,43	2,28	0,5
11	H2	43	2,86	0,26	3,75	2,83
12	Br3	57	3,8	0,4	2,5	0,25
13	Fo2	39	2,6	0,22	4,37	1,75
14	Br4	57	3,8	0,4	2,5	0,25
15	Fr	53	3,53	0,36	2,76	0,33
	Min	35	2,33	0,19	2,28	0,25
	Mean	**47,37**	**3,15**	**0,3**	**3,43**	**1**
	Max	61	4,06	0,43	5,25	2,83

Figure 12. Spatial configuration and relationship determination Rumah Kembar Darat

significant opposite trend between Foyer 1 (Fo1) and Toilet (To). The former shows that the lowest index of TDn, MDn, and RA at 35.00, 2.33, and 0.19, respectively, but shows the highest index of integration (*i*) at 5.25. Foyer 1 (Fo1) in the third steps depth also depicts red colour code that defines this room is more integrated rooms. However, the Toilet (To) presents the TDn, MDn, and RA in the highest index at 61, 4.06, and 0.43, respectively, but it also depicts the lowest index in integration (*i*) at 2.28. The step depth shows 7 space types structures; *a-structure* (H1, Br1, Br2), (H2, Br3, Br4, Fo2), *b-structure* (Te, H1, Fo1, Pr), (Lr, H2, Br3), (Ki, To), (Fo2, Fr) and *c-structure* (O, Te, H1, Fo1, O1, Fo2, H2, Lr). A ring form determines a loop feature or calls ring-shaped to describe the permeability of the configuration in



Room Code		TDn	MDn	RA	i	CV
0	0	170	3,61	0,11	8,78	2,75
1	Te	216	4,59	0,15	6,39	0,2
2	Te1	185	3,93	0,12	7,83	0,7
3	Te2	187	3,97	0,12	7,72	0,7
4	Lr1	182	3,87	0,12	8	0,66
5	Fr1	163	3,46	0,1	9,31	4,14
6	Br1	209	4,44	0,14	6,67	0,16
7	Br2	209	4,44	0,14	6,67	0,16
8	Br3	209	4,44	0,14	6,67	0,16
9	Fo1	203	4,31	0,14	6,92	0,5
10	Co	146	3,1	0,09	10,91	5,41
11	Br11	245	5,21	0,18	5,45	2,5
12	To8	291	6,19	0,22	4,43	0,33
13	Te.b	291	6,19	0,22	4,43	0,33
14	Pr2	192	4,08	0,13	7,45	0,14
15	Br10	192	4,08	0,13	7,45	0,14
16	To5	192	4,08	0,13	7,45	0,14
17	To6	192	4,08	0,13	7,45	0,14
18	To7	192	4,08	0,13	7,45	0,14
19	Su	132	2,8	0,07	12,71	1,25
20	Te3	203	4,31	0,14	6,92	0,45
21	Lr3	187	3,97	0,12	7,72	2,45
22	Lr4	208	4,42	0,14	6,71	2,83
23	Br14	254	5,4	0,19	5,22	0,25
24	Br15	254	5,4	0,19	5,22	0,25
25	H1	189	4,02	0,13	7,61	1,75
26	H3	164	3,48	0,1	9,23	0,58
27	Br16	235	5	0,17	5,75	0,33
28	Br12	233	4,95	0,17	5,81	0,25
29	Br13	233	4,95	0,17	5,81	0,25
30	H2	180	3,82	0,12	8,12	2,75
31	Dr	159	3,38	0,1	9,65	0,5
32	Fr3	226	4,8	0,16	6,03	0,25
33	Ki2	226	4,8	0,16	6,03	0,25
34	Lr2	190	4,04	0,13	7,55	0,66
35	Fr2	171	3,63	0,11	8,71	4,61
36	Pr1	148	3,14	0,09	10,7	7,41
37	Br4	217	4,61	0,15	6,35	0,16
38	Br5	217	4,61	0,15	6,35	0,16
39	Br6	217	4,61	0,15	6,35	0,16
40	Br7	217	4,61	0,15	6,35	0,16
41	Br8	194	4,12	0,13	7,35	0,11
42	Br9	194	4,12	0,13	7,35	0,11
43	To2	194	4,12	0,13	7,35	0,11
44	To3	194	4,12	0,13	7,35	0,11
45	To9	194	4,12	0,13	7,35	0,11
46	To10	194	4,12	0,13	7,35	0,11
47	Ki	194	4,12	0,13	7,35	0,11
	Min	132	2,8	0,07	4,43	0,11
	Mean	201,75	4,29	0,14	7,29	1
	Max	291	6,19	0,22	12,71	7,41

Figure 13. Spatial configuration and relationship determination Rumah Kembar Laut

a distributes system route. It defines one route from point to any other points.

Regarding this result, the spatial organization layout of *Rumah Kaca* has routed linear form distribution that shows low integration. Fo1 (See red dashed border in Figure 12) is as spatial penetration or intersection space on movement with accessing social concept short models.

Rumah Kembar Laut has two storeys building with 6 step depths and 47 rooms (Figure 13). This simulation shows a root node as Terrace/Stairs (O^r). The spatial organization shows that this layout presents the combination between a tree-form and a ring-form. The latter form determines loops or ring-shaped to describe a distribution one system route, such as Outside (O), Terrace 3 (Te3), Living room (Lr4), Hall 1 (H1), Hall 3 (H3), Stair up (Su), Praying room (Pr2), Foyer room (Fr2), Living room 2 (Lr2), and Terrace 2 (Te2). Terrace back (Te.b) and Toilet 8 (To8) depict the highest index of TDn, MDn, and RA at 291, 6.39, and 0.22, respectively but the lowest index of integration (*i*) at 4.43 than other rooms. Meanwhile, Stair Up (Su) describes the lowest index of TDn, MDn, and RA at 132, 2.8, and 0.07, respectively, but the highest index of integration (*i*) at 12.71. *Stair Up* (*Su*) in the fifth step depth also depicts red colour code that defines this room is more integrated rooms. The step depth depicts *a-structure* (O, Te, Te1, Te2, Te3, Lr3), (Fr1, Br1, Br2, Br3, Fo1, Co), (Br11, To8, Te.b), (Co, Pr2, Br10, To5, To6, To7), (Lr4, Br14, Br15, H1), (H1, H3, Br16, Lr4), (Lr3, Br12, Br13, H2), (H2, Dr, Fr3, Ki2), (Fr2, Br4, Br5, Br6, Br7), (Pr1, Su, Br8, Br9, To2, To3, To9, To10, Ki), *b-structure* (O, Te), (Te1, Lr1, Fr1, Br3), (Te3, Lr4, Br14), (Fo1, Br11, To8), (Lr2, Fr2, Pr1, Br8), and *c-structure* (O, Te2, Lr2, Fr2, Pr1, Su, H3, H1, Lr4, Te3).

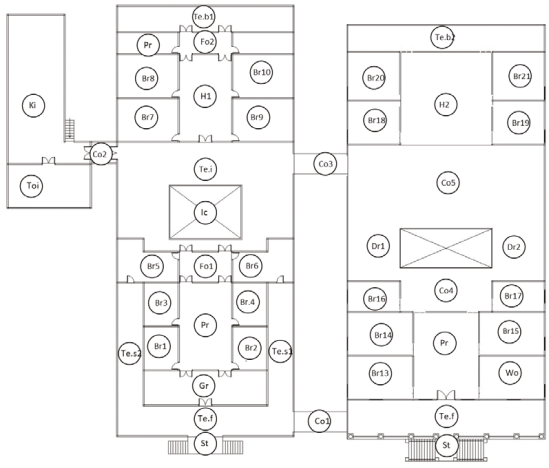
Regarding this result, the spatial organization layout of *Rumah Kembar Laut* has linear form distribution. It shows high integration but the concept of movement is stasis. *Su* (See red dashed border in Figure 13) is as spatial penetration or intersection space on movement with generating social concept long models.

5.4.2. Kampung Kapiten 7 Ulu

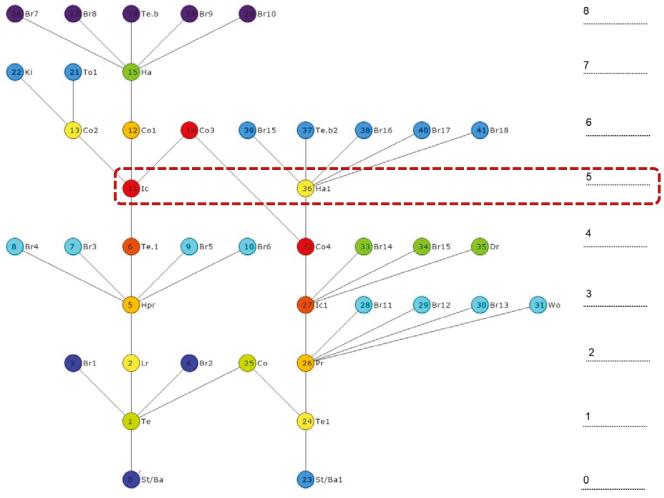
The four observed traditional dwellings are also a tourist destination. Following this, these traditional dwellings were constructed through the involvement of Chinese communities.

Rumah Abu and *Rumah Kapiten* are linked together. This house has one storey-stilt building with 41 rooms and 8 step depths (Figure 14). This simulation reveals that the Stair/Balcony (St/Ba) as a root node space $(St/Ba)^r$. The spatial organization layout shows combination between *a-structure* (*STAR*) and *b-structure* (*PATH*), and *c-structure* (*cycle-ring shaped*). *Inner court* (*Ic*) is located in the fifth step depth and depicts the red color code which means this room is more integrated. Additionally, this room is the highest integration (*i*) value at 8.2 among other rooms

a. Rumah Abu + Rumah Kapiten JPG Grammar Results



(Rumah Abu) *(Rumah Kapiten)*



Room Codes	TDn	MDn	RA	i	CV
0 St/Ba	223	5,43	0,22	4,5	0,2
1 Te	183	4,46	0,17	5,77	4
2 Lr	180	4,39	0,16	5,89	0,36
3 Br1	223	5,43	0,22	4,5	0,2
4 Br2	223	5,43	0,22	4,5	0,2
5 Hpr	168	4,09	0,15	6,45	5
6 Te.1	157	3,82	0,14	7,06	0,41
7 Br3	208	5,07	0,2	4,91	0,16
8 Br4	208	5,07	0,2	4,91	0,16
9 Br5	208	5,07	0,2	4,91	0,16
10 Br6	208	5,07	0,2	4,91	0,16
11 Ic	141	3,43	0,12	8,2	1,83
12 Co1	169	4,12	0,15	6,4	0,41
13 Co2	177	4,31	0,16	6,02	2,25
14 Co3	144	3,51	0,12	7,96	0,58
15 Ha	199	4,85	0,19	5,16	5,5
16 Br7	239	5,82	0,24	4,14	0,16
17 Br8	239	5,82	0,24	4,14	0,16
18 Te.b	239	5,82	0,24	4,14	0,16
19 Br9	239	5,82	0,24	4,14	0,16
20 Br10	239	5,82	0,24	4,14	0,16
21 To1	217	5,29	0,21	4,65	0,33
22 Ki	217	5,29	0,21	4,65	0,33
23 St/Ba1	219	5,34	0,21	4,6	0,33
24 Te1	179	4,36	0,16	5,94	1,66
25 Co	186	4,53	0,17	5,65	0,53
26 Pr	164	4	0,15	6,66	4,53
27 Ic1	153	3,73	0,13	7,32	3,5
28 Br11	204	4,97	0,19	5,03	0,16
29 Br12	204	4,97	0,19	5,03	0,16
30 Br13	204	4,97	0,19	5,03	0,16
31 Wo	204	4,97	0,19	5,03	0,16
32 Co4	144	3,51	0,12	7,96	0,86
33 Br14	193	4,7	0,18	5,39	0,2
34 Br15	193	4,7	0,18	5,39	0,2
35 Dr	193	4,7	0,18	5,39	0,2
36 Ha1	174	4,24	0,16	6,16	5,33
37 Te.b2	214	5,21	0,21	4,73	0,16
38 Br16	214	5,21	0,21	4,73	0,16
39 Br15	214	5,21	0,21	4,73	0,16
40 Br17	214	5,21	0,21	4,73	0,16
41 Br18	214	5,21	0,21	4,73	0,16
Min	141	3,43	0,12	4,14	0,16
Mean	198,38	4,83	0,19	5,39	1
Max	239	5,82	0,24	8,2	5,5

Figure 14. Spatial configuration and relationship determination Rumah Abu and Rumah Kapiten

and the lowest index of TDn, MDn, and RA at 141, 3.43, and 0.12, respectively. The step depth shows *a-structure*, *b-structure*, and *c-structure*.

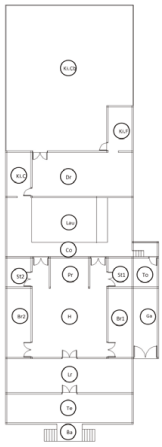
According to the result, the spatial organization layout of *Rumah Abu and Rumah Kapiten* seems linear and tree form distribution. It shows high integration but the concept of movement is stasis. *Ic* (See red dashed border in Figure 14) is as spatial penetration or intersection space on movement with generating social concept long models.

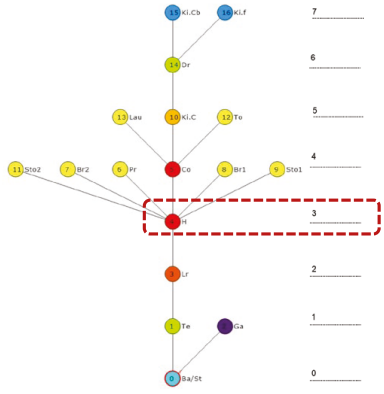
Rumah Selir Kapiten has one storey building with 16 rooms and 7 step depths (Figure 15). This simulation shows that the Balcony/Stair (Ba/St) as a root node space $(Ba/St)^r$. The spatial organization depicts *a-structure* (*STAR*); (*Ba/St*, *Te*, *ga*), (*H*, *Pr*, *Co*, *Br1*, *Br2*, *Sto1*, *Sto2*), (*Co*, *Lau*, *Ki.C*, *To*), (*Dr*, *Ki.Cb*, *Ki.F*) and *b-structure* (*PATH*); (*Ba/St*, *Te*, *Lr*, *H*, *Co*, *Ki.C*, *Dr*, *Ki.Cb*). Hall (H) is in the third step depth which defines the red colour code and the highest index of integration (*i*) and control value (*cv*) at 7.05 and 5.75, respectively. Meanwhile, Hall (H) has the lowest index for TDn, MDn, and RA at 33, 2.06, and 0.14, respectively. The step depth shows *a-structure* and *b-structure*. Regarding this result, the the spatial organization layout of *Rumah Selir Kapiten* seems linear and tree form distribution. It shows high integration but the concept of movement is stasis. *H* (See red dashed border in Figure 15) is as spatial penetration or intersection space on movement.

Rumah Mayor Letnan Tjia Kiam Boh is one storey building and has 10 rooms with 5 steps depth. The simulation depicts Te $(Te)^r$ as a root node space. The spatial organization shows *a-structure* (*STAR*); (*H*, *Dr*, *Br1*, *Br2*, *Br3*, *Br4*), *b-structure* (*PATH*); (*Te*, *Lr*, *Fr*, *H*, *Dr*, *Ki*). Hall (H) depicts the highest index of integration (*i*) and control value (*cv*) at 9 and 5, respectively, while the Hall (H) also shows the lowest index of TDn, MDn, and RA at 31, 3,44, and 0,11, respectively. Hall (H) in the third steps depth also depicts red colour code that defines this room is more integrated rooms. The step depth shows *a-structure* (*STAR*); (*H*, *Dr*, *Br1*, *Br2*, *Br3*, *Br4*) and *b-structure* (*PATH*); *Te*, *Lr*, *Fr*, *H*, *Dr*, *Ki*).

b. Rumah Selir Kapiten
(now – Rumah Pak Iskandar)

JPG Grammar Results



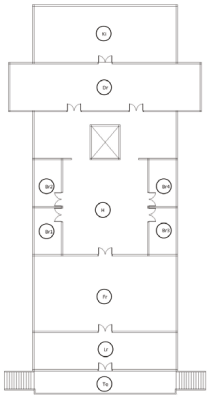


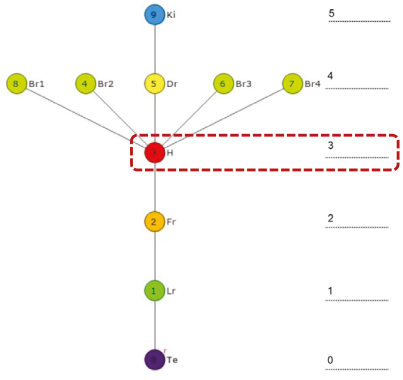
Room Codes		TDn	MDn	RA	i	CV
0	Ba/St	66	4,12	0,41	2,4	1,5
1	Te	53	3,31	0,3	3,24	1
2	Ga	81	5,06	0,54	1,84	0,5
3	Lr	42	2,62	0,21	4,61	0,64
4	H	33	2,06	0,14	7,05	5,75
5	Co	36	2,25	0,16	6	2,64
6	Pr	48	3	0,26	3,75	0,14
7	Br2	48	3	0,26	3,75	0,14
8	Br1	48	3	0,26	3,75	0,14
9	Sto1	48	3	0,26	3,75	0,14
10	Ki.C	45	2,81	0,24	4,13	0,58
11	Sto2	48	3	0,26	3,75	0,14
12	To	51	3,18	0,29	3,42	0,25
13	Lau	51	3,18	0,29	3,42	0,25
14	Dr	56	3,5	0,33	3	2,5
15	Ki.Cb	71	4,43	0,45	2,18	0,33
16	Ki.f	71	4,43	0,45	2,18	0,33
	Min	33	2,06	0,14	1,84	0,14
	Mean	**52,7**	**3,29**	**0,3**	**3,66**	**1**
	Max	81	5,06	0,54	7,05	5,75

Figure 15. Spatial configuration and relationship determination Rumah Selir Kapiten

c. Rumah Mayor Letnan Tjia Kiam Boh

JPG Grammar Results



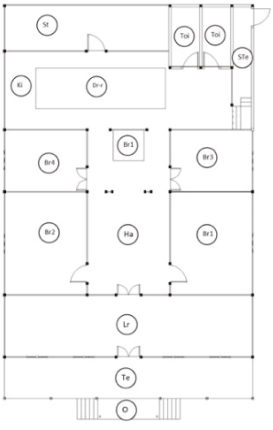


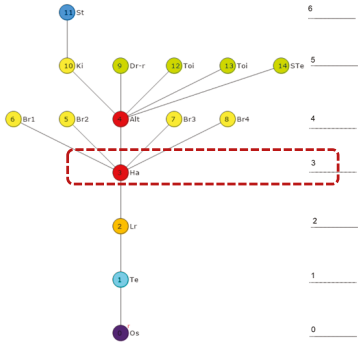
Room Codes		TDn	MDn	RA	i	CV
0	Te	31	3,44	0,61	1,63	0,5
1	Lr	23	2,55	0,38	2,57	1,5
2	Fr	17	1,88	0,22	4,5	0,66
3	H	13	1,44	0,11	9	5
4	Dr	19	2,11	0,27	3,6	1,16
5	Br2	21	2,33	0,33	3	0,16
6	Br1	21	2,33	0,33	3	0,16
7	Br3	21	2,33	0,33	3	0,16
8	Br4	21	2,33	0,33	3	0,16
9	Ki	27	3	0,5	2	0,5
	Min	13	1,44	0,11	1,63	0,16
	Mean	**21,4**	**2,37**	**0,34**	**3,53**	**1**
	Max	31	3,44	0,61	9	5

Figure 16. Spatial configuration and relationship determination Rumah Mayor Letnan Tjia Kiam Boh

d. Rumah Kerabat Kapiten
(now – Rumah Pak Gempita)

JPG Grammar Results





Room Codes		TDn	MDn	RA	i	CV
0	Os	57	4,07	0,47	2,11	0,5
1	Te	44	3,14	0,32	3,03	1,5
2	Lr	33	2,35	0,2	4,78	0,66
3	Ha	24	1,71	0,1	9,1	4,66
4	Alt	25	1,78	0,12	8,27	4,66
5	Br2	37	2,64	0,25	3,95	0,16
6	Br1	37	2,64	0,25	3,95	0,16
7	Br3	37	2,64	0,25	3,95	0,16
8	Br4	37	2,64	0,25	3,95	0,16
9	Dr-r	38	2,71	0,26	3,79	0,16
10	Ki	36	2,57	0,24	4,13	1,16
11	St	49	3,5	0,38	2,6	0,5
12	Toi	38	2,71	0,26	3,79	0,16
13	Toi	38	2,71	0,26	3,79	0,16
14	STe	38	2,71	0,26	3,79	0,16
	Min	24	1,71	0,1	2,11	0,16
	Mean	**37,86**	**2,7**	**0,26**	**4,33**	**1**
	Max	57	4,07	0,47	9,1	4,66

Figure 17. Spatial configuration and relationship determination Rumah Kerabat Kapiten

Regarding this result, the spatial organization layout of *Rumah Mayor Letnan Tjia Kiam Boh* seems linear form distribution. It shows low integration and the concept of movement is axially. H (See red dashed border in Figure 16) is as spatial penetration or intersection space on movement.

Rumah Kerabat Kapiten has 15 rooms with 6 step depth that represent the amount of integration (Figure 17). The root node is Outside Stairs (OS^r). The level of depth shows that how the building spaces are distributed by root nodes. The less deep means the spatial is more integral. In this spatial housing has combination between linear form and tree form. Hall (Ha) depicts the minimum score of TDn, MDn, and RA at 24, 1.71, and 0.1, respectively than other rooms and the highest score for integration (*i*) and control value (*cv*) at 9.1 and 4.66, respectively. This spatial organization shows that this layout presents the combination between *a-structure* (*STAR*); (*Ha*, *Alt*, *Br1*, *Br2*, *Br3*, *Br4*), (*Alt*, *Dr.r*, *Toi1*, *Toi2*, *Ki*, *Ste*) and *b-structure* (*PATH*); *Os*, *Te*, *lr*, *Ha*, *Alt*, *Dr.r*), (*Ki*, *St*). Based on this result, the spatial organization layout of this dwellings seems linear form distribution. It shows low integration and the concept of movement is axially. Ha (See red dashed border in Figure 17) is as spatial penetration or intersection space on movement with distancing social concept long models. Ha is more public, more integrated and connected, more visual movements, and more control related to move to others.

5.4.3. Kampung Songket 30–32 Ilir

The three observed traditional dwellings were constructed through the involvement of native Palembang communities.

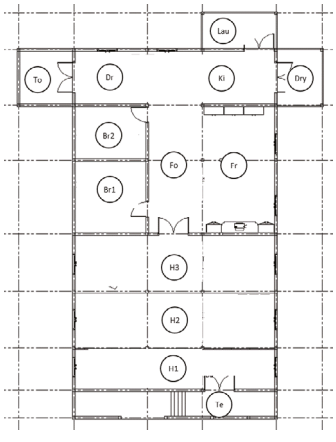
This Rumah Limas has 13 rooms with 6 steps depth that depicts the number of integration (Figure 18). The root node space is Stair $(Sta)^r$. The level of depth defines the spatial distribution orderly through Stair (Sta) as root node space. The spatial organization shows that this layout presents the combination between a path-form and a star-form. *a-structure – STAR* (*Fo*, *Dr*, *Ki*, *Fr*, *Br1*, *Br2*), *b-structure – PATH* (*Sta*, *Te*, *H1*, *H2*, *H3*, *Fo*, *Dr*, *Sto*). Foyer (Fo) in the fourth steps depth also depicts red colour code that defines this room is more integrated rooms and also as control spatial distribution. Foyer (Fo) defines the minimum score of TDn, MDn, and RA at 26, 2, and 0,16 respectively. Meanwhile, Fo depicts the highest index of integration (*i*) and control value (*cv*) at 6 and 4,33, respectively.

In terms of this result, the spatial organization layout of *Rumah Limas* seems linear form distribution. It shows low integration and the concept of movement is axially. Fo (See red dashed border in Figure 18) is as spatial penetration or intersection space on movement with distancing social concept long models.

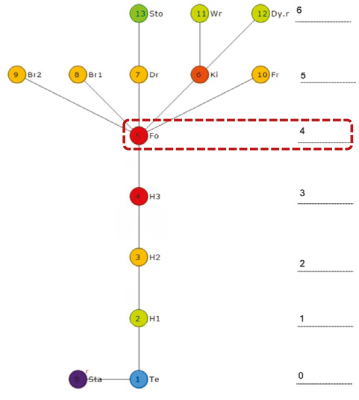
This *Rumah Gudang* has 14 rooms with 7 step depths that present the number of integrations (Figure 19). The root node space is Outside $(Ot)^r$. The spatial organization shows that this layout presents the combination between a path-form and a star-form. *a-structure – STAR* (*Ot*, *Te*, *Lr*), (*Fr1*, *Br1*, *Ss*), (*Fr2*, *Ic*, *Br2*, *Br3*), (*Ic*, *Ki*, *Lau*, *Te.b*); *b-structure – PATH* (*Ot*, *Lr*, *Fr1*, *Fr2*, *Ic*, *Ki*, *Toi*, *Ba*), *and c-structure – CYCLE* (*Lr*, *Fr1*, *Ss*), (*Ot*, *Lr*, *Fr2*, *Br3*, *Te*). Family room 2 (Fr2) in the third steps depth depicts red colour code that defines this room is more integrated rooms and also seems the highest index of integration (*i*) at 6.5, but *Inner court* (*Ic*) has the highest index of control value (*cv*) at 2.75. Additionally, Fr2 depicts the lowest index of TDn, MDn, and RA at 28, 2, and 0.15, respectively, while Balcony (Ba) is the highest index of TDn, MDn, and RA at 64, 4.57, and 0.54, respectively.

Regarding this result, the spatial organization layout of *Rumah Gudang 1* seems linear form distribution. It shows low integration and the concept of movement is axially. Fr2 (See red dashed border in Figure 19) is as spatial penetration or intersection space on movement with distancing social concept long models.

a. Rumah Limas



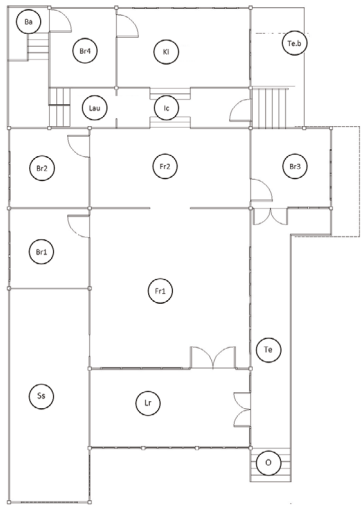
JPG Grammar Results



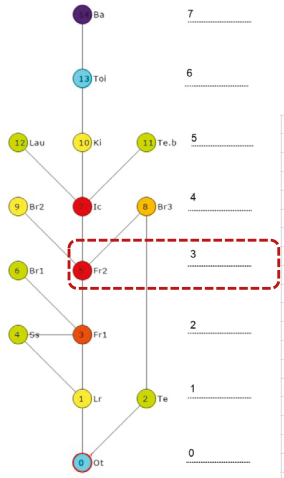
Room Codes		TDn	MDn	RA	i	CV
0	Sta	66	5,07	0,67	1,47	0,5
1	Te	54	4,15	0,52	1,9	1,5
2	H1	44	3,38	0,39	2,51	1
3	H2	36	2,76	0,29	3,39	1
4	H3	30	2,3	0,21	4,58	0,66
5	Fo	26	2	0,16	6	4,33
6	Ki	34	2,61	0,26	3,71	2,16
7	Dr	36	2,76	0,29	3,39	1,16
8	Br1	38	2,92	0,32	3,12	0,16
9	Br2	38	2,92	0,32	3,12	0,16
10	Fr	38	2,92	0,32	3,12	0,16
11	Lau	46	3,53	0,42	2,36	0,33
12	Dy.r	46	3,53	0,42	2,36	0,33
13	Sto	48	3,69	0,44	2,22	0,5
	Min	26	2	0,16	1,47	0,16
	Mean	41,42	3,18	0,36	3,09	1
	Max	66	5,07	0,67	6	4,33

Figure 18. Spatial configuration and relationship determination Rumah Limas

b. Rumah Gudang 1



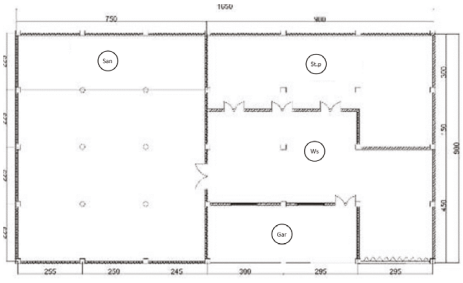
JPG Grammar Results



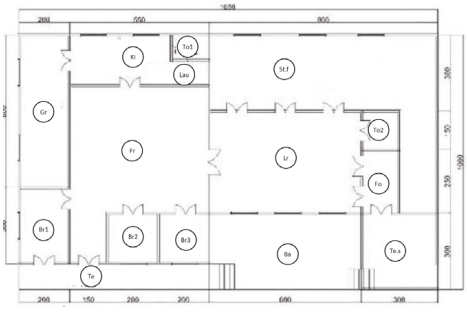
Room codes		TDn	MDn	RA	i	CV
0	Ot	50	3,57	0,39	2,52	0,83
1	Lr	41	2,92	0,29	3,37	1,25
2	Te	45	3,21	0,34	2,93	1
3	Fr1	33	2,35	0,2	4,78	2,08
4	Ss	43	3,07	0,31	3,13	0,58
5	Fr2	28	2	0,15	6,5	2
6	Br1	46	3,28	0,35	2,84	0,25
7	Ic	31	2,21	0,18	5,35	2,75
8	Br3	37	2,64	0,25	3,95	0,75
9	Br2	41	2,92	0,29	3,37	0,25
10	Ki	40	2,85	0,28	3,5	0,75
11	Te.b	44	3,14	0,32	3,03	0,25
12	Lau	44	3,14	0,32	3,03	0,25
13	Toi	51	3,64	0,4	2,45	1,5
14	Ba	64	4,57	0,54	1,82	0,5
	Min	28	2	0,15	1,82	0,25
	Mean	**42,53**	**3,03**	**0,31**	**3,5**	**1**
	Max	64	4,57	0,54	6,5	2,75

Figure 19. Spatial configuration and relationship determination Rumah Gudang 1

c. Rumah Gudang 2 (Kemas Ali)

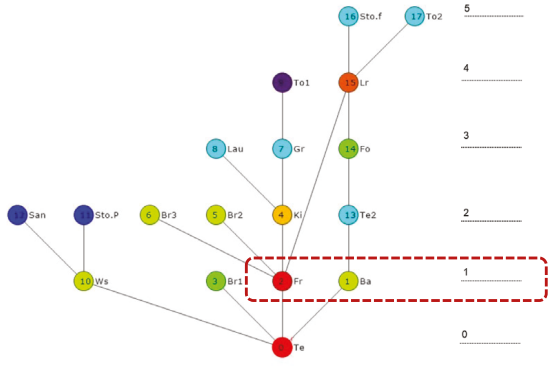


Ground floor



First floor

JPG Grammar Results



Room Codes		TDn	MDn	RA	i	CV
0	Te	37	2,17	0,14	6,8	2,03
1	Ba	49	2,88	0,23	4,25	0,75
2	Fr	33	1,94	0,11	8,5	2,83
3	Br1	53	3,11	0,26	3,77	0,25
4	Ki	43	2,52	0,19	5,23	1,7
5	Br2	49	2,88	0,23	4,25	0,2
6	Br3	49	2,88	0,23	4,25	0,2
7	Gr	57	3,35	0,29	3,4	1,33
8	Lau	59	3,47	0,3	3,23	0,33
9	To1	73	4,29	0,41	2,42	0,5
10	Ws	49	2,88	0,23	4,25	2,25
11	Sto.P	65	3,82	0,35	2,83	0,33
12	San	65	3,82	0,35	2,83	0,33
13	Te2	57	3,35	0,29	3,4	1
14	Fo	53	3,11	0,26	3,77	0,75
15	Lr	41	2,41	0,17	5,66	2,7
16	Sto.f	57	3,35	0,29	3,4	0,25
17	To2	57	3,35	0,29	3,4	0,25
	Min	33	1,94	0,11	2,42	0,2
	Mean	**52,55**	**3,09**	**0,26**	**4,2**	**1**
	Max	73	4,29	0,41	8,5	2,83

Figure 20. Spatial configuration and relationship determination Rumah Gudang 2 (Kemas M.Ali)

This *Rumah Gudang 2* (*Kemas M. Ali*) has two storeys with 18 rooms and 5 steps depth that present the number of integrations. The root node space is Terrace (Te)^{r}. The spatial organization reveals the combination between a path-form, a star-form, and a cycled-form. *a-structure – STAR* (*Te*, *Ba*, *Fr*, *Br1*, *Ws*), (*Ws*, *San*, *Sto.p*), (*Fr*, *Br2*, *Br3*, *Ki*, *Lr*), (*Ki*, *Gr*, *Lau*), (*Lr*, *Sto.f*, *To2*); *b-structure – PATH* (*Te*, *Fr*, *Ki*, *gr*, *To1*), (*Ba*, *Te2*, *Fo*, *Lr*, *Sto.f*), and *c-structure – CYCLE* (*Te*, *Ba*, *Te2*, *Fo*, *Lr*, *fr*). Family room (Fr) in the first steps depth depicts red colour code that defines this room is more integrated rooms and also seems the highest index of integration (*i*) and control value (*cv*) at 8.5 and 2.83, but

this room has the lowest index of TDn, MDn, and RA at 33, 1.94, and 0.11, respectively.

Regarding this result, the spatial organization layout of *Rumah Gudang 2* seems tree form distribution. It shows high integration and the concept of movement is stasis. Fr (See red dashed border in Figure 20) is as spatial penetration or intersection space on spatial movement distribution.

6. Results and discussion

The twelve traditional houses in this urban kampung are examples of traditional architecture which was comparing between *Ilir* area and *Ulu* area in South Sumatera, Indonesia. According to this approach, this applied JPG grammar highlights three design stages which follow three syntactical steps; collecting data, extracting JPG grammar, and formulating JPG grammar. It is generally used to decode or decompose design processing (Hillier & Hanson, 1984) and also to simulate a design process version (Economou, 2000). This decoding and design processing utilize spatial grammar rules through nodes and links. Hence, this leads to spatial connection, distribution, relation, integration, step depth, syntactical order and pattern (van Nes & Yamu, 2021). These features can be seen in the simulation of dweller's spatial distribution to investigate their natural movement in traditional buildings. This investigation is kind of a doubled assessment to validate and prove the result of spatial structures types and JPG in simulation in appearing colour graphic to understand effectively.

The structure of this spatial configuration referred to the natural movement which could influence the flow of human movement in the spatial configuration of traditional housings (Table 6, Table 7, Table 8). The spatially more integrated in spatial structure types, the higher the flow of movement and the more attractive the rooms for the activities (Hillier et al., 1993; Yamu et al., 2021). Space syntax theories and methods could imply the pedestrian movement pattern not only in building scale but also in urban scale. The spatial organization of traditional housings presents a correspondence between socially identified groups and spatial domains that identify the dynamics of spatial behaviour structuring of social activities in traditional housings (Hasgul, 2015). In terms of this case study, the settlement layouts in traditional buildings impact how the spaces are actually used by dwellers and how the spatial structures could shape the dweller flows in the system.

Table 6. The spatial distribution refers to natural dwellers' movement (Kampung Al Munawar 13 Ulu)

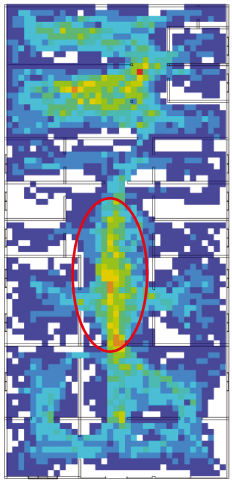
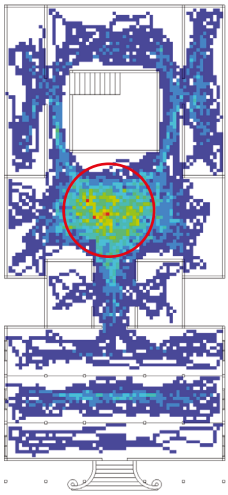
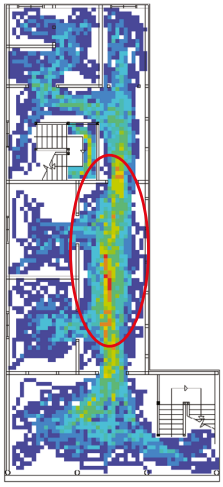
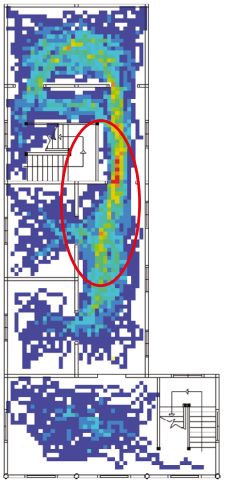
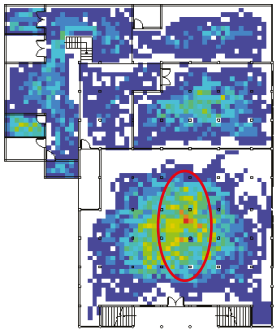
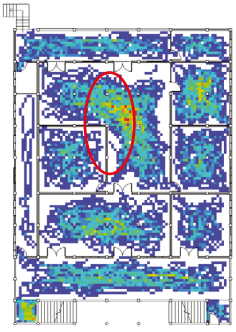
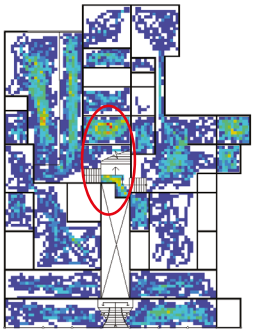
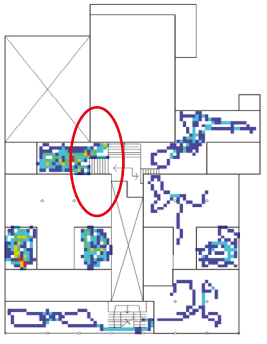
Kampung Al Munawar 13 Ulu			
1. Rumah Darat (GF)	2. Rumah Batu (GF)	3. Rumah Kembar Darat (GF)	Rumah Kembar Darat (1F)
			
4. Rumah Tinggi (GF)	Rumah Tinggi (1F)	5. Rumah Kembar Laut (GF)	Rumah Kembar Laut (1F)
			

Table 7. The spatial distribution refrers to natural dwellers' movement in traditional houses (Kampung Kapiten 7 Ulu)

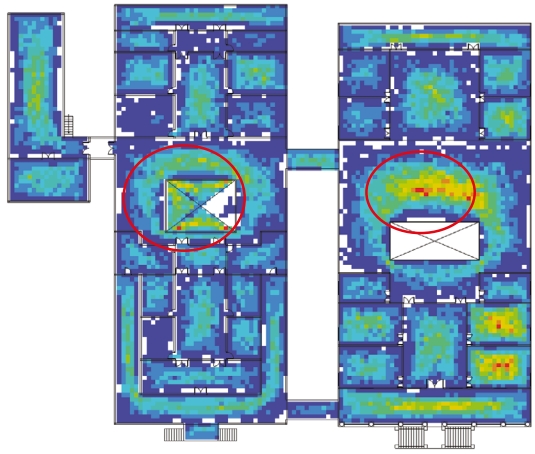
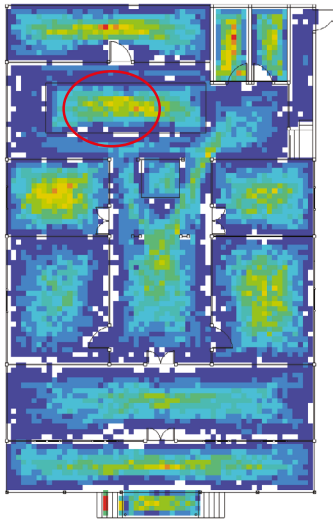
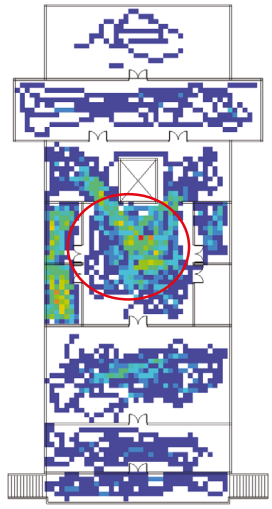
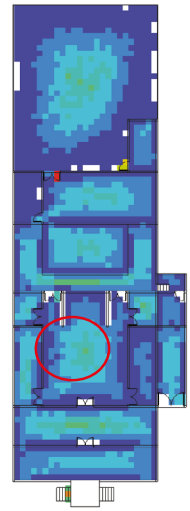
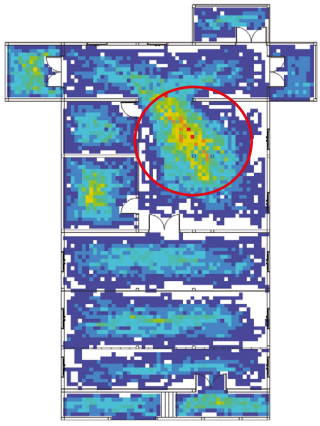
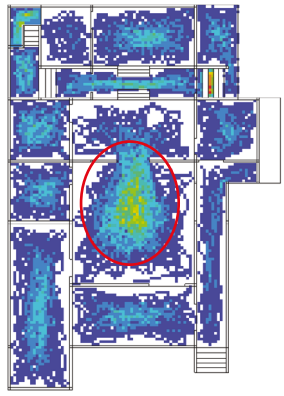
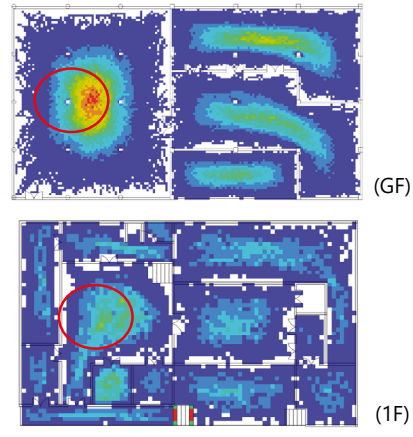
Kampung Kapiten 7 Ulu		
6. Rumah Abu+Rumah Kapiten		
		
7. Rumah Kerabat Kapiten *(now Rumah Pak Gempita)*	8. Rumah Mayor	9. Rumah Selir Kapitan *(now Rumah Pak Iskandar)*
		

Table 8. The spatial distribution refers to natural dwellers' movement in traditional houses (Kampung Songket 30–32 Ilir)

Kampung Songket 32 Ilir			
10. Rumah Limas	11. Rumah Gudang 1	12. Rumah Gudang 2 (GF)	Rumah Gudang 2 (1F)
		 (GF) (1F)	

Consequently, this leads to the spatial performance into the overall spatial system, in particular the contribution of movement distribution patterns.

In accordance with results, by highlighting the similarity of red colour codes in movement patterns indicates that this space is more likely to be utilized, more acceptable and possible to generate social interaction and social activities, compared to other colours. Additionally, it determines functions as a transit route with the greatest number of connections to other rooms. This depicts the correlation between the spatial organization of traditional houses in urban kampung and the patterns of spatial distribution for pedestrian movement.

The findings reveal a comprehensive of users' spatial distribution in building layout plan, such as *Kampung Al Munawar 13 Ulu* (Picture 9), *Kampung Kapiten 7 Ulu* (Picture 10), and *Kampung Songket 30–32 Ilir* (Picture 11). These spaces (see red circle Pictures 9, 10, 11) indicate the highest number of connections to other rooms as well as expecting to generate social interaction and social activities. This depicts the correlation between the spatial organization and the patterns of spatial distribution between users in traditional houses. It means that spatial structures and organizations in traditional dwellings affect how users utilize the rooms and control spatial distribution. In *Kampung Al Munawar 13 Ulu* (Picture 9), Hall (Ha) and Foyer (Fo) are the most noticeable rooms to control spatial distribution. In *Kampung Kapiten 7 Ulu* (Picture 10), Inner court (Ic) and Hall (H) are the most striking rooms to control spatial distribution. Hall (Ha) in *Kampung Songket 30–32 Ilir* (Picture 11), have the higher rates of movement which reflects a spatial connection with internal connectivity. Hall (Ha), Foyer (Fo), and Inner Court (Ic) could be a lesson-learnt for designing human-centric as basic principles for spatial organization that might have a contribution the design language in these traditional houses. Regarding this investigation, it encourages and leads to settlements preservation in adopting this design for new transformation form. Another finding is that the blue colour codes refer to segregated and private spaces, not only in a connectivity but also in visual perception. This space is inadequate to generate social interaction and social activities between users.

7. Conclusions

In accordance with the results and discussion, experimenting grammatical of decoding spatial form pattern in traditional houses particularly *Kampung Arab 13 Ulu*, *Kampung Kapiten 7 Ulu*, and *Kampung Songket 30–32 Ilir*, could identify a logical order as a hidden order of spatial configuration and express a rule of its culture and social aspect intangibly. By comparing the community-built traditional houses in three distinct kampungs, the finding results provide insight on the spatial integration and depth levels, spatial form in JPG simulation as a grammatical approach, spatial structures types, and spatial movement distribution patterns. The constructed spatial organization in comparing traditional housings in "Ulu area" and "Ilir area", Palembang, which were built by native and non-native communities, are underlying the social and cultural information for this spatial arrangement patterns. The dwellers mostly have constructed the spatial configuration axially and created a spatial penetration or intersectional space on movement with generating and distancing social concept long models.

In the context of these kampungs, the investigated results of traditional layouts have definitely shown that both indigenous and non-indigenous inhabitants are integrated as spacious hall-centred which represents a rule-structure and form based. It shows the orientation of human activity in a place. For instance, the stilt-traditional buildings always start at stairway or terrace as a connecting between indoor and outdoor area. Meanwhile, the hall of houses is the main central space of these traditional houses and as a spatial penetration or intersectional space, especially the *Ulu* and *Ilir* area in this kampung. The hall is a central space as an intersectional space in *Kampung Al Munawar 13 Ulu* and *Kampung Songket 30–32 Ilir*, while the inner court is the primary space and as an intersectional space in *Kampung Kapiten 7 Ulu*. These three different kampungs seem that their topological graph size is correlated with the higher social stratum. The more complex specification for the house and greater the number of nodes in the functional graph. This room also depicts in terms of integration values space and control rooms to distribute dwellers or visitors to other various rooms, which also refer to the most daily activities between family members and visitors.

The grammatical approach on this investigation provides defining statistical and graphical support, also exploring spatial pattern of traditional housings in urban kampung. This creates spaces for social interaction and communal social activities between the owner and guests or family members. The syntactical analysis seems to be empirical simulation and computational calculation of people's use and movement pattern prediction that identify the conceptualisation and description between spatial form and social life in these houses. Validating the social interaction life and movement pattern, it can be analysed by dweller's movement using agent-based simulation. The stairway or terrace serves as a starting point to move towards to a penetration room, then it is distributed to other rooms. A penetration room or intersectional room is a designated space to make social interaction life between residents and visitors. This result is comparable to that of the JPG's finding.

Afterwards, this study could identify the human behaviour and social structures as basic rules intangibly of traditional houses that were built by communities. This will be a potential for further research to compare the spatial organization of contemporary housings, modern housings, traditional housings, or other locations. Another comparing, the spatial distribution simulation can be added to another variable, such as furniture, to simulate the real

spatial distribution because this study only conducts in open layout without furniture to reduce vectors during simulation. This could be a highlight reason for further research to understand and investigate others the spatial organization of traditional buildings relationships, like genotype, through spatial decoding to preserve the work of a local genius of other kampung. Also, it could help designers or architects to generate new adaptation or transformation for new houses.

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Author contributions

Nova Asriana: conceptualisation, investigation, methodology, software, visualisation, writing – original draft. Rendy Perdana Khidmat: conceptualisation, methodology, writing – review and editing. All author(s) read and approved the final manuscript.

Disclosure statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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