

Review on Selection And Suitability of Rail Transit Station Design Pertaining To Public Safety

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Abstract: Railway has emerged as a fast, convenient, safe, clean, and low-cost alternative to air and road transportation. Many countries have invested in rail transportation. In America, Europe and Asia, large investments are planned for rail transportation. This is because congestion problems can be reduced with the introduction of rail transportation. Rail transportation involves several components which are important to ensure the smooth and safe delivery of services such as locomotives, rail stations and railway tracks. Rail transit stations are places where trains stop to pick-up and drop-off passengers. Stations are vital for many to enable them to engage in work and social commitments. This paper focuses only on the rail transit station as it is one of the important components in rail transportation. It is also considered as a key public meeting place and space for interactions in a community. The role of rail transit station and the requirements of a good rail transit station are also described in this paper. Steps in selecting the location of rail transit station include the function and facilities in rail transit station are discussed with reference to best practices and handbooks. Selection of the appropriate rail transit station locations may help users indirectly. In addition, this paper will also elucidate on the design considerations for an efficient and effective rail transit station. Design selections for the rail transit station must be balanced between aesthetic value and functional efficiency. The right design selection may help conserve energy, assure and facilitate consumers even though a rail transit station plays a smaller role in attracting consumers compared to a shopping complex or a residential building. This will contribute towards better and greener building for a green transportation facility. Thus, with this paper it is expected to assist the relevant authority to identify important elements in the selection and determination of suitable rail transit station design for the future. It is also important to ensure the design is appropriate from the selection and suitability perspective as design and operation will assist to facilitate the success of the national rail network and encourage the public to use rail transit system. A conducive and neatly design railway station will not only add to the passenger experience but also, as a supporting facility to the economic, social and environmental benefits of the rail industry.

Introduction to Rail Transportation Industry

Local public transport is recently re-recognized even in the developed countries, as an available resolution for the social issues in the urbanization, such as traffic congestion and safety, globe warming by CO₂ emissions, and the process of low birthrate and aging society[1]. Rail transportation was one of public transport network that is often used by community. Railway has emerged as a fast, convenient, safe, clean, and low-cost alternative to air and road transportation [2]. Rail transportation has made a comeback over the past few years. Increased fuel efficiency, as well as a growing demand for bulk freight transportation and a lower carbon footprint, has resulted in greater demand for the Rail Transportation industry's services. Recent fluctuations in the price of oil have also made rail transportation more competitive compared with other forms of transportation.

Rail transportation is characterized by a high level of economic and territorial control since most rail companies are operating in situation of monopoly, as in Europe, or oligopoly, as in North

America where seven large rail freight carriers control and operate large networks. Rail transportation involves several components which are important to ensure the smooth and safe delivery of services such as locomotives, rail transit stations and railway tracks. Rail transit stations are places where trains stop to pick-up and drop-off passengers. Rail transit stations are vital for many to enable them to engage in work and social commitments.

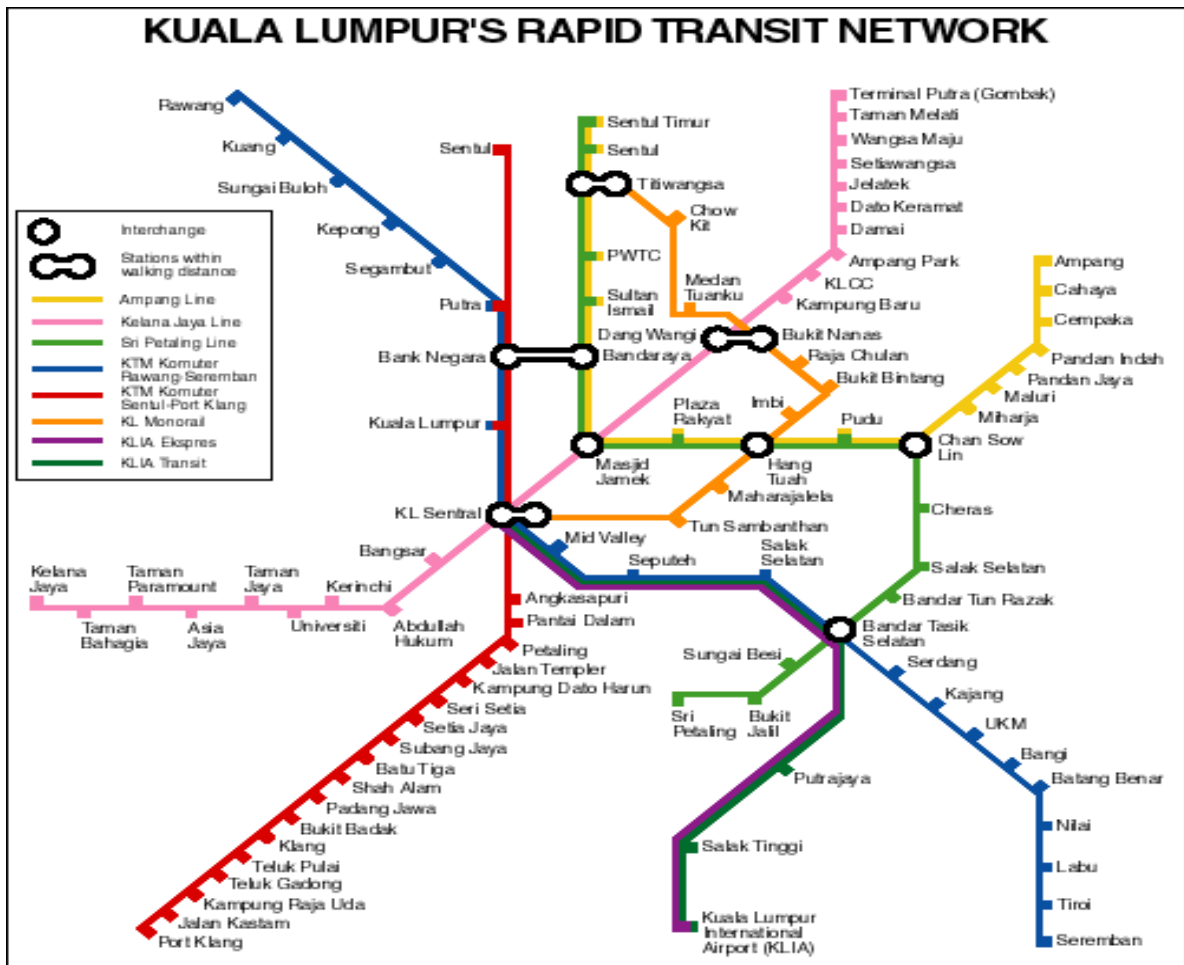


Figure 1 : Rail Transportation Network at Kuala Lumpur, Malaysia(2014)

Rail Transit Station as Community Interaction Hub

Community is defined as a ‘social construct incorporating four elements: people, meanings, practice and spatial configuration’ [3]. Community, for the purpose of this paper, refers to both communities within a geographical locality to train stations as we explore how train stations can contribute to the wellbeing of these communities. Throughout the world, railway stations are important places within cities and neighborhoods. They are places where people gather, wait, meet, and begin and end journeys. Stations are part of many people’s experience of the public realm, and so the quality of that experience can have impacts on people’s daily lives. As rail transit stations are a central feature in many communities, they hold the potential to impact personal and collective wellbeing by providing equitable access to public transport services and a space for social interaction, community information exchange, activity and expression. Further, by revitalising rail transit stations as community hubs a new form of community asset is created.

Role of Rail Transit Station

Railway technology quickly developed to become the primary people-moving system of the nineteenth century industrial city, and the stations reflected this civic significance in the attention given to their architecture. For many travellers of the time, stations were the impressive gateways into the city or the neighbourhood, the first and last point of call, and the comfort of passengers and the experience of the station was given substantial consideration [4]. Rail transit stations are primarily a means of access to the national rail network, in turn acting as a gateway to or from other destinations.

Rail transit stations are places where trains stop to pick-up and drop-off passengers. Rail transit stations are vital for many to enable them to engage in work and social commitments. Stations function as hubs to allow passengers to board and disembark from trains. They are also payment checkpoints and allow passengers to transfer between modes of transport, for instance to buses or other trains. Rail transit station is a part of railway infrastructure where passengers board or alight from trains. Includes facilities, such as platforms, station buildings, ticket machines, toilets, waiting area, seats and passenger information displays [3]. Rail transit station is an important component of public transit system in urban fundamental facilities. Viewing from the practical urban progress of all countries, rail transit station becomes a major urban transit tool in developed countries and regions for its advantages such as mass transit capacity, fast speed, safety and reliability, punctuation and comfort [5].

Requirement of a Good Rail Transit Station

Rail transit station will be an important rail hub, where it connects passengers with the train to reach the desired destination [6]. A good rail transit station makes passengers feel comfortable and safe when they are at the station while awaiting the train. There are several requirement of a good rail transit station that is accessibility, ease of navigation, comfort and amenity, information, safety and local area integration [7].

Accessible public transport refers to the provision of access to public transport for all members of the community, including people with special needs [8]. An accessible station is one that everyone can use, efficiently connects different transport modes and incorporates the idea of universal design. An accessible station is also one that is well positioned, in a place that is safe and secure and links to surrounding destinations. Creating an accessible rail transit station involved a few elements such as equitable access for all users regardless of personal circumstances, seamless connections between transport modes and with external routes and destinations and convenient station location that is close to key local activities and destinations. Locating a station away from an activity center and existing transport routes makes the station and train network more difficult to access and use.

Rail transit station navigation must be intuitive for first-time users. Good navigation promotes a constant flow in and around the precinct and includes signage to connecting transport services and external routes. The elements identified as central to ease of navigation at a station is simple station layout that is intuitive and promotes ease of movement and effective wayfinding to help people locate facilities and connect between transport modes and with external routes and destinations. A comfortable rail transit station is a place where people want to be. To be comfortable, rail transit station needs to offer a range of facilities that are durable, functional and well kept. A rail transit station must be attractive, require minimal physical effort to move around in and support the needs of as many different users as possible. Maintaining the rail transit station and its facilities shows consideration for its passenger. The elements identified as central to creating a comfortable and amenable station is convenient facilities that are available where and when users need them, pleasant station design that attracts people and encourages them to use the station and ongoing maintenance that ensures the station is clean and functional. A good rail transit station has accessible, clear, timely and accurate information about public transport services, station facilities and the surrounding area. A variety of audio, visual and tactile methods of communication is important, as is face-to-face contact with staff. Staff should be knowledgeable on all aspects of the rail station precinct, and therefore able to provide good customer service, even if their own role is only to do with a particular part of the station operations.

Safety is one of the essential requirements of a good rail transit station. In a safe rail transit station, people know that they can use any part of the station without fear of injury, incident, threat or mistreatment; and feel assured of protection in an emergency. Promoting a safe environment is more than trying to reduce hazards. It is also about creating a place that people enjoy where passengers can feel calm, comfortable and anxiety-free. The following elements are central in creating a safe station which is safe access to the station and within the station precinct, sense of security that ensures passengers can see and be seen, adding to their sense of safety and help in an emergency that is available through clear emergency procedures, information and assistance. Local area integration is also important to ensure a good rail transit station. An integrated station connects with its surrounds and reflects the character and identity of the community. Rail transit station is part of the community it services, not just a place that people travel through, so the rail transit station should contribute to and enhance the local area. Local people and businesses should benefit from the rail transit station and its facilities. The character of the local area should influence station design, keeping it consistent with shopping precincts, or any local heritage building features.

Function and Facilities in Rail Transit Station

Rail Transit Station and the surrounding incorporate a number of different function and facilities [9]. They offer public transport services arriving and departing from different locations, ticketing facilities, waiting area, and onward travel by bus, taxi, cycle or on foot. Rail Transit Station should be welcoming, safe to use, easy to navigate and contribute positively to the all overall journey experience. Good function and facilities encourage passengers to return and to regard rail travel as the most convenient and enjoyable way to travel.

Step in Selecting the Location of a Rail Transit Station

The positioning of the station in relation to the local environment is a significant opportunity for high quality urban design [10]. It is to be expected that the majority of passengers would seek to arrive at the station by foot and therefore the local environment should reflect the need for pedestrians to access the station.

There are three types of rail transit station as shown in Figure 1, Figure 2 and Figure 3 which is such a station can be elevated, underground, or about ground level depending on the level of the train tracks. This is because of the location of the Rail Transit Station. Smaller land size mostly needs an elevated Rail Transit Station but the cost to build the station is expensive. However, elevated construction cost is cheaper than underground Rail Transit Station construction works [11]. Deeper stations result in increased operating costs due to ventilation requirements and greater vertical transport infrastructure costs.



Figure 2 : At-grade Rail Transit Station

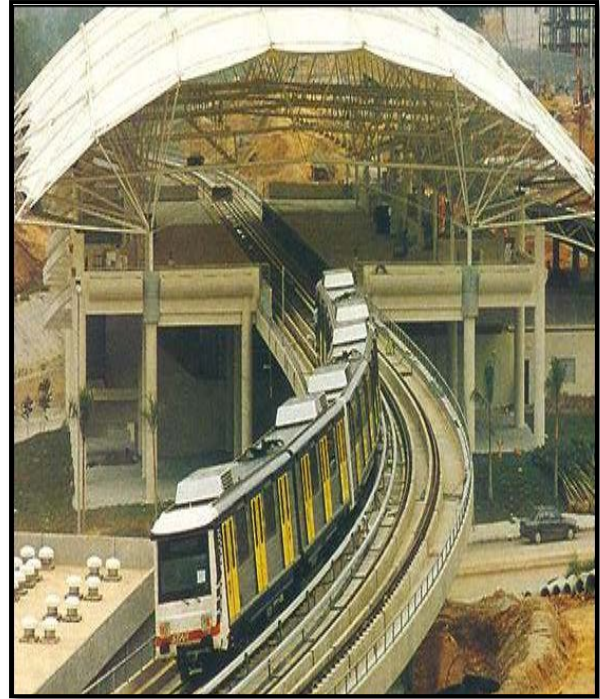


Figure 3 : Elevated Rail Transit Station



Figure 4 : Underground Rail Transit Station

There are several things should be considered when choosing a location such as travel time to railway station, distance from railway station to public transport and other facilities, safety and coordination with civil-defence facilities, compatibility and harmonization with the environment and adjustment to the present and likely future city structures [12].

Design Consideration for an Efficient Rail Transit Station

A station is made up of several constituent parts and from the perspective of its users, fulfills a range of role and function. A good station design will give due consideration to the location, role and function the station will play and the different users it will serve. Station designs need to cater for a broad range of activities and should be resilient to the changing conditions experienced within a station, both during the operational day and throughout the year. Station designs may also need to accommodate a range of operational scenarios such as major events, changes to service or adverse weather conditions. The design of station must recognize the differing needs and aspirations of the station varied stakeholder and user groups [9]. Good Rail Transit Station design should have four important features which is called as 4 themes that is usability, efficiency, quality and value [9]. The movement of passengers, public transport vehicles and non –users through a station can be complex. The design must be usability and it is important to plan and design safe, secure, legible and accessible spaces that make the use of station easy, attractive and accessible for all users. the design theme of usability is covered by four design principle that is movement, access and inclusivity, way finding and passenger information and comfort and attractiveness.

(i) **Movement**

A station is dynamic environment, involving movement and potential conflicts between a range of station users. Movement within and around the station environment should be logical, comfortable and optimized to minimize conflict now and into the future.

(ii) **Access and Inclusivity**

Accessible station design is about making places easy to use for all passengers and station users. Users include people with visual or cognitive impairments, those in wheelchairs, older people, people with heavy or bulky baggage and young children. Accessible design relates to stations, their amenities, surrounding context and information systems that support movement, use and understanding.

(iii) **Wayfinding and Passenger Information**

Adopting principles of accessible and legible design for passenger information and wayfinding from the outset will result in places that are easy to use, require minimal signage and are well integrated with their surroundings. The philosophy underlying signing and passenger information at station should be that of clarify, consistency and coherence in order to guide people through the station in a steady, convenient and safe manner helping to ensure stations users have a positive, stress-free experience. This philosophy supports a well-planned an well laid out station, and is integral to its design.

Information is a fundamental requirement for a positive passenger experience. Information can serve multiple uses including rail services, station and facility opening hours, maps of local area and information for interchange modes. Information should be delivered across the full range of media including audio, visual and tactile to meet the needs of all interchange facility users.

(iv) **Comfort and Attractiveness.**

Comfortable, clean, well maintained stations provide an attractive environment that protects users from uncomfortable climatic conditions and unpleasant sensory experiences such as polluted air, dirt and noise provides users with a sense of security and safety. Amenities should be included, where appropriate to fulfill basic needs and add value to passenger experience.

Effective planning, management, and operation of stations is essential to realize a positive outcomes for users and operators. Operability includes consideration of service coordination, operating costs, integrated ticketing, maintenance, safety and servicing.

- (i) **Station Operational**
Robust and resilient station operations require integrated and optimized operation of fleet, infrastructure and facilities to provide easy access for transport services, seamless movement across modes and effective maintenance. Efficient stations ensure cost savings for operators and owners.
- (ii) **Management and Maintenance**
Effective station management and maintenance practices help sustain the quality of the station environment. This maintains the longevity of the station, while also making it more appealing to users and realizing the benefits of whole-life cost assessments. An efficient management helps enhance the safety of rail users and can indirectly increase the level of consumer confidence in rail transportation at the rail transit station. Station maintenance should be undertaken efficiently and without compromise to train services or passengers' experience. An efficient maintenance regime minimizes impacts on passenger experience, train service reliability and operations. Systematic management and maintenance can reduce the rate of accidents at the station.
- (iii) **Safety**
Major concern when using a public service is safety. Passenger safety is the overarching requirement for rail transit station design [8]. For rail transportation, safety at the station is an essential to enhance passenger's confidence level. Considered design and maintenance of infrastructure can minimize risk of accidents and conflicts. It can also tackle perceptions of safety and increase passenger satisfaction and enjoyment. Clean, well maintained infrastructure and places create a sense that the environment is safe, controlled, managed and cared for. This reduces the fear of crime or accidents for all users. CCTV installation is the other ways to raise the level safety at the station. CCTV monitoring provides numerous benefits, including the recording of criminal activity and crowd management in stations. Used overtly, it can also act as a deterrent to crime and reduce fear of crime in stations, on-street and in vehicles.
- (iv) **Be secure by design**
Station design must consider public security against a range of different threats, both man-made and natural. All stations face a certain level of risk associated with various threats be they the result of natural events, such as flooding and accidents, or through malicious practices. Facilities and spaces in and around stations should be designed to discourage crime throughout the day and night. Crime and the fear of crime can be greatly reduced by removing isolated areas and ensuring locations are well lit and visible to others.

Providing high quality station environments will improve all aspects of a station user's experience. Design of high quality facilities is based on a combination of performance, accessibility and function, all of which form an essential part of a user's experience. Integrated, high quality station environments will improve all aspects of a station user's experience. Design of high quality facilities is based on a combination of performance, accessibility and function, all of which form an essential part of a user's experienced while remaining adaptable and able to meet with the changing needs of passengers and function.

- (i) **Integration with context**
Stations that are well integrated with their surrounding urban context help to create thriving places that are well designed, well built, well run, well connected, and well served, while remaining inclusive, safe and environmentally sensitive. Context sensitive station design can deliberately shape and animate surrounding public spaces, and in turn,

create buildings that are active, integrated fixtures within their local communities. Station facilities should be designed to integrate seamlessly with the public realm, including adjacent office buildings and shopping facilities, and to facilitate cross-, as well as through-movement. Creating a strong relationship between the station and its surrounding context delivers a richer and more fulfilling environment, enhancing local character and providing a sense of place for its users.

An interconnected network of transport, streets, footpaths, bike routes and public spaces helps connect people with destinations. This enhances accessibility throughout the local area, providing a familiar and consistent network to encourage users to travel by more sustainable transport modes.

(ii) Promote good design

Worldwide experience demonstrates that public transport systems that are user-friendly are of high quality and which ‘put the passenger first’, are able to attract significantly wider economic benefits and revenues than less well focused or integrated systems. This benefits operators and passengers, as well as the surrounding communities, developments and environment. Station environments and amenities should be designed as welcoming places where people want to travel, shop and work. A station fulfills a different function for each user so it is important to minimize any conflict between these functions. This can be achieved by the efficient use of space and operations.

(iii) Sense of Place

A sense of place refers to a characteristic that some geographic places have and others do not, but to which an individual can relate. It also refers to a feeling or perception held by people through belonging or attachment. Stations and the urban environment within which they sit mean many different things to many different users. It is important that good design harnesses these perceptions to maintain and ultimately enhance the area to instill a positive sense of place for all.

(iv) Anticipate passengers’ dynamic changing needs

Design needs to be dynamic, with enough flexibility to ensure it is able to anticipate and adapt to the changing needs of passengers over time. This does not simply mean ensuring there is sufficient capacity provision or ensuring that there are sufficient facilities available. It is also about the need to provide the right mix of facilities and services that support the needs of the users of the station and the local community.

Planning and design of station must deliver good value for money, give due consideration due to environmental and ecological impacts and consider wider opportunities for regeneration and development.

(i) Whole-life costs

Whole life costs go beyond the initial cost of construction and will comprise ongoing maintenance and operational costs for the life of the infrastructure. To evaluate the viability and minimize the whole life costs of any station scheme it is necessary to ensure that all costs are considered and that value for money can be achieved beyond the initial design and construction period. Optimising functionality of a station design minimizes operational costs and waste, and the consumption of natural resources. This can deliver significant cost and energy savings over the life of the building and provide an economic return.

(ii) Positive economic, social and environmental impact

Well-designed places can have a positive impact on the environment and deliver a wide range of sustainable benefits (such as low carbon emissions). This will generate a value to society, and whole-life cost savings to the customer. The application of best practice

standards enables developers and designers to qualify the environmental credentials of buildings to planners and clients and increases the acceptability of a scheme to key stakeholders.

(iii) Respect and conserve natural system

Well thought out station design strategies can contribute to the overall ecological balance of the network as well as mitigating the negative effects of construction on natural systems. Environmentally responsible design can help to minimize disruption to air, water, soil and ecosystems, contributing to the long-term health of the natural environment. The value of an ecological landscape asset can easily be degraded. This is particularly important for rail network as many of its stations have existed for generations and are now part of the local ecology.

(iv) Act as catalyst for regeneration

Stations can act as a catalyst for regeneration. Long-term planning can stimulate the development of sustainable economies that provide long-term benefits and regenerative success.

Possible Limitations and Constraint to Achieve Idea Construction of a Rail Transit Station

Various constraints such as designated route, station locations, road crossings, and other stakeholder requirements have driven to achieve the idea construction of a rail transit station [8]. The selection of a suitable rail transit station location will facilitate passengers to reach destination easily. There were several constraints in the selection of a suitable location for rail transit station construction that is space constraint, time constraint, construction cost and land acquisition. Rail transit stations connected by the railway network. Rail transit station should be built based on the railway network. With the rapid development of the country, there are many buildings built especially in urban areas. Therefore, this has caused constraints for the railway station construction as well as the constraints of space and land acquisition. If this happened, the solution is build-up the elevated rail transit station or underground rail transit station but it will increase the cost of the construction.

Concluding Remarks

Railway stations played a vital role for passengers, non-travelling users and the communities in which they are located. They serve the growing needs of an increasingly mobile population and are used by a wide range of users. Based on the review on selection and suitability of rail transit station, the essential fact is the effort by the operators to ensure the public safety during their stay at the stations. It is because when the station is safe, indirectly it will improve the quality of the public service by the operators. Passengers will feel confident and safe when at rail stations. The community will choose rail as the preferred public transport when they are confident with the service. From the review, it was also found that rail transit station quality has long been recognized as an important factor in influencing travellers behaviour and terminals quality is certainly part of it. Literatures showed that rail transit station quality can be further decomposed into several attributes including cleanliness, subjective and objective security, lighting, climate control, information availability and, last but not least, the architectural/aesthetic quality. Selection of appropriate rail transit station location helps passenger arrived the destination easily. The type of rail transit station based on the location that has been choosing either it is at grade rail transit station, elevated rail transit station or underground rail transit station. The suitability design of rail transit station also will make passenger feel comfort and easy to navigate if the passenger are not familiar with the station. The most important is the passenger felt safe when they are at the rail transit station. Finally it can be concluded that a rail transit station will be a factor that attracts the public to use its services and gave a good first impression. A good station design and suitable landscape will further entice

the public to be eager in engaging with the rail transit services. Rail transit station must be able to inculcate safe and attractive features whilst embedding user friendly facilities for the elderly and disable commuters. The future transportation system with the over growing population in the world is rail transit system and with the development of advanced ICT and other techniques, rail transit systems and facilities will achieve its greatest height in public transportation services.

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