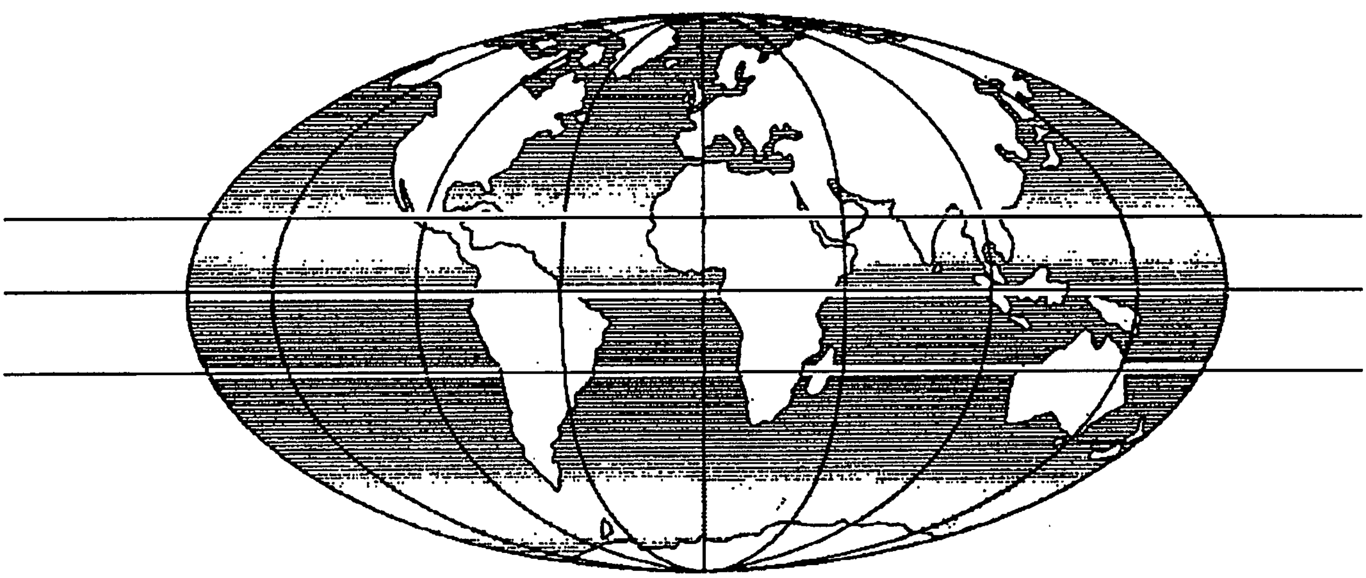
TRANSPORT RESEARCH LABORATORY

ODA

Reprint

TITLE **The identification, prioritising and analysis of accident blackspots in Malaysia**

by **Radin Umar Radin Sohadi and C J Baguley**



Overseas Centre
Transport Research Laboratory
Crowthorne Berkshire United Kingdom

Sohadi, R U R and C J Baguley, 1993. The identification, prioritisation and analysis of accident blackspots in Malaysia. In: National Conference on Engineering Education and Research: Achievements and challenges, held at University Pertanian Malaysia, Serdang, Selangor, 15 - 16 June 1993.

THE IDENTIFICATION, PRIORITISING AND ANALYSIS OF ACCIDENT BLACKSPOTS IN MALAYSIA

by

RADIN UMAR RADIN SOHADI
Dept. of Civil and Environmental Engineering
Universiti Pertanian Malaysia

and

C.J. BAGUELY
Overseas Centre
Transport Research Laboratory, United Kingdom

ABSTRACT

This paper presents the accident investigation and treatment framework developed for the Seremban and Shah Alam Pilot Project. Accident data are based on the revised police accident form POL27(Pin 1/91) specially designed to enable processing and analysis to be carried out using a customised microcomputer accident analysis package, MAAP. A hazardous location identification and prioritising system based on accident maps, link-node-cell and grid coordinates was developed for urban areas while a kilometre post system was proposed for highways in rural areas. In-depth analyses on selected blackspots are discussed and appropriate countermeasures proposed.

1.0 INTRODUCTION

Since 1990 Universiti Pertanian Malaysia (UPM), Ministry of Science, Technology and Environment under the mechanism of IRPA and the National Road Safety Council (MKJR) have been funding research programmes to improve the accident data collection and analysis system in Malaysia. The programmes also aim to encourage wider usage of the system to assist in the identification and effective treatment of accident blackspots to improve road safety in this country. In view of the massive number of accident records to be analysed (96,500 nationwide in 1991), the use of computer based analysis systems was investigated in early 1990 and a micro computer accident analysis package, MAAP, licensed by the Transport Research Laboratory (TRL), United Kingdom, was customised to fulfil the requirement.

A pilot project on the diagnosis system for analyses of road accidents was then carried out under the funding of the research sub-committee MKJR with the cooperation of the Royal Malaysian Police (PDRM) and TRL, United Kingdom. The two districts of Shah Alam and Seremban were selected as pilot areas where the PDRM agreed to cooperate by using a redesigned report form in addition to their current accident form, POL27 (Pin 1987). The new police accident form, POL27 (Pin 90 – Pilot Project), was designed to be easier to complete and incorporated several new items of information of importance to highway engineers; in particular, more accurate location data and collision diagrams. Following appropriate training of relevant police officers in the completion of the new form, it was introduced fully in these two districts from the beginning of 1991.

During the course of this trial period several improvements to the form were recommended, though these were relatively minor in nature. A revised version of the form known as POL27 (Pin 1/91) was then printed in late 1991 for its full-scale implementation in January 1992. An extensive training programme for the police investigation officers over the whole country was carried out prior to 1992.

2.0 METHODOLOGY

2.1 Theoretical Framework

In this phase the framework of accident investigation and treatment was developed. The accident analysis process involves the identification of accident blackspot locations, establishing general patterns of accidents, analysis of the factors involved, site studies, implementation of countermeasures and evaluation of their effectiveness. The overall process is summarised schematically in Figure 1[1]. The level of

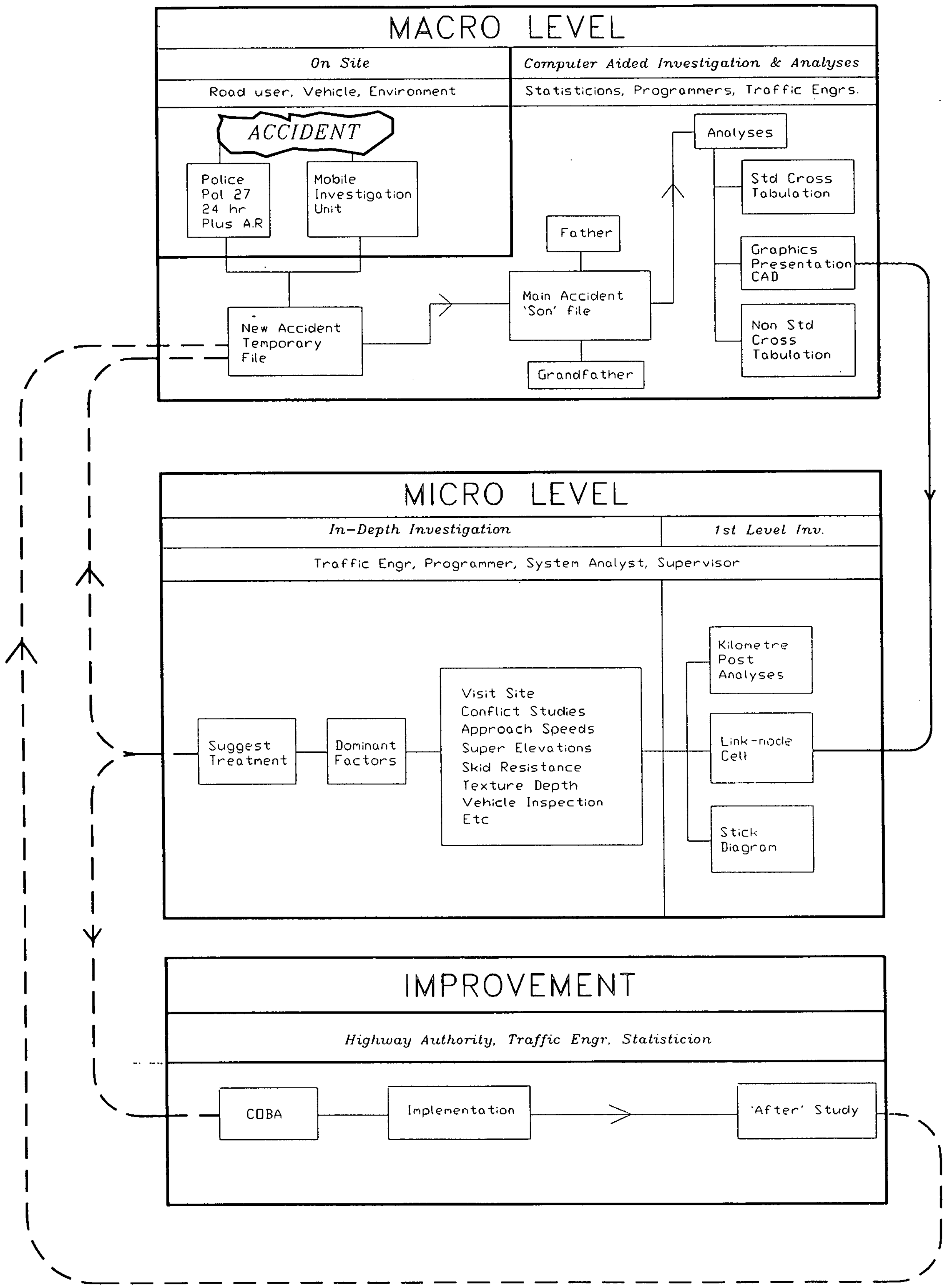


Figure 1: Blackspot Investigation and Treatment Process

investigations and relevant authorities involved are also outlined.

2.2 Computer Program Development

Advances in computer technology have been employed to enable efficient interpretation and analysis of large quantities of accident data. The data input, processing and analysis framework adopted is summarised schematically in Figure 2[(2)]. Specification files, text files and pointers in MAAP were modified and customised to match exactly with the accident information in POL27 (Pin 1/91). This data were keyed-in directly to the microcomputer using the first MAAP programme option NEWACCS. Geographical maps have been spatially digitised using the Autocad Release 11 software and an A1 size digitiser. The digitised data were later used for the graphical display of accident information using either the MAPINFO Geographical Information System (GIS) or the new version of MAAP (Ver. 5.0 Prototype). In the latter case, the digitised data were converted from .DWG format to a simplified .DCM format.

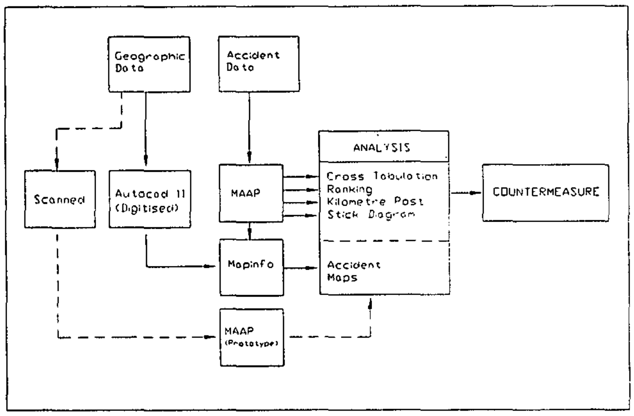


Figure 2: Data Input and Processing Framework

There are three basic types of standard cross tabulations available in MAAP: accident information, injury information and vehicles involved in the accidents. Graphical output can be obtained directly using a special interface with the commercial Quattro Spreadsheet package. If a detailed analysis is required on a particular subject (for example, accidents involving a motorcycle at dawn or dusk) appropriate conditions can be specified during analysis using the non-standard cross tabulations option.

2.3 Accident Location System

A location identification system was developed based on road maps. The link-node-cell and coordinates system (Figure 3) have been proposed and used in the pilot urban areas, while a kilometre post system has been used on the rural highways. To identify the most dangerous spots, the DETAILED ACCIDENT INVESTIGATION program option of MAAP was used to plot and list the accident blackspots according to the required rankings. The list can be based on either the kilometre posts, junctions, links between intersections or using the grid coordinates.

3.0 RESULT AND DISCUSSIONS

3.1 Accident Blackspots and Site Prioritising

In this pilot project, accidents in Seremban and Shah Alam have been given their location code by map grid coordinates, node-link-cell numbers and kilometre posts. Ranking of blackspots could now be carried out using any of the above methods. Each method has its own merits depending on the degree of accuracy and/or speed of analysis required.

3.1.1 Accident Maps

Figure 4 shows the distribution of accidents in Shah Alam where the size of circle is proportional to the frequency of accidents. The actual frequency of accidents at each blackspot can be displayed by zooming into the relevant window of the map as each accident is represented by a concentric circle (Figure 5). Inspection of the distribution and size of concentric circles can then be carried out and this gives a rapid visual identification of blackspots in specific areas.

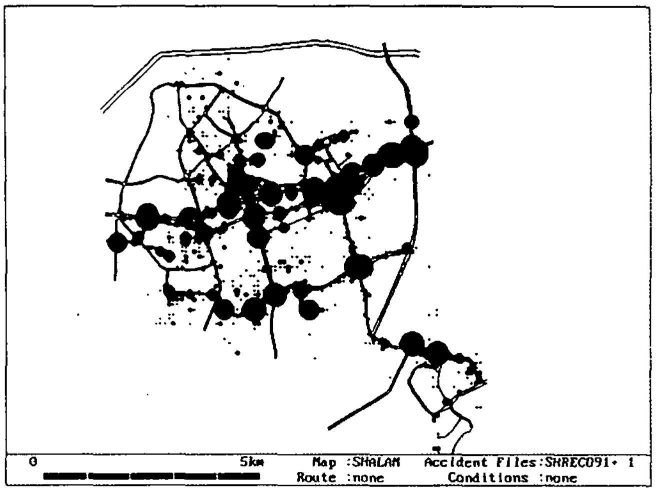


Figure 4: Accident Blackspots in Shah Alam Using Grid Coordinates

3.1.2 Nodal Analysis

Besides accident maps, accidents within 20 metres from major junctions can also be displayed using the nodal analysis options. The above ranking can be cross tabulated using the non-standard cross tabulations option of MAAP with appropriate nodal conditions specified for further ranking analysis as shown in Table 1. An accident point system based on weightings

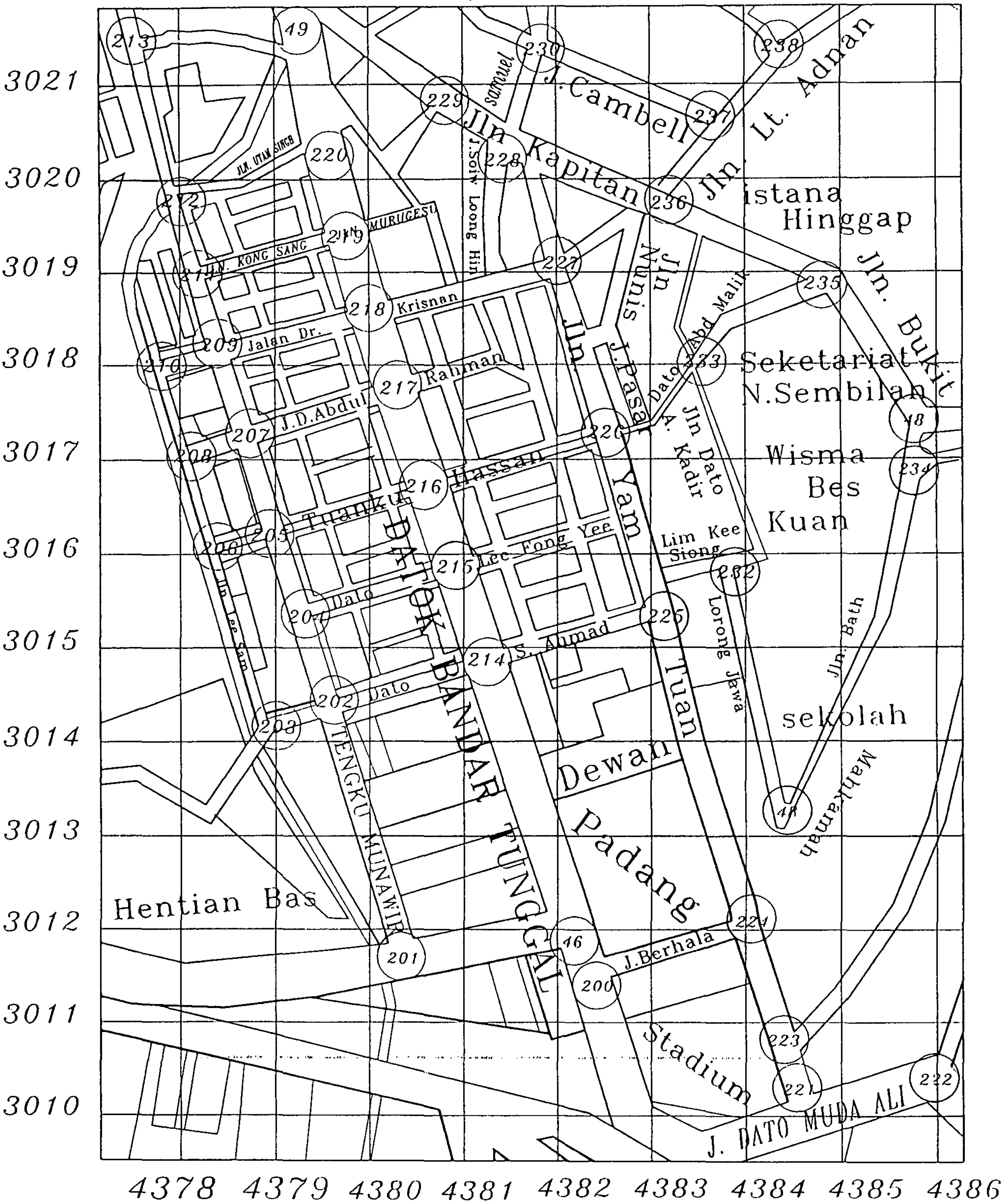


Figure 3: Location Identification System in Seremban

Table 1: Nodal Analysis in Seremban

Node Accident No.	Junction Name Accident	ACCIDENT SEVERITY			Damages	Points	Costs
		Fatal	Serious	Slight			
225	Yam Tuan/Sh. Ahmad	2	0	11	55	31.8	RM547,500
214	D.B. Tunggal/Sh. Ahmad	1	3	8	48	31.0	RM387,000
215	D.B. Tunggal/Lee F. Yee	0	4	12	27	27.0	RM280,000
313	Zaaba/D. Linggi	0	4	9	22	23.6	RM228,000
224	Yam Tuan/Jln. Berhala	1	1	3	14	20.2	RM231,000

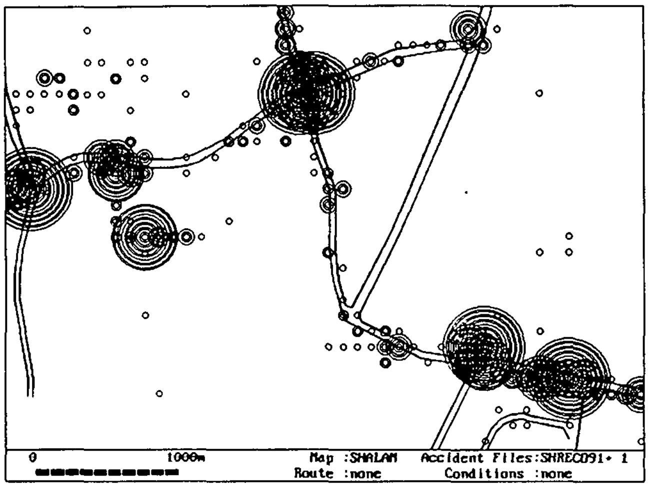


Figure 5: Relative Magnitude of Accident Blackspots within a Selected Area of Shah Alam

```
KILOMETRES        accidents

 0   - .9     7   xxxxxxx
 1   - 1.9    13  *xxxxxxxxxxxx
 2   - 2.9    106 *xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
 3   - 3.9    128 ******xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
                  xxxxxxxxxxxxxxxxxx
 4   - 4.9    54  *xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
 5   - 5.9    24  *xxxxxxxxxxxxxxxxxxxxxxx
 6   - 6.9    28  *xxxxxxxxxxxxxxxxxxxxxxxxxxx
 7   - 7.9    18  **xxxxxxxxxxxxxxxx
 8   - 8.9    24  *xxxxxxxxxxxxxxxxxxxxxxx
 9   - 9.9    31  **xxxxxxxxxxxxxxxxxxxxxxxxxxxxx
 10  - 10.9   20  xxxxxxxxxxxxxxxxxxxx
 11  - 11.9   22  *xxxxxxxxxxxxxxxxxxxxx
 12  - 12.9   15  *xxxxxxxxxxxxxx
 13  - 13     2   xx
-----------------------------------------------------------------
      Total=      492
-----------------------------------------------------------------
                  * Fatal      x Injury or Damage


Listing of worst 100m sections

  Kilometre Post 3.0      51  accidents
  Kilometre Post 2.1      50  accidents
  Kilometre Post 2.0      46  accidents
  Kilometre Post 3.1      41  accidents
  Kilometre Post 4.8      23  accidents
  Kilometre Post 11.2     19  accidents
  Kilometre Post 3.2      17  accidents
  Kilometre Post 8.0      17  accidents
  Kilometre Post 9.6      16  accidents
  Kilometre Post 6.4      14  accidents
```

Figure 6: Histogram of Accidents Along Selected Route in Seremban

adopted by the Highway Planning Unit can be used to compute the site priorities where 6.0, 3.0, 0.8 and 0.2 points are assigned to fatal, hospitalised, minor and damage-only accidents respectively. In addition, accident costs based on ESCAP figures[3] could also be used to compute the economic loss due to accidents to give a blackspots ranking for future economic analysis. Similarly, link and cell analyses could also be carried out based on the above methods for stretches between two major junctions (mid-block accidents) or areas.

3.1.3 Kilometre Post Analysis

For accidents along the State and Federal roads where kilometre posts are installed, histograms of accidents along a selected route can be plotted as shown in Figure 6. Histograms of accidents within selected stretches which have high accident concentrations can also be produced by further dividing the stretch into smaller sectors, each of 100 meter length. Ranking of accidents within sections of road at 100 meter intervals can also be produced using MAAP.

3.2 In-Depth Analyses

For each blackspot selected, detailed analysis using stick and collision diagrams must be carried out to search for patterns of accident that are likely to be reduced by engineering treatment. Whenever possible, site studies should be organised to collect supplementary data such as traffic conflicts, flow, origin-destination, speeds etc in an attempt to obtain further indications of factors leading to road user conflicts which in some events have resulted in accidents.

Print Date: Mon 04-05-1993

Universiti Pertanian Malaysia

STICK DIAGRAM ANALYSIS

ACCIDENT RECORD FILES: NO0225

CONDITIONS SET: Node 1 = 225

Node 2 = 000

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
BLN	09	09	09	12	08	08	08	10	10	10	01	11	11	11	11	11	03	03
TRH	07	19	30	02	01	10	16	13	20	23	03	07	11	15	29	30	04	09
HRI	7	5	2	2	5	7	6	1	1	4	5	5	1	6	6	7	2	7
MSA	16	10	12	20	15	09	15	09	18	09	09	21	17	01	20	11	13	12
PEJ																		
PRH	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	I	D
BK	BK	BK	BK	BK		BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK
>*<											>*<							
>*>															>*>	>*>		>*>
>*|																	>*|	
ANI																		
OT					OT													
SS	SS		SS	SS		SS			SS	SS			SS					
D&D																		
DRK																		

	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
BLN	02	03	03	03	03	03	04	04	04	05	05	06	06	06	07	08	08	08
TRH	29	10	14	15	19	26	01	06	20	02	08	14	27	29	24	05	23	30
HRI	7	3	7	1	5	5	4	2	2	7	6	1	2	4	6	4	1	1
MSA	12	08	00	15	21	18	17	16	13	10	07	16	10	17	12	11	11	14
PEJ														PEJ				
PRH	D	D	D	I	D	D	D	D	D	D	D	I	D	I	D	D	D	I
BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK
>*<																	>*<	
>*>	>*>	>*>	>*>															>*>
>*|									>*|								
ANI																		
OT					OT	OT												
SS				SS			SS	SS		SS	SS	SS	SS		SS	SS		
D&D						D&D												
DRK																		

	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
BLN	03	04	04	04	04	06	06	05	05	05	07	07	01	01	02	02	02	02
TRH	27	05	05	12	30	03	09	03	10	30	03	11	05	14	03	06	10	12
HRI	4	6	6	6	3	2	1	6	6	5	4	5	1	3	2	5	2	4
MSA	15	20	10	21	17	12	16	13	16	13	20	20	13	16	01	18	15	19
PEJ			PEJ					PEJ										
PRH	D	D	I	D	D	D	D	I	D	D	D	I	D	D	D	D	I	F
BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK
>*<		>*<																
>*>	>*>					>*>								>*>		>*>		
>*|															>*|			>*|
ANI																		
OT									OT									
SS				SS	SS		SS			SS		SS	SS				SS	
D&D																D&D		
DRK																		

	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
BLN	09	09	10	10	10	10	10	11	11	11	11	11	12	12				
TRH	06	06	06	08	13	13	23	15	16	09	22	14	22	11				
HRI	1	1	3	4	3	3	6	1	2	2	1	7	3	6				
MSA	23	13	13	14	11	11	14	08	06	11	14	20	17	22				
PEJ								PEJ						PEJ				
PRH	D	D	I	D	D	D	D	I	D	D	D	D	D	F				
BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK	BK				
>*<																		
>*>							>*>											
>*|													>*|					
ANI																		
OT																		
SS		SS		SS		SS			SS		SS							
D&D									D&D									
DRK																		

BLN= BULAN TRH= TARIKH HRI= HARI MSA= MASA

PEJ= PEJ.KAKI PRH= KEPARAHAN BK = BAIK >*<= HEADON

>*>= REAR END >*|= SIDE ANI= ANIMAL OT = OVERTURN

SS = SIDESWIPE D&D= SUBUHSENJA DRK= DARK

Stick Number = Accident Code Number:

1 =021139 2 =022084 3 =023430 4 =030387 5 =019100 6 =019730 7 =020055 8 =025006
9 =025632 10=025898 11=000253 12=027504 13=027706 14=028153 15=029898 16=030053
17=005640 18=006068 19=007627 20=008423 21=008420 22=009096 23=010276 24=012604
25=013342 26=010386 27=010793 28=012139 29=015955 30=016991 31=000659 32=001813
33=004612 34=005113 35=005466 36=005626 37=007209 38=008200 39=008617 40=008743

41=009150 42=009674 43=010265 44=010452 45=011281 46=012372 47=012970 48=016538
49=017877 50=018113 51=021177 52=023359 53=026505 54=027712 55=028721 56=028797
57=033104 58=033357 59=034229 60=034232 61=035419 62=037828 63=037829 64=037219
65=038520 66=037699 67=041581 68=040492

Figure 7: Stick Diagram at Node 225 Seremban

3.2.1 Example of an In-Depth Analysis at Node 225 Yam Tuan/Sheikh Ahmad Junction

Using the available database of 1991 and 1992, it can be seen from Table 1 that the worst blackspot in the Seremban pilot area is node 225. This site is a T-junction on the North-South Federal Road F0001 passing through the middle of Seremban town. The majority of accidents at this site occurred on the major one-way road as shown in the stick and collision diagrams in Figures 7 and 8. Side swipe accidents involving vehicles merging from the side road, Jalan Sheikh Ahmad, constitute the majority of collisions and a total of three injury and one fatal accidents were reported. Another major type of accident involving injury arises from vehicle-pedestrian collisions (one fatal and four injuries) and, at present, there are no special facilities for pedestrians to cross this busy one-way street.

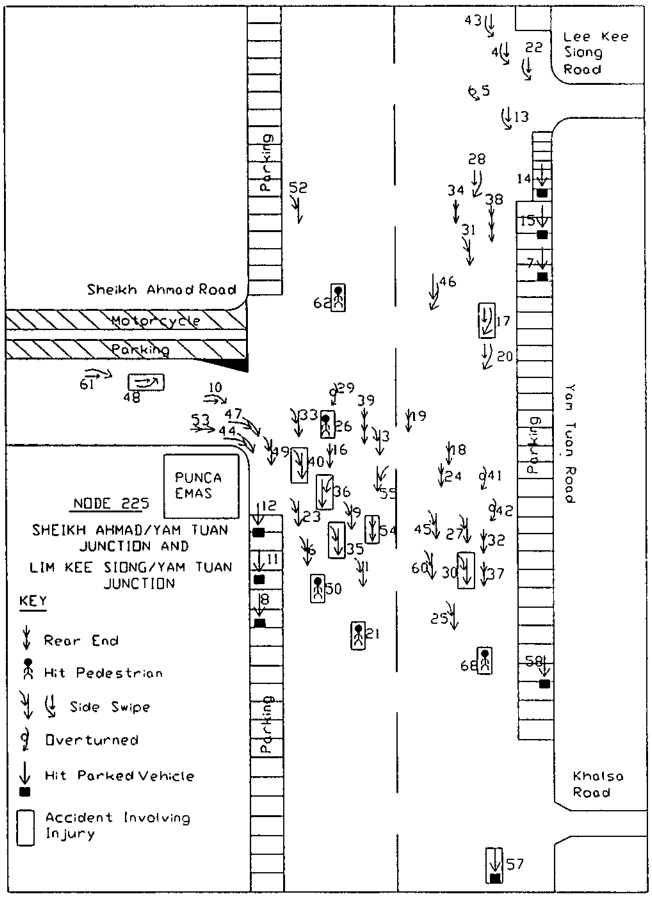


Figure 8: Collision Diagram at Node 225 Seremban

A one-day site study was carried out to capture the near misses, approach speeds, vehicle and pedestrian flows and their manoeuvres. The vehicle and pedestrian flow counts are shown in Figure 9 and the conflicts recorded over the six-hour period are summarised in Table 2. It can be seen that there are relatively large numbers of pedestrians crossing the busy Jalan Yam Tuan (maximum of 890 peds/h) and yet no crossing facilities have been provided. It can be seen also that the merge type of conflict is most prevalent immediately after the Jalan Sheikh Ahmad junction. This is due to the high merging flow which tends not to give way to vehicles from the major stream, often crossing to the left-hand side to Jalan Khalsa as soon as they have joined the main road. Pedestrian conflicts are relatively frequent especially when business activity begins. Approach speeds along the major road were found not to be excessive with a mean speed of 30 km/h and 85th percentile speed of 37 Km/h respectively (Figure 10).

3.3 Proposed Countermeasure

In view of high conflicts amongst the merging and through vehicles, strategy to minimise the number of opportunities for conflicts by segregation would be the best option. A raised pavement extension is proposed to begin the segregated lane in the position as shown in Figure 11. A solid delineator is required downstream of Jalan Sheikh Ahmad so that vehicles joining the main stream will have to form a single file. The channelisation should be extended beyond Jalan Khalsa so that the abrupt crossing conflicts observed will not occur.

Table 2: Traffic Conflicts at Node 225, Seremban

Conflict Manoeuvre Type	Number of Slight and { Serious } conflicts at junction of J. Yam Tuan/J. Sheikh Ahmad in hour beginning:						6-hour Total
	09:00	10:00	12:00	13:00	16:00	17:00	
Merging	34 { 1 }	29 { 2 }	38 { 3 }	39 { 1 }	37	38 { 1 }	215 { 8 }
Pedestrian	0	1	6 { 1 }	8 { 1 }	2	5	22 { 2 }
Rear-end	6	2	7	8	4	6	33
Crossing	4	5	3	1	1	2	16

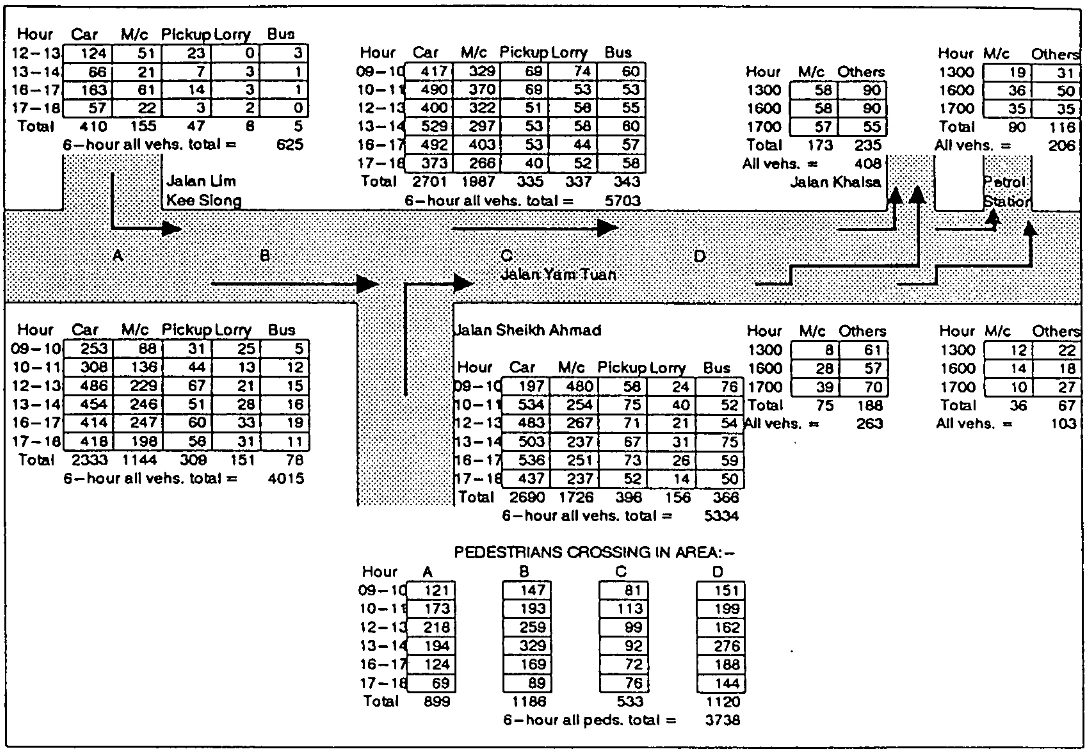


Figure 9: Pedestrian and Flow Counts at Node 225 Seremban

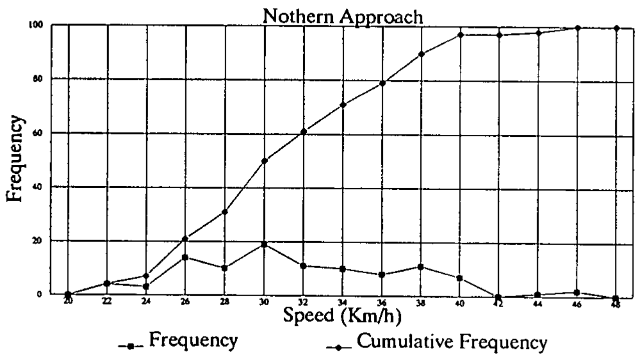


Figure 10: Distribution of Approach Speed at Node 225 Seremban

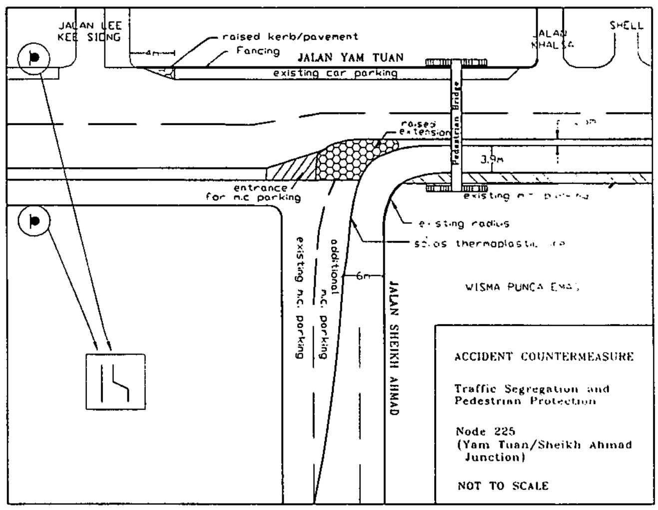


Figure 11: Proposed Channelisation with Pedestrian Bridge at Node 225 Seremban

In order to reduce pedestrian-vehicle conflicts, a pedestrian crossing facilities is strongly recommended. A pedestrian bridge with appropriate guard railing is required to provide a safe crossing facility and to channelise pedestrians to the bridge. Alternatively, if the construction cost of the bridge is too high, a pedestrian refuge may be incorporated in this channelisation scheme as shown in Figure 12. Large road studs along the boundary line of the hatch area and direction arrows on the refuge are suggested to reduce the likelihood of collisions with the new refuge. This arrangement will enable more space to be available for motorcycle parking in the side roads and is, in fact, likely to be more popular with pedestrians than a bridge.

3.4 National Accident Database

Following the success of the pilot project in implementing a flexible diagnosis system and the launching of the new accident form POL27 (Pin 1/91) in January 1992, it was decided in early 1992 to extend the system to the national level. A downloading transcription programme was written in mid 1992[4] and tested with the national accident data available on mainframe computer at Police Headquarters, Bukit Aman. This mainframe computer is used to store all

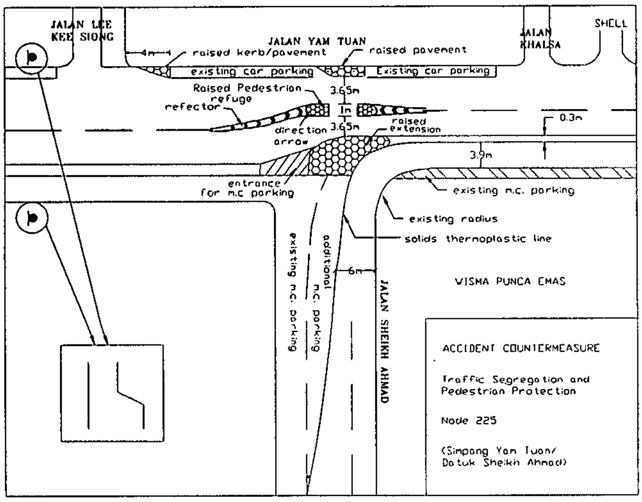


Figure 12: Proposed Channelisation and Pedestrian Refuge Option at Node 225 Seremban

national data and was designed to produce standard accident tables for the national statistics. Since queries on accident statistics from local authorities, JKR, MKJR etc are frequently non-standard and often very specific, this has now necessitated the writing of special Cobol programs by police personnel to meet these requests. The police are therefore very keen to use the diagnosis system, MAAP, to enable them to respond much quicker to such non-standard queries without the need for special software.

A '386' microcomputer has been purchased under this project primarily to perform the task of downloading and converting data formats and to carry out analyses of national accident statistics at Bukit Aman. An on-line computer linkage using a networking system is currently in the process of being introduced. Accident data will soon be accessible to all agencies responsible for road safety and should thus help these agencies tackle accident problems in a more objective and scientific way.

4.0 CONCLUSIONS

An accident diagnosis system and blackspots prioritising system have been developed and tested for diagnosing accident problems in the pilot project areas. An accident treatment framework has been demonstrated which provides a working model for full implementation throughout Malaysia. The new accident form, POL27 (Pin 1/91) has been redesigned and is now in use nationwide (since January 1992). The computer analysis system developed enables a thorough analysis not only on a macro scale but also on specific blackspots. A hazardous location identification system based on accident maps, link-node-cell system and coordinates has been recommended in the urban areas, with a kilometre post system for the rural highways. In-depth analyses of blackspots can be produced by means of stick and collision diagrams.

Appropriate field investigations for capturing supplementary data in order to obtain further indications of events leading to accidents have been demonstrated. Diagnosis of actual causes of accidents at a problem location can now be done expeditiously, more easily and more accurately so that appropriate remedial action can be taken. This process also provides the essential "before" data for carrying out qualitative evaluations of the countermeasures implemented.

5.0 ACKNOWLEDGEMENTS

The authors would like to thank Universiti Pertanian Malaysia, Ministry of Science, Technology and Environment and the National Road Safety Council for funding the research projects and to Dr. Brian Hills of the Transport Research Laboratory, United Kingdom for his technical support which helped make the project possible. The authors are also grateful to the Royal Malaysian Police; in particular, ACP Supian Ahmad, ACP Abdul Halim, ACP Syed Abdul Rahman, ASP Acryl Sani and Insp. Roslan, and also to Dr. Aminuddin Adnan of Pengurusan Lebuhraya Berhad and to all research assistants for their support throughout the duration of the project.

6.0 REFERENCES

1. Radin Umar R.S and Aminuddin A, Accident Investigation Model for Seremban-Port Dickson Highway, Proc. Int. Seminar on Road Safety, JKR/JICA, Kuala Lumpur 1990.

2. Radin Umar R.S, Ahmad Rodzi M. and Aminuddin A, Model Diagnosis Kemalangan Jalan Raya di Malaysia, Paper accepted to be published in the Journal Sains dan Teknologi Pertanika, 802/92, Universiti Pertanian Malaysia, 1993.

3. Improving Traffic Accident Recording and Analysis System In Malaysia, United Nations-Economic and Social Commission foe Asia and the Pacific Report, Thailand 1985.

4. Baguley C.J, TRL Support for MAAP Pilot Project in Malaysia, Technical Paper OU/TP/188/92, MKJR/TRL, Crowthorne, United Kingdom, 1992.