User Initiated Research into Traffic Accident Frequency at Signalised Intersections

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Abstract:

Traffic accidents are a primary interest for traffic engineers and others involved in road safety and community health. However, road safety practitioners often have a limited view of sites and tend to rely on traditional investigation techniques and countermeasures. The roles of different participants provide the interaction between need, research and practice which should be improved to develop more appropriate analytical techniques. Some principles of ensuring that research is applicable to users are discussed. These are illustrated by an example of research into accidents at traffic signals supported by the Main Roads Department in Western Australia and applications which result.

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Investigating traffic accidents is a primary interest for traffic engineers and others involved in road safety and community health. There is a continuing requirement to reduce the number of traffic accidents. Accident frequency is a basic tool used by traffic management authorities to identify hazardous sites for possible remedial treatment. However road safety practitioners often have a limited view of sites and tend to rely on traditional investigation techniques and countermeasures. Consequently there is a need for research to develop improved techniques for investigation. The roles of manager, practitioner and researcher provide the interaction between need, research and practice. The interaction between these elements should be improved to develop more appropriate analytical techniques.

Some principles of ensuring that research is applicable to users are discussed. These are illustrated by an example of research supported by the Main Roads Department in Western Australia. The results have various applications in understanding accidents at traffic signals and investigating particular sites in detail.

Introduction

In the modern era of output orientated organisations most public sector managers operate under considerable real time pressure. Traffic engineers in the public sector who are accountable for the traffic management component of our transport system are no exception to these rules. Pressures are added by such things as the public demand for local area traffic management, the need to reduce the impact of traffic on the community and upon our energy resources and the availability of modern technology. These factors expand the opportunities for system enhancements but bring with them diverse demands for the manager's attention and energy.

In the background of these modern trends there is a demand driven by public opinion that sites where there are high accident frequencies should be upgraded. This demand is reinforced by the manager's own social conscience and in the past year a very large window of opportunity has been opened by the Commonwealth Black Spot Program. The sudden need to increase the traffic output of improvement projects brings with it a compelling need to streamline analysis methods and to produce documentation of projects to a standard sufficient for the purpose of securing Commonwealth funding of the projects.

In this environment it is easy for practitioners to contend themselves with existing analysis tools and continue to apply old methods in selecting and verifying improvement projects. There is little inducement to get involved in sophisticated modelling techniques which even if efficient in themselves require the significant training process to enable staff to apply them properly. In addition, there is the risk

that novel analysis methods however well supported by rigorous research may be judged less acceptable to top level program managers than the time honoured proven techniques

In these circumstances there is little motivation for traffic engineering managers to become involved with research unless there is a perceived high probability of significant return This paper sets out to identify the possible role for the traffic engineering manager in supporting selected research in the specific field of accident frequency at signalised intersections. It attempts to identify roles for the manager and practitioner alongside the researcher in these endeavours and to highlight the possible returns that might be enjoyed through cooperative direction of readily applicable research in this area

Perspectives on transport research

Transport research

In its purest form, research is investigation which leads to information which has not previously been available From the practitioner's viewpoint literature reviews and summaries are research because the concise presentation of information effectively makes it available. More traditional forms of scientific research include theory building, feasibility studies, data collection and analysis, and surveys

Research can be stimulated in two ways according to Noonan (1987). These are curiosity driven (or basic research) and applied research, driven by particular objectives There is some debate as to which type is most appropriate. The Federal Office of Road Safety (FORS) attempts to identify the correct balance between basic and applied research which will produce the greatest social and economic benefits. Applied research is considered most likely to produce outcomes which lead to community benefits being realised in the short term while pure research presents new opportunities. In addition, FORS also tries to prevent unproductive duplication in research and to facilitate synergism wherever possible.

Research as an end in itself is usually wasteful and therefore socially unjustified. It may be useful to the researcher and the research community to undertake research which does not yield any immediate return. However in times of economic downturn there is a strong incentive to avoid expenditure of resources without the expectation of an appropriate return.

Transport is a derived commodity not useful in itself but only in the value it adds to other products and resources. Pure research in transport is thus one step further removed from the productive level than pure research in some other areas A case can therefore be generated to argue that it is vitally important that research in transport should be directed towards immediate application.

The researcher

The researcher is someone who is the major performer in the research process. Normally this person (or group) does (or arranges for others to do) almost all of the activities from finding the existing information, through developing new information to documentation and review The initial and final steps of defining the problem and implementing the results are normally undertaken by others. This separation of the central section from the first and last stages can be a major weakness in the process. Economists argue that people act to maximise their personal benefit (utility). The greatest benefit to researchers as individuals may not require the application of their research It may be sufficient for the researcher to discover not to apply the new knowledge.

McLean (1988) notes that the Australian professional traffic engineering community did not allow in its early days a demarcation between research and practice because they have been so closely interwoven in the development of the discipline. Therefore researchers and practitioners have been difficult to differentiate. This link may be weakened if the distinction is developed in any of the areas involved in research or practice. Training programmes of the 50s produced a professional community which understood, appreciated and supported research. The more formalised research programmes commenced in the 60s may weaken this link. The initial traffic engineering studies conducted in this country were firmly established to address particular problems. Many were implemented specifically to validate theories which had already been adopted as the basis of legislative change such as the system-wide adoption of priority definition at intersections and the compulsory wearing of seat belts. This emphasis towards implementation has also led to the development of Australian standards in the field (McLean 1988). Researchers will provide what the users want if they are the same people. The more removed the researchers are from the users the more likely that the results of research will not be put into practice. Users are rarely managers but managers make research decisions. The research decisions must have input from the practitioners.

In effect the early traffic engineering practitioners saw themselves as the researchers and tended to allow practice to lead research. This placed the onus on the true researcher to monitor the field of practice closely to ensure that opportunities to monitor changes of practice were not lost and with them the chance to better understand their effects on the traffic system.

The practitioner

Users need usability. Any research is wasted opportunity until it is put into practice in some way. Therefore research needs an end focus. The conclusions should be specific enough to make the results affect normal engineering practice. The direction should be identified from the outset so that when the end is reached the implementation naturally follows. Therefore users should be involved at commencement as well as completion. If there are any substantial changes to the direction of the process by other pressures then the users should be consulted to ensure the changes are acceptable. Results must be provided in a form which is suitable for users. To do otherwise is to place the value of the research in terms of its immediate applicability at risk.

Australia's relatively small population limits the amount of intellectual resource available for one discipline. However it promotes the advantage of strong formal and informal links between users and researchers, and between complementary disciplines (McLean 1988).

There appears to be a current trend towards more academics being involved in consulting practice This gives academics and hence institutional research a more practical direction Another trend towards fewer students from industry undertaking higher education in specific scientific disciplines degrades the direction of institutional research.

The manager

Managers have a different set of personal values and goals to either users or researchers. In a transport authority a manager is likely to have a wider view and emphasise organisational and financial aspects He is also more motivated to provide results in a fixed time frame sometimes at the expense of sound change control and such circumstances can result in the loss of research opportunities.

The most useful role the manager can play is to provide an interface between the users and the researchers Practitioners cannot generally communicate with the researcher unless they are closely involved with one another in an area of common interest It is the manager who can ensure this line of communication is strengthened so that practice and research interact to maximise the potential benefits to both.

This is not to suggest that managers themselves should attempt to keep up to date with all current research in their total area of responsibility. The same effect can be realised by encouraging staff to read in areas of interest and discuss material relevant to current activities. Most importantly any management decision to change elements of the managed system should be reviewed in terms of the relevance of recent research and its possible relevance to research opportunities.

A model for transport research

The diagram at Figure 1 shows a series of actions and interactions which illustrate the structure of the research process. The activities which are usually done worst are indicated with an asterisk. In many situations elements of the structure are not specifically recognised and in many situations not all elements are completed. Failure to complete certain elements leads to a weakening of the structure, a loss of quality in the process and a failure to meet the objectives of the research endeavour. The structure is discussed below as it applies research in the field of traffic engineering.

Values

Values are defined as the qualities which make something desirable and important. Values are based partly on fact and largely on emotion. Politics and religion are two common areas dominated by value judgements. There are few technical areas which are strongly affected by values directly. Values are difficult to define. They provide the reasons for attitudes which are predisposed tendencies to act in a particular manner when faced with a particular stimulus. In traffic engineering values which play a major part include mobility, equity and safety. Because elements of the traffic system often favour one of these against others there is a need to set up a clear value system against which to judge the output of the research effort.

The environment in which traffic engineering is currently practised recognises an expressed community goal to improve transport safety. High emphasis on safety drives programs such as the Commonwealth Government Black Spot Program and extensive research into accident mitigation. Perhaps a future generation may consider our efforts should have been directed towards energy conservation in transport. However we are obliged to accept the values of the day.

Identifying goals

Values are not useful in themselves but provide the motivation for actions which follow. Goals are the ends of activities which are consistent with the underlying values. They are based on underlying values and available information. Goals are the basis for constraints on the research process.

Research may be seen as a course to be followed to achieve a specific objective. If the objective is not defined there is an excellent chance that comprehensive research may be undertaken which is of no value. Transport

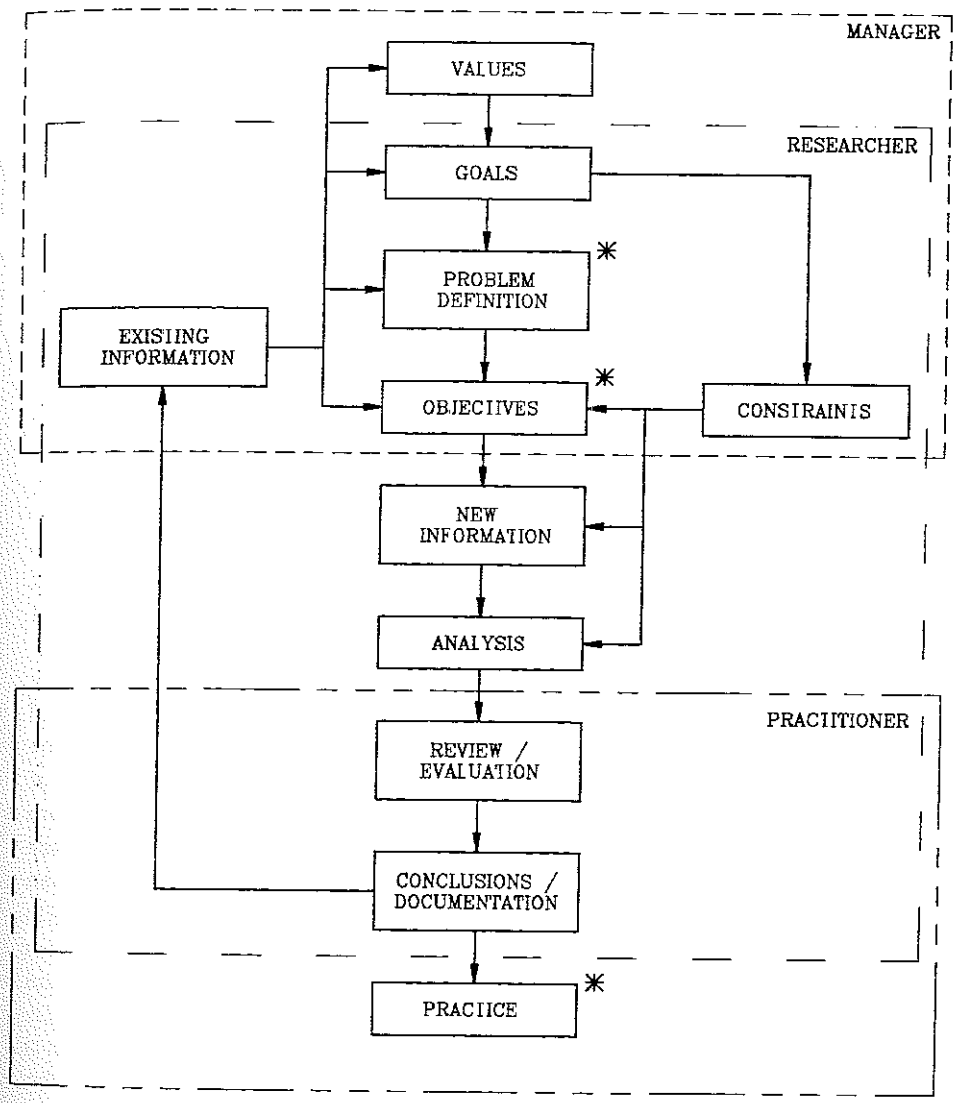

Figure 1. A Model for Practical Research.

research should have the basic goal of improving information which is useful in improving the transport system.

Noonan (1987) identifies that road safety should be based on countermeasure development which is based on high quality research into the nature of the problems being addressed.

Defining problems

Sometimes problems are considered in excellent detail. In other cases they are not specifically thought of at all. Sometimes a benefit of engaging external consultants is that documentation summarises some background including the need for the project. Documents rarely makes the project more general. Writing itself is a process whereby general thoughts are crystallised. Any thoughts written will become clearer and more specific.

McLean (1988) notes three areas of change in traffic engineering; road users, traffic policy and technology These are expected to arise because this branch of transportation is responsive to the demands from the system Therefore there is not a particularly defined or effective mechanism for identifying and progressing issues. Neither is the discipline pro-active in addressing problems which are likely to arise. The advances in the future should be driven from the identification of needs and not merely for the sake of change which is artificially desirable The most significant example is the use of technology. There are a great variety of systems which are technically feasible and notionally desirable. However these are not necessarily needed, nor are they necessarily cost effective. Therefore they should not be arbitrarily accepted as being required without first determining the needs and expected benefits.

Objectives, existing information and constraints

It is at this point that the research endeavour should become focused upon the intended outcome. In particular it is the point at which applied research links contractually to the practitioner and the manager

The defined problem is tested against existing information and validated as a problem worth expenditure of resources in quest of a solution The experimental design process identifies the method of attack upon the problem and the constraints of time, money and technology determine the intensity of enquiry The practitioner or manager, if he maintains his involvement through this stage, develops an expectation of the outcome and if appropriate prepares his plan to exploit the opportunities which the new knowledge will provide.

Data and analysis

Scientific research is often based on numerical analysis of data. In some cases new data is sought while in other situations existing data is reanalysed. The procedure for obtaining data is worthy of a book in itself (Taylor & Young 1988). There is considerable expertise required to efficiently and accurately gather data for research. While cost constraints tend to arbitrarily minimise the amount of data collected, good design should indicate the point beyond which data samples cannot be reduced if the value of the analysis and findings are to be sustained.

Analysis is traditionally thought of as the core of research. This is where the real work is. Someone once said that genius is 10% inspiration and 90% perspiration. Research as a whole could be considered as 1% inspiration, 19% analysis and 80% perspiration. Research supervisors know the work put into a project before it officially starts, and after the data has been analysed. For instance, there is a great amount of work which has not been well documented and is therefore difficult for anyone else to retrieve and use. A tradition of rigorous analysis has been a hallmark of traffic engineering research in Australia (McLean 1988).

Review and evaluation

At this stage the researcher depends heavily upon independent review. The cost to correct any deficiency or ambiguity at this stage in minuscule compared with the cost of misinterpretation or misapplication. The conclusions should also include a critical assessment of the research. Any weaknesses should be specified and the effects defined. In certain circumstances the review may also conclude that more research is required to reach satisfactory conclusions. This may be required immediately or possibly at some later time in the future. Contemporaries can be a very effective part of this activity. It is important that the evaluation methodology is planned in advance of the research and not appended after the event.

The management process used by FORS is designed to include an evaluation phase (Noonan 1987). Nevertheless not all projects commissioned are as successful as originally intended. The management programme attempts to evaluate the outcome of research programmes. This permits definition of future priorities to be formulated in the knowledge of what techniques are likely to produce suitable pay-offs.

McLean (1988) describes an extensive research programme of the 60s which aimed to produce an Australian Highway Capacity Manual. The USA version lacked applicability to Australian conditions due to inadequacies. The research programme languished and was overtaken to some extent by further work in the USA and was never completed. It should be recognised that the research process

should be terminated at any time when the future cost of completion is more than the benefits of the results. In this case the research process was overtaken by an alternative solution to the problem leading to the loss of opportunity to benefit by applying the findings. Abandoning a project is a very difficult step to take since the preceding work is seen to be wasted. We should not be cajoled by hindsight which makes no judgement on previous decisions. Rather decisions must be taken on their merits at a particular time. Equally, we should be careful that if the initial stages of the process are followed then research is much more likely to be successfully completed. This programme suffered to some extent from being over ambitious. Therefore the initial stages of considering resources were not well done. McLean's example suggests that the particular research was overtaken by other events. While a decision to terminate could have been made earlier, it was certainly not made prematurely and the correct decision was made.

Another example is the signalised intersection capacity analysis. This was initially developed for the simplest of cases. Over 20 years the work has been assessed as very useful and has consequently been continually improved and adapted to changing situations (including technology). Here the review has continually kept the research process cycling as results remain useful and practised.

It is also important to recognise the value of findings which prove the negative of the original hypothesis. Viney and Pretty (1988) examined the hypothesis that traffic control signals should be turned off during early morning hours to improve traffic flows. The conclusion was that benefits are too small and accident risks are unacceptable. That is, the research failed to substantiate the hypothesis. Often this result would not be reported because their has not been a benefit proven. In fact there is a negative hypothesis which is very useful; traffic signals should not be turned off during early morning hours. The point is that research information is worthwhile even if the hypothesis has not been proven. Users desperately need to know what doesn't work as much as what does.

Conclusions and documentation

If the aim of the research has been well defined then the essential ingredient of the conclusions will be clear. It should be concluded that the research was successful and the answers to the initial problem have now been provided. However conclusions can be more far reaching. There are instances where the primary question has been answered but there are other conclusions which can also be drawn.

It is imperative that the research is properly documented so that it remains available and accessible to practitioners and students alike. Firstly, it should be available for scrutiny by others so that numerical results can be subjected to further

analysis with a view to extracting further information. Secondly, it should be available for scrutiny with a view to challenge and validation. Finally, it must be available for managers and practitioners to apply in the field.

It should not need to be stated that the documentation should be comprehensive clear and concise. There is a considerable amount of work which has been completed but is not generally available since it is stored in academic archives or on authority files. Survey results are particularly susceptible to this treatment. The Australian Road Research Board is clearly resolved to avoid this situation and its current customer orientation bears clear witness to this attitude.

Practice

Finally the documented information should be put into practice. A purist, isolated researcher may only need to write up a report document but in the real world there is more. Specific studies may not need to be widely circulated although this is normal within most organisations.

Results should be shared with the rest of the learned community for several reasons. First, methods and approaches can be used by others for similar studies. Second, the results may be required by others. The same research does not need to be undertaken again or it may be used for routine information when otherwise it would be unavailable.

If the research has been properly conceived then putting the results into practice can be a major obstacle. This may be the function of either the manager or the practitioner, depending on the results and the reporting technique.

Noonan (1987) notes that the leap from theory into practice is often monumental and many propositions have failed due to a poor implementation phase regardless of the quality of the proposition. Arbitrary divisions between research, policy formulation and implementation tend to isolate the researcher from the problems of the implementation phase. This may encourage the 'ivory tower' concept so appropriate checks and balances are required (ie review).

Example of user oriented research

The authors were involved in an example of user initiated research which led to the production of the report titled "Accident Relationship to Exposure at Signalised Intersections" (Hughes 1990).

The research was inspired by a prime value of our time, the improvement of safety in the transport system. The goal was to enable the Main Roads Department to exploit its stock of traffic volume data in conjunction with accident data to enhance its selection of improvements to traffic signal installations.

The practice had been to use accident frequency alone as an indicator of probable deficiency and to apply treatments which had been shown by before-and-after studies to have been effective in other locations. Effectiveness assessment often depended on accumulation of further accident history and therefore postdated the treatment, sometimes by years. There was a risk that treatments were being misapplied and in addition the methodology could not address situations wherein the signal modifications were to be accompanied by significant changes in traffic patterns.

The major proposition was that:

> The majority of accidents at traffic signals can be categorised into a few types. Variations between observed frequencies can be substantially related to the differences in traffic volumes.

Therefore the primary objective was:

> To develop a typical relation between major accident types and conflicting movement volumes at intersections controlled by traffic signals

Problem definition and a review of existing information were undertaken by the authors generally in the course of daily work and professional development. The opportunity to progress the project came with the award by the Department of a bursary for a year of study and research.

The research investigated 121 traffic signal sites based on routinely available accident history and traffic counts. Accident information was from reports to police of fatal, injury and property damage accidents over a 4 year period. The traffic volume information was based on turning movement counts factored to represent annual traffic flows.

The analysis disaggregated accidents by type (rear end, sideswipe same direction, right angle and indirect right angle) for individual approaches and complete intersections. Statistically reliable relationships to accident exposure were found. Therefore it was concluded that typical accident patterns could be predicted at traffic signal controlled intersections.

In addition to the presentation of a report the information was documented, presented in forum and made available in spreadsheet form for use by members of staff. Thus other users had a better understanding of the information than would be obtained by merely studying a method from a handbook. However its advent coincided with that of the Commonwealth Black Spot Program which encouraged the use of conventional analysis methods and demanded the unswerving attention of staff. The method is confidently expected to find extensive application in the review phase of that Program.

The work has provided a basis for further research such as the comparison of operation of existing roundabout sites to determine the most suitable form of control at these intersections. A similar investigation to compare staggered T junctions and single intersections in different circumstances is also considered to be an appropriate extension of the work.

This research project derived several advantages from the circumstances in which it was undertaken. Firstly, a practitioner undertook the research. Relevant background such as typical practice, weaknesses, alternative opinions and theory were to a certain extent understood before resources were committed. The problem and the research objectives were easily defined because they developed naturally from daily work practices. The research was completed within the minimum resources available as demanded by the constraints which applied. Subsequently the results were distributed to users in an appropriate and educational form. However, the extent to which widespread practice changes remains to be seen. Certainly the commissioning authority obtained what it sought, the means to more rigorously diagnose and prescribe treatments for apparent safety deficiencies of signalised intersections.

Conclusions

McLean (1988) suggests that traffic engineering research in Australia has lost a focal point. There is no forum or coordination and therefore no consensus of issues and needs. He suggests that new institutional frameworks may develop to address this neglect.

This paper has outlined the roles of the researcher, practitioner and manager in a particular example of research into traffic accident frequency at signalised intersections. It identifies the opportunities presented by a piece of research jointly supported by these three suppliers.

It is clear that the increase in knowledge generated by this study presents an opportunity to enhance the performance of the traffic system. It can be expected that having participated in the acquisition of this knowledge the practitioners will ensure it is exploited to its full potential.

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