GUIDELINES FOR THE PROVISION OF BYPASS ROADS AT AND THROUGH-WAYS IN CITIES AND TOWNS

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ABSTRACT

Roads provide linkages between cities and towns, neighbouring countries, and to other points of interest. Up until the mid-20th century, roads forming part of the national network in South Africa generally passed through cities and towns. As these areas grew and traffic volumes increased, it became clear that bypasses would be necessary. In 1960 the National Transport Commission adopted its freeway policy which included the concept of bypass roads.

Despite the adoption of the concept of bypass roads, the provision of these roads remained a controversial issue. The perceived benefits to the city or town of through traffic are weighed up against the benefit of a bypass to long-distance traffic in terms of travel time and cost, and road safety considerations.

The aim of the paper is to provide guidelines for the planning and management of bypass roads and through-ways, as well as for the economic impact analysis of these roads.

The paper refers to Christaller's Central Places Theory which explains the spatial distribution of a system of cities and towns, as well as the road network linking these centres with one another. The assessment of the need for a bypass road is then addressed. Guidelines are provided on aspects such as land use development, road network planning, and route determination principles. An economic analysis framework, addressing both social cost-benefit analysis and economic impact analysis methodologies, is presented. Finally certain conclusions are reached.

The paper is based on a research project, Project P2.5 of 2018: "Provision of bypass roads and through-ways in settlements, towns and cities", conducted as part of the SANRAL Research Programme.

1. INTRODUCTION

1.1 Background

National roads provide links between cities and larger towns, and neighbouring countries. Up until the mid-20th century, roads forming part of the national network generally passed through cities and towns, also linking them to the network. As cities and towns grew and traffic volumes increased it became clear that bypasses would be necessary (Mitchell & Downie, 2018). In 1960 the National Transport Commission adopted its freeway policy, including the concept of bypass roads (The Civil Engineer in SA, 1970).

TRH26 (COTO 2012) defines a bypass road as a “high standard mobility road with limited access designed to carry traffic which does not have a destination in the urban area which is bypassed.” The function of a bypass road is therefore to enable through traffic without a destination in a town (or city) to bypass that town. TRH26 (COTO 2012) states that these roads are treated as rural roads for functional classification purposes.

A through-way fulfils the same function as a bypass road and is defined by TRH26 (COTO 2012) as follows: “A through-way is similar to a bypass, but one which passes through rather than around an urban area”. Although located in an urban area, these roads are also treated as rural roads in the TRH26.

Despite the above logic, the provision of bypass roads has long been a controversial issue. The perceived benefits to the city or town of through traffic are weighed up against the benefit of a bypass to long-distance traffic in terms of travel time and cost savings, and road safety considerations (Floor, 1985). The question remains, under what circumstances should bypass or through-way roads be provided and what will the impact of such roads be on the communities being bypassed? How should the impact be analysed and how should the network be planned and designed to minimise negative impacts on the town while benefitting long-distance traffic?

SANRAL, as part of its research programme, appointed a research team to investigate the provision of bypass roads and develop the following:

- A guideline document for the planning and management of bypass roads and through-ways.
- A guideline document for the economic impact analysis of roads, specifically bypass roads and through-ways.

This research project, Project P2.5 of 2018: “Provision of bypass roads and through-ways in settlements, towns and cities”, forms part of Research Focus Area 2: Transportation planning, economics, public administration, and management.

1.2 Aim of the Paper

The aim of the paper is to provide an overview of the contents and findings of the above-mentioned research project.

1.3 Scope of the Paper

The scope of the paper is as follows:

- Discuss the role of the road network in supporting human settlement and activity.
- Provide guidance on the assessment of the need for a bypass road.
- Suggest a planning framework and highlight aspects related to route determination for bypasses.
- Address the economic analysis of the investment to provide a bypass road. A distinction is made between social cost-benefit analysis (SCBA) and economic impact analysis (ECIA).
- Present conclusions.

2. ROAD NETWORK ASPECTS

2.1 Central Places Theory

The German geographer, Walter Christaller, studied urban systems in Germany during the 1930s. He investigated the characteristics of cities and towns within a regional context, focussing on their relationship in terms of services offered, their relative size, and their geographic distribution. His findings transpired in a theory of spatial structure and order, addressing urban, economic and transportation geography. This theory is referred to as Central Places Theory (Jean-Paul Rodrigue, 2020).

In summary, Central Places Theory attempts to explain the spatial distribution of a system of towns and cities. This distribution is built around the concept of a centrally located "place" with a certain market area; and offering certain goods and services to the surrounding population. Such goods and services could include commercial services (shopping), educational services (schools and tertiary institutions), medical services (medical doctors, clinics, and hospitals), and administrative services. Consumers within the market area travel to the central place to obtain the services and goods. The "central place" is part of a hierarchy with other central places, forming a spatial order. Figure 1 illustrates a system of central places according to the market principle, with three orders of centres. In this case, the market area of a centre of higher order includes the equivalent of three market areas of centres of the next lower order. As an example, in terms of educational facilities the lowest order centre may have primary schools which are relatively small and require a small catchment area to be viable. The middle order centre may also have secondary schools which are more specialised, have more pupils and require a larger catchment area to be viable. Tertiary level education facilities (for example universities and colleges) require an even larger catchment area to be viable and will be encountered at the highest order centre.

2.2 The Road Network

Seen in the light of the Central Places Theory, the role of the local road network is to connect consumers to service centres. Within a service centre or town these roads are generally centrally located to provide optimum access to the town.

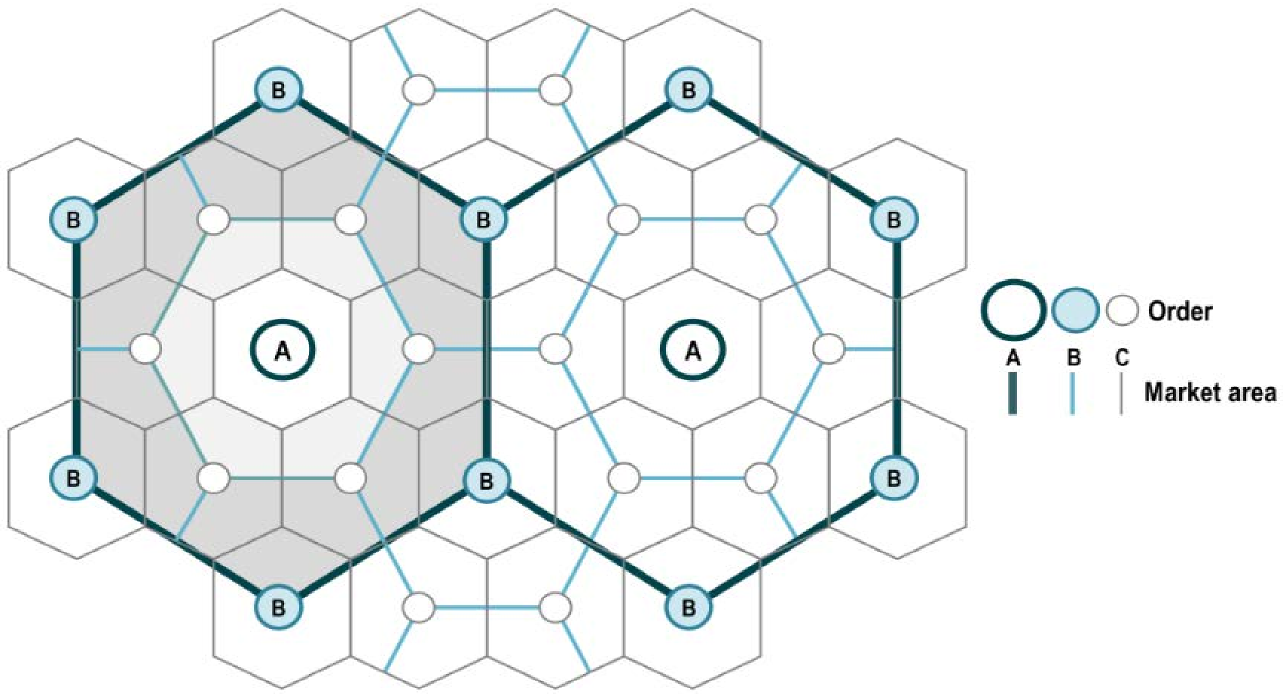

Figure 1: Schematic presentation of the Central Places Theory (Market Principle) (Jean-Paul Rodrigue, 2020)

Apart from servicing local traffic, the local network was historically also used by long distance traffic. With relatively low traffic volumes there was no need to duplicate the basic road infrastructure at service centres. Towns and other urban centres were also generally smaller than today and offered less resistance to through traffic. Travel speeds were lower, partly because of vehicle technology, and partly because of lower road design standards. Time lost travelling through a town wasn't considered a problem. With economic development, growing towns and increasing traffic volumes over time, however, it became necessary to consider new strategies, and specifically the provision of bypass roads for long distance traffic.

Regarding the modern view on long distance travel, TRH26 (COTO 2012) refers to the concept of travel stage. When a long-distance trip is undertaken, travel is undertaken in three stages, local travel at the origin, then through travel, and again local travel at the destination. While local travel is served by access roads, through travel should be served by mobility roads. The implication is that in a well-classified and functioning network, through traffic should not need to travel on access roads during the through phase of travel. Ideally, bypass roads should therefore eventually have to be provided around cities, towns, and other concentration points serving local consumers, where the role of the bypass is to provide mobility to the long-distance traffic - in terms of TRH 26 (COTO 2012).

3. ASSESSMENT OF THE NEED FOR A BYPASS ROAD

3.1 Identification of the Need for a Bypass

In many instances, main roads do still pass through towns. As the town grows, the capacity of the local roads is required for local traffic to a point where the provision of facilities to remove through traffic from the town needs to be considered, for the following reasons:

Seen from the perspective of the town (CUTR 2014):

- The impact of congestion and other negative factors such as noise, air pollution, and vibration become a burden to the town.
- Road safety within the town deteriorates due to increased traffic volumes.
- Pavement deterioration becomes a challenge, especially where the pavement wasn't designed for the high traffic loading.
- Crime and other social challenges related to high volumes of through traffic affect the urban quality negatively.

Seen from the perspective of through traffic:

- The level of resistance of travelling through the town becomes overriding.
- Significant time and travel cost savings can be achieved by bypassing the town.
- Safety benefits related to the bypass road, compared to travelling through the town, become significant.

The questions normally asked when the provision of a bypass road is considered, include (CUTR 2014):

- Is a bypass the best solution to the congestion experienced in the town?
- What can be done to alleviate such congestion, apart from the provision of a bypass road?
- In terms of solutions, what are the alternatives, and the benefits and costs associated with each?

3.2 Aspects to be Considered

One of the most important factors to consider in the assessment of the need for a bypass road is the impact of through traffic on the main road passing through the town. When local traffic volumes are low enough for the road infrastructure also to be able to accommodate the through traffic, a bypass road is probably not required. The exception would be negative impacts of through traffic other than increased traffic flow, for example noise, pollution or road safety considerations. In the case where local traffic is so high that through traffic has a significantly negative impact on traffic flow conditions in the town, consideration should be given to the provision of a bypass road (CUTR 2014).

Regarding through traffic, it needs to be established whether such traffic requires services within the town. Typical services required include fuel and food, but also accommodation. While services related to fuel and food can relatively easily be made available along a bypass road or between towns, accommodation tends to be provided inside towns. As a result, in cases where significant accommodation needs exist it will be important to ensure easy and adequate access to the town. This would typically apply to a town which is a day's travel away from a large centre (where a large proportion of trips start or end).

The nature of the traffic on the main road needs to be considered. In the case of high-volume corridors, the provision of a bypass road is a higher priority than in the case of lower-volume arterial roads. The same applies to routes experiencing high traffic growth, or with a high percentage of heavy vehicles.

The spacing of towns along a corridor influences the bypass road decision. In the case of towns being far apart the impact on long-distance traffic driving through the town is less severe than in the case of towns located close to each other. The probability that services like accommodation, food and fuel will be required is also higher in the case of towns being located far apart. An example of a route with towns closely spaced is the old road from Bela-Bela to Polokwane in the Limpopo Province, and of a route with towns relatively far apart, Kimberley to Victoria West in the Northern Cape. Table 1 compares the characteristics of these routes. The average distance between towns on the Bela-Bela Polokwane route is 47km, and an estimated 9.2% of the distance is travelled in built-up areas (taking 18.2% of the travel time). The average distance between towns on the Kimberley Victoria West route is 91km, and approximately 2.4% of the distance is travelled in built-up areas (taking 5.2% of the travel time). In the Bela-Bela Polokwane case National Route N1 was constructed around 1990 as a route bypassing the towns, while on the Kimberley Victoria West route the road still passes through the towns (except for Strydenburg which is bypassed). The motivation for the N1 bypass along the Bela-Bela Polokwane corridor was of course wider than the aspect discussed.

Linked to the above, the provision of bypass roads should ideally not be considered in isolation. The corridor effect needs to be studied. From the perspective of through traffic it is not sensible to provide a bypass route at one town only while similar challenges are experienced at the preceding or the next town(s) and are not being addressed.

One of the most important considerations for a bypass road is when the negative effects of through traffic affect the town adversely. Negative effects not only refer to quality-of-life aspects (noise, pollution, and crime, for example), but also the economy of the town. If the local economy is built around tourism, for example, or the town is a retirement destination, a bypass road will probably be economically beneficial to the town’s economy.

4. PLANNING FRAMEWORK

The approach towards the planning of bypass roads needs to focus on the role of these roads in the wider road network, the impact on the urban centre (town) and mitigation measures, and the economic justification of the project.

4.1 Bypass Road Characteristics

A bypass route needs to be planned in such a way as to address the following aspects, where applicable:

(a) When the town is visible from the bypass road and access roads are well located, it has the benefit that passer-by traffic with a need for specific goods or services in the town can easily access the town.

(b) Linkage between the town and the bypass road is also necessary to serve the needs of the town in terms of connectivity to the network. The town generates and attracts traffic on the regional network and should therefore be easily accessible.

(c) Sufficient space should be allowed between the bypass route and the town to allow for the growth of the town without the need to encroach onto the bypass road or jump across it. Yet, the bypass road should also not be so far from the town that interaction with the town is lost, as discussed in the previous point.

Table 1: Comparison of trip characteristics between two case studies

Name of city or town	Distance: Centre to centre (km)	Distance in open area (km)	Distance in built-up area (km)
Route: N14 in the Northern Cape			
Kimberley			3.5
Hopetown	126	122	1.8
Strydenburg	55	54	0.3
Britstown	79	78	1.3
Victoria West	104	101	2.0
Total	364	355	8.9
Average distance between towns	91		
% Distance		97.6%	2.4%
Average speed (km/h)		110	50
Travel time (hrs)	3.40	3.23	0.18
% time		94.8%	5.2%
Route: N1 in Limpopo			
Bela-Bela			1.5
Modimolle	28	24	4.9
Mookgopong	46	42	2.9
Mokopane	52	48	5.3
Polokwane	62	57	2.6
Total	188	171	17.2
Average distance between towns	47		
% Distance		90.8%	9.2%
Average speed (km/h)		110	50
Travel time (hrs)	1.89	1.55	0.34
% time		81.8%	18.2%

(d) The number of access links from the bypass road to the town, the location of such access links and the spacing of intersections need to be considered. Access points at both ends of the town will in general make it easier for through traffic to visit the town, should there be a need for it. A single access point, on the other hand, will make access more difficult, but could be a measure to better protect the town against through traffic, should it be a requirement. The number of access roads has cost implications that must be considered. Refer to Figure 2 in this regard.

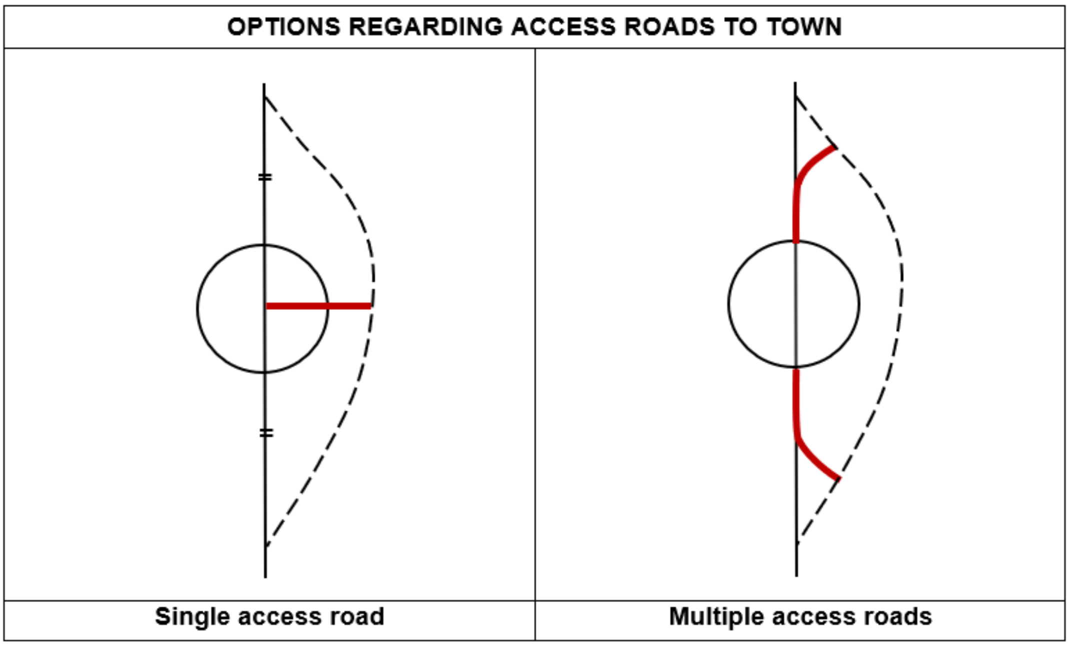

Figure 2: Options regarding access roads to a town

(e) The location of other long-distance roads (typically cross-roads) leading to the town needs to be considered. Ideally traffic from these roads should be diverted to the bypass road without a need to travel through the town, in other words, the bypass should be positioned in such a way as to intersect such access roads. Refer to Figure 3 in this regard.

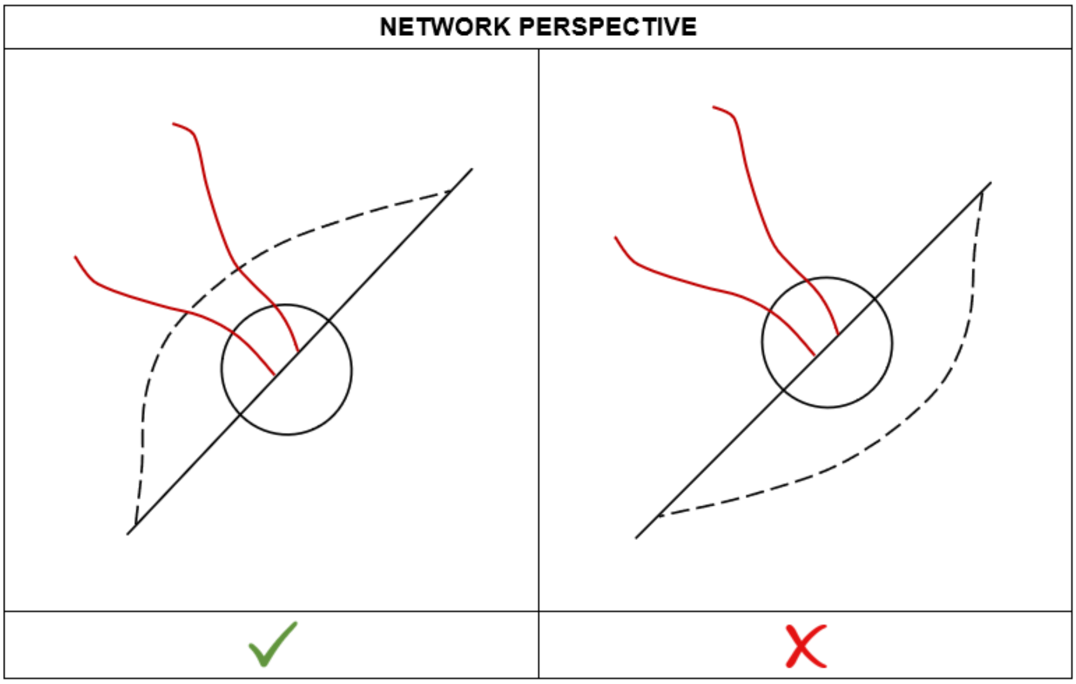

Figure 3: Local of a bypass road: Network perspective

(f) The possible effect of local traffic using the bypass road for short distances should be considered. Ideally the local road network should be planned in such a way as to eliminate the need for local traffic to travel on the bypass road, i.e. a secondary network should be in place.

(g) Proper integration of the access road(s) into the town's road network needs to be addressed. The town should have a road network masterplan in place which will form the basis of this integration.

(h) The intersections between the bypass road and the access roads to the town need to be designed for current and future traffic flow and volumes. From a road reserve perspective, it may be necessary to make provisions for future intersection types on the bypass road, such as interchanges. Staged implementation in a traffic-growing situation needs to be considered (also refer to Paragraph 4.6).

(i) Regarding the alignment of a bypass road, the designer should establish whether there are features or barriers which could be used to direct the alignment of the bypass road. Examples include the foot of a mountain range, a railway line, a river, or a nature reserve boundary.

(j) A "through-way" in essence fulfils the same function as a bypass road but is provided within the town, rather than around the town. The designer should establish whether a bypass road or a through-way is more appropriate. A through-way will typically be considered in cases where there is insufficient space for a bypass road, or where the additional travel distance due to the bypass option is too long to be practical.

(k) In the case of a through-way consideration should be given to the negative impact of the road dividing the town into two (creating physical and possible social divide). The design should strive to avoid or minimise the barrier/partitioning effect. This can, for example, be addressed with the provision of several grade separated crossroads and pedestrian crossings to link the two sides of the town. The through-way can be positioned such that the negative effect on community life is minimised, for example by placing it between a residential and an industrial area.

(l) If service facilities in terms of fuel, food and accommodation are required along the bypass road, the optimum position for such facilities should be identified. Factors to be considered are ease of access, visibility, and impact on the town. The options of placing such a facility on one side of the bypass road only, or duplicating it on both sides, should be evaluated.

(m) Intersections should ideally be located at points where the vertical road alignment is conducive to at-grade or grade separated junctions, both for road safety and cost of construction considerations.

(n) Road signage is to be provided as per the normal design convention (SADC RTSM, 2012). Adequate provision must be made to inform long-distance travellers about the presence of the town being approached. The need for special signage to guide the road user to facilities such as a police station, medical facilities or a filling station must be established and addressed as part of the bypass investigation.

(o) In certain cases, there may be a need for noise reduction measures, such as sound barriers.

(p) Regarding public transport and non-motorised road users (NMT) the following questions need to be addressed: What will the impact of the bypass road on public transport be? How can public transport be enhanced? How will needs related to NMT be addressed? Are there specific infrastructure or operational requirements which need to be addressed?

As with all road projects, alternative solutions for the bypass road should be identified, quantified, and compared in terms of benefits and disadvantages.

4.2 Road Network Efficiency

An important reason for providing a bypass road is to benefit both local and through traffic. These benefits typically consist of the following, and need to be quantified:

- Travel time savings.
- Travel distance savings if any.
- Travel cost savings.
- A reduction in the level of congestion and delays experienced.
- Road safety improvements.
- Reduced emissions.

Local traffic also gains from less congestion, menacing foreign heavy traffic and foreign through travellers who are not familiar with local conditions. Other aspects to be addressed include:

- The traffic mix (heavy versus vehicles).
- The role of public transport along the main route.
- Local versus long distance travel.
- Level of service (LOS) before the implementation of a bypass road, and projection of the LOS to be expected, not only in the town, but also on the bypass road.

Quantification of the above benefits is being done as part of the Social Cost Benefit Analysis (SCBA) methodology, referred to in Section 5 of the paper.

4.3 Role of a Bypass Road in the Regional Network

A bypass road in a town should never be considered in isolation. The influence of the bypass on the regional network needs to be assessed, specifically along a corridor. The long-distance road user should experience a certain level of consistency when travelling along a route/corridor. This would imply a similar approach to bypass roads in towns along this route/corridor.

The influence of the provision of a bypass road on the regional network in terms of possible capacity or road safety problems being created or worsened needs to be considered and solutions need to be developed.

An urban centre’s role within the broader region also needs to be considered. Certain towns and cities on a larger spacing, say 500km apart, function as overnight stopover centres. For such towns, easy access to the road network is more important than in other cases. As an example, Beaufort-West and Bloemfontein are popular destinations to overnight in on the N1 corridor between the Western Cape and Gauteng.

As previously discussed, the spacing of towns in the region also needs to be considered.

4.4 Spatial Planning

Spatial planning is in South Africa being done in terms of the Spatial Planning and Land Use Management Act (The Presidency, 2013). The local municipality is the authority primarily responsible for land development and local municipalities will generally have a spatial development framework for the municipal area in place. Schoeman (2004) refers to the role of integrated development plans (IDPs) in urban development, as well as the integrated nature of land use and transportation in urban areas. Integrated Transport Plans (ITPs) serves as a sector input in the preparation of IDPs.

When a bypass road is being considered, it is essential to ensure that the bypass road is properly integrated into the local land use planning framework and ITP.

4.5 Alternatives

As with route alignment investigations in general, it is necessary to define bypass alternatives - refer to the requirements for the Basic Assessment Report as spelt out in Appendix 1 of the 2014 Environmental Regulations (Department of Environmental Affairs, 2014) in this regard. A minimum of two alternatives should be defined and investigated. The continued use of the route through the town is in normally the Do Minimum alternative.

Alternatives should be addressed at an early stage as part of the road network master planning and road functional classification process (which should in turn be integrated with the broader spatial and transport planning processes).

4.6 Interim Solutions Versus Final Solutions

In some cases, it may not be possible/practical to implement the final solution at the time when solutions are being considered. Restrictions may include insufficient funding, land development considerations, or traffic volumes being too low to justify the final solution. In such cases interim solutions need to be developed in such a way as to enhance the final solution.

4.7 Heavy Vehicle Bypass Roads

In terms of vehicle class, the largest impact of through traffic in a town is generally attributable to heavy vehicles. This impact includes congestion, pavement deterioration, noise, air pollution, illegal parking, and attracting negative elements to the town. In some countries bypass roads are provided for heavy vehicles only, for example in Australia (Queensland Government). Although it is not the practice in South Africa to provide such roads, it is an option worth considering.

4.8 Mitigating Measures

With the provision of a bypass road, there will be positive aspects and/or negative impacts on the town and its business community, mainly in terms of the local economy. Certain mitigating measures can be considered to counter any negative effects:

- Measures to enhance the attractiveness of the town centre or the area along the arterial road, such as urban renewal/beautification initiatives, the provision of pedestrian/parking facilities, or the implementation of traffic calming measures.
- Initiatives that could be implemented to strengthen the town’s economy, for example the enhancement of current economic opportunities and the development of new opportunities (tourism attractions, for example).
- Upgrading of existing roads within the town to better serve local traffic.

- Road safety improvements.
- Improvement of public transport facilities and NMT infrastructure.

5. ECONOMIC ANALYSIS

5.1 Social Cost Benefit Analysis

The social cost-benefit analysis (SCBA) of road projects is a well-known methodology being applied to evaluate the economic feasibility of the investment in a road project. The approach to SCBA is addressed in TMH20 (COTO 2018). In terms of the application of the methodology the HDM-4 software package is widely used for the analysis (Kerali, 2006). The implementation cost of economically viable bypass road and through-way projects is justified by the direct savings in travel time, vehicle running costs (notably fuel consumption) and improvements in road safety resulting in lower overall accident costs. These savings are not only experienced by through traffic but also by local traffic in the bypassed area when congestion is eased by the diverted traffic.

Apart from providing an indication of whether a bypass road project promises to be economically viable, an SCBA is also utilised to give guidance on:

- The timing of bypass implementation.
- Location of the route alignment.
- The capacity to which it should be supplied.

The decision on the route alignment addresses the choice between the road bypassing the town in the form of a bypass road or run through the town in the form of a through-way.

Traffic congestion and an increase in accident rate on the primary route through the town are usually the main indicators that increased traffic capacity needs to be provided. Streets can be widened by adding additional lanes, pairs of one-way routes can be established, additional traffic controls can be installed, and other measures applied that do provide relief, but in general the construction of a new road would eventually be necessary.

5.2 Economic Impact Analysis

Apart from the benefits to road users, bypass roads and through-ways also have ‘non-road user’ consequences for local communities. Bypass roads will as a rule be of net general economic advantage when the projects are economically viable from an overall road user perspective. However, although economically viable on an economy-wide basis, particular non-road user groups within the bypassed area might perceive them as economically disadvantageous. The evaluation of road user consequences falls within the ambit of SCBA, while community consequences are dealt with within an ECIA.

In the ECIA the impact that road provision and use will have on regional income is investigated. The focus is on the expected performance of a road project as an economic growth and development instrument (i.e. income growth and broadening of the income base) in a region. Whereas SCBA is the method used to determine whether a project is economically viable and for the ranking of projects, an ECIA is applied to indicate and quantify the economic impacts of a project on the economy in an area (Kearney, 2022; Quantec, 2022).

The methodology according to which an ECIA of a bypass or through-way project must be undertaken consists of an estimation of the following:

- The once-off regional income that results from investment in the road project during its construction period.
- Recurring regional income that results from operation and usage of the road during its service period. Of interest here is the gross value added by kind of economic activity for the country, the province, and the municipality in which the bypass road will be located.
- The impact that the road would have on employment levels, price stability, balance of payments stability, and on the equitable distribution of wealth.

An ECIA of a road project should be done in tandem with the project's SCBA. Where relevant, the same input parameters should be used. The results produced by the SCBA will serve as partial input into the ECIA.

It is foreseen that ECIA will be addressed as TMH 20 Volume 2, to be produced within the near future.

5.3 Transportation and Traffic Studies

Bypass roads and through-ways will require transportation and traffic studies such as origin-destination studies, capacity analysis and modelling of expected changes in traffic flow. These studies serve as input to both the SCBA and the ECIA and provide guidance on future economic growth rates, changing and emerging traffic classes, changing vehicle mixture, land-use changes, and geographical redistribution of economic activities at the traffic generating trip origins and traffic attracting destinations of the long-distance mobility route, as well changing travel patterns in the bypassed local urban area.

5.4 Winners and Losers

An ECIA is usually undertaken when there is public concern about the impacts of a proposed project. Net beneficial road projects do not always lead to improvements for all groups and there are often situations in which a road project could be to the detriment of some groups.

One of the limitations of SCBA is that it is based on the Pareto principle that winners can, in principle, compensate the losers of a project and still be better off. If the losers are compensated there would in theory be no losers. Whether such compensation occurs is another issue which does not form part of an SCBA, but which should be addressed as part of an ECIA. The general principle regarding assessment of compensation is that it serves as reparation for loss or harm suffered. Therefore, compensation should be that amount of money that will put the losing or harmed party in the same position it would have been had it not suffered the loss or harm.

6. CONCLUSIONS

The paper provided an overview of the contents and findings of the research project, "Provision of bypass roads and through-ways in settlements, towns and cities" (SANRAL Research Project P2.5 of 2018).

The role of the road network in supporting human settlement and activity was discussed by providing a short overview of the Central Places Theory. Although, ideally, all cities and towns should eventually have bypass roads, especially on the national road network, it is not always practical or feasible to implement such bypass roads. Guidance was provided on the assessment of the need for a bypass road.

A planning framework was then suggested, highlighting several aspects to be considered in the planning of a bypass road (or a through-way). The focus was not only on aspects affecting the road itself but also on measures to be considered for implementation within the town itself. It was pointed out how several of these aspects influence the route determination phase of a project.

The economic analysis of the investment to provide a bypass road was addressed. A distinction was made between social cost-benefit analysis (SCBA) and economic impact analysis (ECIA). It was demonstrated that whereas SCBA is the method used to determine whether a project is economically viable and for the ranking of projects, an ECIA is applied to indicate and quantify the economic impacts of a project on the economy in an area.

It is believed that the guideline documentation developed will be of benefit to engineers, town planners and economists involved in the investigation and planning of bypass roads and through-ways.

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