# Strategies for Inducing Intelligent Technologies to Enhance Last Mile Connectivity for Smart Mobility in Indian Cities


**Moushila De, Shailja Sikarwar and Vijay Kumar**

**Abstract** The rapid growth of India's urban population has put enormous strains on urban transport systems. During the last few decades, more cars, congestion, and the related urban transport problem arise. There are many issues related to safety and security especially for women, children, disabled, and senior citizens. People often have a problem in starting their trip, i.e., from their home. These difficulties do not lie in the main transport network but in the available options that a person has beyond his residence to reach the station located at main transport network. This paper is an attempt to identify the issues related to last mile connectivity at various metro stations of Delhi, to examine the constraints in ensuring last mile connectivity and to suggests measures to improve last mile connectivity in the selected case study stations with the help of various information- and communication-based solutions. Various ICT-based solutions have been suggested in this paper which will help to improve the last mile connectivity for smart mobility in Indian cities.

**Keywords** Smart urban transportation system · Automatic fare collection system
Integrated parking management system · Transi-oriented development
Passenger information system

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## 1 Introduction

Intelligent technologies play an important role to improve last mile connectivity for smart mobility in India's cities. People often have a problem in starting their trip, i.e., from their home. This defines the problem associated with first and last mile connectivity from home and from transit to destination. Though cities also develop into certain structure with regard to distribution of activities and the type of public transport network it has, in spite of which there are certain gaps and loopholes that fails to connect people directly to the main network. This is the problem of the Last Mile which starts at a user's residence till points where public transport network ends. Providing best last mile connectivity options can reduce the cases of various crimes and also helps in the prevention of crimes. Cities are more or less becoming car-centric cities to avoid the first and last mile problem. But still, people face problems related to traffic congestions. No one is ready to walk and use bicycle due to poor conditions of road infrastructure. Therefore, it is necessary to improve last mile connectivity with the help of various ICT based solutions.

## 2 About the Study

The study is research based for enhancing knowledge on the last mile connectivity for mass transit and evolving an approach to last mile connectivity. These studies evolve an approach to improve last mile connectivity of metro stations, which further results in the increase in number of users walking to metro.

## 3 Present Scenario of Last Mile Connectivity in India: Case Study New Delhi

In Indian cities, the conditions of last mile connectivity are very poor. Most of the cities do not have proper last mile connectivity facilities. To understand the existing conditions of last mile connectivity in Delhi, a survey was conducted in New Delhi to understand its existing scenario. It is inferred from the survey that presently only 41 out of 138 stations have proper feeder bus facility which has been connected to various MRTS stations. For understanding the present scenario of last mile connectivity, a field survey was conducted and four stations were chosen based on ridership data up to January 2017, last mile connectivity modes quality assessment through Reconnaissance survey, abutting land use around yellow line metro stations, activity intensity around the stations and typology of the stations. Based on the abovementioned criteria, four stations, i.e., Saket, Vishwavidyalaya, INA, and Sultanpur had been chosen and further existing scenario had been studied to improve the last mile connectivity through intelligent systems (Table 1).

**Table 1** Case study identified parameters stations

| Quality | Name of station | Ridership | Typology | Adjacent land uses | Density | Options for interchange |
|---|---|---|---|---|---|---|
| Good | Saket | 57,000 | Mid-block, underground | Residential and commercial | Medium | Feeder bus, auto, Grameen seva |
| Good | Vishwavidyalaya | 23,182 | Mid-block, underground | Commercial, institutional and residential | Medium | Rickshaw, auto, bus, E—rickshaw, bicycle |
| Average | I.N.A | 30,590 | Mid-block, underground | Commercial, residential and inner ring roads | Medium | Bus, auto |
| Average | Sultanpur | 6377 | Mid-block, elevated | Informal residential | High | Bus, E—rickshaw, auto |

Figure 1 explains the calculated landuse data of four case study stations, i.e., Saket, INA, Sultanpur, and Vishwavidyalaya metro stations which have been calculated using ArcGIS 10.2. Figure 2 explains the comparative analysis of footfalls data. It is depicted from the figure that Saket has the highest footfalls, followed by

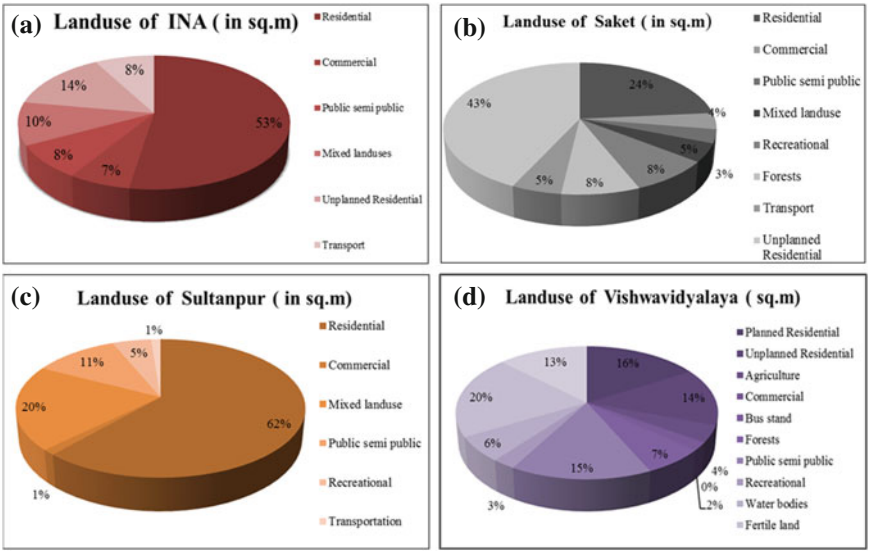


**Fig. 1** **a–d** INA, Saket, Sultanpur and Vishwavidyalaya metro station landuse 2017 (calculated using ArcGIS 10.2)

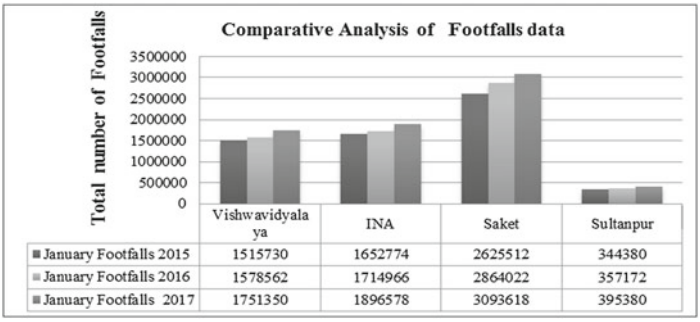


**Fig. 2** Comparative analysis of footfalls data. *Source* Retrieved from DMRC on February 2017

Vishwavidyalaya and INA has the mid footfalls and Sultanpur has the lowest footfalls. The main reason behind these difference in ridership is the availability of abutting landuse around the selected case study stations.

## 4 Methodology Adopted to Improve Last Mile Connectivity for Smart Mobility in Selected Case Study Stations

The study has been divided into four stages:

**Stage 1**: It is a preliminary stage establishing aims, objectives, and need of the study. It also involves studying literature and other facts and findings to support the study.
**Stage 2**: This stage included trip investigation in terms of trip characteristics, user characteristics had been done for selected metro stations. It was followed by identification of improvement areas.
**Stage 3**: Qualitative evaluation of trip characteristics was done based on the trip investigation. Station area assessment was conducted at the selected metro station to support the evaluation.
**Stage 4**: Based on the existing analysis and evaluation of the selected metro station, alternative scenarios and ICT based solutions were framed and evaluated to find the best scenario for improving last mile connectivity at selected case study stations.

## 5 Survey Findings and Analysis

### (a) IPT and NMT survey analysis

For IPT (Intermediate Para Transit) survey operators within a kilometer radius were interviewed within chosen metro stations. For these, 50 surveys were

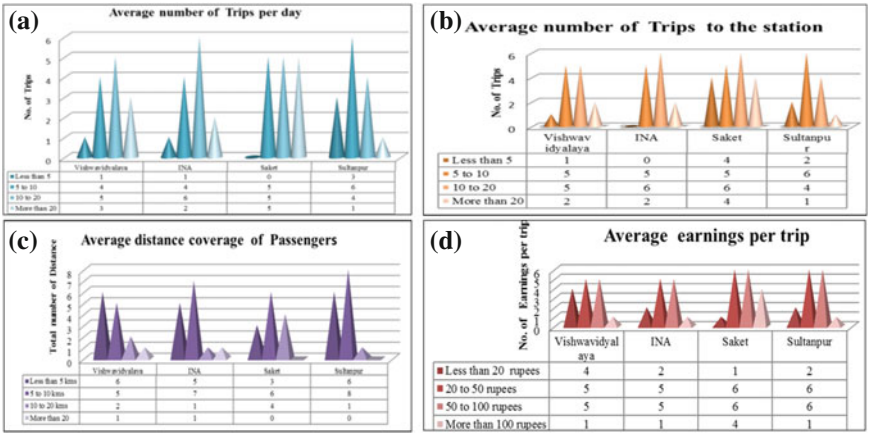


**Fig. 3** **a–d** IPT and NMT survey analysis

conducted and interviews were taken from various NMT and IPT operators. A brief assessment was also conducted on the personal characteristics of NMT and IPT operators across stations to understand the average number of trips from the station, average number of trips to the station, average distance coverage of passengers, average earning per day of operators, issues regarding the operation of IPT and NMT operators, etc. The analysis of IPT and NMT operators survey is as follows (Fig. 3).

(b) **Bicycle facilities at selected case study stations**

In Saket metro station, total 36 cycles are available on both sides. In one side, almost 12–17 cycles have been rented by the people. The monthly cycle package is Rs. 300 per month. Almost 500–600 customers have taken the monthly package in Saket metro station. No other cycle stands near Saket metro station.

In Vishwavidyalaya metro station, total 26 cycles are available for rental purpose. The rental of cycle basically depends on the number of students. Sometimes, it goes 30, 50 or 70.

(c) **Private vehicle users survey analysis**

For private vehicle users survey was conducted near parking stations and within a kilometer radius of various offices, educational institution, etc.; 50% were car users along with 50% two-wheeler commuters in these study were taken for survey. 50 samples were collected near the four metro stations of the private vehicle users (Fig. 4).

(d) **Metro users survey analysis**

A brief assessment was also completed on the personal characteristics of users across station at trip producing and trip attracting area to understand the travel behavior and impact of ridership on metro. Users were assessed on basis of gender, age, income, occupation, frequency of trips, vehicle ownership, etc. (Fig. 5).

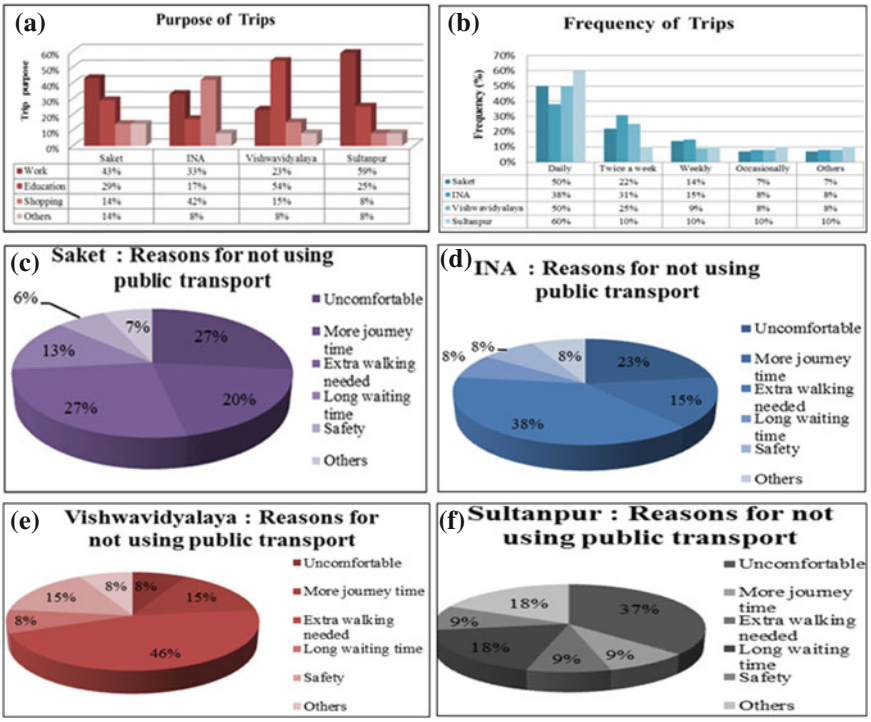


**Fig. 4** **a–f** Private vehicle users survey analysis

(e) **Metro users and intermediate paratransit/nonmotorized transport operators suggestions and preferences**

(i) *Saket metro station*:

- Improvement and strengthening of road from SangamVihar to Saket (Near SBI) through Sainik Farms is needed to avoid traffic congestion. Pedestrilization needs to be developed near Saket metro station. The focus should be on people who are on foot.
- The road from Neb Sarai to Western Marg connecting Saket metro needs to be strengthened. Feeder bus service may be required from Saket metro station to pushpvihar.

(ii) *INA metro station*:

- New feeder bus services needs to be started connecting INA metro station to Sarojini Nagar and R.K. Puram Colony.
- Nonmotorized transport options need to be enhanced especially from Sarojini Nagar to INA metro station market or from Sarojini Nagar railway station to INA market, Sarojini Market.


**Fig. 5** **a–f** Metro user survey analysis

- Inner roads of Lakshmi Bai Nagar and Sarojini Nagar needs to be strengthened, so that maximum people can use inner roads for cycling, biking, and walking directly to the metro stations.

(iii) *Vishwavidyalaya metro station*:

- Foot over bridge or subway needed near Vishwavidyalaya metro stations connecting both sides of the stations.
- There is scope for improvement in terms of more and better quality provisions for "bicycle on rent" as present supply runs short of huge demand.

(iv) *Sultanpur metro station*:

- Roads conditions are very bad, it needs to be strengthening. Feeder bus service is required.
- Roads from Gurudwara to Sultanpur metro station needs to be strengthened. Drainage problem needs to be solved. The focus should be given on pedestrilization specially the road connecting senior secondary school to Sultanpur metro stations.

## 6 Strategies for Inducing Intelligent Technologies to Enhance Last Mile Connectivity for Smart Mobility in Indian Cities

(i) **Smart mobility systems**

It is necessary to have smart mobility system and there is a need to integrate all modes with the main mode, i.e., multimodal transportation system. There should be designated parking for NMT vehicles such as E-Rickshaws and paratransit, TSR zone is also needed in every metro. Charging station should be provided near metro stations especially for battery operated vehicles such as E-rickshaws, etc. It is necessary to abolish the manual cycle rickshaw. In every metro station, total number of 100 parking spaces should be provided for E-Rickshaws and other multimodal environmental friendly modes (Fig. 6).

(ii) **Passenger information systems**

To reduce passenger waiting anxiety, Passengers Information Systems (PIS) boards need to be installed at all bus shelters, metro stations, etc. (Fig. 7).

(iii) **Multipurpose mobility card, automatic fare collection system, and automatic ticket vending machines**

It is necessary to use multiuse mobility card for last mile connectivity. The multiuse mobility card will help bring the various modes of transport even closer AFCS will reduce journey times by ensuring quicker boarding and alighting (Fig. 8).

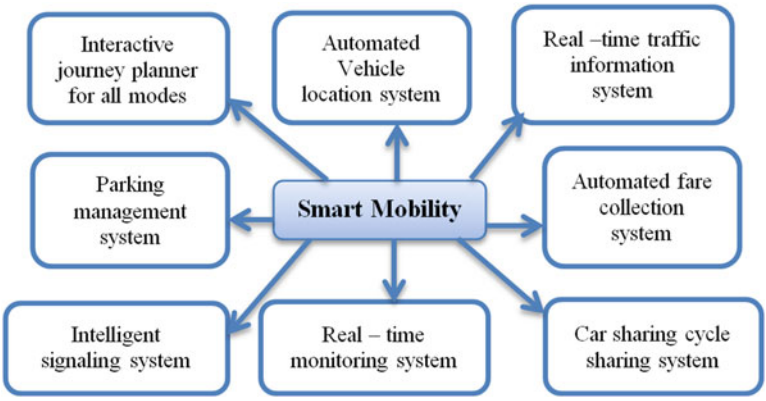


**Fig. 6** Components of smart mobility system

**Fig. 7** Passenger information system. *Source* Safe access Manual, EMBARQ India

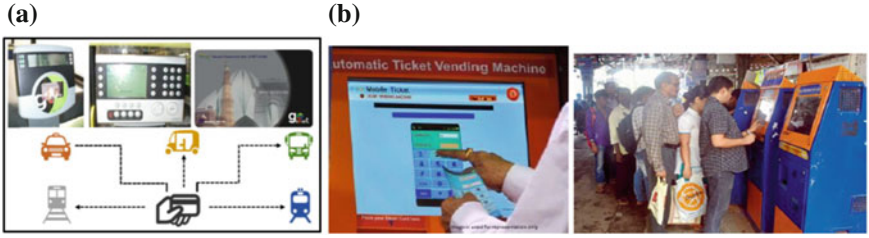


**Fig. 8** **a**, **b** Multipurpose mobility card, and automatic ticket vending machine. *Source* Smart and Connected Transport—A Case Study of Delhi

(iv) **Operation control center, dynamic messaging system, smart traffic signaling system, and electronic road pricing system**

see Fig. 9.

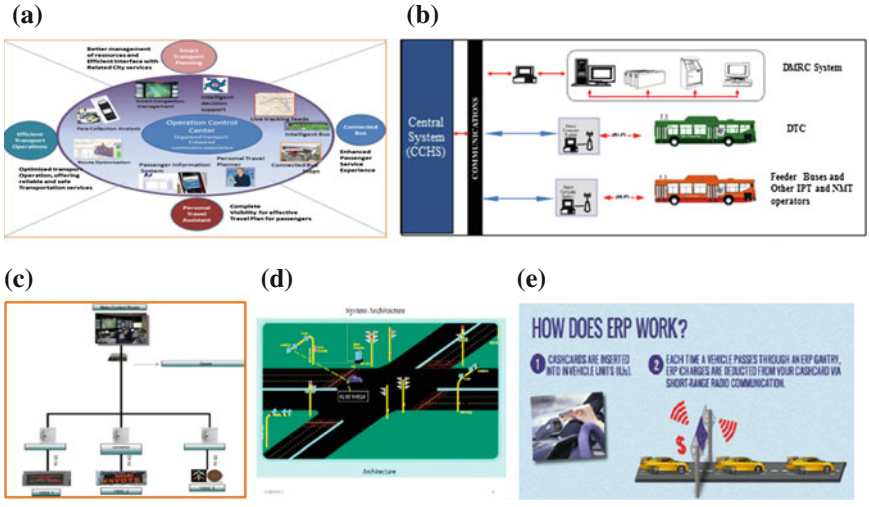


**Fig. 9** **a**–**e** Operation control center, central systems, dynamic messaging system, smart traffic signaling system, electronic road pricing. *Source* Smart and Connected Transport—A Case Study of Delhi

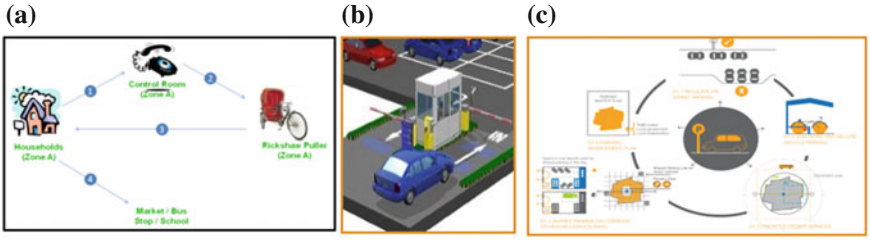


**Fig. 10** **a–c** Dial-a-rickshaw facility, RFID based parking management system and other steps in parking management. *Source* Smart and Connected Transport—A Case Study of Delhi

(v) **GPS-based vehicle tracking system, dial-a-rickshaw facility, and improvement of bicycle infrastructure and parking, use of RFID technologies**

A separate call center needs to be set up for booking and the despatch of auto rickshaws. GPS-based Vehicle Tracking System needs to be installed in all auto rickshaw in the city. It is also necessary to introduce dial-a-rickshaw facility "GreenCAB" as a feeder service for the commuters who will use it as the last mile connectivity modes. There is a need for fully automated locking system that allows users to check bicycle easily or out of bike share systems. There is a need for wireless tracking system such as radio frequency identification devices (RFIDs) that locate within a bicycle and car are picked up, returned and identifies the users. Parking policy for metro stations and other important destinations should be formed to discourage increased private vehicle stations. For example, initiatives as high parking rates (Fig. 10).

## 7 Application of Intelligent Based Solutions in Saket Metro Station

The catchment area of Saket has been divided into three zones: Primary, Secondary and Tertiary zones, i.e., 500 m, 1 and 1.5 km (walking, cycling and other feeder modes). For station area improvement, it is divided into two parts i.e. (i) within station, (ii) Outside station access area of station i.e. the immediate influence (1.5 km radius) area which considers the access and transit area of a station. A multi-utility zone of 200 m has been proposed near Saket metro station, so that street vendor does not encroached footpaths and parking of NMT and IPT. Other than these various routes and various ICT based solutions have been suggested and proposed to improve the last mile connectivity conditions in that particular station (Fig. 11).

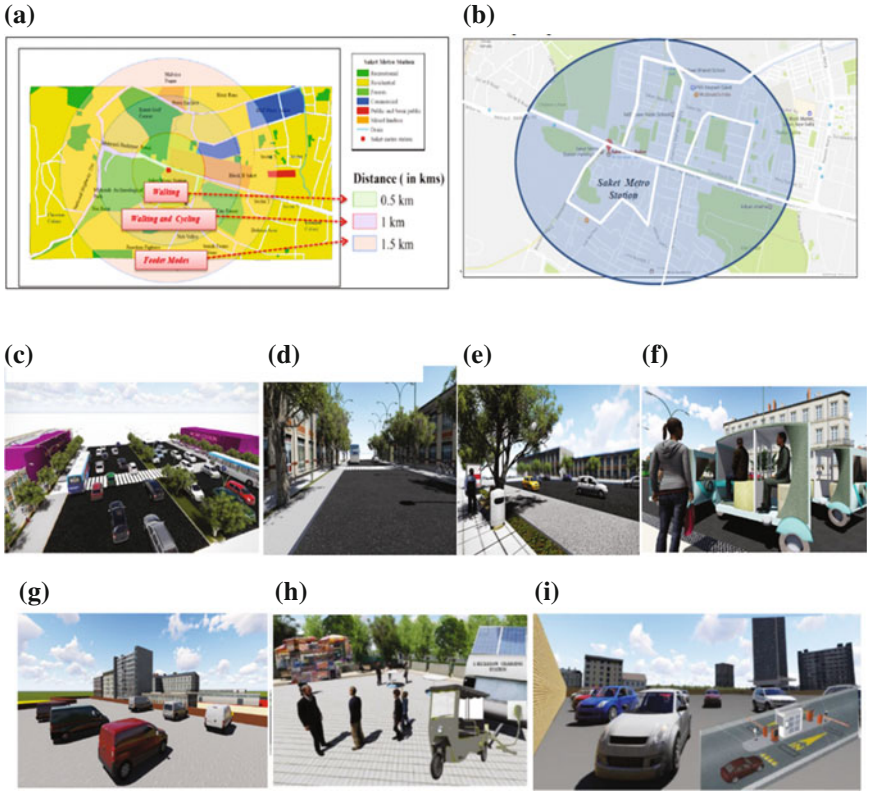


**Fig. 11** Catchment area, improving pedestrian network and Application of Information and Communication based solutions in Saket metro stations

## 8 Conclusion

People often have problem in starting their trip, i.e., from their home. These difficulties do not lie in the main transport network but in available options that a person has beyond his residence to reach the station located at main transport network. During the last few decades, more cars, congestion and related urban transport problem and safety and security related problem arise. Thus, it is necessary that last mile connectivity should not be considered just an option at metro ends but be treated as an opportunity from a user's home. With physical integration and fare integration and with the help of intelligent systems, last mile connectivity can be improved.

**Ethical Information**

1. The paper contains the data collected and synthesized personally (through primary survey) with the users (with the prior-proper verbal consent) of the Metro and private vehicle users and NMT IPT operators, and they submitted absolutely no issue/problem in providing their opinions/

statements/observations regarding this data, as these data were collected for only academic purpose.

2. Regarding the data collected from the secondary sources, only that record/data have been used, which was available on public domains and since the data is being used for academic and research, the concerned office, i.e., Officer of DMRC and DDA did not object/raised any issue/problem. Rather the concerned offices/officers provided all possible help in this research work.

So the authors undertake that there is no ethical issue in the data/records produced/mentioned by us in this paper.

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