International Journal of Electrical, Energy and Power System Engineering (IJEEPSE)
e-ISSN: 2654-4644
Vol. 3, No. 3, pp. 94-99, October 2020
ijeepse.ejournal.unri.ac.id

Performance Analysis of DSR and TORA Model Routing Protocols In Vehicular Ad Hoc Network

Linna Oktaviana Sari*
Electrical Engineering Dept
Universitas Riau
Pekanbaru, Indonesia
linnaoasari@lecturer.unri.ac.id

Agusrio Azmi
Electrical Engineering Dept
Universitas Riau
Pekanbaru, Indonesia
rioazmi28@gmail.com

Ery Safrianty
Electrical Engineering Dept
Universitas Riau
Pekanbaru, Indonesia
Esafrianti@eng.unri.ac.id

Feranita Jalil
Electrical Engineering Dept
Universitas Riau
Pekanbaru, Indonesia
feranita@lecturer.unri.ac.id

**corresponding author: Linna Oktaviana Sari, linnaoasari@lecturer.unri.ac.id*

***Abstract*— Pekanbaru city is a large area, therefore traffic congestion often occurs due to the density of society's vehicles. From this problem, it is needed a technology that can exchange information between vehicles. Information Technology that can involve many vehicles with special network types without dependence on infrastructure is Ad Hoc Network. One type of network is Vehicular Ad Hoc Network (VANET). VANET is a new concept in enabling communication between Vehicle to Vehicle (V2V). For efficient data packet delivery, VANET requires a routing protocol. In this research, for simulated and analyzed performance is used the Dynamic Source Routing (DSR) and Temporally Ordered Routing Algorithm (TORA) protocol. NS-2 is used to simulated a moved node, SUMO software is used to a simulated real map of SKA Mall crossroads and parameter the quality of performance routing protocol DSR can determine by End to End Delay, Packet Delivery Ratio (PDR) and Routing Overhead (RO). This simulation uses scenario 100 nodes, 150 nodes, 200 nodes, and 250 nodes. The simulation results with the scenario of changing the number of nodes, the DSR routing protocol produces better performance with an average of end to End Delay is 0.1066s, the average of PDR is 95.45% and the average of RO is 1.0076. While the TORA routing protocol has an average of End to End Delay is 0.1163 s, the average of PDR is 93.49% and the average of RO is 1.0801. And in the scenario of node speed changes, the TORA routing protocol produces better performance with an average of End to End Delay is 0.0861 s and an average of PDR 97.37%. While the DSR routing protocol is better with an average of RO is 1.0076.**

***Keywords*— DSR, routing, TORA, VANET**

I. Introduction

Traffic congestion is a daily phenomenon in Pekanbaru City, which is caused by the abundant personal vehicle used by the people. Another cause of congestion is some events or activities that often take place in the city also worsen the situation and makes certain roads are more crowded and inaccessible for others.

Previous research findings related to the Vehicular Ad Hoc Network have been widely used and developed before. In 2013, [1] has done test the performance of the routing protocol B.A.T.M.A.N-Adv in a wireless Mesh-based network. Then in 2014, [2] have done analysis GSR and TORA routing protocols from node density. In [3] they have compared the performance of the DSDV and OLSR routing protocol for changing node speed in the IEEE 802.11ah standard. In [4] they have analyzed the performance of Gytar and GPRS based routing protocols. In 2016, [5] they have upgraded the MAODV routing protocol with the selection of rebroadcast nodes on VANETS. In [6] ,they have compared the performance of the AODV routing protocol and DSR with the Hybrid GRP routing protocol under IEEE 802.11g MANET. Then in [7], they have implemented the AODV routing protocol on VANET with SUMO and Vanet Mobisim using NS-2. In 2017, [8] they have compared the performance of the TORA and AOMDV Routing Protocols on MANET. In [9] they have compared studio details of AODV, DSDV, DSR, TORA, and OLSR routing protocols on the Ad Hoc Network. In 2016, [10] has done compared the performance of the DYMO routing protocol to the AODV routing protocol on the VANET network. In [11] they have analyzed secure-AODV on VANET against Denial of Service (DoS) attacks. Then in 2016, [12] they have compared OLSR and AOMDV routing protocol performance on the VANET network. VANET itself is a new concept that allows Vehicle to Vehicle communication (V2V) and Vehicle to Roadside communication. Communication done through VANET will be used to provides information to applications related to transportation for example for safety, entertainment, and for the comfort of drivers. VANET builds its *Ad Hoc network* between vehicles by using high *node* movement dynamics that needs the implementation of *routing* protocol that fits its characteristics. The topology-based routing protocol is one of the categories of VANET protocol routing.

Based on the background mentioned above, this thesis will be discussing a model that the writer has built - which is the model of VANET network applying DSR and TORA protocol routing that is reactively simulated by using *Network Simulator* 2 (NS-2). In choosing the routing protocol, the writer has compared both protocols and the writer believes that the most efficient and giving the most maximum performance is with the urban scenario around the intersection of SKA Shopping Mall (jalan Tuanku Tambusai - jalan Soekarno Hatta) in Pekanbaru city. Next, the scenario that will be used is a real scenario with changes in the amount of *node* and its speed. Three performances will be compared out of these parameters, which are *end to end delay*, *packet delivery ratio*, and *packet routing overhead*.

Received: Augt 21, 2020 | Revised: Sept 30, 2020 | Accepted: Oct 13, 2020

II. LITERATURE REVIEW

A. *Dynamic Source Routing*

Dynamic Source Routing (DSR) is a reactive protocol routing that is based on the source routing concept. This protocol was initially designed to be implemented in the mobile network, but it has been upgraded so it can be used optimally in the VANET environment. DSR has few different characteristics, which are having the possibility to self-organize and self-configure, as well as not using a periodic message routing so it reduces the overhead bandwidth network [13].

The advantage of the use of DSR is the intermediate node does not have to control up-to-date about the routing information when it passes the package, because each package is always filled with routing information within its header. Comparing it with another on-demand routing, DSR has the best performance in terms of its throughput, routing overhead (within the package), and the average of pat length. However, DSR also has a bad time delay in the process of finding a new route. While the disadvantage of this routing is the route maintenance mechanism is unable to self-repair the broken or downlink.

The use of this routing will be very optimal on scenarios where there is only a little number of the node used or less than 200 nodes. For a bigger number of the node used, it will create a collision between the package and add more time delay on the time where it will build a new connection.

B. *Temporally Ordered Routing Algorithm*

Temporally Ordered Routing Algorithm (TORA) is an adaptive protocol that depends to link reversal to produce a dynamic routing network algorithm and wireless multihop network. This will maintain the next destination to relay packages by finding more than one route to the destination node [14]. The advantage and main uniqueness of TORA are that TORA provides multiple routes from the source node to the destination node, so the change of topology network does not heavily affect TORA. TORA will react when all routes to the destination node are not available. Multiple routes will be achieved by using a control message that is localized in a group of the node where the node only keeps the information of the routing around it (one-hops). Another advantage of multiple routes is that when topology changes, the route discovery process is not needed in the situation where the route is down in sending the data. The TORA routing algorithm is temporal that is based on a link reversal algorithm. TORA is supposed to be able to reduce control messages in a dynamic Ad Hoc network, unlike DSR. In TORA, the node should often send request messages in transferring some data to the source destination, because the shortest found route is not the main priority of this protocol. Thus, the old route will cause some delay or even the loss of data [15].

III. METHODOLOGY

A number of vehicles are connected to each other through *an Ad Hoc* channel that forms a wireless network called *Vehicular Ad Hoc Network* (VANET). In VANET, the movement of *the node* depends on the *Ad Hoc routing protocol* to decide how to send a message from the sender *node* to the receiving *node.*

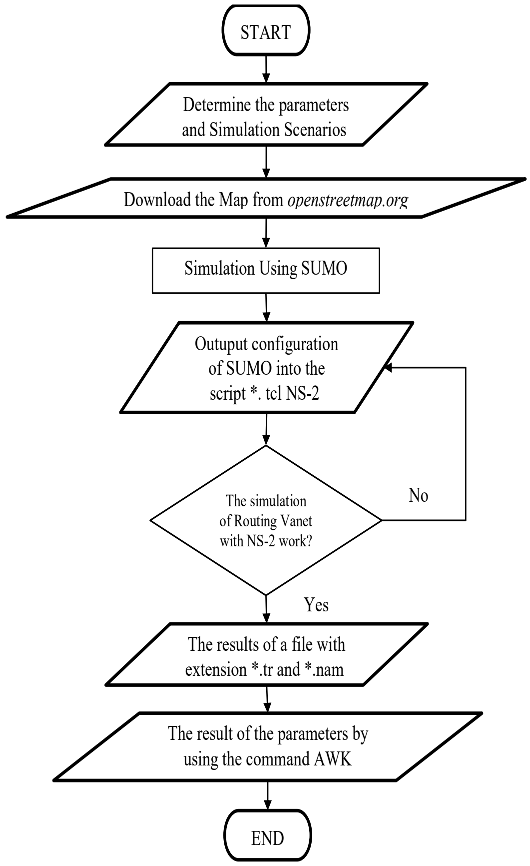

Fig 1. Flowchart design simulation

TABLE I. SIMULATION PARAMETER

No.	Parameter	Specification
1	Network Simulator	NS-2.35
2	Routing Protocol	DSR, TORA
3	Simulation Time	300 seconds
4	Packet Size	512 Bytes
5	Number of Node	100, 150, 200, 250
6	The Speed of Node	10, 15
7	Simulation Area	7729 m x 7889 m
8	Type of Antenna	Omni-Antenna
9	Propagation Model	Two-ray Ground
10	Data Type	ACK, FTP, RTP
11	Channel Type	*Wireless Channel*

Received: Augt 21, 2020 | Revised: Sept 30, 2020 | Accepted: Oct 13, 2020

Ad Hoc routing protocol itself can be classified into two categories, which are topology-based routing and position-based routing. This research is using the routing protocol reactive DSR and TORA. In Figure 1, it can be seen that the design process begins by determining the parameters and simulation scenarios as shown in Table 1. After that, the map as a research area is downloaded. Then simulate it using the SUMO application.

IV. Result

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

A. Result and Performance Analysis of Routing Protocol on Changes in Numbers of Nodes

The Routing protocol performance on changes in the number of nodes compared to QoS parameters, namely packet delivery ratio, routing overhead and end to end delay.

The data of End to end delay value shown in Table 2 are based on the average value of five times data retrieval which can be seen in the attachment. The results of an end to end delay performance for urban scenarios for change the number of nodes can be seen in Table 2.

TABLE II. Delay Result for Change Numbers of Nodes

Number of Node	Delay Value (s)	
	DSR	TORA
100	0.0627	0.0501
150	0.0911	0.0827
200	0.1001	0.2467
250	0.1727	0.0860

In Table 2, The delay results are seen from changes in the number of DSR and TORA routing protocol nodes. Clearly, the Delay results diagram can be seen in Figure 2. Based on Figure 2, the end to end delay value for the DSR routing protocol is higher when there are more nodes. This is by the theory that exists in the characteristics of the DSR routing protocol, which says that large numbers of nodes will cause collisions between packets which cause increased time delay when establishing a connection. Whereas in the TORA routing protocol there is a high delay on the number of nodes 200 of 0.2467s, and then in the number of nodes 250 the delay returns down with a value of 0.0860s, which corresponds to the number of nodes. This happens in the simulation scenario used. In theory, the higher the number of nodes, the higher the delay generated because the queue time and processing time increase. DSR has a better delay average which is shown by the results of the overall delay on nodes 100, 150, 200, and 250 which are smaller which are 0.1066s while TORA has an average delay of 0.1163s. This can happen because the intermediate node on the DSR does not need to maintain up to date routing information. After all, each packet always contains routing information in its header. Whereas at TORA, the node must send a request message frequently when sending some data from the destination source node, so that this causes an increase in time delay.

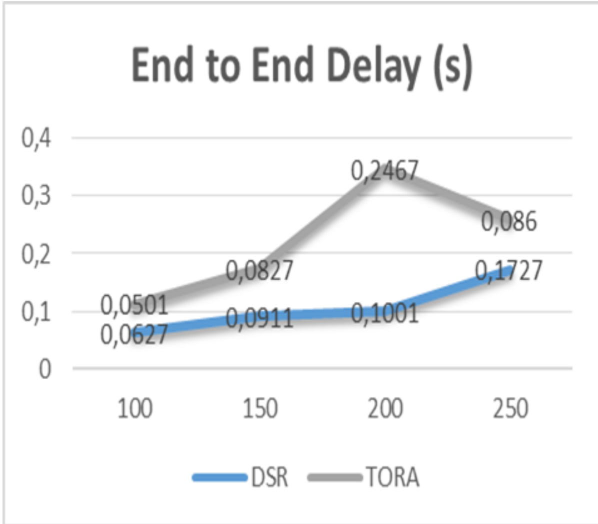

Fig 2. The Effect of number of nodes on delay in urban scenario

The data of packet delivery ratio value shown in Table 3 is based on the average value of five times data retrieval which can be seen in the attachment. The results of the packet delivery ratio performance for urban scenarios change the number of nodes can be seen in Table 3.

TABLE III. PDR Results for Change the Number of Nodes

Number of Nodes	PDR Value (%)	
	DSR	TORA
100	86.59	91.44
150	97.40	98.62
200	98.92	84.60
250	98.91	99.27

In Table 3, The PDR results can be seen from changes in the number of DSR and TORA routing protocol nodes. Clearly, the PDR results diagram can be seen in Figure 3. From figure 3, it is seen that the DSR routing protocol has a better PDR value by showing the average increase in PDR results in each number of nodes, compared to the TORA routing protocol which decreases the PDR value at number 200, then at the number of 250 250 PDR values rise back. This can occur because of TORA on packet forwarding by finding more than one route to the destination node which is done in 3 steps, namely route creation, route maintenance and route deletion. And also, because the condition of the area on the map causes a decrease in PDR performance. The higher the PDR value given by the routing protocol the higher the success rate of the routing protocol in finding or finding paths

Received: Augt 21, 2020 | Revised: Sept 30, 2020 | Accepted: Oct 13, 2020

and maintaining the path. Because the greater number of nodes, the distance between nodes is getting closer. Overall, these two routing protocols have good PDR values for each number of nodes. DSR has a higher average of 95.45% while TORA has an average of 93.48%.

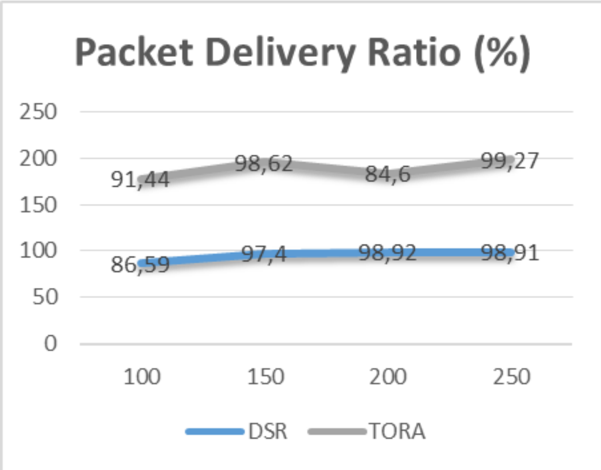

Fig 3. The Effect of number of nodes on PDR in urban scenario

The data of routing overhead value shown in Table 4 is based on the average value of five times data retrieval which can be seen in the attachment. The results of routing overhead performance for urban scenarios for change the number of nodes can be seen in Table 4.

TABLE IV. RESULTS RO FOR CHANGE NODE SPEED

Number of Nodes	RO Value (packets)	
	DSR	TORA
100	10.088	10.810
150	10.048	10.110
200	10.072	12.074
250	10.098	10.212

In Figure 4, it shown that the RO value in the TORA routing protocol is higher than the DSR routing protocol for each change in the number of nodes even though experiencing RO results is not significantly up and down. Because the denser the node, the routing protocol loads and the use of channel bandwidth gets bigger. The RO value is said to be better based on a lower value. DSR has a lower average RO value of 1.0076 while TORA has an average of 1.0801. This is because the DSR routing protocol does not use periodic routing messages, thereby reducing network bandwidth overhead. And the DSR routing protocol does have the best performance in terms of throughput, routing overhead and average path length.

B. Result and Performance Analysis of Routing Protocol To Speed Changes of Nodes

The Routing protocol performance on changes in node speed compared to QoS parameters, namely packet delivery ratio, routing overhead and end to end delay.

The Data of End to End Delay value shown in Table 5 are based on the average value of five times data retrieval which can be seen in the attachment. The results of end to end delay performance for urban scenarios change node speed can be seen in Table 5.

TABLE V. DELAY RESULTS FOR CHANGE THE SPEED OF THE NODE

Node	Delay Value (s)			
	Speed 10 m/s		Speed 15 m/s	
100 nodes	DSR	TORA	DSR	TORA
	0.0957	0.0880	0.1031	0.0843

In Table 5 Delay results are seen from changes in the speed of the DSR and TORA routing protocol nodes. Clearly, the delay results diagram can be seen in Figure 5.

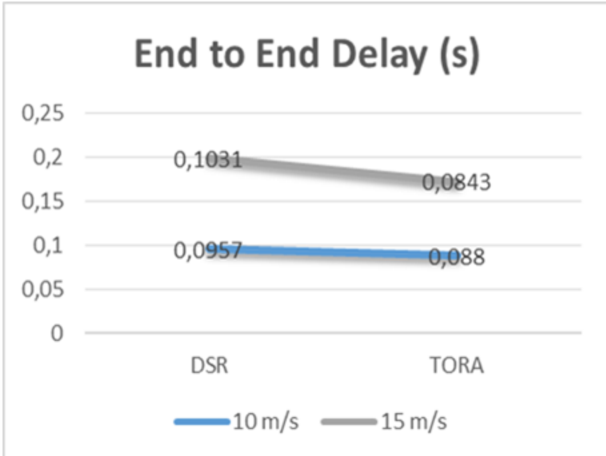

Fig 5. The Effect of node speed on delay in urban scenario

Figure 5 shows that the performance of the TORA routing protocol is better with the average value of end to end delay which is 0.0861 s compared to the DSR routing protocol which has an average value of 0.0994 s. Increased speed allows for topology changes and makes the distance between nodes more distant so that it can cause a breakdown. In theory, the higher the speed of the node, the greater the delay because the relationship between nodes is getting farther and the delivery time is long. But in this simulation there is a fluctuation in the TORA routing protocol because the simulation scenario area used is urban with traffic signs at each intersection.

The data of packet delivery ratio value shown in Table 6 is based on the average value of five times data retrieval which can be seen in the attachment. The results of the packet delivery ratio performance for urban scenarios for node speed changes can be seen in Table 6.

TABLE VI. PDR FOR CHANGES THE SPEED OF THE NODE

Number of Node	PDR Value (%)			
	Speed 10 m/s		Speed 15 m/s	
100 nodes	DSR	TORA	DSR	TORA
	94.59	98.52	98.99	96.22

Received: Augt 21, 2020 | Revised: Sept 30, 2020 | Accepted: Oct 13, 2020

In Table 6, it seen the PDR from changes in the speed of the DSR and TORA routing protocol nodes. Clearly, the routing PDR results diagram can be seen in Figure 6.

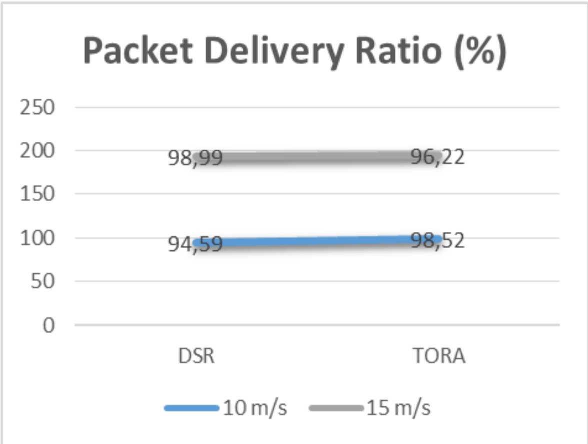

Fig 6. The effect of node speed on PDR in urban scenario

The data of routing overhead value shown in Table 7 is based on the average value of five times data retrieval which can be seen in the attachment. The results of routing overhead performance for urban scenarios change node speed can be seen in Table 7.

TABLE VII. THE RESULTS RO FOR CHANGE NODE SPEED

Number of Node	**RO Value (packets)**			
	Speed 10 m/s		**Speed 15 m/s**	
	DSR	**TORA**	**DSR**	**TORA**
100 nodes	10.080	10.156	10.050	10.236

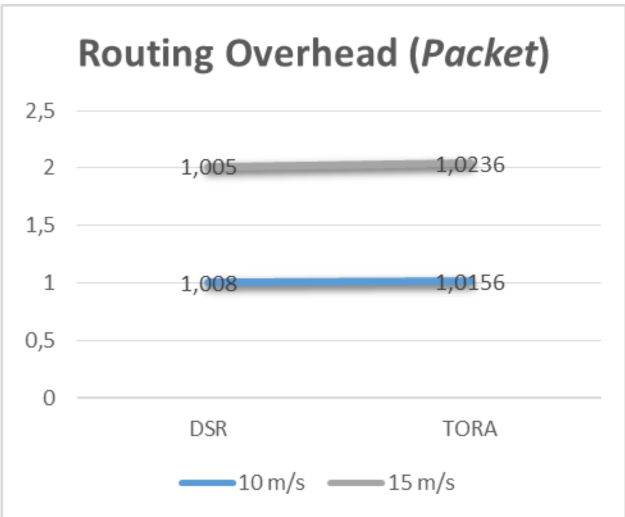

Fig 7. The effect of node speed on RO in urban scenario

Figure 6 can be seen when the speed of the node increases the PDR value of the TORA routing protocol decreases, while the DSR routing protocol increases the speed of the node then the PDR value increases. At TORA, this can happen because the package delivery is done in three steps, namely route creation, route maintenance and route deletion. Because of the number of intersections in this scenario and the combination of speed and number of nodes in the scenario, there are many broken lines and result in repetition of the search/creation of new routes so that the PDR value decreases. Whereas in DSR there is an increase in PDR value with increasing node speed because DSR has different characteristics, namely allowing the network to organize themselves and have their own configuration. Overall the PDR value of the TORA routing protocol has a better average of 97.37% while DSR has an average of 96.79%.

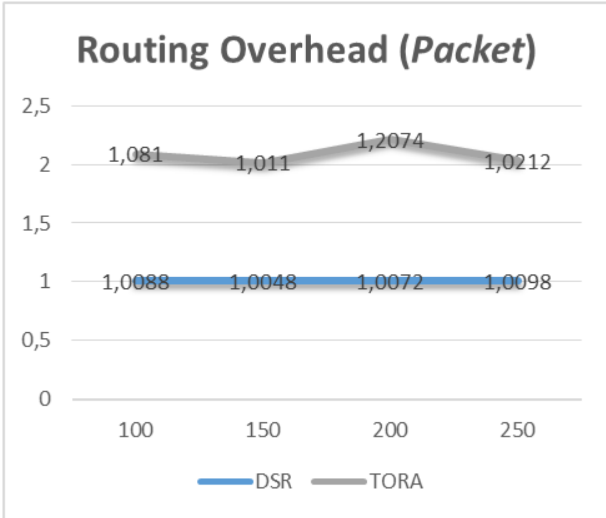

Fig 4. The Effect of number of nodes on RO in urban scenario

Based on Figure 7 shows that an increase in the RO value with added speed on the node in the TORA routing protocol and a decrease in the DSR routing protocol. At TORA this happens because in this urban scenario there are many intersections. Due to the random movement of nodes at the intersection, there are nodes that turn simultaneously, there are also nodes that turn in the opposite direction, therefore the likelihood of link failure or path failure is greater due to changes in network topology that are increasing. The average RO results on node speed show better DSR which is 1.0065 while TORA has an average value of 1.0196. This is because the DSR routing protocol does have advantages, namely the best performance in terms of routing overhead

V. CONCLUSION

On the scenario where the amount of node changes like this research, it is shown that the routing protocol DSR produce a better performance with the average of End-to-End Delay 0.1066s, Packet Delivery Ratio 95.45% and Routing Overhead 1.0076, while TORA has the average of 0.1163 s for End-to-End Delay, Packet Delivery Ratio 93.49% dan Routing Overhead 1.0801. On the scenario where the change of node speed is observed, routing protocol TORA experienced a decline of performance in terms of Packet Delivery Ratio dan Routing Overhead, while the routing protocol DSR experienced another decline on its End to End Delay performance.

Received: Augt 21, 2020 | Revised: Sept 30, 2020 | Accepted: Oct 13, 2020

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Received: Augt 21, 2020 | Revised: Sept 30, 2020 | Accepted: Oct 13, 2020