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Conceptual Framework of Built Environment Factors on Cycling Behaviour among Residential Neighbourhoods

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INFORMATION ARTICLE

Abstract: Cycling as one of a mode of transport in urban and residential areas has been determined as a solution for the urban issue. It is an active and environmentally friendly mode of travel. However, the relationship between physical built environment and cycling behavior among residential are less associated with increasing the bike ability of residents. The main factors as a major contributor for bike ability behavior are built environment and social factors. The main aspect to determine the interaction between all the factors will be based on the behavior of individuals and their personal characteristics. The new conceptual framework of bike ability behavior was discovered in assisting and producing cycling behavior within neighborhoods.

Keywords: *Built Environment Factors; Cycling Behavior; Residential.*

Abstrak: *Bersepeda sebagai salah satu moda transportasi di perkotaan dan pemukiman telah ditetapkan sebagai solusi untuk permasalahan perkotaan. Ini adalah mode perjalanan yang aktif dan ramah lingkungan. Namun, hubungan antara lingkungan fisik binaan dan perilaku bersepeda antar pemukiman kurang terkait dengan peningkatan kemampuan sepeda penghuni. Faktor utama sebagai penyumbang utama perilaku kemampuan sepeda adalah lingkungan binaan dan faktor sosial. Aspek utama untuk menentukan interaksi antara semua faktor akan didasarkan pada perilaku individu dan karakteristik pribadinya. Kerangka konseptual baru dari perilaku kemampuan bersepeda ditemukan dalam membantu dan menghasilkan perilaku bersepeda di lingkungan sekitar.*

Kata Kunci: *Faktor Lingkungan Binaan; Perilaku Bersepeda; Perumahan.*

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INTRODUCTION

Cycling activity has been recognized and widely defined as an environmentally friendly and healthy benefit mode of transport. From on spot of places to another that can encompass distances long enough to efficiently cover many urban and suburban trips. Most of the uses for cycling activity will be implemented in residential and neighborhood area. Cycling with the advantages of society, economy, and environment, is starting to receive increasing attention as a sustainable transport mode by many countries worldwide (M. Peng Koh, Wong & Zhong, 2014). As listed by European Commission (2000), the main benefits of cycling include social benefits, positive ecological impacts, economic benefits, and political benefits. In order to profound the impact of cycling, most of the study realized and identify the major factors that affect individual's choice to choose cycling behavior. Some of the policies for cycling promotion are based on the identification of factors affecting bicycle use. Based on Wang, Chau, Ng & Leung (2015), they have been listed the factors influencing an individual's physical activity. The factors including social factors, personal factors, natural environmental factors and built environment factors. Among all the factors, the main contribution for behavior of cycling is built environment factors because it's becoming a basic and motivators for choosing physical activities.

Cycling also has been recognized a greater attention from residents from residential communities. First, cycling is suitable for all age of groups and not require special skills of major development. Secondly, it's allow people to choose their favourite route and suitable for longer trips. Thirdly, it allows a low-income people to remake their lifestyles in reducing sedentary and inactive life. (Brownson, Houseman, Brown, Jackson, King & Malone, 2015). Based on the development of urban areas, residential development and public area, cycling has been proven as an alternatives mode of transport with many benefits. It's an active, environmentally friendly mode of travel, that can encompass distances long enough to efficiently cover many urban and suburban trips (Anne Vernez et al., 2014). Cycling activities and non – motorized transportation also related to the significant impacts of physical activities and physiological health. It is an activity with more common as an exercise or recreational activity. Ane Vernez et al., (2005) mention about 15% of American Adults and 24% of Canadian adults report cycling at least once a week for recreation or exercise purpose. Instead of previous research showed that cycling can become a travel mode and a form of exercise and recreation is well organized, a comprehensive understanding of cycling behavior and its environmental correlates is lacking. This study will focus on the factors that related to cycling behavior among the residential neighborhood.

The Problem statements for this study listed below to conduct a comprehensive study of theoretical study and literature. There are 4 problem statements listed; First, the study and planning of cycling facilities is well organized by a group of local authorities and private sectors. But the lacking comes with a better understanding on a relation between physical condition and behavior. Most of the development of cycling facilities only focus on physical development such as route quality, traffic conditions, signalize, cycling lane design. The most important is to recognize the mix of a relation between physical factors and behavior. Secondly, the planning of cycling lane and design still lack on Level of Services. It's must be assessing cyclist safety based on routed related variables. Thirdly, there still lack people's decision factors to choose either to bike or not. The list of major factors that affect individual's choice to cycle still undeniable during developing and planning of cycling facilities. Fourthly the main contributing factors to enhance cycling behavior among residents is the social factor, personal factors, natural environmental factors and built environment factors. (Wang et al., 2015)

Research Objectives

To this study, the research objectives are to provide a comprehensive review to identify specific focus on planning and design of residential neighborhood by identifying the specific factors that can enhance the cycling behavior in the residential neighborhood. The focus among neighborhood is a good started for cycling culture because peoples on average time will spend the significant and relaxing hours their day at home. (Brasche & Bischof, 2005). The second objectives are to identify general and specific characteristics of physical built environment factors that can enhance the level of cycling. The third objectives are to identify the major environment barriers that hinder cycling activities. The last objectives are to develop a framework of physical built environment factors on cycling behavior.

RESEARCH METHODOLOGY

The research methodology has been separated and classifies by level of the stage. There is three stage in conducting the study. Stage one is focusing on establishing the literature review. The comprehensive literature review focusing on study related to cycling activity. Its also related to cycling behavior and types of people that cycling. The other review is to identify the determinant factors that enhance cycling activity. Stage two in this research is to develop a research methodological design. From the factors listed that influencing on cycling behavior, the main review on built environment factors has been developed. The findings from this

factors review were determined from the journal papers that embracing the study related to cycling activity and cycling behavior. The last stage is developing the conceptual framework on determinant factors. The main factors in enhancing the cycling behavior is built environment factors.

RESULTS AND DISCUSSION

Physical Built Environment Barrier

Within residential areas, current and standing of built environment factors also can be barriers to cycling activities within residential neighborhoods. The classification of barriers was based on the finding of Lee and Moudon (2004). The barriers listed are opportunity barriers, access and distance barriers, safety barriers and physical setting barriers. (Refer Figure 1)

Opportunity barriers

Based on Lee and Moudon (2004) they created these barriers as a result of lack appropriate main facilities for people to undertake cycling activities and it will be lower cycling activity levels. Lack of recreational facilities, numbers, location and bike lanes becoming the determinant factor for residents to produce a negative effect on physical activities. The opportunity for the resident to cycle will be facing a lack of diversity in destination within distance, and land use diversity. The density of resident among housing area by zone could produce negatives effect on cycling activities. People in dwelling residential area were found less active than people dwelling in the higher residential area. (Frank et al., 2005). Higher density residential were often more mixed and interconnected. It seems that the quantity and quality of development and planning of facilities among residential area will become an opportunity for residents to develop and involve in physical activity like cycling and walking.

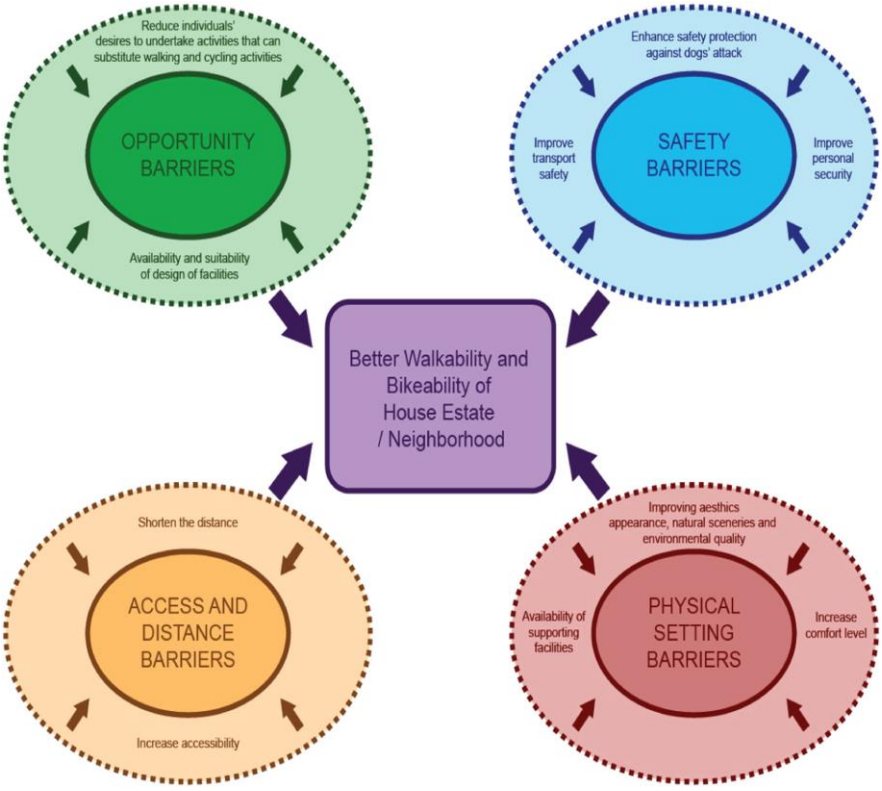

Figure. 1: Environment factors barriers to bikeable residential neighbourhood.*(Lee & Moudon 2014)*

Access and distance barriers

It's a physical and economic barriers created as a result of low accessibility to cycling facilities. The connection between accessibility and physical activity levels show a connection and direct relation. Low accessibility to recreational facilities will lower people's cycling activity levels, especially for low-income neighborhoods. The road design, road furniture and interconnection of the road might cause traffic jams form the major hindrances to physical activity. Distance barriers are the barriers created by the distance between the place used for cycling and individual resident's origin. Larger services radius will make a resident with a sense of distance and alienation to places. Facilities located in a large radial distance from their homes made people lose interest in visiting. Distance barriers becoming major hinders for residents to involve in cycling activity. The distance between places used for cycling activities and resident's house will affect the willingness to cycling. The suitable distance for cycling was around 5 – 10 km in a radius of the residential area.

Safety barriers

It created by fear of crime, traffic accidents or personal injuries in relation to the built environment. The direct relation between physical activity levels and safety barriers clear when the people perceive the environment to be insecure. Crime, traffic accidents are the important factors as an obstacle to undertaking the physical activity. Most of the resident in the residential area especially in high-density cluster will fear of traffic accidents and exposure to automobile and discourage them from doing physical activity level especially in cycling near the road. It depends on user needs groups especially for adults, teenagers, and children. Fear of traffic conditions, traffic volume, and vehicles on the road discouraged people from cycling. The category of fear among residents determined by the type of safety and barriers listed below in Table 1.

Table 1. Compilation of factor related with fear of cycling behaviour

Factors for cycling	Type of barriers	Authors
Violent crime	Important obstacles to undertaking cycling activity especially housing area with lower density.	Giles-Corti & Donovan, 2002a; Van Dyck et al., 2013
Security levels	High security levels within residential area develop a confident situation for residents	Addy et al., 2004
Fear of traffic conditions	Increasing of traffic vehicles and motorized discouraged people from cycling	Rank, Folke and Jespersen, 2001
Fear of injury	Concern about falling and injury lowered the physical activity level for youngster and elders	Bruce, Devine and Prince 2002

Source: (Lee & Moudon 2014)

Physical setting barriers

Feeling discomfort or unpleasantness and eventually become barriers for people to do physical activity when its lack of quality natural and built environment. The people's motivation to undertake cycling activities will be weakened by poor aesthetics appearance, poor environmental quality, improper built environment design or discomfort due to inclement weather condition. (Lee & Moudon 2014) Cycling activity also depends on cycling lane materials. Li, Fisher & Hammer (2015) named the material of road surface, types of material with the unsuitable condition will reduce the enjoyment of cycling. Most of the facilities in the residential area facing a maintenance problem without adequate repair and becoming a barrier

for people for doing physical activity. Another physical setting for enhancing cycling behavior is parking for a bicycle. It's related to resting area and point of stop for a cyclist. Although there was not enough persuasive evidence to reveal the associations between bicycle parking and physical activity levels, it can be considered as one of the factors that influence cycling activity level in neighborhood. (Pikora et al., 2002).

The Attributes Factor Of Cycling Behaviour

The attributes factors of cycling behavior has been determined by criteria in general built environment factors. All the criteria have been listed and compiled by previous research and literature.

General built environment factors.

General built environment factors becoming a list of major affection for the behavior of people to chose for cycling or not. Pucher, Peng, Mittal, Zhu and Korrattyswaroopam (2007) identified a list the affecting factors such as climate, transport policies land use pattern, transit services, cycling facilities and car availability. From previous research, there are a few general characteristics of physical built environment factors within residential neighborhoods that influence and affect the choices of cycling among residents. Table 2 below has been listed and summarizes the factors by different types of research finding. The factors becoming the list of attributes to enhance the level of cycling activities.

Table 2. Built environment factors attributes to enhance cycling behaviour

Factors	General Characteristics
Land use pattern	Its influence the mode of transport, the density of development and affect the public transport usage.
Availability and suitable of design facilities	The suitable design facilities for cycling affect the choice of cycling activity especially development of bicycle path
Opportunities	Opportunities factors that reducing individual to undertake activities that can substitute cycling
Distance	Shortening the distance
Accessibility	Increasing accessibility
Security	Improving personal security
Safety	Improving personal safety
	Improving transport safety
Injury reduction	Reducing fear of injury, accident and dog attack
Physical setting	Aesthetic appearance, sceneries and environmental quality
	Comfort level
	Supporting facilities

(Y. Wang, Chau, Ng, Leung, 2015)

Land use pattern and transport

It is a co–dependent and mutually influencing each other in a complex and dynamic way. Land use pattern influences the transport mode choices to a large extent (Meng et al., 2014). Density and mixture of land use can affect public transport usage. In the US, there is a huge dependency on the vehicle because of sprawling suburb land use pattern of the major metropolitan regions. But in European countries, there is a stronger urban planning and design controls to make it more compact and higher density urban form and hence increased use of public transport. Cervero and Duncan (2003) have found that urban landscape can generally affect walking and cycling. For example at San Francisco Bay.

Availability and suitability of design.

Planning for cycling and walkable path especially within the neighborhood is the most important factors that affect the levels of cycling activities. Bikeable paths, sidewalks and, cycling trails could increase and make a suitable determination for residents to cycling. All the provision facilities will increase the level of cycling activity. (Leslie and Cerin, 2008). Leslie has been mention that the cost for cycling path, not the main factor but even a low-cost cycling trail was found to be able to enhance the physical activity levels, especially on cycling. The design, suitable for facilities and condition also influences resident's motivation to undertake cycling activities. The cycling path and network lane must be connected and continue to induce more individuals to adopt cycling a regular physical exercise. Well organized, the maintenance aspect and well supervision for cycling path must be conducted and deliberate task by the local authority. Plain road configuration (King et al., 2005) could also increase the determination and encourage more cycling activities, especially for elders.

Individual Opportunities

Other than cycling and walking among residents in the neighborhood, there are others activities like running, playing sports related to field and courts like football and tennis. Adding trails and bike lanes within the scale of suitable distance for residents will increase the opportunities to involve in cycling. The small area of theneighborhood with the allocation of a nearest convenience store, restaurants, shops and public facilities may also support cycling. (Moudon et al., 2014). The suitable and effective nearest facilities also influence the residents' motivation to undertake walking and cycling facilities. Most of the residents will take a shortcut if they have been offered a choice of route and lane. People will choose more on cars than walking and cycling for traveling even for a short trip. (Lopez & Hynes, 2006). The most important to create an opportunity for choosing the cycling activities is completely plan and design the built environment in such a way to reduce the other opportunities to undertake that can substitute cycling activities.

Shortening the distance.

The multi planning and development of land use has been determined as a major representation for the resident to using facilities and space. The specific and within a distance of shop office, convenience store, fast foods, schools, mosque, and housing may also support cycling. The distance and space in land use area must be within radius of walking and cycling route. People who already have the intention of cycling will locate themselves in areas that offer substantial bicycle infrastructure and related land use within suitable distance. This type of infrastructure incentives people to cycle more. Gabriel & Ahmed (2015) has been determined that distance was a significant and important event on a small scale. It also indicates that access to services for bicycles (shop) should be considered at a relatively small scale because respondents find bicycle convenient and flexible only within a relatively small area. Distance factors also influence cycling activity levels despite their influences on transport cycling activities (Owen et al., 2007) Distance between house and trail, or open space did not have a significant association with leisure walking and cycling activities because of shorter distance less important as a consideration for people to walk and cycle. The other facilities and land use like a shopping mall, bus stations, and others within 400 – 1500 were associated with regular transport by cycling. Facilities or public spaces should be located near resident's home (15-minute walk and cycling) to be more visited. The geographical location and scenario also produce a positive and negatives effects. Increase in distance of neighborhood from urban development boundary will increase the levels of cycling and walking activity while increasing its distance from central business district reduced the levels of cycling and walking activity (Brown et al., 2014)

Increasing accessibility

The accessibility is one a major element in developing and planning facilities in the neighborhood area. Most of the idea in residential density will highlight on accessibility for a determined level of usage among residents. Increasing of accessibility of walking and cycling facilities will definitely increase the usage rate. (Y.Wang et al, 2015). Walking trails on the route of cycling could be easily reached by foot or bicycle were visited more frequently than those that could only be reached by cars. This approach to accessibility can enhance the walking and cycling activity level. Rimmer, Riley, Wang, Rauworth & Jurkowski, (2004), has been listed the criteria for facilities must be designed with fully accessible for both healthy people and people having an impairment to encouraged participation in physical activity. Cycling infrastructure, especially for development of cycling route and facilities, is one of the major important influencing the extent and quality of cycling levels. Asadi Shekari, Moeinaddini & Shah (2013) found that cyclist is sensitive and alert with a different kind of cycling route. Street connectivity in route design and lane has always been linked with better-planned intersections and pedestrian crosswalks. Patterns and criteria concepts for cycling lane related to types of road pattern for vehicles. Grid streets pattern, short block lengths, and few cul-de-sacs have been considered to be one of the important signs for a high access walkability and bike neighborhood (Saelens et al., 2008). A convenient road network system could increase the frequency of usage of bike facilities by residents and mostly can induce more frequent walking, cycling, and jogging activities. A highly connected jogging, route for cycling lane and walking pathway produced positive impacts on the physical activity levels of nearby residents.

Improving Safety Network

Safety and design for walking and cycling facilities have been listed as a general characteristic for built environment factors. The safety criteria divided into personal security, personal safety, transport safety and reducing of injury and accident. (Y.Wang et al., 2005). Personal security and safety have proven by earlier evidence that feelings of safety always produced positive effects on cycling activities in the neighborhood. The crime rates, the perception of crime situation also have a stronger impact than real crime on walking and cycling activities. (Mason & Kearns, 2012). From the traffic situation in the residential area, the traffic safety impacts have been increasingly concerned by people in order to develop on physical activity. Classification of road, density, and capacity of vehicles on road, mixed land uses and facilities along the road can control the traffic accidents. (Yu, 2014) Traffic volume capacity and conditions also could reduce the chances of people and cyclist from collisions with motor vehicles. The safety features also reflect the need to provide safe physical environments for people. Burden et al., (1999) combine the elements of safety: personal (presence of lighting and level of passive surveillance) and traffic (availability of crossings). The situation of safety among residential area also has been listed by T. Pikora et al, (2003). The safety preferences identify by crossing aids on the road design. The crossing facilities connected each other to make a path for cycling lane useful and reliable. The lighting elements in the spot area along the cycling lane will produce a safe situation and surveillance for a cyclist.

Physical setting

Ana B et al., (2014) has been finalized the physical setting by criteria into five categories. The criteria by physical element divided into the factors that influence the choice of routes for a cyclist. Table 3 below listed the factors by physical setting. The physical setting can be influenced by losing materials on roads or lane surfaces cause it can reduce the possibility for people to cycling. Another element in physical implementation is resting areas. It's become a major barrier by category of users. Facilities without maintenance might also become a barrier for people.

Table 3. Factors that influence the choice of routes for cyclist (physical setting)

Group	Factors
Characteristics of the roads	Width / Number of traffic lanes
	Type and condition of pavement
Characteristics of the traffic	Traffic volume and speed
	Sharing the road with motor vehicles
	Functional classification of the road
Characteristics of the environment	Perception of security
	Adjacent of land use
Characteristics of the trip	Length and duration
Characteristics of the route	Number of roundabouts, intersections
	Physical barriers

(Ana B. et al., 2014)

CONCEPTUAL FRAMEWORK

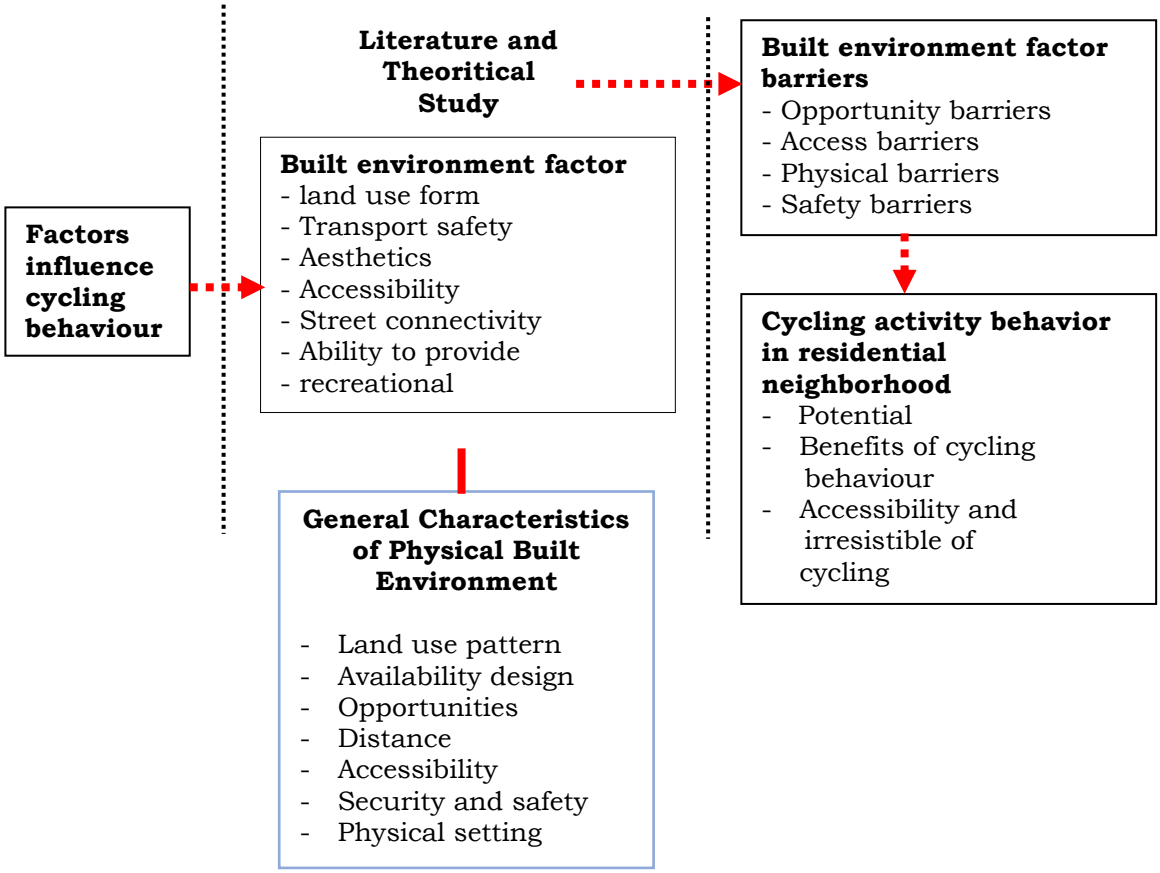

Figure 2: Schema of the built environment factors that influence cycling behavior in neighborhood

CONCLUSION

The study points to this research is to identify the built environment factors that influence cycling behavior in the residential neighborhood. The relative specific built environment factors apparently influence the determination of residents to choose cycling activity. The identification a list of factors can help overcome the barriers and create an environment with supportive facilities to cycling. Based on a previous research there are a few research gaps has been finding. Firstly, the previous study only focuses on physical factors but in order to enhance

the cycling behavior among residents. The relation between each factor must be correlated and interconnected. Example, the physical factors must be tested with a data from social factors. The data of socioeconomics for residents must be compared with physical factors. Secondly, the decisions for choose to cycle not only depends on physical development but also other factors like costs. The decision to develop a detail and holistic design of cycling facilities must be adequate within a knowledge on informing the most important and critical planning.

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