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Study of Spatial Structure of the Old Port Area of the Kingdom of Aceh in the West Coast of Aceh and its Sustainability System Case Study: Settlement Around Kuala Bubon, West Aceh District

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ABSTRACT

The Kuala Bubon area on the west coast of Aceh was one of the important ports during the XVII-XIX centuries of the Aceh Kingdom, which had a hinterland of royal economic commodities in the interior. Its current existence is as an important fishing area in West Aceh district, although it was destroyed during the 2004 tsunami. The difference in the role of the area can be seen in the difference in the structure of the area's space. This paper aims to explore the concept of the spatial structure of the region and the regional sustainability system in the context of the geographical environment and development policy. This paper is important related to climate change mitigation strategies related to the revitalization of old residential areas on the coast related to SDGs. point 11. The research approach is a phenomenological study of the history of settlements. The qualitative descriptive research method examines and interprets the eco-logic of important places in an area as an element forming the spatial structure of the area and understands the phenomenon of the development of the place until present day. The data consists of 3 types of topics: a) geographical conditions of the place, b) the spatial structure of the area, and c) data on regional development policies. The results showed that the condition of the bay waters and the position of the headland in the Kuala Bubon area has the potential to develop as a traditional port, which is connected to the interior with the hinterland activity center by the Kreung Bubon River. Thus, it formed a spatial structure with a linear pattern towards the interior (North-South). Plantation farming villages developed around the river. The period of the unitary state of the Republic of Indonesia until the XXI century with the 2004 tsunami disaster with the construction of infrastructure for the mainland West coast of Aceh that crossed the Kuala Bubon area, attracted the growth of villages around the road with a linear pattern (West-East) and a centralized pattern in Muara Kuala Bubon with developing aquaculture community. The role of rural villages is weakening. The conclusion of the study is that the shift in the orientation of the spatial structure of the area shows the pattern of the regional sustainability system which is related to 3 things: a) the right choice of place for a city traditionally and the ability to revitalize itself by managing natural potential in a contextual manner, b) political policy for regional development according to the potential of the place, and c) the high spirit of place from the community.

Keywords: aquaculture, sustainability, spatial structure, traditional

1. Introduction

The province of Aceh is located at the northern tip of the island of Sumatra and is surrounded by international waters. It has held strategic maritime value since ancient times, peaking during the seventeenth century when the Kingdom of Aceh emerged as a maritime cosmopolitan power, its territory extending across Sumatra to parts of Peninsular Malaysia [1][2]. The Kingdom of Aceh dominated the spice trade, supplying Europe and other parts of the world with commodities sourced from Sumatra's interior [3]. To support this economy, the kingdom established multiple ports along the coast, both near Banda Aceh [4] and at strategic estuarine points along the West Sumatran coastline [5].

Many of these port cities were later destroyed by recurring natural disasters—especially tsunamis—which particularly devastated the west coast of Aceh. Cities with sustained regional importance, such as Meulaboh, have been rebuilt with enhanced protective infrastructure [6]. The loss of these settlements erased significant historical and spatial traces of past civilizations. Nonetheless, post-tsunami community resilience, particularly following the 2004 disaster, has been notable. Residents often returned to their original land and rebuilt homes within familiar landscapes [7].

One such area is Kuala Bubon, located on Aceh's west coast. Severely damaged by the tsunami, this area was later reconstructed, allowing residents to return once infrastructure and housing developments were restored [8]. Today, Kuala Bubon serves as a critical fishery hub in Aceh Barat district and is surrounded by villages historically linked to its function as a port under the Aceh kingdom during the 17th century [9]. Although affected by regional planning policies and natural disasters, Kuala Bubon has maintained its presence and now also plays a role in regional tourism. Figure 1 illustrates the strategic geographical positioning of the Kuala Bubon area, emphasizing its natural features—specifically the sheltered bay, coastal landforms, and estuarine system shaped by the Kreung Bubon River. These features underscore why Kuala Bubon was historically selected as a port location. The calm bay waters and protruding headland provide natural protection from strong waves, especially during the west monsoon. Meanwhile, the river estuary facilitates inland access to the Bukit Barisan hinterlands, reinforcing the port's economic and logistical value. This physical geography directly influenced the linear development of settlements along the river and supported agricultural hinterland activities critical to the kingdom's economy.

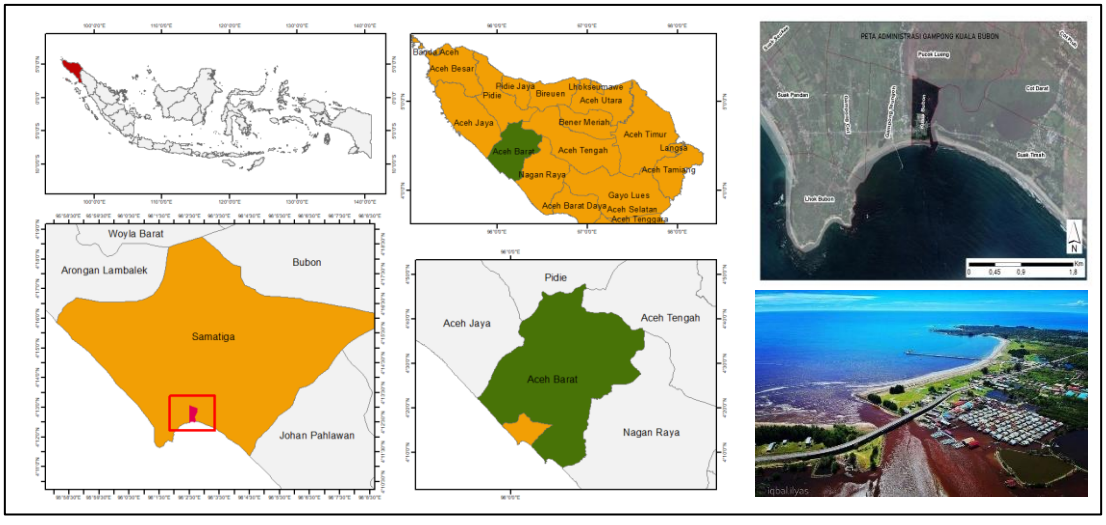

Figure 1 Location of Kuala Bubon area and geographical conditions of the bay coast and river estuaries on the west coast of Aceh

The redevelopment of Kuala Bubon is aligned with the principles of sustainable development, particularly SDG 11, which promotes inclusive, safe, resilient, and sustainable human settlements [10]. Understanding the evolution of Kuala Bubon's spatial structure from the 17th to the 21st century allows for a more nuanced approach to planning in disaster-prone coastal zones. This paper explores how the changing spatial patterns of

the Kuala Bubon region reflect a broader sustainability system, driven by both geographic context and socio-political development policies.

2. Method

This study adopts a qualitative research paradigm grounded in a phenomenological and interpretive-historical approach, aiming to explore the formation and transformation of spatial structure in the Kuala Bubon region as a former port settlement of the Aceh Kingdom. In accordance with Groat and Wang (2013) in Architectural Research Methods [15], the study falls under the category of historical-interpretive research, which seeks to investigate how specific architectural and spatial phenomena evolved over time, and how meaning is embedded within the built environment through lived experience and cultural memory.

The methodological strategy employed in this study is a place-based spatial inquiry, where the concept of "place" is examined through toponymic tracing, geographical character analysis, and contextual historical reading. This includes the identification and interpretation of place names (toponyms), land-water interface typologies, and settlement morphology in relation to both natural geography and socio-political history.

The primary data sources consist of oral histories and community narratives, collected through semi-structured interviews with local elders, village leaders, and cultural historians. These narratives are critically cross-referenced with archival data, including colonial maps, governmental planning documents, regional toponymic records, and relevant literature. To complement textual data, field observations and sketch mapping techniques are used to spatially document current physical configurations and trace remnants of historical structures and land-use patterns. In line with Groat and Wang's framework [15], the data analysis process follows a triangulated model, integrating: narrative coding of interview transcripts to extract thematic patterns related to spatial memory, settlement resilience, and socio-political transitions ; chronological reconstruction of spatial forms using historical cartography and GIS-based layering to compare spatial patterns across centuries (XVII to XXI) ; and phenomenological interpretation of place qualities, especially those relating to "spirit of place" (genius loci), physical thresholds (e.g., headlands, estuaries), and symbolic landmarks (e.g., mosques, administrative dwellings).

The methodological approach acknowledges that place is not only defined by its physical attributes but also by the interplay between environmental affordances, cultural practices, and collective memory, as emphasized in Groat and Wang's treatment of interpretive strategies for architectural research. The logical-rational interpretation of the relationship between geographical features and settlement patterns allows this study to identify spatial resilience mechanisms and cultural continuities amidst natural and political disruptions. Finally, the validation of findings is ensured through cross-verification between oral testimonies, documented historical evidence, and spatial configurations observed in the field. The methodology aligns with current discourses in environmental phenomenology, historical urbanism, and post-disaster settlement studies, making the study methodologically robust and relevant to the academic fields of architecture, urban planning, and heritage conservation.

3. Results and Discussion

In the history of the development of the coastal area, it has always been associated as a port that connects water and land areas. The old coastal city always starts from the existence of strategic traditional fishing settlements, both physically and geographically, and the constellations between regions. The area is slowly growing with the complexity of the facilities according to its era [11]. Thus, looking at the morphology of the area can be started by understanding the concept of human settlement as proposed by Doxiadis (1968) in the ecistic theory: human settlement. The theory explains the interrelationships of the 5 elements forming a residential environment that are integrated with each other and their influence in a solid system, the elements are: nature, man, society, shell and networking. Human experience in its natural environment provides knowledge on how

to build a residence and organize its natural environment according to natural potential equipped with contextual infrastructure, in order to form a specific spatial structure.

The structure and form of regional space as an artificial environmental system will adapt to the structure and shape of the geographical environment [11], which is natural and irregular. Modern development in the area, is often carried out more efficiently and economically by applying a regular spatial structure pattern and doing engineering on the pattern of the natural environment so that a better area can be created [12]. Thus, if the natural environment changes, then humans and their community systems will adapt for a sustainable life. The place where the activity is carried out will be connected to the movement network system which will produce a certain spatial structure system. The sustainability of a regional life will be seen from the dynamics of the spatial structure and spatial arrangement of the area, which describes the stable economic life of the community from time to time [13]. The phenomenon of human and natural relations is illustrated in arranging the spatial patterns of the residential area [14].

Geographical Potential of The Kuala Bubon Area as A Berth

The Kuala Bubon area is a sloping marshy coastal plain, situated in shallow bay waters, with a significant headland in the northwest. The headland's position significantly reduces the impact of the Indian Ocean's large waves, particularly during the west monsoon, which could otherwise erode the coastal land. Additionally, the Kuala Bubon Bay is strategically located where the Krueng Bubon River flows into the Bukit Barisan Mountains, making it a natural hub for inland access. The calmness of the bay's waters enhances the ease of maritime navigation, providing clear entry and exit routes via the Krueng Bubon River estuary. This geographical configuration offers a significant advantage for establishing a coastal settlement and makes the Kuala Bubon area a strategic site for port development.

Historically, the name of a place upstream of the Krueng Bubon river is Ujung Medang, and there is also Mount Meudang, which likely derives its name from Sanskrit. It is plausible that the area has been inhabited long before the arrival of Islam, with the route through the Kuala Bubon Bay serving as a corridor for inland migration. The flow of the river and its connectivity to the interior of the Bukit Barisan Mountains created strategic routes that were vital for trade, particularly for natural resources such as flora, fauna, and minerals (including gold) that were abundant in the hinterland. As such, the development of settlements in the Kuala Bubon Bay and its surroundings is a natural consequence of the region's geographical advantages [2].

The Aceh Kingdom (17th to 19th century), renowned for its maritime trade, saw the establishment of several ports along the West Coast of Sumatra, with Kuala Bubon being one of the most important. The Kingdom controlled vast territories in the northeastern and western parts of Sumatra, particularly those that produced spices and other essential commodities. The Kingdom of Aceh built port cities at the mouths of large rivers, which provided direct access to the hinterland, enabling trade and the export of these valuable resources. Notably, several key ports on the West Coast of Aceh included Lhoong, Meulaboh, Pase, Teunom, Woyla, and Kuala Bubon, among others [3].

In each of these settlements, both along the coast and inland, Ulee Balang, the traditional rulers of the Aceh Kingdom, managed local economies and social life. These rulers' residences were strategically placed and often larger than typical dwellings. These houses served not only as administrative centers but also as symbols of power and governance. Mosques often served as social and economic hubs and were typically positioned centrally within villages, named after influential clerics or rulers. Such spatial characteristics were common in settlements governed by Ulee Balang, with Ulee Balang's house, environmental mosques, and residential housing areas forming the key elements of these towns [9]. Figure 3 illustrates an example of this architectural typology: the Ulee Balang Residence in Samatiga District, still in use today, and the Teuku Umar Mosque in Lhok Bubon, which continues to serve its community despite the destruction from the tsunami.

The historical governance of Bubon and Lhok Bubon by the Hulubalang (a term used for the head of the region) continued until 1840. These rulers played a key role in managing both the economy and the community,

serving as extensions of the Kingdom of Aceh's political authority. The Teuku Umar Mosque in Lhok Bubon, named after the famous warrior and ruler, serves as a historical landmark reflecting the power and influence of the Ulee Balang in the region. Figure 2 shows a schematic representation of the mainland Bay-Tanjung area near Kuala Bubon, highlighting its strategic location for port development, supported by natural features like the bay and river estuary.

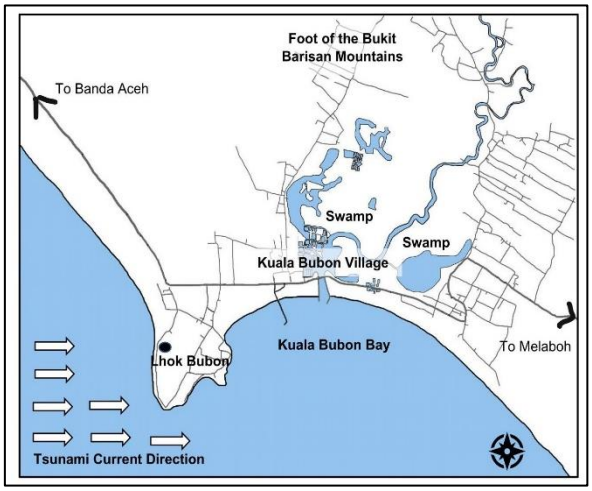

Figure 2 Schematic of the mainland Bay-Tanjung area Kuala Bubon is strategically located for a port

(a) (b)

Figure 3 Ulee Balang Residence to Samatiga District which is still in use and the Teuku Umar Mosque in Lhok Bubon after the tsunami which is still in use

Reconstruction of The Spatial Structure of The Kuala Bubon Region during The Kingdom of Aceh and The Physical Potential of The Area. Tsunami Hazards and Places of Defense

The Kuala Bubon area played a crucial role as the Old Port Area during the Aceh Kingdom, as evidenced by the presence of the Teuku Umar mosque in Lhok Bubon. According to local informants, this mosque served as the administrative center where Teuku Umar governed the area. The headland in this region is particularly significant as it served as a strategic point for controlling access into and out of the bay area. This spatial characteristic is reminiscent of the Ujung Pancu area near the northern tip of Banda Aceh City, which was similarly used for coastal surveillance during the 14th century [4].

The role of Lhok Bubon is strongly tied to the abundant natural resources in the hinterland, which were vital for producing international economic commodities. These included agricultural products such as pepper from plantations in the area and other forest products [9]. The interior, known as Bubon Country, hosted numerous villages around the Krueng Bubon River, which became central to the region's development. This area had a diverse economy, with significant plantation areas (pepper, cloves, areca nut, etc.), rice paddies, cattle farms, and other agricultural outputs. The high strategic value of Lhok Bubon led to it being specifically managed by a Hulubalang (a local ruler) who also assumed the role of harbormaster and water traffic controller. Consequently, the region developed a linear spatial pattern stretching from the coast to the interior, connected

by the river. Figure 4 below illustrates this linear spatial structure pattern: a relationship between the inland and coastal areas, with the riverside villages oriented toward the land and river. Based on the diagram above, the spatial structure of the Bubon region during the Aceh Kingdom comprised four main zones: (1) Kuala Bubon area, the central hub of activity and port in Lhok Bubon; (2) The center of activity in the interior, situated in the Bubon land; (3) Riverside villages, which were crucial for supporting economic activities; Agricultural areas that produced essential commodities; (4) The river flow as a primary transportation route.

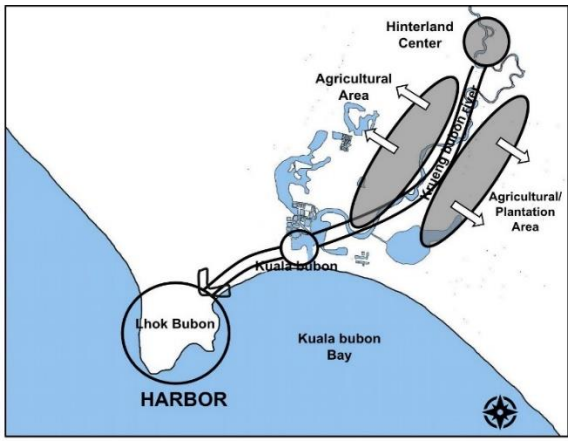

Figure 4 Linear spatial structure pattern: inland-coast with riverside villages oriented land-river

The prominence of the Kuala Bubon area, as a historical port during the Aceh Kingdom, contributed to the development of strategic inland villages that supported more complex settlement patterns. The stability of life was reflected in the naming of places, which often connected local identities to their geographic features and roles. During the Dutch colonial period, the conquest of the Kuala Bubon area was a significant challenge for the colonial forces. Instead of a direct maritime invasion, the Dutch advanced via the land route from Meulaboh, and fortifications were constructed in almost every village. Cot Seumerung, the central village, was eventually controlled, but this required the establishment of a bivouac by the Dutch. This conquest illustrates the strength of the maritime government (Lhok Bubon), which managed to retain its control over the region. However, over time, villages in the interior and along the riverbanks saw a decline and became relatively underdeveloped.

Functions and Roles of the Kuala Bubon Area from the Independence Period to the XXI Century

The strategic value of the Kuala Bubon area after the independence of the Republic of Indonesia experienced ups and downs, both related to natural disasters and regional development policies on the west coast of Aceh. These two things affect the development of the spatial structure of the Kuala Bubon area and the Bubon area. The construction of a land route along the west coast of Aceh before the 1970s. There was no bridges built over the river and vehicles was crossed by using a raft system, led to the development of transit points in the raft area. This changes the spatial structure pattern of the Region in almost all major river mouths in the western region of Aceh. The road trajectory in the Kuala Bubon area with the Krueng Bubon river estuary caused a raft transit area to be integrated with the fishing village. Later, developing as a village known as Kuala Bubon village. Important places during the Aceh kingdom experienced a decline in their role.

In the development of the Ku Region until the end of the XX century, Kuala Bubon village developed rapidly as a fishery area which was confirmed as a Fish Landing Area (TPI) and a crossing port to Simeulue. The development of the Kuala Bubon Village area until 1999 was evident from the total population of 670 people, where 90% of whom were fishermen. However, socio-economically, the community is relatively low-educated, including those who are less prosperous and the general public are less able to develop their lives outside of fishing. Somehow, they have a strong tradition of living in fishing communities [16].

During the 2004 tsunami, the Kuala Bubon area was destroyed and community settlements had to be relocated. However, in the 10 years after the tsunami, the community has returned to its original residential location with

various assistance programs for the restoration of community life, such as the construction of aid housing and regional infrastructure. The rebuilding of the Kuala Bubon area is mostly concentrated in the village of Kuala Bubon, such as the construction of modern floating house fishermen housing integrated with fish landing sites (TPI) and the construction of an overpass that crosses the Krueng Bubon river estuary.

In fact, the development of the Kuala Bubon area occurs with the growth of residential neighborhoods along the road. It appears that people live based on their livelihoods from the sea, swamps, and coastal land forests. This gives rise to a culture of Aquaculture that lives according to the seasons both on land and in the waters. The development of these developments led to changes in the spatial structure of the area. The spatial structure of the area is formed into a centralized pattern in the village of Kuala Bubon and a linear pattern with housing developments along the road (Figure 5). The rapid growth of Kuala Bubon village can be seen from buildings and places of community economic activity. While the population is only 393 people in 2021, but the population growth per year is 2.04% which is relatively high (Secretary of Kuala Bubon Village, 2022). The spatial structure pattern of the Kuala Bubon area can be seen in the image below.

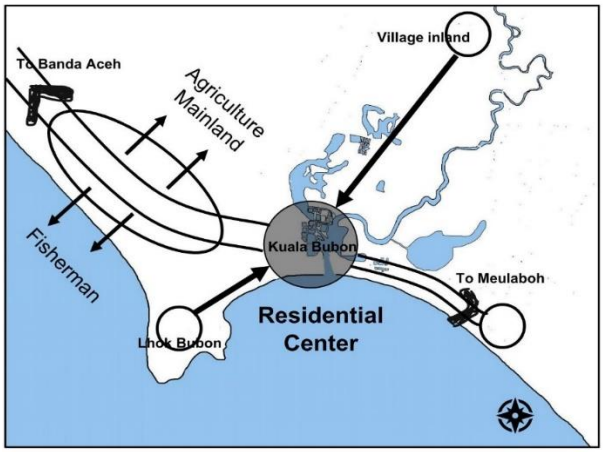

Figure 5 The pattern of spatial structure of the Kuala Bubon area from the independence to the twentieth century: a combination of centralized and linear.

Sustainability of The Kuala Bubon Area and Development of Sustainable Resource Potential

The sustainability system of life in the Kuala Bubon area has been tested by the 2004 tsunami disaster. The area was rebuilt, including both the basic infrastructure of the region, the housing environment, and modern economic facilities. Initially, the community was relocated 2 km inland, making it difficult to access the sea. Therefore, the community desired to return to their original area, continuing their lives as fishermen. The community believes that nature will restore itself, as expressed by a local informant (Bu Nur), which demonstrates the strong spirit of the people to rise again. This spirit is closely tied to the abundant natural potential of the region.

The development of the area in Kuala Bubon village appears to be carried out in a modern way, such as: a) the construction of permanent floating housing integrated with the fish landing area (TPI) on swampy land; b) the construction of road infrastructure and flyovers that cross the Krueng Bubon river estuary; c) the construction of river estuary safeguards for boat entry and exit, which has led to changes in the morphology of the coastal land, expanding the coastline. These three factors have made the land active and broad enough to accommodate community activities. This impacts the spatial structure of the Kuala Bubon area and people's lives. See Figure 6 for a comparison of the condition of Kuala Bubon village before the tsunami and the current center of activity (15 years after the 2004 tsunami).

Figure 6 Comparison of the level of development of the kuala bubon village area before tsunami (2002) and the current center of activity (2022) is concentric.

Currently, the Kuala Bubon area is a relatively well-developed fishing settlement area. There are three zones/areas with different potential sources of livelihood, which are continuously developed by various parties to improve the community's economy, namely: a) the bay waters area with FAD development [17]; b) coastal land and swamps with various types of coastal plants; c) the flow of rivers and swamps. Development of natural resource potential in each of these areas is improving the economy of the community, both as traditional and modern fishermen.

As traditional fishermen, the people have started to develop aquaculture culture. By cultivating crabs and shrimp in the swamps around the residential areas, the economic life of the community is increasing dynamically. This geographical potential has allowed the Kuala Bubon area to redevelop as an advanced fishing area and even evolve into a coastal tourism destination.

4. Conclusion

The Kuala Bubon area, which geographically is in the form of a gentle sloping bay beach and a variety of natural resources, is ideal for the development of the culture of living. The development of the Kuala Bubon area has experienced ups and downs related to regional development policies as an external factor that forms a specific regional and regional spatial structure. Spatial structure of the area of the Aceh kingdom in the seventeenth century was linear from the waters to the interior which developed a pattern of hinterland and port cities. An agricultural-fishing society was formed. In the modern era until the XXI century after the tsunami, the spatial structure was in the form of a centralized and linear combination with a more heterogeneous community character, including the fishing community, aquaculture and trading services. The shift in the orientation of the spatial structure of the area shows a pattern of regional sustainability systems related to 3 things: a) the right choice of a traditional city location and the ability to revitalize itself with contextual management of natural potential, b) regional development political policies according to the potential of the place; and c) the high spirit of place from the community.

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6. Conflict of Interest

The authors declare no conflict of interest in the preparation and publication of this manuscript.

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