



Land Use for Developing Areas Around High-Speed Railway Stations in Lao PDR: A Case Study of Guidelines for the Transit-Oriented Development in the Vientiane Capital and Vang Vieng

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ABSTRACT

Developing Lao infrastructure to promote socio-economic development has resulted in rapid urbanization. This causes various problems in the city such as traffic, pollution, environmental and social problems, etc. The purpose of this study is to present guidelines for the development of transit-oriented development (TOD) in the Vientiane Capital and Vang Vieng High Speed Railway (HSR) station areas. It analyses national and local development policies, and analyse the area around the Vientiane Capital and Vang Vieng HSR stations, including the application of basic TOD principles. Qualitative research methods are used to collect data in target areas, including interpretations of articles, researches, documents, and journals. The results of the study found that analysis of national railway development policies and provincial urban development policies are important in determining land use zones in each area to promote socio-economic development and sustainable urban development. For the analysis of the areas around the HSR stations, it is found that those areas are newly grown and have not yet been developed. The development of the areas requires the use of the 5Ds principles of TOD, including the development of local communities surrounding the station areas. Therefore, appropriate TOD development guidelines for the areas around the Vientiane Capital and Vang Vieng HSR stations should take into account national development policies, urban and regional development plans, related laws, transportation routes, geography and area context of the areas, and in order to consistent with actual area conditions.

1. INTRODUCTION

Over the several decades, the development of countries in the world has paid great attention to the development of urban transportation infrastructure to promote socio-economic development, such as the construction of roads, expressways, rail transportation and airports, etc. However, there was an important turning point in the development of the world's transportation infrastructure as Japan was the first country to successfully develop the high-speed rail (HSR) system and opened for service in 1964 [1]. This has led to the rapid development of the country's economy. At the same time, the global energy crisis occurred in the 1970s, which affected various industries, such as the lack of aviation networks, ships, cars, etc [2]. In the other hand, most cities have urban sprawl due to settlements along transportation routes and an increase of urban population, as well as traffic, pollution, environmental, and social problems [3]. For these reasons, many countries in Europe (France, Germany, Italy, and Spain) and Asia (S. Korea and China) have focused on developing HSR as an alternative to

other transportation systems for passengers and freight since the end of the 1970s [4].

China has only recently started developing HSR from 2004 and the first service began in 2008. HSR is a part of the One Belt One Road (OBOR), also known as the Belt and Road Initiative (BRI), launched by President Xi Jinping in 2013. It consists of two parts: (1) the Silk Road Economic Belt and (2) the 21st Century Maritime Silk Route Economic Belt [5]. In the BRI cooperation framework, China has also focused on the Six Economic Corridors. One of the Six Economic Corridors related to Southeast Asia is the China-Indochina Peninsula Corridor [6]. To connect Southern China to the Economic Corridor, Lao People's Democratic Republic (Lao PDR) has become a part of the BRI. Lao PDR is the first country of Southeast Asia to connect with Southern China under BRI. The Laos-China HSR Construction Project commenced in 2016 and opened for service in late 2021, with a total distance of 414 kilometres from Vientiane Capital to Luang Namtha Province (border with China) [7].

The development of China's railway system has resulted in rapid economic development in the past decade.

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According to information from the Chinese government, China's rail transport volume was 3.02 trillion tonnes per kilometres in 2019, compared with 2.49 trillion tonnes per kilometres in 2009. Railway passenger traffic was increased to 1,471 billion passenger kilometres in 2019, compared to 788 billion passenger kilometres in 2009. Meanwhile, from 2016 to 2020, China invested 3.5 trillion yuan in the railway sector with a total distance of 146,000 kilometres, which built nearly 38,000 kilometres of HSR, ranking the first of the world regarding to their distance and covers 95% of cities those have populations of one million or more [8]. Inter-city and international connectivity with HSR under BRI currently link to 35 cities in China and 34 cities in Europe [9]. These achievements are the results of investment in construction of HSR networks and transportation hubs at HSR stations in many major Chinese cities. There are public transportation links with the HSR stations, focusing on developing the Transit Oriented Development (TOD) [10].

From the lessons of China's development, when considering the development context of Lao PDR in the past two decades, it appears that Lao PDR has many problems and challenges that are different from other developing and developed countries. Even though, Lao PDR has an average economic growth rate of 8% from 2000-2016 [11], this has affected the fastest expanding city in Southeast Asia, and according to the 2015 Lao Population and Housing Census, approximately 33% of the majority of the population lives in the city area [12]. In addition, Lao PDR also faces insufficient infrastructure, environmental problems, unregulated growth, insufficient access to urban services, inefficient land use and poor urban management, include inadequate spatial planning, urban planning and community services [13]. However, Lao PDR has provided HSR services and has a railway development strategic plan aimed to expand railway network nationwide in order to boost socio-economic development and become a regional hub because this is not only link to China railway but also links to Thailand, Malaysia and Singapore in the further, to shifting Lao PDR from a landlocked country to a land-linked country with HSR network [14]. However, the most recent evaluation indicates that the ASEAN 2025 blueprint has experienced delayed progress in addressing non-tariff measures and enhancing connectivity. This, in turn, has a direct impact on the synergistic effects of Laos' Land Link strategy [15]. For these reasons, to achieve the national development goals and urban development, including solving urban problems, Lao PDR should have a policy to promote TOD like many other countries. From the economic impact analysis of the Lao-Chinese HSR Project, it was found that Lao PDR should have TOD because Lao PDR will benefit the most from HSR services than other countries such as China, Thailand. This is because profit will be dramatically increased in accordance with the frequency of HSR services [16]. Therefore, studying the guidelines for

developing TOD in Lao PDR aims to lead to sustainable urban development. There are two different study areas: the Vientiane Capital HSR Station area and Vang Vieng HSR Station area in Lao PDR.

For the research question is: What should be the appropriate development guidelines for the development of the areas around the Vientiane Capital and Vang Vieng HSR stations?

2. OBJECTIVE

To present guidelines for the development of transit-oriented development (TOD) in the Vientiane Capital and Vang Vieng High Speed Railway (HSR) station areas. The objective of this study is to develop a case-specific implementable for the Vientiane Capital and Vang Vieng HSR station. This will be achieved by two main mechanisms. Firstly, the Lao PDR's railway strategy, the Law on Urban Planning (2017) and relevant master plans will be incorporated into the planning logic. Secondly, a diagnosis of the land-use structure, population, employment density, accessibility and environmental constraints in the 0-1km station catchment area will be conducted through field surveys and geospatial indicators of the TOD guidelines. Thirdly, the international 5-D principles must be adapted to local socio-economic and cultural realities. Finally, these factors must be integrated into spatial and regulatory recommendations to promote compactness, mixed-use growth, seamless last-mile mobility, and inclusive economic upliftment in the station area and its surrounding communities.

3. LITERATURE REVIEW

3.1 Transit Oriented Development (TOD)

The results of national development have affected the transformation of many cities in the world. At the same time, cities have developed spatially to accommodate residences and businesses due to the movement of the majority of the population from the countryside to the cities. As for the urban population, they have moved to settle along transportation routes. Cities are expanding urban sprawl and have a high level of dependency on automobiles for transportation, leading to various urban problems such as traffic, pollution and environmental problems. Therefore, many countries have used TOD to solve urban problems based on the Peter Calthorpe concept. TOD is an urban development model that involves planning cities to be compact and increase travel efficiency for sustainable community development. It defines TOD as "a mixed-use community within an average walking distance of 2,000 feet from a transit stop and core commercial area. The purpose is to show "comfortable walking distance" (10 minutes). TOD combines housing, retail, offices, open space and public uses in a walkable environment. To make it convenient for residents and employees to travel by public

transports, cars, bicycles or walks” [17]. TOD is divided into two important parts: (1) Core Commercial Areas, areas with a radius of 500 meters from the location of the mass transit station within the city as the center, and (2) Secondary Areas, areas with a radius of 500-1,000 meters. Due to the central location of mass transit stations within the city, this means that every TOD may have adjacent secondary areas as well as areas across from main routes. It is within a mile of the main commercial area. There are three types of secondary areas: those separated by an arterial but close to the transit stop; those separated by the arterial but further from the transit stop; and those of greater distance but without arterial separation [17].

In addition, TOD design depends on individual travel behavior such as needs, resources, lifestyle, attitudes, social norms, and perceptions [18]. These things are also an important part in designing TOD. For this reason, TOD focuses on multidimensional development. Starting with the principles of 3 Ds (density, diversity, and design), later adding the 2 Ds (destination accessibility and distance to transit) as concepts Cervero and Kockelman (1997), and Ewing & Cervero (2001) [19]. Nowadays, the 5 TOD dimensions are very important in TOD design with the following meanings:

Density- It concerns the agglomeration and number of business establishments in an area [20]. Ratio of population, dwelling units, employment, building floor area, or something else [19, 20]. The idea is that developments with high population densities are an indication of high travel demand [19]. Reduce travel times and thus increase the use of public transportation as it is more feasible for commuters [18, 19].

Diversity- It involves the number of different land uses in an area and the level of land use within the area [18, 19]. Increasing land use and housing balance may be positively related to mass transit use as a destination [18], such as shops, services, and facilities, including various environmental measures (existence of viewing and recreation areas) [20]. However, in the context of TOD, diversity is used to describe a mix of different uses and levels of balance, a varied physical design, expanding the public realm, and multiple social groupings of different races, ethnicities, genders, ages, occupations, and households [21].

Design- It refers to the nature of the road network within an area [19]. Design measures include carefully land-use mixtures, safe and smooth accessibility to transit stations (pedestrian paths, bicycle paths, street lights, etc), including facilities (benches, parks, landscaping and libraries). These things help to develop the environment well. Neighbourhood design should consider walkability and cycling for sustainable mobility in cities and increasing transit ridership [21].

Distance to transit- It involves transport proximity, location of train and bus stations, transport related service

facilities, travel time and trains [20]. The TOD definition invites walking for 5–10 minutes or an average walking distance of 2,000 feet [17]. However, public transport distance choices are also influenced by factors, such as land use, psychosocial, cultures, and habitual behavioural processes. Using proximity and accessibility data alone cannot determine public transit use [21].

Destination accessibility- It is about the destination's parking availability and proximity to public transportation. It is access in the form of walking, access to facilities and access to transportation [20]. However, mass transit systems need to be designed to facilitate access to a variety of destinations, such as workplace, service centre, recreation, etc. Providing efficient and efficient public transport services can increase the number of transport passengers [21].

The empirical evidence from the suburbs of Pathumthani, Thailand, has validated the 5Ds framework using 10 indicators of sustainable mobility, providing a regional reference for the measurement system of this research [22]. However, the TOD development model doesn't recommend the “one-size fits all” approach to TOD [23]. There should be other elements taken into consideration in order to lead to sustainable urban development planning guidelines. In 2004, Cervero found evidence of an increase in TOD ridership from self-selection in California. 19.6% of people living within 1/2 mile of a train station use the service, while 8.6% of people who live beyond 1/2 mile [24]. Residents within the TOD area uses the service 2 times higher because it is close and convenient to access the train station. The results of this research reveal the differences in residential areas that affect the use of station services. There are also TOD research results in some areas of China that show ineffective results, lack of public participation, and impact on changing the way of life of local communities surrounding station areas. This may cause social gaps from national development [25].

For this reason, to reduce this gap, research has suggested that importance should be given to determining station typology in accordance with the city's neighbourhoods in each area in order to lead to TOD strategic plan, such as results of research on station types in the city and county of Denver, United States. Station classification based on station area characteristics. It is divided into five types (TOD Typology) [26]: Downtown, Urban Center, General Urban, Urban, and Suburban. In Europe, there is research that suggests that the station classification is based on the location of the HSR station, as there is empirical evidence that HSR investment catalyzes urban restructuring and benefits rapid urban development. There are 3 types [4]: the station is located beside or within the traditional Central Business District, the station is usually located on the edges of cities, adjacent to, but separate from, the main urban centers. This helps in developing of additional sub-centers within the urban area, and the station uses the station as a

driver for a new commercial 'edge city' on the periphery of the urban area. Recent evidence from Bangkok shows that urban-metabolism-based mobility planning can curb energy use when 5 Ds principles are correctly applied, strengthening the theoretical link between TOD design and sustainability goals [27]. In the case of Surat Thani in southern Thailand, Chanthawong illustrated that with the application of SWOT-TOWS analysis, it is possible not only to identify strengths and mitigate risks but also to efficiently match the 'scenario-measure' matrix for formulating phased strategies regarding station area development. This approach further informed the Transit-Oriented Development (TOD) zoning concept adopted in this study [28]. These findings reveal that developing TOD requires an understanding of station locations and neighborhoods in each area to determine station types for strategic planning.

In addition, Kidokoro (2020) presented the TOD policy in Asia with four aspects: TOD planning, Station area development, Collaboration with stakeholders and community, and Value capture [29]. However, when reviewing research on HSR strategic planning in both Europe and Asia, namely France, Germany, Spain, Italy and Japan. It was found that these countries have devised different HSR strategies by developing international standard HSR systems and multi-purpose HSR systems depending on the country's context and geography. For instance, the design should take into account the unique characteristics of the urban form, city structure, economic structure, urbanization, topography characteristics and natural disaster risks, including traffic patterns, population density, safety, value, economic and social benefits, etc. [30].

The results of the literature review on TOD development found that each country has clearly different approaches to TOD development, both national and local policies. It is not possible to use the same format or the "one-size fits all" approach, which depends on many factors or conditions of that country, as mentioned above. The researcher therefore suggests that an appropriate TOD consists of two aspects: First, it should focus on national and local development policies. Second, it should pay more attention to defining station types and developing areas around stations to be consistent with the city's neighborhoods in each area, including using the basic principles of TOD (Core Commercial Areas/Secondary Areas) together with the 5 Ds principles to connect with local communities and various important areas around the HSR station area.

3.2 Rationale for Development of TOD in Lao PDR

Lao PDR is currently accelerating the survey and strategic planning for the development of railway projects throughout the country to connect cities and border areas that are important to the country's economic development. Lao PDR focuses on being a center of international and regional connectivity, which is in line with BRI [7], and ASEAN

Strategic Transport Plan 2011-2015: Singapore-Kunming Rail Ling (SKRL). The SKRL project was proposed at the Fifth ASEAN Summit in 1995. This is an important project of the ASEAN-Mekong basin development cooperation [31]. On the other hand, Lao PDR has focused on maritime exits, especially important ports of neighboring countries, consisting of four main projects [32]:

- The Savannakhet-Lao Bao railway project, with a distance of 220 kilometers, to connect Thailand and Vietnam through Lao PDR.
- The Vientiane Capital to Vung Ang railway project, or A3 railway project, will provide the capital city of Lao PDR with access to a port in Vung Ang, Vietnam, a distance of 550 kilometers.
- The Thakhek to Vangtao railway project is a route to the Lao-Thai border (Ubon Ratchathani Province).
- The Pakse to Veun Kham railway project is a route connecting the Lao-Cambodian border to Phnom Penh and a port in Cambodia.

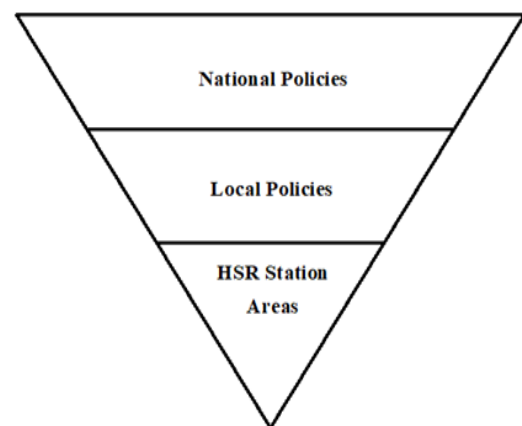


Fig. 1. Conceptual Framework.

However, this strategic plan is a part of the reform policy for the development of Lao PDR called "Chintanakan Mai" (New Thinking) in 1986 by Kaysone Phomvihane, Secretariat-General of the Lao People's Revolutionary Party. This is an important policy of opening up the country and reforming the economy of Lao PDR [33]. Therefore, the development of modern infrastructure (roads and railways) will reduce geographic limitations that used to be an obstacle to socio-economic development from a landlocked country to a country linked with neighboring countries [14]. For this reason, if Lao PDR has appropriate TOD development guidelines in each area, it will result in sustainable urban development as well as gaining great benefits at the national, provincial and local community levels around the TOD areas and communities in the TOD area. So, the researcher proposes two aspects of TOD as mention in in the literature review above two aspects. There is an analysis of development policies at national and local level in order to lead to appropriate TOD development guidelines in two

areas: the Vientiane Capital HSR Station area, which is the national capital area, and the Vang Vieng HSR Station area, which is a district area for tourism.

4. METHODOLOGY

In this study, the researcher used qualitative research methods to collect and analyse data. Primary data and secondary data were collected, including Google maps used for surveying the areas around HSR stations as follows:

Primary data was obtained from field survey of the area around the Vientiane Capital and Vang Vieng HSR stations in Lao PDR. The field survey covers areas around the stations in an average radius of 2,000 feet according to TOD principles. In addition, local government authorities were also coordinated to inquire about information in the areas. It surveys the migration of population from the HSR station areas.

Secondary data was obtained from literature review, such as books, research reports, articles, journals and the Internet as well as official documents of the Lao government.

For data collection and analysis, it begins with the analysis of national and local development policies, including the context and geography of Lao PDR, and secondary data. In addition, the findings obtained from the policy analysis are integrated with the primary data analysis in the areas around the Vientiane Capital and Vang Vieng HSR stations.

5. STUDY AREAS CONTEXT

Lao PDR was established in 1975 with a total area of 236,800 square kilometres (6,000 square kilometres inland) and a population of approximately 7.75 million (2022). It is a landlocked country in Southeast Asia. It has borders with five neighbouring countries: China, Cambodia, Vietnam, Thailand and Myanmar. Most of the terrain, 80 percent, is mountains and plateaus. As for the cultivation area, there is only 50,000 square kilometres, or about 20 percent of the total area. Thus, strategic planning for the railway projects is very important in the socio-economic development of Lao PDR. Exploring the context and geography of Vientiane Capital and Vang Vieng City is important in planning the city's sustainable development.

5.1 Vientiane Capital

Vientiane Capital is the capital and largest city of Lao PDR. It has a total area of 3,920 square kilometers (0.59 percent of the country's area) and has a population of approximately 1 million people (2020). It is located in the central region of the country. The special point of the city is that it borders the Nong Khai province of Thailand. There is the Mekong River as the boundary line between them but they are connected for transportation by the first Lao-Thai Friendship Bridge (travel by car and train) and also have borders with neighboring provinces (Vientiane Province and

Bolikhamxai Province). The Vientiane Capital is divided into nine districts, namely Chanthabouly (the main district), Xaysettha, Xaythany, Sikhottabong, Sisattanak, Naxaithong, Hadsayfong, Sangthong and Pakngum.

National development has caused the Vientiane Capital to expand and its population has increased continuously, with a rapid pace of economic growth and social conditions change. These have resulted in social problems and the charm of the city may have disappeared from the capital that was once known as the "forest capital" where people lived in harmony with nature [34]. However, the Vientiane Capital has prepared "Master Plan for the Development of Vientiane Capital 2030" to strengthen the city's economy and improve living conditions amid rapid population growth. The preparation of this master plan is in compliance with the urban planning law (1999). It was the first law which divided city planning into four levels (national plan, regional plan, provincial plan and district plan) [35]. At the same time, it is also consistent with the government's five-year National Economic and Social Development Plan (NSED). As for the Vientiane Capital structure concept, it is necessary to strengthen the urban economic functions, especially in the fields of trade and business, industry and logistics, and simultaneously improve liveability. The concept of "Multi-core Structure" that takes into account the location and size of necessary functions to support various activities. The multi-core structure aims to control the expansion of existing urban centers by creating sub-centers and urban clusters. There are a few to avoid over-concentration and unregulated expansion of existing urban centers [36]:

- Sub-centers are developed as new urban accumulations to relocate certain urban functions from the urban center and embrace new urban activities. There are KM 21, Thanaleang, Dongdock, Naxaithong and Railway Town.
- Urban clusters are developed as local economic and service centers to serve surrounding villages as well as disperse the population away from the urban center. It's Khok Hae, Tha Ngon and Ban Pao.

At the same time, Vientiane Capital has divided the city into four zones:

- (1) Historic Conservation Zone is the place of historic and cultural heritage.
- (2) The Inner Urban Zone strengthens the urban function of Vientiane Capital as a regional economic hub in The Greater Mekong Subregion (GMS), in addition to the national center of Lao PDR.
- (3) Outer Urban Zone is the surrounding area of the inner urban and can provide adequate living space and a good living environment.
- (4) Outskirts Zone is important from an environmental and disaster prevention point of view. The zone should be maintained/conserved similar to current land use.

It also plans to develop infrastructure and improve the urban landscape, such as expressways, roads, parks, botanical gardens, etc. However, the Vientiane Capital currently has five Special Economic Zones (SEZs), which are national projects [37]: Saysettha Development Zone, Thatluang Lake SEZ, Longthanh-Vientiane SEZ, Dongphosy SEZ and Vientiane Capital Industrial and Trade Area. The SEZs are expected to be one of the leading drivers for economic development in both urban and border areas to modernize Lao PDR. Meanwhile, Laos issued a law on urban planning, No. 40/PPPO, dated 16 November 2017 (revised) to replace the version No. 03/99/PPPO, dated 03 April 1999 [38]. This will have an effect on defining urban development areas. This law emphasizes the importance of dividing land use zones in the city-level comprehensive plan. It is divided into areas:

- The cities of metropolises, cities, municipalities and districts: city center zones, around city center zones, sub-urban zones, urban expansion zones and restricted zones.
- Urban community: urban community center zones, urban expansion zones and restricted zones.

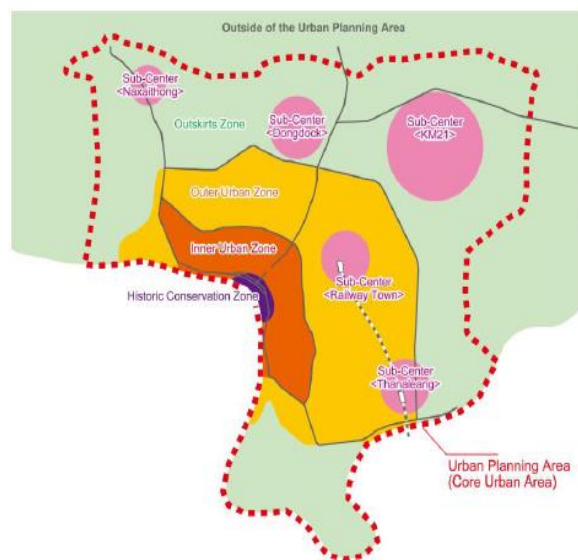


Fig. 2. Land Categorization in the Core Urban Area of Vientiane Capital. Source: JICA. (2011).

Over the past several decades, land use changes driven by national development have inevitably resulted in rapid urbanization, significantly reshaping local communities on the periphery of Vientiane Capital. Since the early 1990s, the Lao government has enacted a series of three pivotal regulations to guide urban planning and zoning in Vientiane. The first regulation, issued in 1991, delineated an urban area spanning 9,300 hectares, encompassing 100 villages. The second regulation, introduced in 2007, expanded this urban area to 20,950 hectares and incorporated 180 villages. The most recent regulation, enacted in 2022, further extended the urban area to 61,600 hectares—representing approximately

16% of Vientiane's total area—and included 288 villages [39]. Building on these developments, the Lao government adopted the multi-core infrastructure development model in 2010. This approach seeks to stimulate economic growth, improve livelihoods, and support both national and local development through the establishment of sub-centers and urban clusters. As Vientiane's urban footprint has expanded rapidly, the areas surrounding high-speed rail (HSR) stations have undergone a strategic reclassification. Previously designated solely as sub-centers, these regions are now redefined to serve dual roles as both city centers and sub-centers. While this shift highlights the economic prominence of HSR station areas, it also presents pressing challenges, such as ensuring balanced urban development, managing infrastructure demands, and addressing resource allocation disparities. These issues underline the need for careful planning to harmonize regional growth with equitable urban management.

5.2 Vang Vieng District

Vang Vieng is a small district in Vientiane Province with a population of only 62,085 people. It is located 96 kilometers from the provincial municipality. After the opening of the expressway and high-speed rail service, Vientiane-Vang Vieng takes only about 1 hour by car (distance approximately 113 kilometers). The district is located along the Song River and the most prominent feature of the city is the limestone mountains and forests surrounding the town. Vang Vieng has a total area of 1,679.28 square kilometers and is bordered by many districts [40].

Vang Vieng is one of the main tourist destinations in Lao PDR as most of the town is mountainous and the mountain ranges run north and south or along the banks of the Song River. It is a source of natural attractions (caves, water sources and waterfalls). Each year the number of tourists coming to visit this town is ranked among the top in Lao PDR. There is statistical information that there were 4,468 tourists visiting Vang Vieng in 1997, and in 2012 there was an increase of 177,191 tourists, with an average increase of 7.69 percent tourists per year [41]. And according to Lao tourism statistics, in 2019 there were a total of 4.2 million foreign tourists visiting Lao PDR, an increase of 8.2 percent from 2018, with Chinese tourists the most coming to Lao PDR, followed by Thailand, Vietnam, and South Korea, respectively [42]. However, the outbreak of the COVID-19 has affected global tourism, including Lao tourism.

Vang Vieng has focused on urban development and transportation. Recently 26 projects on road and waterway transportation, and 112 building construction projects were approved by the local authority. While the Lao-China HSR project and Vientiane – Vang Vieng expressway are under the national level. Local public transportation network in this town consists of 12 routes for local bus services and 1 international bus route. Vang Vieng has accelerated the development of such infrastructure to promote trade,

investment, tourism, transportation of goods, etc. The goal of the of Vang Vieng is to upgrade from Vang Vieng District to become Vang Vieng City [40].

Since the early 2000s, urban development has driven the rapid transformation of Vang Vieng from a predominantly rural community to an increasingly urbanized area. This shift was catalyzed by the Lao government's establishment of formal urban boundaries in 2010, which divided the region into six functional zones [43]: the urban center area, urban periphery area, suburban area, urban expansion area, green agricultural area, and natural green area designated for environmental protection. Notably, local communities situated near the railway stations were initially classified as part of the urban expansion area before the commencement of the high-speed railway (HSR) project. The subsequent development of HSR infrastructure introduced profound changes to these communities, producing a dual spectrum of effects. On the one hand, the railway's construction and operation have stimulated regional economic activity, improved connectivity, and enhanced access to urban amenities. On the other hand, it has also resulted in significant disruptions, including land acquisition, displacement of residents, and shifts in traditional livelihoods. These complex dynamics underscore the need for a balanced urban development strategy that minimizes adverse impacts while maximizing the socioeconomic benefits for local populations.

6. RESULTS

6.1 Analysis of the Importance of the Laos-China High-Speed Railway Project

The Belt and Road Initiative (BRI), also known as One Belt One Road (OBOR), is a flagship strategy aimed at reviving and extending historical trade routes to enhance global connectivity and economic integration. It seeks to establish an expansive network of infrastructure projects, including roads, railways, oil pipelines, power grids, ports, airports, and dams, which together connect China to Central Asia, Europe, and the Indo-Pacific region. This initiative draws inspiration from the ancient Silk Road, with the ambitious target of completing its core projects by 2049. Structurally, the BRI is divided into two main components: the "Belt," representing the Silk Road Economic Belt, which connects China to Central Asia and Eastern and Western Europe through land routes; and the "Road," signifying the 21st Century Maritime Silk Road, which links China with Southeast Asia, Africa, and Central Asia via maritime routes.

The BRI framework includes six designated economic corridors and a key maritime shipping route [44]:

1. New Eurasian Land Bridge (connecting western China and western Russia)
2. China-Mongolia-Russia Economic Corridor (Northern

China and Eastern Russia via Mongolia)

3. China-Central Asia-West Asia Economic Corridor (Western China and Turkey via Central and Western Asia)

4. China-Indochina Peninsula Economic Corridor (South China and Singapore via Indochina)

5. China-Pakistan Economic Corridor (Southwest China to and via Pakistan)

6. Bangladesh-China-India-Myanmar Economic Corridor (Southern China and India via Bangladesh and Myanmar)

7. Maritime Silk Road connecting the coast of China to the Mediterranean Sea via Singapore-Malaysia, the Indian Ocean, the Arabian Sea, and the Strait of Hormuz

The Laos-China high-speed railway (HSR) project, a centerpiece of the China-Indochina Peninsula Economic Corridor, exemplifies the BRI's goals of fostering connectivity, reducing trade barriers, and stimulating regional economic growth. As an integral part of this corridor, the Laos-China HSR establishes a critical transportation link between China and Southeast Asia, positioning Laos as a gateway to the region. From China's perspective, the project advances its broader strategy of enhancing economic influence, expanding industrial product markets, and integrating its economic and political interests across Asia. Simultaneously, the railway serves as a vital economic catalyst for Laos, supporting its ambition to transition from a landlocked to a land-linked nation.

For Laos, the HSR project represents the most ambitious and costly infrastructure development in its history. By connecting the northern, central, and southern regions of the country, the railway facilitates both internal mobility and international trade. Complementary projects, including the establishment of special economic zones, highways, hydropower plants, mining initiatives, and agricultural programs, further reinforce this transformation. By December 2022, one year after the railway's inauguration, the line had transported 1.2 million passengers and nearly 2 million tons of goods, including over 1.576 million tons of cross-border goods [45]. These figures underscore the project's critical role in reducing transportation costs and fostering trade and investment, while also enhancing connectivity between rural and urban areas. Moreover, the railway has catalyzed investments in industrial zones, hydropower development, and the expansion of agricultural production along its route.

However, the development of the Laos-China HSR has not been without challenges. Local communities have faced profound disruptions due to the acquisition of land for railway tracks and station construction. In Xaythany District of Vientiane Capital, for instance, Ban Xay—home to the Vientiane Capital HSR Station—lost approximately 50 hectares of agricultural land, predominantly rice fields, to the project [46]. Similarly, in Vang Vieng, Ban Phudindaeng saw the repurposing of 32 hectares of farmland, including

fruit orchards and vegetable plots, to accommodate railway infrastructure [47]. These changes have forced many residents to transition to new livelihoods, often with inadequate support or compensation. Furthermore, the influx of urbanization around HSR stations has created social inequalities between transit-oriented development (TOD) areas and neighboring rural communities, deepening existing socioeconomic divides.

Addressing these challenges requires a multidimensional approach to urban and infrastructure planning. Incorporating the principles of TOD, urban development strategies must emphasize inclusive decision-making processes and local community engagement. Specific measures, such as ensuring fair compensation for displaced residents, providing skill training for occupational transitions, and fostering transparent governance, are essential to minimize negative impacts and enhance equitable development. By integrating local voices into planning and implementation, the Laos-China HSR can better fulfill its potential as a transformative project that bridges economic aspirations with social sustainability.

6.2 Lao Railway System Development Policies

(1) National policies on rail ways system of Lao PDR are to promote the socio-economic development of the country by reducing geographic limitations that used to be an obstacle to national development. To shifting from a landlocked country to a land-linked country connecting to neighbouring countries by rail system and become a centre for GMS and ASEAN, as well as connecting beyond its region. In addition, it is also aiming to find important outlets to the seaports, such as ports in Vietnamese, Cambodia Thailand and Singapore.

The Lao-China HSR Project create a multi-purpose railway system with an emphasis on intercity and international connectivity. It is an HSR that provides freight and passenger services in both ordinary and high-speed trains because Lao PDR is a small sized country with tiny population. Also, the geography of the country has a lot of high mountains, located in the middle of many larger countries with much larger economies, including China, Thailand, Vietnam, Myanmar and Cambodia.

(2) Development policies of Vientiane Capital aim to strengthen the urban economic functions, promote trade and business, industry and logistics, and improve the liveability of the city. "Multi-core Structure" concept are applied to support various activities and to control the expansion of existing urban centres by creating urban development areas into two types: sub-centres and urban clusters, The city areas are divided into four zones. The area around the HSR station is a sub-centre in the 3rd level of urban area or Outer Urban Zone with the goal of developing this area into a railway town. However, this urban development policy was designed under the Urban Planning Law of 1999, but currently the Urban Planning Law of 2017 (revised) has

been enforced, dividing land use zones in the comprehensive plan according to the level of the city. In addition, there is the Regulations on Managing Vientiane Capital City Master Plan in 2022, which has changed the definition of the expansion scope of Vientiane Capital City. The design of urban development areas should be further studied in detail.

Nowadays, urban development in Vientiane Capital is mostly related to national development policies. There is a large amount of land use under the responsibility of the government, such as five Special Economic Zones (SEZs), intercity expressways, etc. Moreover, there are also various projects under the responsibility of local level or Vientiane Capital Administration Office, such as expressways between district to district, shopping centre zones, industrial zones, etc. Therefore, urban development in Vientiane Capital remains highly challenging, both due to the overlap between national and local development policies and the importance of priority development areas in the short, medium and long term.

(3) The Vang Vieng development policy emphasises on tourism promotion and upgrading Vang Vieng District to become Vang Vieng City. Due to the fact that Vang Vieng are rich of natural resources and natural tourist attractions. It is a popular destination for both Lao and international visitors. A main revenue of this district comes from tourism industry. Therefore, connecting cities and regions with HSR and intercity expressways is a key development priority.

Another key priority of Vang Vieng policy is to promote land use for infrastructure development, including industrial zones. These development projects are under the responsibility of local government authority at the provincial level to enable trade, investment, transportation of goods, tourism and others. So far, some land development projects and investment have been made to develop Vang Vieng in direction of green growth and sustainability and to be upgraded from a district to a city. But if the development in the areas is not well balanced with the needs or primary services for local communities, it may have negative impact on livelihood of local people and bring various problems of urbanization.

6.3 Land Use Developing Areas Around the Vientiane Capital and Vang Vieng HSR Stations

From field survey and data collection at areas around Vientiane and Vang Vieng SHR stations to understand its physical elements and context, the result can be summarized as follows:

6.3.1 Context of Vientiane Capital HSR Station Areas

Currently, Lao-China Railway Company Limited (LCR) has received a concession for the area around the HSR station. The radius of the area from the front of the station building is not clear, but the road built into the station area is about 1.5 kilometres and the back of the station has a radius of about 500 meters. In the past, almost all of this area was rice

fields and there were not many densely populated houses. Due to the construction project of the HSR station, people living in this area were relocated. When calculating the area of HSR station by Google map, it found that recently total spaces for passenger hall, terminal, offices, and other buildings have a length of approximately 500 meters and a width of approximately 60 meters. In front of the passenger hall, there is an open concrete-paved area for parking and passenger stopping. It has a length of approximately 500 meters and a width of approximately 160 meters. The areas next to this concrete area are rice fields and some trees which can plan for further development.

6.3.2 Context of Vang Vieng HSR Station Areas

LCR also has a concession for the area around the Vang Vieng HSR station, but the size of this area is much smaller than the Vientiane Capital HSR station. The approximate radius of the area is not yet clear, but the road built into the station area is about 1 kilometre and behind the station is close to mountains and national forest areas. In the past, all of the land in this area was gardening area and there were not many densely populated houses. However, when the land was used to develop the HSR project, it resulted in the movement of the population out of that area. A survey by Google map found that passenger hall, terminal, offices, and other buildings cover a total area of approximately 300 meters in length and approximately 50 meters in width. Next to the passenger hall is an open area with a concrete floor for parking and passenger stopping. It has a length of approximately 300 meters and a width of approximately 100 meters. Lands next to this concrete area are gardens and some trees which can be further development as well.

6.4 Guidelines for the Development of TOD in the Vientiane Capital and Vang Vieng HSR Station Areas

Analysis of field survey in two areas around the HRS stations, Vientiane Capital and Vang Vieng, found that:

(1) Size of each area around HRS station is different. The area around Vientiane Capital HSR station is larger than Vang Vieng's. But this does not affect the presentation of TOD development guidelines in the two HSR stations, an average radius area 500 meters.

(2) Both areas around the HSR stations of Vientiane Capital and Vang Vieng are newly grown and have not yet been fully developed. Those areas are large and suitable for Calthorpe's TOD construction principles, namely Core Commercial Areas, areas with a radius of 500 meters from the HSR station location / Secondary Areas, areas with a radius of 500-1.000 meters.

Next to the locations of HSR stations or next to main areas, are the 'Secondary Areas' which are between the Core Commercial Areas and near the main road before entering the HSR station.

(3) The location of the Vientiane Capital HSR Station is

in the Outer Urban Zone, which is an urban expansion area and approximately fifteen kilometres from the city. As for the location of the Vang Vieng HSR station, it is in the area around the city centre which is an urban expansion area and is approximately four kilometres from the centre. Due to the nature of the location of both stations, the stations are of Suburban type. However, currently the area around the location of the Vientiane Capital HSR Station has developed new urban areas, new production line zones and special economic zones.

(4) Characteristics of the area around the HSR station as mentioned above, TOD design to maximize the potential of space and travel:

- Design of Core Commercial Areas with an average radius of 500 meters. The design of this main area should use the principles of creating the 5 Ds (Density, Diversity, Design, Distance to Transit and Destination accessibility). At the same time, mixed-use core commercial areas should be prioritized as key links between transit and land use. However, the size and mix of uses in each core commercial area may vary depending on the size, location and overall function of the site in the region (Calthorpe, 1993).

- Design of Secondary Areas, average radius area 500-1.000 meters. It provides an important support base for both the transit ridership and core commercial area:

- To drive agile access to space as nodes with better access and high service frequencies increase the chances of a successful TOD.

- It is an area between direct access points to the main area (transit, bike, and pedestrian facilities) and the local community, including important areas in Vientiane Capital and Vang Vieng.

- The general design of this area should include a variety of residences with not too high density, such as parks, open spaces, parking and low to medium intensity employment, etc. However, the design of this area has not yet been the result of the research. The design depends on the planning of the relevant agencies in each area to be appropriate.

(5) TOD development should take into account the connection with the development of local communities surrounding the HSR station areas, which are communities affected by land use for the development of the HSR station areas.

TOD promotes sustainable urban development models to solve various urban problems and help promote economic and social development, including environmental improvements. For this reason, the development of TOD is important in order to obtain maximum benefits, such as increasing the number of passengers, income, safe area, increase the value of land and real estate, and increasing opportunities for living, etc. At the same time, it also helps reduce costs, congestion, reduce emissions, preserve open space, reduce parking fees, increase retail sales, reduce

crime, increase social capital and citizen participation [24]. However, the guidelines for developing TOD in Vientiane Capital and Vang Vieng are for sustainable community development. It is necessary to consider many dimensions in order to suit the area: national railway development policies, provincial urban development policies, and analysis of the area around the HSR stations according to the TOD concept, including urban and regional development plans, local community development plans, transportation routes and relevant laws to be consistent and appropriate to the area as the following Figure 3 and Figure 4.

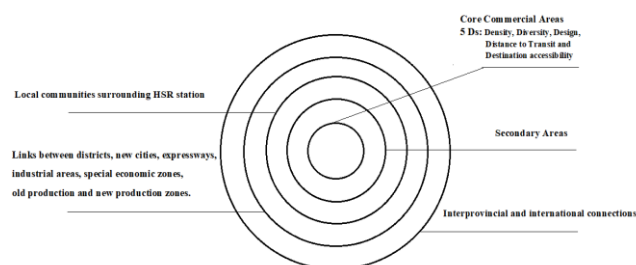


Fig. 3. Guidelines for Developing TOD in the Vientiane Capital HSR Station.

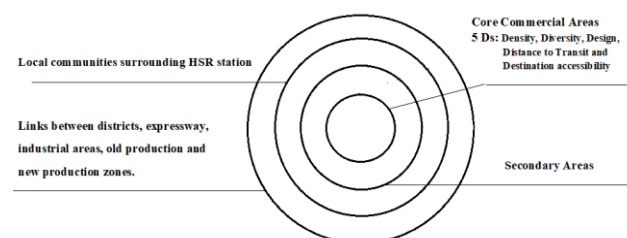


Fig. 4. Guidelines for Developing TOD in the Vang Vieng HSR Station.

Transit-Oriented Development (TOD) offers significant potential to address urban challenges while fostering sustainable economic, social, and environmental progress. By prioritizing compact, connected, and accessible urban areas, TOD ensures that communities residing within these areas derive the maximum benefits from such development. However, to bridge the disparities between local communities surrounding railway station areas and those directly within TOD zones, it is essential to enhance awareness and understanding of TOD concepts among affected local populations. Policymakers should prioritize educational initiatives and community outreach to ensure these populations fully comprehend the nature and benefits of TOD. Moreover, effective TOD planning must actively integrate the voices and needs of local communities situated around high-speed railway station areas. This involves conducting thorough consultations to understand their concerns, capacity for adaptation, and long-term aspirations. Equally important is fostering meaningful community engagement throughout the planning and implementation processes. By incorporating these communities as active

stakeholders, policymakers can ensure that TOD initiatives not only address the technical aspects of urban design but also mitigate the social impacts of land-use changes stemming from high-speed rail development. Such inclusive planning will help align TOD objectives with the equitable and sustainable development of affected areas. However, in order to successfully develop TOD the relevant organizations should have communication plans to raise awareness and increase understanding on TOD development for all including public sector, private sector and civil society especially communities surrounding the HSR stations. The communication can be through social media platforms and dissemination workshop at national, sub national and village level.

7. CONCLUSION

Over the past decades, development of many countries in the world, especially infrastructure development (roads, expressways, rail transport and airports) in order to develop the country's economic and social development, have affected cities in many dimensions such as population settlement problems along transportation routes, traffic problems, pollution problems, environmental problems, and social problems, etc. However, to solve urban problems in many countries, TOD has been used in areas around rail transit stations. When reviewing the literature, it was found that developing a model of TOD is different on each continent or country. It depends on many factors or conditions within that country which lead to HSR strategic planning or national policy making. Therefore, studying the TOD development guidelines in the Vientiane and Vang Vieng HSR stations of Lao PDR in order to lead to sustainable community development is a new approach. It analyses development policies at all levels, especially the interconnections at national, local and TOD development areas.

The results of the analysis of national and local development policies found that Lao PDR develop a multi-purpose HSR system due to its geographic location from a landlocked country and want to become a country linked to neighbouring countries by rail systems. The goals are to find a way to the sea, boost economic and social development of the country, enhance international cooperation (GMS and ASEAN hubs) and connectivity beyond the region. Analysis of the Vientiane Capital development policies found that the Multi-core Structure concept was used to strengthen the urban economic functions in Vientiane Capital. The goal is to develop the area around HSR station into Sub-centre or Railway Town. In addition, there are many land use projects, both national and local, which pose serious challenges, both overlapping and prioritizing the development of different areas. Analysis of the development policies of Vang Vieng found that there is a focus on the development of many waterway and land transportation projects under the responsibility of the province to promote tourism and want

to develop Vang Vieng District to become Vang Vieng City. There is also an emphasis on connecting cities and regions with HSR system and intercity expressway. However, Vang Vieng has extensive land use and has invested heavily in developing the areas as planned. Therefore, if the development of areas is not well balanced with the needs or services of the local population. It may affect the way of life of the local community and cause various problems. Analysis of the area around the Vientiane Capital and Vang Vieng HSR stations found that two areas are new grown and have not yet been developed into large areas which are suitable for building TOD (Core Commercial Areas / Secondary Areas), including principles of creating the 5 Ds and linking the development of local communities surrounding the HSR station areas.

However, Guidelines for developing TOD in Lao PDR should be linked in many dimensions to suit the areas, namely development policies at all level, related laws, and analysis of areas around HSR stations according to the TOD concept. Moreover, the researcher suggests that TOD development guidelines should include strategic planning or short-term, medium-term, and long-term development policy with the participation of many sectors (public sector, private sector, and civil society).

Analysis of national and local development policies found that there are many national and local projects for sustainable urban development. In practice, old projects have not been successful (national/local level), but new projects have been approved. This may result in the development of urban areas not being as planned due to the use of capital and the use of a large amount of land. Moreover, laws still need to be improved to support new project development and TOD development.

TOD development guidelines consider that there is a social gap between the development of Core Commercial Areas/Secondary Areas and the local communities surrounding HSR station areas. This is a community that has been affected by land loss because in the past there was no research on integration. Therefore, the development of TOD requires further research in the future to reduce the social gap and to gain mutual benefits from national development.

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