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A New Methodology for Road Crash Data Collection in Bangladesh Using Local Record Keepers

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Abstract

The lack of good road crash data is a serious obstacle to analysing road safety problems in Low- and Middle-Income countries (LMICs) and this complicates, for example, the sound assessment of road safety interventions. Police crash reports are the main source of crash data, but often have significant limitations. This paper describes a complementary new methodology for road crash data collection called the Local Record Keeper (LRK) methodology. This methodology deploys trained people from the local community and a new supervisory and quality control process to record road crashes. A comprehensive description of the LRK methodology is provided. The LRKs were able to collect most of the data in the crash forms without difficulty. The LRK methodology recorded significantly more crash data than the Police and provided details on crash location and road user involvement that were important input for the design of a speed management programme on a rural highway that traverses three villages in Bangladesh. A 19.7% reduction of the mean speed caused by the speed management programme was accompanied by a recorded reduction in the LRK data of 66.7% in the number of fatalities, and 59.4% in the number of serious injuries. These recorded reductions as a result of measured speed reductions were consistent with what has been reported in the literature. It is recommended to consider the LRK methodology as a complementary source of crash data in LMICs.

Key Findings

- A new methodology was developed for recording road crashes using local record keepers.
- The new methodology recorded significantly more crash data than the Police.
- The methodology provided important input for designing a speed management programme.
- It was possible to evaluate the speed management programme with the new methodology.

Introduction

The lack of good road crash data is a serious obstacle to structurally improving road safety, especially in Low- and Middle-Income countries (LMICs) which suffer from poor road crash data (WHO, 2018). Without good data, it is impossible to obtain an accurate picture of the road safety problems, to conduct high-quality road safety studies, and to design effective road safety strategies (Wegman, 2016).

In 2016, government reports failed to capture 84% of all road crash fatalities in Low-Income countries, versus 51% in Middle-Income countries and 11% in High-Income countries (WHO, 2018). This phenomenon is known as underreporting. The WHO estimates that only 9.5% of all road fatalities in Bangladesh in 2016 were recorded in the national crash database (WHO, 2018). Police crash reports are the main source of crash data in LMICs. Limitations of Police crash data in LMICs include (biased) underreporting; espe-

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cially underrepresenting vulnerable road users (VRUs) such as pedestrians (World Bank, 2019; WHO, 2010).

The probability of reporting of road crash fatalities and injuries is proportionate to the severity of the injuries, irrespective of the country's development level. The less severe the injuries, the less likely it is that they will be reported (World Bank, 2019).

For the safety evaluation of a speed management programme on a highway in Bangladesh it was decided not to rely on Police data, as these were considered insufficient, but to develop a new methodology using local record keepers (LRK). This methodology deploys trained people from the local community, together with a process for supervision and quality control, to record road crashes for a bounded geographical area and timeframe. The LRK methodology was conceived by a Dutch not-for-profit organisation called Safe Crossings in 2012.

Van der Horst et al. (2016) describe evaluation techniques of this speed management programme; a road crash database created by LRKs being one of them. However, the description of the LRK methodology in this article was very limited, e.g., a process description was absent, and there was no assessment of the performance of the LRK methodology.

The aim of this paper is to provide a comprehensive description of the LRK methodology and to assess the performance of the LRK methodology for the design and safety evaluation of a speed management programme.

Method

Design of a speed management programme in Bangladesh

The speed of motor vehicles (excessive speed and inappropriate speed) is at the core of the road injury problem (Peden et al., 2004). Speed is related to the risk of being involved in a crash and also related to the crash severity (for an overview see Aarts & van Schagen, 2006 and OECD/ITF, 2018). Studies suggest that excessive speed is involved in as much as one-third of fatal collisions. These studies report on High-Income countries. This proportion is likely to be greater in LMICs, given the higher proportion of deaths among VRUs (WHO, 2017). Effective speed management is central to most intervention strategies in the world (WHO, 2018).

In line with their aim to prevent road crashes, particularly for VRUs, Safe Crossings searched for locations in Bangladesh that were suitable for a speed management programme. The main selection criteria for the locations were: i) presence of a road with high-speed traffic, and ii) considerable numbers of pedestrians crossing the road (at least 100 crossing pedestrians per hour).

Safe Crossings searched for suitable locations on the N2 highway. This highway, a single carriageway two-lane asphalt road, is a national highway that passes through rural areas and villages, connecting the capital Dhaka to the Sylhet district.

In several candidate locations, interviews were held with local stakeholders including medical professionals about the road crash situation, preliminary traffic analyses were conducted, and initial speed measurements were made.

Interviews with medical professionals revealed that there was no structured collection of road crash data by the staff of the medical facilities on or near the N2 highway. Speed measurements with a laser gun (type: Laser Patrol, Jenoptik) showed that about 10% of the buses and approximately 25% of the cars and minibuses drove faster than the prevailing speed limit of 80 km/h.

Three villages were selected for intervention locations: Nil Kuthi, Nama Para, and Kundar Para. All villages were rural community settlements with activities on both sides of the highway, such as shops, houses, schools, bus stops, and religious buildings. In each village an unpaved minor road, leading to the fields and more houses and shops, crosses the N2 in the heart of the village.

The risk of road crashes in each village was expected to be significant due to the combined effects of fast-driving buses and passenger cars, frequent overtaking, considerable numbers of pedestrians crossing the road, the mix of high- and low-speed traffic, traffic coming from the unpaved minor side-roads, and buses and other vehicles changing speed to pick up and/or drop off people.

Figure 1 presents pictures of typical road scenes. A Nosimon is a slow-moving motorised tricycle that transports several passengers and /or cargo in the back. A CNG (compressed natural gas), or auto-rickshaw, is a three-wheel vehicle that is mainly used for passenger transportation. The most common type is characterised by a sheet-metal body with a small cabin at the front for the driver and space for passengers in the back.

Appendix 1 contains more information on the speed management programme. Vet et al. (2016) contains a description of the other interventions, such as the education programme for school children.

Description of the LRK methodology

Data collection was based on a before-after design. Data collection by LRKs started in November 2012 in Nil Kuthi, and in June 2013 in the other two villages (Nama Para and Kundar Para). The speed management intervention programme was implemented between January and May 2015. Crash data collection continued until December 2016. All staff (record keepers and coordinator) were operational, without any interruption, during the 4-year period of the study.

The methodology consisted of six phases as follows.

Phase 1: Selection of the LRK coordinator

The LRK coordinator was responsible for the selection, training, and supervision of the LRKs. In addition, the LRK coordinator served as the main contact person for the LRKs. Key qualifications of the LRK coordinator included: i) previous experience in monitoring and evaluation (M&E), ii) the ability to engage with people in the local communities, and iii) having a basic understanding of the road safety challenges in local communities.

Figure 1. Typical road scenes in villages in Bangladesh, with a Nosimon (below-left) and CNG (below-right)

The LRK coordinator in this study was an experienced M&E professional from Bangladesh with extensive experience in community engagement and an excellent understanding of road safety challenges in the country. The selection of the LRK coordinator was done by Safe Crossings and senior management from the Centre for Injury Prevention and Research, Bangladesh (CIPRB), the local implementation partner of Safe Crossings. There was one LRK coordinator for six LRKs in the three villages. The LRK coordinator was based in Dhaka.

Phase 2: LRK selection and design of the initial crash report form

The LRK coordinator selected two LRKs in each of the three villages. The two LRKs in each village were assigned the same task: to record road crashes twenty-four hours a day, seven days a week on a 400-metre stretch of the N2 highway. The mid-point of the 400-metre stretch was the intersection of the N2 highway and a crossing with an unpaved minor road.

Key criteria for selecting the LRKs included: i) interest in road safety; ii) living and working close to the intersection; iii) being respected in the local community; and iv) having observational and recording skills. It was possible to find enough qualified LRKs.

Safe Crossings and CIPRB designed an initial paper-based crash report form with the intention to capture all crashes that resulted in bodily harm, while also creating a form that was feasible for the LRKs to use.

The decision was made to exclude crashes with property-only damage (POD) as the aim of the project was to reduce fatalities and injuries. Furthermore, including POD crashes would multiply the workload of the LRKs and the LRK coordinator with limited added value.

The chosen definition of a fatality was "a person who died on the spot at the crash scene, during or shortly after the crash, and as a result of a road crash". Due to lack of reliable communication options with nearby hospitals, it was not feasible to use the recommended definition of "any person killed immediately or dying within 30 days as a result of a road traffic injury accident, excluding suicides" (WHO, 2010).

Two injury severity classes were defined: i) minor injuries (bruises and minor lacerations) and ii) serious injuries (fractures and other injuries that require a hospital visit). This distinction between minor and serious injuries is in line with the recommendation by WHO (2010).

For identifying the crash location, three categories were used: i) at the intersection (the intersection itself plus 15 metres in both directions); ii) 15 - 75 metres from the intersection in both directions; and iii) 75 - 200 metres from the intersection in both directions. The LRK coordinator believed that it might be too demanding to ask the LRKs to record the exact location of the crash.

Phase 3: LRK training and pre-testing, and design of the final crash report form

The LRK coordinator gave two days of training to the LRKs. On day 1, there were 2-hour classroom sessions in the morning and 2-hour feedback sessions in the afternoon, focusing on the different aspects of the role of the LRK. On day 2, there was a practical session for an hour in and around the intervention areas, and another classroom session on the process of completing the checklist.

The LRKs pre-tested the initial crash report form for one month. Based on their feedback it was decided to make four adaptations to the initial report: i) removing the "location of death"; ii) removing all personal details of the victims other than age and gender; iii) removing "the type of collision" (e.g., head-on); and iv) adding a vehicle category, a so-called Nosimon, to the crash report form. The first three adaptations were made as the LRKs were concerned that they could not provide adequate answers to these questions. The Nosimon was added as a vehicle category because the LRKs unanimously believed that Nosimons were a different vehicle type than the other modes.

Appendix 2 shows the final crash report form.

Phase 4: Collection of crash data

Crash data were collected by the LRKs twenty-four hours a day, seven days a week. If the LRK was present in the village when the crash happened, the LRK went to the site of the crash, taking notes on paper, interviewing witnesses, talking to crash victims if possible, and filling in as many elements of the paper-based crash report form as possible. After leaving the crash scene, the LRK completed the crash report form as needed.

In most cases, the crashes were recorded by the LRKs themselves, as approximately 90% of crashes happened between 08:00 and 20:00 when the LRKs were present in the village. Each LRK set up a process to ensure that – when the LRK was not personally present when a crash happened – other people in the local community would record the crash data and pass them onto the LRK as soon as possible.

The two LRKs in a specific location were asked to record the same crashes independently from each other. Each LRK received a monetary compensation of approximately ten Euros per month for their work.

Phase 5: Data entry and quality control

At the beginning of each month, the LRK coordinator received the completed crash report forms of the preceding month from each LRK. The LRK coordinator checked each form for completeness and accuracy. The LRK coordinator contacted the responsible LRK if there were any questions about a specific crash report form. The checked forms were entered into the computer by the LRK coordinator to create the road crash database.

The LRK coordinator made planned and unplanned visits to the LRKs in the villages. During each visit the LRK coordinator checked the crash report forms and discussed with the LRKs how the crash data collection process went.

Every month, the LRK coordinator sent a summary of the road crash statistics and details of each fatal crash to Safe Crossings. On a quarterly basis, and on request, the LRK coordinator sent a copy of the road crash database to Safe Crossings. Safe Crossings conducted its own analysis of the completeness and accuracy of the data in the road crash database by reviewing the newly entered crash data records in the database regarding anomalies, such as inaccurate coding of the type of crash, and by comparing the number of fatalities and injuries in the latest month with the averages of the preceding months. Safe Crossings contacted the LRK coordinator if there were any questions about data quality.

Phase 6: Analysis

Using the data in the road crash database, it was possible to conduct various analyses, such as time-series analyses, comparisons between the three different villages, and analyses on the frequency and severity of crashes involving VRUs. For example, Figure 2 shows the number of crashes, fatalities, and the number of injured people per month from June 2013 to December 2016.

Assessment of the LRK methodology

A good road crash data system should, at a minimum (WHO, 2010):

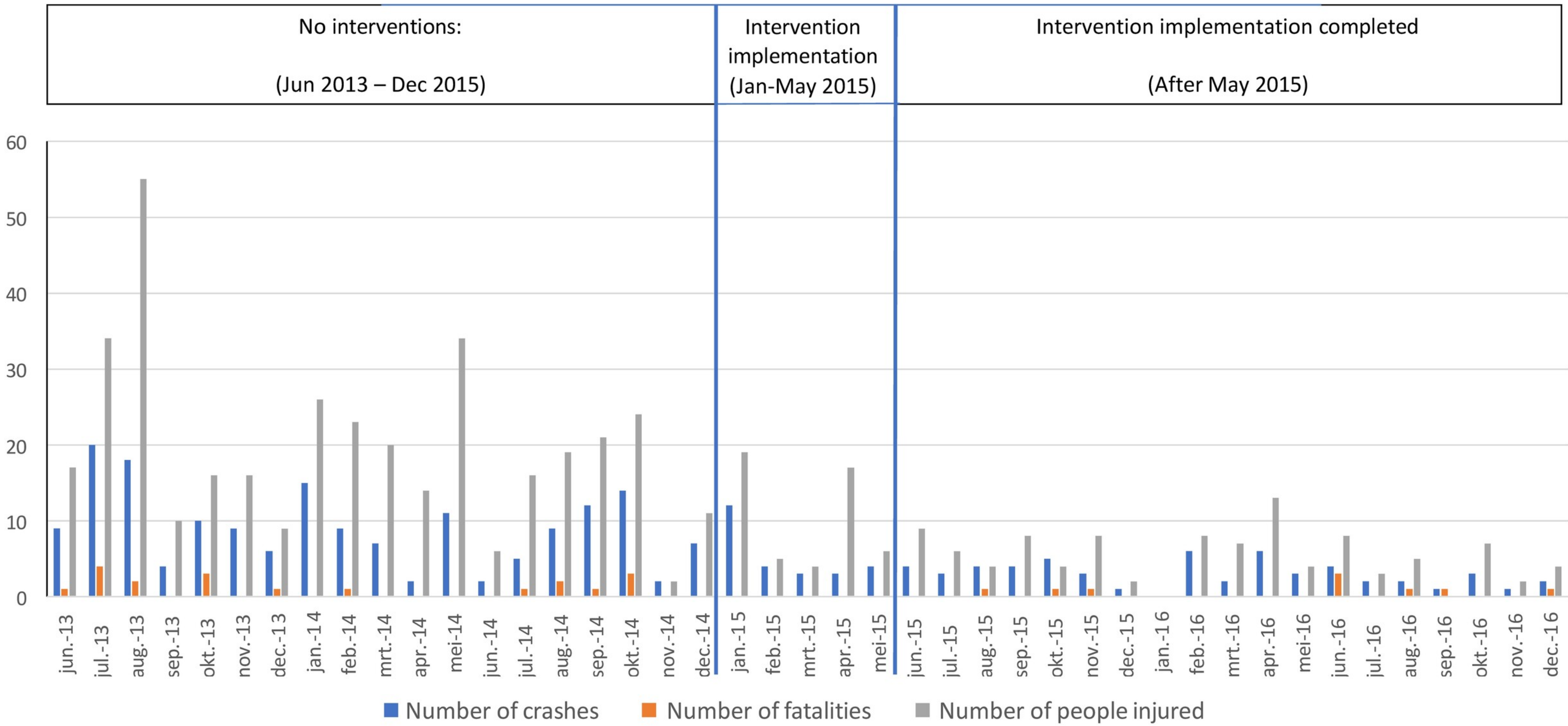

Figure 2. The number of crashes, fatalities, and injured people per month in the three villages as recorded by the LRKs

1. capture nearly all crashes that result in death and a significant proportion of those that result in serious injuries;
2. provide adequate detail on the vehicle, the road-user, and the road/environment to assist with identification of causes, and selection of countermeasures;
3. include accurate crash location information; and
4. provide reliable output in a timely manner to facilitate evidence-based decisions.

There is a fundamental methodological challenge when evaluating a new crash data system in a country, such as Bangladesh, that does not have reliable crash data from the Police or alternative sources. In the absence of an adequate benchmark or data set, it is never 100% certain that a new crash data system meets the requirement of capturing nearly all fatalities and significant proportion of serious injuries. Thus, alternative assessment methods need to be used.

The approach taken in this study is to use four feasible assessment methods that cover a different performance aspect of the LRK methodology:

1. qualitative process assessment and assessment of missing data in the LRK crash forms;
2. assessment of the difference between LRK crash data and Police data;
3. assessment of the importance of the LRK crash data for the design of the speed management program; and
4. using the results of speed measurements to compare the casualty reductions recorded by the LRKs with estimates reported in the literature based on the correlation between speed changes and changes in the number of casualties. The power model as developed by the Swedish researcher Göran Nilsson (Nilsson, 2004) was used for this purpose.

Qualitative process assessment and assessment of missing data in the LRK crash forms

The LRK process was assessed in a qualitative way through a semi-structured interview with the LRK coordinator. The focus of the assessment was on the crash data collection by the LRKs, and in particular on the questions: were there data that were difficult for the LRKs to collect? If so, what were these data elements, and how did the LRKs deal with this situation?

If data are missing systematically for certain fields in the crash form, data analysis becomes problematic (WHO, 2010). For each of the data fields in the LRK crash report form, the percentage of missing and complete data was determined. This analysis was done for the period June 2013 – December 2016, i.e., the full period for which LRK crash data from all three villages were available.

Assessment of the difference between LRK data and Police data

Crash data in Bangladesh are collected by local district Police using a standard crash form. Their definition of a fatality is someone who died at the scene of the crash, which is similar to the fatality definition used by the LRKs. The crash form is sent to one of ten Accident Data Units of the Police where it is loaded onto a computer and an electronic copy of the data is sent via Police Headquarters to the Road Safety Cell of the Bangladesh Road Transport Authority (BRTA), which is the custodian of the national crash database.

Police from three different Police stations were responsible for road crash data collection in the three villages in which the LRK data were recorded. The distance between a village and the responsible Police station ranged from 3 km to 17 km.

The LRK coordinator made a series of visits to the three separate Police stations to collect the Police crash records. Given the known underreporting in Bangladesh, it was expected that the LRK database would contain a higher number of crashes, fatalities, and injuries than the Police data. An analysis was made whether the Police data contained any crash records that did not appear in the LRK database. In addition, the difference in the recorded number of crashes, fatalities, and injuries between the LRK data and Police data was determined. This analysis was done for the period June 2013 – December 2015 as it was not possible to get Police data for the year 2016.

LRK data as input for the intervention design

While speed measurements had confirmed the excessive speeds of motorised traffic, these measurements did not provide information on the crash locations and on the road user categories involved in the crashes. Knowledge of the crash location is essential for determining the appropriate location of the speed management interventions, while knowledge of the road user categories involved in the crashes is needed to determine which intervention measures would be most effective. An assessment was made whether the LRK methodology was able to provide these data (crash location, road user categories) and how the LRK data were used in the intervention design. The period for the assessment was June 2013 – May 2014 as the intervention design was finalised in June/July 2014.

Before-after comparison with speed data using Nilsson's power model

The speed management project included speed measurements of free-flowing traffic in the three villages. Traffic was defined to be free flowing if traffic on the highway was not hindered in any way by i) slowing or halting traffic on the highway or ii) road users crossing the road or iii) road users entering the highway from the minor side roads. The power model describes the correlation between speed reduction and the expected reduction in fatalities and injuries. While the relationship between speed and crashes can be somewhat better described by an exponential model than by a power model (Elvik, 2013), the differences between both models are rather small and the resulting conclusions are very similar. Either model can be used to estimate the expected change in crashes following a change in speed (OECD/ITF, 2018)).

A comparison was made between the changes in fatalities and serious injuries as recorded by the LRKs with estimates derived from Nilsson's (2004) power model using the results obtained by Elvik (2009) in his meta-analysis for rural roads/motorways. The mean speed of motorised traffic (buses, trucks, cars, and minibuses) was selected as the input value for the power model as these types of motorised traffic accounted for the large majority of VRU fatalities. For the LRK data, the period October 2013 – September 2014 was selected as the before period, and the period June 2015 – May 2016 was selected as the after period. A period of a year was taken to avoid any seasonal influences. To avoid overlap with the speed management programme, which was implemented between January and May 2015, the before period ended in September 2014, and the after period started in June 2015. Traffic counts were held during the before and after period to correct for differences in traffic volume if needed.

Results

The results of the four assessments can be summarised as follows.

Qualitative process assessment and assessment of missing data in the LRK crash forms

There were two main outcomes of the semi-structured interview with the LRK coordinator. Firstly, the LRKs were able to collect most data in the crash form without difficulty. Secondly, in some cases, LRKs faced challenges in getting all the required data.

The main challenges for the LRKs were:

1. while each LRK had set up a process to ensure that – when the LRK was not personally present when a crash happened, other people in the local community would record the crash data and pass them on to the LRK as soon as possible – in some cases the provided data were incomplete. The standard response of the LRK was to call the LRK coordinator and for the LRK coordinator to cross-check on the missing data with the other LRK who also recorded the same crash;
2. in some cases, the LRKs were not able to record the name of the hospital for injured people who were taken away from the crash site, as either the name of the hospital was not yet known or not shared with the LRK. In a few cases, the LRKs visited the hospital facility to cross-check; and
3. in some cases, the LRKs were not able to record the ages of the victims.

The records in the LRK database were filled for 96.8% of the crashes. Of the 14 data fields, 8 were completed 100%: identification number; crash date; crash time; village name; location in village; type of road users involved in crash; number of people injured; and number of fatalities. Some data were missing for the following 6 variables (the percentage of data that was missing is shown in parentheses): Hospital admittance and hospital name (21.5%); victim's age and gender (9.0%); Police attendance at crash site (4.3%); and injury severity (1.5%).

Assessment of the difference between LRK data and Police data

In the period June 2013 to December 2015, the LRKs in the three villages recorded 221 crashes with 22 fatalities and 194 people with serious injuries. The Police data for the same period and locations showed 4 crashes with 4 fatalities and 1 person seriously injured. All crashes recorded by the Police were present in the LRK data. Calculated as a percentage of the LRK data, the Police data contained 1.8% of the crashes with fatalities or injuries, 18.2% of the fatalities and 0.5% of the serious injuries.

LRK data as input for the intervention design

The LRKs recorded the location of 120 crashes that happened between June 2013 and May 2014. Most crashes (75.8%) took place at the intersection between the N2 highway and the minor side road. For the intervention design, this meant that the intersection was chosen as the midpoint between the two speed humps.

These 120 crashes resulted in 12 fatalities. Table 1 shows the road user categories that were involved in these fatalities. Most (91.7%) of fatalities were VRUs, with pedestrians being the largest category (41.7% of all fatalities).

Buses were involved in 6 of the 12 fatal crashes (50%) and trucks in 3 of the 12 fatal crashes (25%). For the intervention design, this meant that speed humps were selected with the required dimensions to significantly reduce the speed of these vehicle categories.

Before-after comparison with speed data using Nilsson's power model

As a result of the speed management programme, the mean speed of motorised traffic in the three villages declined from 63.6 km/h in the before period to 51.1 km/h in the after period, i.e., a reduction of 12.5 km/h or 19.7%.

The LRKs recorded 9 fatalities and 69 people with serious injuries in the before period versus 3 fatalities and 28 people with serious injuries in the after period, which equates to a reduction of 66.7% in the number of fatalities and 59.4% in the number of people with serious injuries.

Table 2 shows that the recorded reductions by the LRKs for both fatalities and serious injuries are in line with the estimates of the power model using Elvik's exponents (Elvik, 2013).

Total traffic in the after period was 2.9% lower than in the before period, but the combined traffic volume of buses and trucks, which together accounted for most fatalities, was 3.3% higher in the after period. On balance, it was assumed that there was no significant effect of the change in traffic volume on the LRK data.

Table 1. Road user categories involved in fatal crashes

	Bus	Truck	Car/minibus	Motorcycle	CNG	Pedestrian
Bus	0	1	0	2	2	1
Truck	0	0	0	0	1	2
Car/minibus	0	0	0	0	0	2
Motorcycle	0	0	0	1	0	0

Table 2. Comparison between LRK data and power model

Road safety indicator	LRK data	Power model estimate		
	Measured reduction	Best estimate	95% Confidence interval	
			Lower bound	Upper bound
Number of fatalities	- 67%	-63%	-58%	-68%
Number of serious injuries	- 59%	-54%	-10%	-70%

Discussion

The LRK methodology has the potential to be a useful complementary methodology for road crash data collection in LMICs. The first potential application is for the design and evaluation of road safety programmes in specific locations, similar to this study. A second potential application is to use the LRK methodology as a kind of 'surveillance system', aimed at developing insight into the magnitude and type of the road safety problems in a region over time.

In this study, the Police data included 18.2% of the fatalities recorded by the LRKs, which is a higher reporting percentage than the WHO's estimate for the reported Police fatalities in the entire country (9.5%). The higher reporting percentage in this study may be caused by the fact that the villages were on a major national highway and relatively close to a Police station (between 3 km and 17 km). On the other hand, the Police data included only 1 of the 194 serious injuries (0.5%). This finding is in line with the literature: The lower the severity of the injury, the less likely it is that it will be reported.

In this study, the LRK coordinator believed that it might be too demanding to ask the LRKs to record the exact location of the crash. With the presence of GPS technology, mobile phones can help determine the latitude and longitude of any location in a future application of the LRK methodology.

Study Limitations

A limitation of the study was that the assessment of injury severity is done by LRKs who are not medically trained, and that the definition of fatality does not fully correspond to the recommended definition. Some crashes may not have been recorded by the LRKs. Not all data fields were recorded for each crash (3.2% of all data fields were missing) and LRKs' data collection may not have been consistent for the entire duration of the study. In addition, the LRK methodology appears to be best suited for locations where road crash risk is 'geographically-concentrated', such as the intersections of the N2 highway and the minor side roads in this study.

Conclusions

A new methodology of road crash recording was developed and deployed to be used for the evaluation of a speed management programme in Bangladesh. This article describes the new methodology using LRKs for the collection of information on road crashes in six phases and presents four procedures to assess the quality of the new methodology.

Firstly, qualitative assessment showed that the LRKs were able to collect most of the data in the crash form without difficulty. In some cases, LRKs faced challenges in getting all the required data. The records in the LRK database were filled for 96.8% of the crashes.

Secondly, the LRK methodology recorded significantly more crashes and injuries than the Police. Calculated as a percentage of the LRK data, the Police data contained 1.8% of the crashes, 18.2% of the fatalities and 0.5% of the serious injuries.

Thirdly, the methodology provided important input for designing a speed management programme, particularly on crash locations and road user categories involved in the crashes.

Finally, the speed reduction of 19.7% associated with the speed management programme was accompanied by a recorded reduction in the LRK data of 66.7% in the number of fatalities, and 59.4% in the number of serious injuries. These recorded reductions were in line with the literature-based estimates; more specifically with the power model developed by Nilsson.

These findings suggest that the LRK methodology can deliver good quality road crash data in LMICs (for a limited geographical area and a limited period of time; in this study, 4 years).

Author Contributions

Martijn Thierry: study conception and drafted the article, design of the study and interpretation of the results.

Jasper Vet: execution and analysis of the speed data.

Kazi Uddin: design, execution, and analysis of the LRK database, execution and analysis of the speed data and the Police data.

Fred Wegman: design of the study and interpretation of the results, revision of the article for intellectual contents.

All authors have read and agreed to the published version of the manuscript.

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Human Research Ethics Review

The Ethical Review Committee of CIPRB approved the LRK approach and the speed management program on 22 May 2014.

Conflicts of interest

The authors declare that there is no conflict of interest.

Data Availability Statement

Data supporting reported results can be provided on request to the corresponding author.

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Supplementary Materials

Appendix 1. Infrastructural interventions at Nil Kuthi

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Appendix 2. Final Crash Form

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