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Measures for Pedestrian Safety Management in Major Transport Corridors: The Case of Kinondoni in Dar es Salaam

Paulo Kitosi

Town Planner, Ministry of Lands, Housing and Human Settlement, Dodoma, Tanzania
Email: kitosisamweli@gmail.com, kitosisamweli@yahoo.com

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Abstract

In developing countries, pedestrians form a large group of road users in many urban centers. Every journey begins with a single step. This research aims to explore the pedestrian safety management measures in place within the Kinondoni Municipality and major transport corridors like the BRT corridors. The study on pedestrian safety management in Kinondoni applied triangulation techniques to ensure the validity and reliability of the collected data. Different methods of data collection were used to collect data and also different sources of data were used to get the data needed to answer the research questions. Both primary and secondary data collection methods were employed in the process of data collection. The results indicate that different measures have been applied such as Sidewalks, Pedestrian Zebra crossings, Segregated pedestrian routes, Pedestrian bridges, Traffic calming, Speed humps, Low-speed limits and Pedestrian barriers. The paper concludes that despite measures taken by authorities to enhance pedestrian safety along and within the BRT routes, there are still challenges that endanger the safety of pedestrians.

Subject Areas

Urban Design and Pedestrian Safety in Urban Built Environment

Keywords

Pedestrian Safety, Safety Management, BRT Corridor, Built Environments

1. Introduction

Road crash accident is a worldwide problem in the transport sector. Vulnerable road users have high-risk road accidents (Komol *et al.*, 2021) [1]. Road accidents

remain a global tragedy with an increasing trend and become the major cause of deaths, injuries, and disability. Tanzania is among the African countries facing high rates of deaths and injuries due to road accidents. In high-income nations, there is a decreasing trend for road accidents while in low-developing countries there is a raising trend of road accidents (Katopola & Mashili, 2022) [2]. Rapid urbanization in developing countries has led to an increase in traffic and regular traffic congestion (Mzee & Chen, 2012) [3]. Poor and unregulated public transport results in a lack of effective mobility options (Mzee & Chen, 2012) [3]. This has increased the number of people who are willing to walk as means of mobility.

Vulnerable road users include motorcyclists, pedestrians and pedal cyclists as they are prone to road accidents (Constant & Lagarde, 2010) [4]. More than 90 percent of road accidents deaths and injuries occur in low developing countries. Tanzania has incurred large human losses due to road accidents (Walugembe, 2020) [5]. From 2014 to 2018 about 6772 road injuries were reported. In Ilala municipality about 28 percent of all deaths were pedestrians (Walugembe, 2020) [5]. In Africa, drivers are the main players in road accidents while about one-third of accidents occur due to environmental and mechanical factors. Pedestrians and passages are at great risk of road accidents in Africa (Deme, 2019) [6].

In Europe, more than half of all road accident victims are vulnerable road users including pedestrians and the situation is yet to improve (Olszewski, Szagała, Rabczenko, & Zielińska, 2019) [7]. Children are among the most victims in road accidents with about sixty to seventh percent pedestrian injuries involving those with age of 10 years. Improper crossing by pedestrian is the reason for risking in fatalities (McComas, MacKay, & Pivik, 2004) [8]. Pedestrian exposure is therefore defined as the rate of pedestrian contact with potentially harmful situations involving moving vehicles (e.g., crossing an intersection). Pedestrian risk is defined as the probability that a pedestrian-vehicle collision will occur, based on the rate of exposure (Raford & Ragland, 2004) [9]. Vehicle and pedestrian accidents always result in fatalities to pedestrians, and this calls for improving technology in protecting pedestrians who are venerable (Olszewski, Szagała, Rabczenko, & Zielińska, 2019) [7].

Traffic management is the term used to describe a wide range of technical practices undertaken to manage traffic across networks, which includes prioritization and slowing down (Priya, Shankar, Prasad, & Reddy, 2013) [10]. Literature indicates that factors such as road width, land use type, the absence of designated bus stop facility, inadequate sight distance, average daily traffic and pedestrian volume, and pedestrian-vehicular interaction considerably affect pedestrian safety at the intersections (Mukherjee & Mitra, 2019) [11]. On the other hand, road width, land use type, inadequate sight distance, and the absence of designated bus stop facilities significantly influence pedestrian safety at midblock road segments (Mukherjee & Mitra, 2019) [11]. The design and imple-

mentation of effective actions and measures to encourage the use of sustainable travel modes in urban areas require the identification of factors that influence the decision to walk and cycle (Arroyo, Mars, & Ruiz, 2018) [12].

A lesser speed limit is likely to decline the likelihood of severe injuries in pedestrian accidents (Lin, Guo, Jelinska, Kourtellis, & Zhang, 2019) [13]. The presence of a traffic control device (signal, "Stop" sign, "Yield" sign, school zone device, flashing signal, etc.) is likely to decrease the probability of higher injury severity in pedestrian crashes (Lin, Guo, Jelinska, Kourtellis, & Zhang, 2019) [13]. To enhance pedestrian safety, there is a need to improve the pedestrian facilities at signalized intersections (Marisamynathan & Vedagiri, 2018) [14]. Factors such as darkness, vehicle movement, whether an accident occurred at an intersection, vehicle type, and land use mix affected the severity of pedestrian injuries from collisions Exposure is defined as the rate of contact with a potentially harmful agent or event (Raford & Ragland, 2004) [9].

In South Africa, different engineering solution have been adopted to enhance the safety of pedestrians in urban areas these includes integration of pedestrians with other motorized traffic by traffic lights, zebra crossing and school patrol areas, also the separation of pedestrian from other traffic like horizontal separations and vertical separations with the use of pedestrian bridges and subways (Ribbens, 1996) [15]. Changes in the built environment through design can help to create a less-risk urban environment in urban areas through separating motorized and non-motorized traffic on urban roads. Elements such as sidewalks and refuge islands aim to protect and increase the safety of pedestrians (Constant & Lagarde, 2010) [4]. The experience shows that there is low use of pedestrian bridges with most male pedestrians less preferred to use it. Pedestrians may have a high perception of risk in not using the overpass bridge but it's less likely to influence the use of overpass. (Mutto, Kobusingye, & Lett, 2002) [16].

There is a need to implement the existing policies and improve enforcement of road safety always in order to increase safety in road infrastructures (Walugembe, 2020) [5]. Crossing of pedestrians on BRT lanes when approaching the stations is the main cause of road accidents along the BRT corridor (Kazaura, 2021) [17]. BRT corridor is among the accident spot zone involving pedestrians in the City of Dar es Salam (Kazaura, 2021) [17]. The government authorities made initiatives to address road accidents including the use of traffic signs, awareness creation, and promotion of rules and laws (Kazaura, 2021) [17]. A major challenge facing planners, transportation engineers, and pedestrian-safety advocates is the lack of detailed, high-quality pedestrian exposure data (Raford & Ragland, 2004) [9].

The road network in an urban built environment must ensure the safety of pedestrians although this is not the case in most urban roads (Stoker, Castro, & Ewing, 2015) [18]. The road is a built environment that should enhance safety and security for pedestrians, but this ideal is not always the case. Literature

shows that the design of the roadway and the development of different land uses can either increase or reduce pedestrian road traffic injury. Planners need to design or modify the built environment to minimize risk for pedestrians. The main focus of this study was to explore the measures in place for pedestrian safety management in Kinondoni Municipality especially in major roads and transport corridors like BRT.

2. Methodology

The study on pedestrian safety management in Kinondoni applied triangulation techniques to ensure the validity and reliability of the collected data. Different methods of data collection were used to collect data and also different sources of data were used to get the data needed to answer the research questions. Both primary and secondary data collection methods were employed in the process of data collection. The project is built around an in-depth analysis of a set of major roads including the BRT corridor in the urbanized portion of Dar es Salam. Data analysis was done and the presentation of data in terms of tables, charts, photos was done.

3. Presentation and Discussion of Results

3.1. Pedestrian Safety Management Measures along the BRT Corridor

Data analysis indicated that there are different initiatives and measures that have been taken to improve safety for non-motorized traffic including the pedestrian. That included the design of the BRT corridor with the consideration of pedestrian needs. Pedestrians and cyclists are among the most vulnerable road users and in some countries, they constitute over half of all road deaths. Through physical observations, the following are the measures used to manage the safety of the pedestrian in Kinondoni municipal. See **Table 1** below with different measures for the management of pedestrian road safety in urban areas.

Traffic police departments in cooperation with different stakeholders such as LATRA, TANROA, DART, TARURA, Municipal council, Associations for drivers, drivers and others have established different measures to enhance pedestrian safety as shown in **Table 1**.

Provision of pedestrian overpass bridges

The built environment of Kinondoni consists of some pedestrian infrastructures such as walkways, bollards, and pedestrian overpasses which have been built to increase road safety for pedestrians in urban areas. Currently, there are four major pedestrian cross bridges out of which three have been constructed by the city Bus Rapid Transport (BRT) arrangement, along Morogoro and Kawawa Road corridors. In Dar es Salaam city, more initiative to invest in pedestrian infrastructures, particularly the pedestrian overpass. There is no clear information on the perception of pedestrians on the use of pedestrian bridges (Katopola & Mashili, 2022) [2].

Table 1. The existing pedestrian safety management in Kinondoni.

Safety Management	Function	Level of Provision in Kinondoni
1) Sidewalks	Used by a pedestrian walking along the roads.	Currently, in Kinondoni only main roads consist of pedestrian walkways including Morogoro, Bagamoyo, Kawawa, and Sam Nujoma roads, but sidewalks are not provided in neighborhood roads.
2) Pedestrian Zebra crossings	These include all zebra crossings on roads.	Zebra crossings have been provided in most roads but in some pedestrian-busy areas they are lacking or the road markings have disappeared.
3) Segregated pedestrian routes	Special routes used only by pedestrians, and no vehicles.	Segregated pedestrian routes available in few roads near or within the CBD area.
4) Pedestrian bridges	Pedestrian crossing bridges or pedestrian overpasses like in Ubungo Manzese, Kimara, and Morocco	All pedestrian crossing bridges have been located in major roads, at Ubungo, Kimara, Manzese and Morocco.
5) Traffic calming	Measures to reduce the speed cars on the road	Traffic calming measures have also been applied near pedestrian crossings to increase safety for pedestrians.
6) Speed humps	Used to reduce the speed of cars, especially in pedestrian-busy areas and when approaching zebra crossings.	Speed humps have been provided in almost all types of roads but still some parts have no speed humps.
7) Low-speed limits	Reduce the speed for car drivers especially in pedestrian-dominated areas.	Through the use of traffic signs, humps, and regular traffic police presence to limit the speed of car drivers.
8) Pedestrian barriers	Separating between pedestrians and other road users Direct pedestrians and discourage them from using non-pedestrian ways.	Presence of pedestrian barriers such as bollards and fencing to protect pedestrians.

Source: Field data, 2016.

The location of pedestrian overpasses considered the number of pedestrians in those areas although the utilization and effectiveness of such pedestrian bridges are still in question as many people still do not use the bridges. Experience from the older pedestrian cross bridge at Manzense shows that only 37 percent of pedestrians interviewed support the use of pedestrian bridges, while 54 percent of interviewed pedestrians do not use these bridges. Only 9 percent of interviewed pedestrians were comfortable to cross the road anywhere (See Figure 1). Pedestrians who reported they were not using the bridge to cross the road at Manzese claimed that it was taking them longer to cross the road by using the pedestrian bridge than to just cross the road without using the cross bridge. Also, older pedestrians complained that it was difficult for them to use the cross bridge because they had to go up a long stairway and this was cumbersome considering their age. One of the solutions for pedestrian safety in Tanzania was to construct

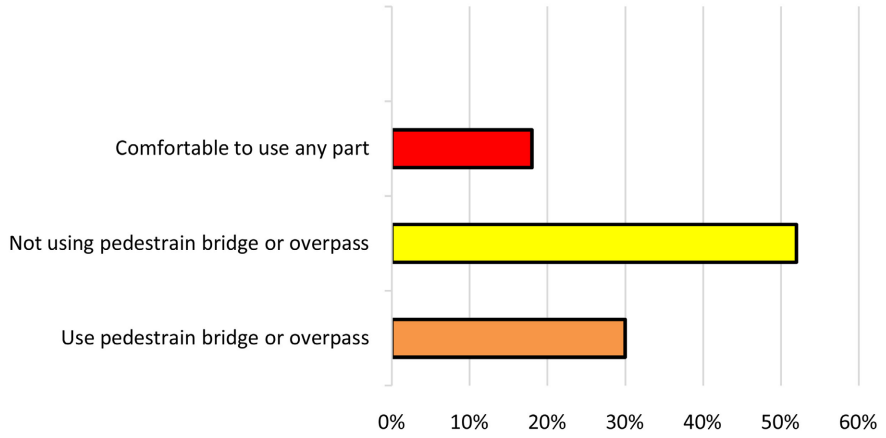

Figure 1. Pedestrian view on use of pedestrian's overpass bridges—Manzese. Source: Field Data, 2016.

pedestrian bridges (Katopola & Mashili, 2022) [2]. The constructed pedestrian bridges didn't stop pedestrians from crossing traffic lanes (Katopola & Mashili, 2022) [2]. Many pedestrians prefer to look for the alternative crossing instead of pedestrian bridges. (Katopola & Mashili, 2022) [2].

Provision of pedestrian walkways through traffic segregation on roads

Another pedestrian safety management measure adopted in Kinondoni is the creation of pedestrian walkways along the Morogoro Road highway, in order to separate pedestrian walkways from the rest of the traffic. See (**Plate 1**) indicating traffic segregations between pedestrians and motorized traffic. Although many parts of urban areas lack pedestrian walkways especially in internal roads and other major roads which are still in a traffic-mix situation, segregated pedestrian walkways increase the chances for pedestrian safety on urban road.

The study uncovered that not all road networks in Kinondoni have been provided with pedestrian walkways which portray the risk of road accidents for pedestrian due to mixed traffic. Pieces of literature indicate that factors such as road width, land use type, the absence of designated bus stop facility, inadequate sight distance, average daily traffic and pedestrian volume, and pedestrian-vehicular interaction considerably affect pedestrian safety at the intersections (Mukherjee & Mitra, 2019) [11]. The lack of pedestrian walkways in urban roads in Kinondoni pose a threat to pedestrian and increases the risk of accidents.

Provision of signalized intersections for traffic safety management

To enhance pedestrian safety, there is a need to improve pedestrian facilities at signalized intersections (Marisamynathan & Vedagiri, 2018) [14]. Road junctions are some of the spot areas where accidents occur frequently, including road accidents that involve pedestrians. Kinondoni consists of a number of major junctions at which the average daily traffic flow is high. These major road junctions include Mwenge Junction, Shekilango Junction, Bamaga Junction, Morocco Junction, Tiptop Junction, Mwembechai Junction, Mazense Junction, and other small junctions which are also characterized by a large number of pedestrian


Plate 1. The newly pedestrian sidewalks along the BRT corridor in Kinondoni. Source: Field data, 2016.

traffic, especially during morning and evening hours. Planners need to design or modify the built environment to minimize risk for pedestrians (Stoker *et al.*, 2015) [18]. Traffic management at these major road junctions is done with the use of traffic lights and with the aid of Traffic Police officers. Despite the presence of Traffic Police and traffic lights in this junction, the interest of pedestrians is always at stake as they are given low priority when crossing the roads. This increases the risk of pedestrians being involved in accidents and reduces their safety. When interviewing a Traffic Police officer, he said that "violation of car drivers and pedestrians themselves of traffic light warnings always result to pedestrians being killed or seriously injured in case of an accident." The provision of signalized intersections is used as a measure to address traffic conflict including pedestrians. The lack of traffic lights in some road junctions creates an unsafe crossing environment for pedestrians in Kinondoni.

Legal enforcement to enhance pedestrian safety

Another approach used by the Traffic Police Department to ensure pedestrians' road safety is to ensure that the existing laws, by-laws and other regulations on the road are well followed by all road users, including pedestrians and car drivers. There is a need to implement the existing policies and improve enforcement of road safety always in order to increase safety in road infrastructures (Walugembe, 2020) [5]. To ensure pedestrian safety, the department checks on road users who violate road regulations and punishes them according to the law. Different by-laws and regulations have been prepared in order to ensure that the built environment is safer for pedestrians and other road users.

Provision of road safety education to road users

An interview with traffic police officers indicated that one of the approaches used in pedestrian safety management in Kinondoni is the provision of safety education through various means, in order to create awareness to different road users on road safety. The government authorities made initiatives to address

road accidents including use of traffic signs, awareness creations and promotion of rules and laws (Kazaura, 2021) [17]. Education to both pedestrians and drivers of motor vehicles is provided to ensure that pedestrians recognize the safety issues on road and vehicle drivers recognize the right of pedestrians on the road. It has been noticed that motorcyclists utilize pedestrian walkways which increases the risk of pedestrians being involved in road accidents. Also, car drivers and motorcycles violate zebra crossings, as it has been revealed by road accident statistics.

3.2. Challenges in Managing Pedestrian Safety in Kinondoni

The management of the pedestrian road safety process is faced with several challenges including low awareness on road safety education, encroachment of pedestrian ways, violation of zebra crossing by car drivers, non-adherence to traffic signals and symbols, non-use of pedestrian overpass, non-use of pedestrian zebra crossing, lack of a pedestrian guide to children, and poor maintenance of pedestrian walkways. While interviewing pedestrians, car drivers, traffic police, town planners, and field observation a number of challenges facing pedestrians in urban roads were mentioned and discussed below.

Encroachment of pedestrian walkways

One of the major challenges facing pedestrians in the urban built environment is the existing and growing informal trade activities along road reserves including many major road junctions in Dar es Salaam City. Petty trade and other informal activities along the road reserves occupy pedestrian walkways, which discourages the movement of pedestrians. This forces the pedestrians to move onto the carriageways. According to an interview with Traffic Police, it was claimed that most of the road accidents occurred due obstruction, including poor visibility caused by informal trade activities on road reserves.

With increasing informal trade activities on road reserves, pedestrians are unable to see the incoming vehicles especially when they want to cross the road, and car drivers similarly cannot see pedestrians intending to cross the road. This way, pedestrians are at risk of being killed or injured. Plate 2 shows informal traders or petty traders occupying spaces that have been designed for the pedestrian which may force pedestrians to take a risky decision to walk on the carriageway for moto vehicles.

On-street parking obscuring pedestrians

On-street parking in most of the urban roads in Kinondoni occupies pedestrian spaces such as pedestrian walkways, which forces the pedestrians to walk onto the carriageway, as their space becomes occupied by cars. The ongoing parking of vehicles on pedestrian ways increases the risk of pedestrians being engaged in the road accidents. Again, on-street parking reduces visibility of pedestrians on incoming vehicles. On-street parking also obscures the pedestrian to see the incoming vehicle and also it obscure the car driver to see a pedestrian who are intending to cross the roads.

Plate 2. Informal trade activities on pedestrian walkways. Source: Field data, 2016.

Lack of enough zebra crossing points

Zebra crossings are very important for pedestrians crossing the road in urban areas with heavy traffic. Many areas in Kinondoni which have a large number of pedestrians have very few or no zebra crossings. Field observation and interviews with pedestrians and Traffic Police showed that most of the roads are not marked with pedestrian zebra crossings; this has only been done for major roads (highways). This increases the risk of pedestrians being involved in road accidents. Also, 55 percent of interviewed pedestrians raised the issue of motor vehicle drivers who do not respect pedestrian zebra crossing, which endangers the safety of pedestrians. The lack of zebra crossing allows pedestrians to take risks to cross in unsafe areas, which exposes them to road accidents.

Poor lighting and lack of street lighting systems

The research findings show that street lights are only provided on major roads and no lighting system is available on small neighborhood roads. About 30 percent of pedestrians admitted that the lack of street lighting is a challenge to pedestrians and that it has increased the risk of pedestrians who are using the existing road network in Kinondoni. In some highway networks, there is street lighting but other highways have no street lighting; this increases insecurity for pedestrians on urban roads. The lack of street lighting systems discourages walking at night and increases the level of insecurity to pedestrians at night. Also, respondents reported that most of the neighborhood streets do not have enough street lighting systems as in the main roads, and that this attracts crime. Fifteen percent of pedestrians raised the issue of theft and robbery, as a direct result of lack of adequate street lighting.

Lack of pedestrian walkways alongside the roads

Not all roads in Kinondoni contain pedestrian walkways. A safer walk needs to be supported by some pedestrian facilities like resting facilities, street benches bus stand shelters ,and other facilities that are needed by the walking pedestrian in urban roads. Pedestrian need to have some convenience infrastructures for

accessibility in urban road slack theses pedestrian-supportive facilities discourage walking and increase discomfort for the pedestrians.

Lack of pedestrian traffic symbols and signs on roads

The safety of the pedestrian on urban roads depends on the existing traffic symbols and signs to warn other road users such as car drivers, motorcyclists and other road users about the existence of pedestrians and pedestrian facilities. Data analysis indicated that 65 percent of pedestrians believe that there are too few pedestrian traffic signs and symbols to enhance pedestrian safety on the road, while 10 percent believe that such signs and symbols are enough. The lack of traffic signs to guide or control the speed of motor vehicles when approaching pedestrian zones is a challenge that can be witnessed in both major and neighborhood roads in Dar es Salaam City.

Absence pedestrian traffic wardens to guide children crossing the roads

The management of pedestrian safety for child pedestrians, like school children in Kinondoni, was also a serious safety issue that was raised during interviews with pedestrians. The research findings indicate that there is little concern by society and other responsible authorities on the need to guide the child pedestrian across the road; this is especially for school children who are still too young to make the right decision on when, how, and where to cross the road. Interviewing school children, it was revealed that most of them had never been given road safety education for their safe crossing of urban roads; similarly, child pedestrians have an insufficient understanding of the existing traffic laws and regulations on urban roads. The research findings indicate that there is a good proportion of the urban child population which is involved in pedestrian road accidents. The study in South Africa discovered that, Children are among the most victims in road accidents with about sixty to seventy percent of pedestrian injuries involving those under the age of 10 years. Improper crossing by pedestrians is the reason for risking in fatalities (McComas, MacKay, & Pivik, 2004) [8].

Lack of facilities for disabled pedestrians

Kinondoni, the research findings indicate that even the few existing pedestrian facilities and walkways have little consideration for the access and safety of the disabled pedestrians. About 55 percent of interviewed pedestrians showed their concern that pedestrian infrastructures for people with disabilities have been ignored except in a few major roads like Morogoro Road. Other roads in Kinondoni do not have pedestrian facilities for the disabled. The disabled pedestrian group forms a minority population but it is a group faced by safety challenges on the road. Little has been done to accommodate disabled pedestrians in the existing urban roads.

Low level of pedestrian road safety education

Interviewing pedestrians and Traffic Police from different parts of Kinondoni, the research findings indicate that about 35% of pedestrians had only heard about safety education but they had never been given such education; about 5% had heard and attended education on safety; and 65% of all respondents admitted

Plate 3. Violation of traffic light directive by careless pedestrian crossing illegally on roads. Source: Field data, 2016.

that they had never heard nor attended safety education. This implies that lack of safety education to different road users including pedestrians has increased the chances of road accidents to road users in urban built environments. Lack of safety education increases the risk of the pedestrian to be involved in road accidents. For example, some of the pedestrians do not understand what various road markings and signs mean, to guide them while using the roads. During an interview with student pedestrians, it was revealed that most of the students do not know about safety education although they are the dominant users of road by walking; about 20% heard and attended road safety education, while the rest (80%) had not attended road safety education.

Non-adherence to laws and regulations by pedestrians and other road user's

One of the ways to manage pedestrian safety is to ensure that the existing laws and regulations are properly followed. In the process of data collection and analysis, it was revealed that despite the existing laws and regulations, there is still violation of such laws and regulations by road users. (Plate 3)

The institution responsible for road transport, Traffic Police, and TANROADS has prepared a set of laws and regulations to ensure the efficient use of roads and to improve road safety for all road users; but road users including pedestrians, motorcyclists, motor vehicles and others do not follow these regulations.

4. Conclusion

Generally, the state of pedestrian road safety is still poor as the rate of pedestrian-related accidents on urban roads is still high. The existing road infrastructure has been designed primarily to accommodate motor vehicles. Little effort has been done to reduce the state of pedestrian road accidents in urban built environments, with the existing facilities inadequate to accommodate the increasing number of pedestrian accidents in the urban area of Kinondoni. The existing plans and design of the built environments expose pedestrians to road

accidents. Similarly, road users have a low level of understanding of the regulations and laws governing the operations on the road.

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Conflicts of Interest

The author declares that there is no conflict of interest.

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