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Design Concept of Dairy Milk Edu-Tourism in Pakem District Using a Tropical Architecture Approach

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Abstract

Indonesia's dairy milk production remains low, requiring imports to meet more than 80% of national demand. Sleman, particularly Pakem District, has significant potential as a dairy cattle center, but limitations in business scale, technology, and sanitation prevent optimal productivity. Meanwhile, tourism in the Special Region of Yogyakarta (DIY) continues to grow, opening up opportunities for integrating livestock farming with ecotourism as a strategy for economic diversification and public education. This study aims to design a dairy ecotourism area in Pakem using a tropical architectural approach that is adaptive to the local climate, sustainable, and supports educational and recreational functions. The methods used include data collection, site analysis, space requirements, and precedent studies. The resulting design emphasizes open mass composition, flexible circulation, shaded facades, productive landscapes, and environmentally friendly utility systems. This design is expected to become a model for ecotourism that increases the economic value of livestock farmers, strengthens public awareness of healthy food, and emphasizes the relevance of tropical architecture in the Merapi slopes.

Keywords: Cow's milk, educational tourism, pakem, tropical architecture

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Introduction

Dairy cattle play a vital role in fulfilling the nutritional needs of the Indonesian population, as they produce milk with high nutritional value and a comprehensive composition of essential nutrients. This makes dairy products a key source of animal-based protein, particularly for younger generations (Utomo and Pertiwi 2017). Dairy cattle are specifically bred and managed for milk production (Widyaningrum 2019), and the milk they produce constitutes an important food resource that significantly contributes to public nutrition. Milk is widely recognized for its high nutritional value and its complete nutrient composition, rendering it a strategic source of animal protein that is especially important for school-aged children and adolescents (Utomo and Pertiwi 2017).

The concept of dairy farm-based edu-tourism presents significant potential as an educational tourism destination that integrates recreation, learning, and local economic empowerment (Maesari, Suganda, and Rakhman 2019). However, the development of livestock and edu-tourism facilities in Indonesia, particularly in tropical regions, often encounters substantial climatic challenges, including high temperatures, extreme humidity, and intense rainfall (Karyono 2016).

Tropical architecture is an architectural approach that responds proactively to the characteristics and challenges of tropical climates in the design of buildings and their environments. Such climates are typically characterized by high humidity levels (often exceeding 90%), relatively elevated air temperatures (ranging from 15–35°C), intense solar radiation, and high annual rainfall (often exceeding 3,000 mm/year) (Karyono 1998). According to Francis D. K. Ching, architecture constitutes an integrative discipline that unifies space, form, technique, and function into a coherent whole. The term “tropical” itself is derived from the Greek word tropikos, meaning “turning” or “line of latitude,” referring to regions located between 23° 27′ north and south latitude. These areas encompass approximately 40% of the Earth’s surface and are generally situated within the 20°C isotherm zone (Desyanti, Agung, and Indarto 2014).

The design of Dairy Milk Edu-Tourism in Pakem District seeks to address these challenges by integrating a Tropical Architecture approach. This approach aims to create an environment that is comfortable, efficient, and sustainable. Pakem District was selected as the project site due to its significant potential for dairy farming, as well as its geographical location in a highland area with relatively cooler temperatures conditions that are particularly conducive to optimal dairy cattle production.

Methods

The analytical method employed in the design process is the deductive approach. Deductive research is a method that begins with general theories or principles and subsequently derives specific applications based on relevant conceptual data. In this study, such data include user circulation patterns and requirements, spatial functions, and other design parameters associated with the development of dairy milk edu-tourism in Pakem using a Tropical Architecture approach.

These principles are subsequently applied to conduct a more specific analysis, including site selection, evaluation of the chosen site, spatial programming, and the examination of architectural, structural, and utility requirements. Furthermore, the analysis incorporates the application of the selected architectural approach, namely Tropical Architecture, as the primary framework guiding the design process.

Data collection method

Data collection in this design study was conducted using two primary methods:

1. Primary Data
   Primary data were obtained directly from the source or field without intermediaries, including:
   a. Field Observation
      Field observations were carried out to obtain first-hand information regarding the site conditions relevant to the design of the dairy edu-tourism facility. This includes the physical characteristics of the site, user behavior and profiles, spatial context, and the availability of surrounding facilities.
   b. Field Documentation
      Documentation was undertaken to complement the data obtained during field observations and to provide physical evidence. This process involved collecting visual records, such as photographs, that are relevant to and support the design process.

2. Secondary Data
   Secondary data were obtained indirectly from various sources, including:
   a. Literature Review
      The literature review aims to establish a theoretical foundation relevant to the proposed design. This includes identifying applicable standards, methodological approaches, and ensuring academic integrity by avoiding plagiarism. Sources for the literature review encompass both printed media such as books, magazines, and newspapers and digital resources, including news articles, scholarly journals, theses, and other relevant documents.
   b. Precedent Study
      The precedent study involves the examination of previously designed or existing built projects that share similar characteristics with the proposed design. These similarities may include comparable functions, design approaches, site conditions,

or contextual challenges. Such analysis provides valuable insights and references for the development of the dairy milk edu-tourism project using a Tropical Architecture approach.

Results and discussion

1. Precedent analysis results

Six case studies were identified as design precedents in the development of the dairy milk edu-tourism concept in Pakem District. These precedents serve as comparative references to inform the design approach, particularly in terms of functionality, spatial organization, environmental responsiveness, and architectural expression. The selected precedents are as follows:

a. Floating Dairy Farm / Goldsmith Company

Figure 1
Floating dairy farm perspective
Source: Karl Dickinson 2024

A unique floating dairy farm concept located within an urban context, positioned close to consumers, thereby shortening the distribution chain and enhancing public awareness of milk consumption. The design emphasizes optimal air circulation through the absence of enclosing walls and the provision of adequate roof height, ensuring improved environmental comfort and ventilation efficiency.

b. Milkindo Green Farm

Figure 2
Milkindo Green Farm Rabbit Park perspective
Source: Matic Malang Regency Tourism and Culture Office 2025

Initially established as a dairy farm in 1984, the site has evolved into an integrated edu-tourism destination. It offers a wide range of educational activities related to livestock farming, agriculture, milk processing, animal interaction, and recreational attractions. The development adopts a natural architectural approach that maximizes daylighting and natural ventilation, while also implementing principles of green architecture.

c. Gundaling Farmstead

Figure 3
Milkindo Green Farm Rabbit Park perspective
Source: Pimsgundaling 2024

Develops an integrated farming concept that encompasses multiple business units, including dairy cattle, beef cattle, a farm-to-table restaurant, and a milk processing facility. The architectural design integrates both local and modern materials that are environmentally friendly, reflecting a balanced approach between tradition and contemporary sustainability practices.

d. Canvas Café Bali

Figure 4
Canvas Cafe Bali perspective
Source: Samma Studio 2019

A café designed with a contemporary tropical architectural approach. The building utilizes exposed red brick with a kamprot (rough plaster) finish, combined with a transparent polycarbonate roof complemented by wooden louvers functioning as shading devices. The design optimizes cross-ventilation and large openings to capture the prevailing winds of Bali, while the incorporation of vegetation contributes to improved air quality and overall environmental comfort.

e. Pupunha House

Figure 5
Pupunha House perspective
Source: Susanna Moreira 2025

A residential design that appears to “float” above the forest landscape, thereby minimizing the need for cut-and-fill interventions. The design maximizes natural ventilation through open-plan spaces with minimal partitions, as well as the incorporation of voids that facilitate daylight penetration and the expulsion of hot air. The use of locally sourced red brick brise-soleil functions both as a solar shading device and as a permeable air membrane, enhancing thermal comfort and environmental performance.

f. Micro Tropicality / RAD+ar

Figure 6
Micro tropical perspective
Source: Hana Abdel 2020

The headquarters of RAD+ar exemplifies a design philosophy that integrates architecture with nature in a symbiotic manner. It adopts the concept of Micro Tropicality, expressed through a multilayered façade system comprising lightweight steel screens, climbing vegetation, and secondary walls which functions as a thermal filter, pollution buffer, and regulator of air circulation. The building also incorporates a rainwater catchment system and open transitional spaces, enhancing both environmental sustainability and spatial adaptability.

2. Discussion

Site data and location

The project site is located on Jalan Kaliurang Km 29, Pakembinangun Village, Pakem District, Sleman Regency, Special Region of Yogyakarta, Indonesia. Based on the Spatial Planning Information System (SIMTARU) of Sleman Regency, the site is designated as a Rural Residential Area and is situated outside disaster-prone zones.

Figure 7
Site location
Source: Google earth 2025

The calculation of the building area is adjusted in accordance with the applicable Sleman Regent Regulation, as stipulated in Sleman Regent Regulation No. 49 of 2012 concerning the Implementation Guidelines of Sleman Regency Regional Regulation No. 5 of 2011 on Buildings. The project site, located in Pakembinangun Village, Pakem District, Sleman Regency, Special Region of Yogyakarta, is categorized under a low-density development zone. According to Article 4(e), buildings in such areas are subject to a Building Coverage Ratio (*Koefisien Dasar Bangunan—KDB*) ranging from 30% to 45%, and a Floor Area Ratio (*Koefisien Lantai Bangunan—KLB*) of 2.0. Furthermore, all buildings are required to provide Public Green Open Space (*Ruang Terbuka Hijau Publik—RTHP*), as regulated in paragraph (1), with a minimum Green Area Coefficient (*Koefisien Daerah Hijau—KDH*) of 20% of the total land area for developments with a KDB between 31% and 70%.

Architectural Design Concept

a. Massing Concept

   The massing concept is derived from a comprehensive site analysis aimed at identifying the site's potentials, constraints, and corresponding design solutions. This concept serves as a fundamental guideline in formulating the architectural design of the dairy edu-tourism facility.

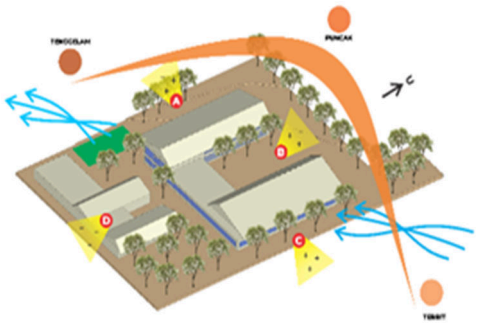

Figure 8
The concept of mass composition

b. Façade Concept

   The façade concept is derived from the results of the site and environmental analysis, and is applied to the design of the edu-tourism facility by considering building orientation in response to climatic conditions, the functional requirements of spaces adjacent to the façade, and the selection of appropriate materials.

Figure 9
Facade concept

c. Interior Concept

The interior concept is developed based on the results of the preceding analyses and is applied to the design of the edu-tourism facility by considering the functional requirements of each space and the selection of appropriate materials for different rooms. This approach aims to enhance user comfort and ensure a coherent and responsive interior environment.

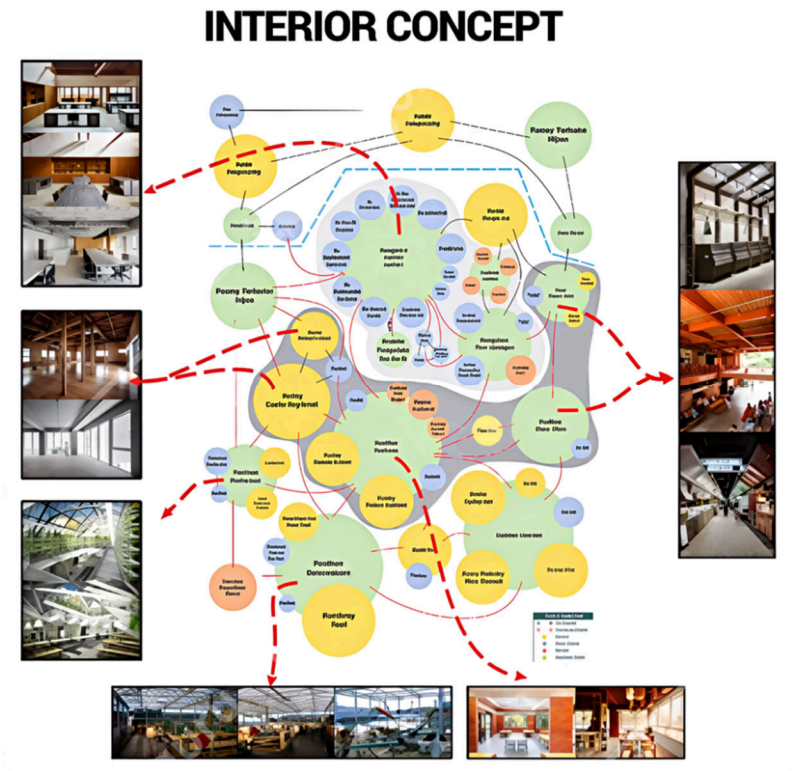

Figure 10
Interior concept

d. Approach Concept

Tropical architecture is an architectural approach specifically designed to respond to and condition buildings within tropical climatic environments. In this design, the approach is implemented through two primary conditioning strategies:

- User Comfort Conditioning

  This concept aims to ensure that users experience thermal comfort during their activities without feeling excessive heat. Such comfort is achieved through effective air circulation, primarily by implementing cross-ventilation strategies. In addition, landscape arrangement is carefully designed to provide shading and mitigate direct solar exposure during daytime, thereby enhancing overall environmental comfort.

(a) use of cross ventilation in buildings

(b) tree positioning creates natural shade

Figure 11
The concept of user comfort conditioning

- Rainy Season Conditioning

Indonesia is a tropical country located near the equator, resulting in the occurrence of both dry and rainy seasons throughout the year. On average, the rainy season lasts for at least four months, typically from October to February. Therefore, it is essential to consider appropriate design strategies to effectively manage rainwater. One key approach is the use of sloped roofs, which allow rainwater to be efficiently drained directly to the ground, thereby preventing excessive load accumulation on the roof structure and enhancing the building's durability.

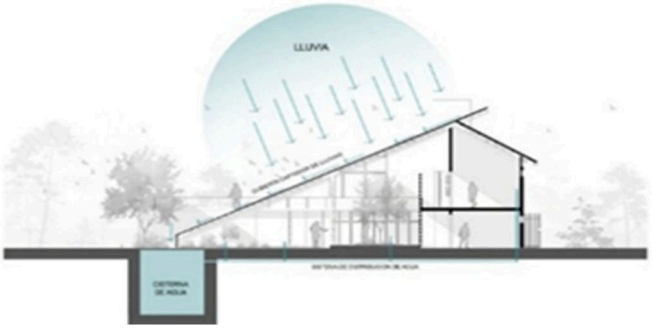

Figure 12
Rainwater conditioning concept

Conclusion

The design of Dairy Milk Edu-Tourism in Pakem District represents a strategic effort to address the low national productivity of dairy milk while simultaneously leveraging the local potential of livestock farming and tourism in Sleman Regency. Pakem District possesses favorable geographical conditions, climate, and accessibility that support the development of a dairy-based edu-tourism area. The integration of educational, recreational, and local economic empowerment functions constitutes the core value of this design concept.

The Tropical Architecture approach is applied as an adaptive solution to the climatic characteristics of Indonesia by optimizing building orientation, employing open massing strategies, and maximizing natural ventilation and daylighting.

The design also incorporates the use of local materials, shaded façades, and sloped roofs to effectively respond to high rainfall conditions. Furthermore, the integration of productive landscape design and environmentally responsive utility systems supports the creation of a sustainable and comfortable environment for users.

Overall, the design of Dairy Milk Edu-Tourism in Pakem District is expected to serve as a model for the development of livestock-based edu-tourism that not only enhances the economic value of dairy farmers but also functions as an educational medium for the public regarding healthy food and environmental sustainability. The application of Tropical Architecture principles in this design underscores the importance of harmonizing buildings with climate and local context, particularly within the environmental setting of the slopes of Mount Merapi.

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