Application of traffic impact studies as part of the EIA process: a case study as applied to the extension of a mineral processing plant

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Abstract

The publication of the National Environmental Management Act (NEMA) (Act 107 of 1998) in South Africa introduced a new approach to and the role of environmental and transportation planning in development. NEMA provides the framework for co-operative environmental governance and promotes the application of environmental assessment and management tools to ensure integrated environmental management of activities. The intention of NEMA was formalized through the publication of the EIA Regulations (2006).

On 3 August, 2010 the revised NEMA EIA Regulations were promulgated that included changes in the process, procedure and listing of activities. With the proclamation of the EIA Regulations the need to determine the impact of traffic (TIS or TIA) within a development site (activity in terms of environmental authorization) became an optional addition as a specialist report. The paper includes the methodology and lessons learnt in the process (case study) of traffic impact study (or assessment) (TIS/TIA) formulation. This intricate interface between the environmental impact assessment (EIA) and TIS/TIA processes and formulation are being investigated based on content, application and implementation principles. The paper is concluded with recommendations as how to mitigate the impact of traffic within a development site in context to the EIA process for activity authorization.

Keywords: traffic impact assessment, transportation planning, environmental assessment, sustainable development, environmental mitigation measures.

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1 Introduction

South Africa was slow to develop and institute formal procedures for environmental assessment. It was only with the enactment of the Environment Conservation Act [1] that provision was made to determine environmental policy to guide decision-making and to prepare environmental impact reports [2]. The publication of a document entitled '*Integrated Environmental Management (IEM) in South Africa'* [3] introduced the concept of environmental management. The term IEM was chosen to indicate a general approach that integrates environmental considerations across all stages of the planning and development cycle and would be applicable to policies, programs, plans and projects [2].

The publication of the National Environmental Management Act (NEMA) [4] introduced the new approach to and role of environment in development. NEMA provides a framework for co-operative environmental governance in South Africa and promotes the application of environmental assessment and management tools to ensure integrated environmental management of activities [5]. The intention of NEMA was formalized through publication of the EIA Regulations (2006) [6]. On 3 August, 2010 the revised NEMA EIA Regulations [7] were promulgated that included changes in the listing of activities.

The alignment between the application of the EIA process and the need for traffic impact studies or assessment (TIS/TIA) is being applied in South Africa based on the nature and extend of such activity and the judgement of specialists involved in environmental authorization processes. There exists thus no formal guiding policy or legal requirements enforcing TIS/TIA formulation other than as a requirement for a specialist report in terms of the environmental authorization process. The purpose of this paper is to highlight the importance of a TIS/TIA to inform environmental authorization processes and how to implement applicable mitigation measures to support sustainable development.

2 Research methodology

The research methodology applied includes the following focuses: policy, legislation and literature considerations; case study content, approach and application; reporting on case study main results from a TIS/TIA perspective and EIA and TIS/TIA mitigation measures, recommendations and implementation.

3 Policy, legislative and literature considerations

3.1 Policy overview

Various tools exist in order to guide environmental management and include Environmental Management Frameworks (EMFs); Strategic Environmental Assessments (SEAs) and Cumulative Environmental Assessments (CEAs) that informs the formulation of EIA. TIS/TIAs on the other hand, is being informed by Integrated Development Plans (IDPs), Spatial Development Frameworks (SDFs); Land Use Management Plans (LUMPs); Land Use Schemes (LUS) (statutory planning procedures); Integrated Transport Plans (ITPs); Public

Transport Plans (PTPs); Transport Infrastructure Plans (PIPs) and Route Alignment Assessment (RAA).

From the diversity of plans as illustrated above the need to integrate decision making within a trans-disciplinary approach can clearly be deduced. However, in terms of the core policies driving the content of the various plans, there are limited measures in place to align and integrate the plans as to promote sustainable development.

3.2 Legislative overview

The formulation of EIAs is prescribed in the National Environmental Management Act [4] and its Regulations (2010) [7]. In terms of the focus of this paper it should be noted that the regulations include certain listings applicable to activities requiring environmental authorization prior to commencement of development.

The EIA is a pro-active and systematic process where potential environmental impacts both positive and negative associated with certain activities are assessed, investigated and reported on. The process contributes to giving effect to the objectives of integrated environmental management (IEM) as decision makers are informed of the desirability of such activities and on the conditions which authorization of the activity should be subject to, where relevant. This in part explains the interface between the concepts of the EIA and the TIS/TIA within the focus of this research as applied to the study area.

In terms of Regulation 32 of the EIA Regulations (2010) [7] provision is made for the compilation of specialist reports that includes the formulation of TIS/TIAs. In context to transportation planning, inclusive of development and operational activities, is being prescribed and guided in the National Land Transport Act (5 of 2009) [8] and its promulgated regulations [9]. No provision is included guiding the need to formulate TIS/TIAs.

The formulation of TIS/TIAs in practice is being guided in terms of the contents of an ITP and the LUS in terms of statutory planning processes within a specific institutional entity. Research undertaken for the compilation of this paper, indicated that a Manual for Traffic Impact Studies were compiled by the Department of Transport in 1995 [10]. From the research it also became evident that a draft manual on traffic impact and site assessments was prepared by the Committee of Transport Officials (COTO) during 2008 [11]. This document includes most of the principles as contained in the Manual of 1995 [10] but was never formally published.

3.3 Literature overview

For the literature related to EIA formulation in South Africa the reader is referred to the content of NEMA [4] and the EIA Regulations [7]. The literature is dealt with in the Department of Environment and Tourism (DEAT) in terms of the Integrated Environmental Management Information Series Guidelines (refer to [12–16]).

For the focus of this paper the literature overview will be based on the content of TIS/TIAs as applicable within international practice. Table 1 shows a concise summary of three recognised formats related to the content of TIS or TIAs.

Table 1: Generic content of TIS/TIAs based on international practice.

Asia Society for Transport Studies [17]	Alberta Traffic Impact Assessment Guideline [18]	Cape Cod Commission Guidelines for Transportation Impact Assessment [19]
Current practices in the Philippines: • Definition of the impact area. • Characterization of baseline traffic. • Estimation of traffic generation attributed to the project. • Formulation of traffic management plan. • Access points and routing analysis. • Parking requirement analysis. • Formulation of implementation mechanisms for recommended counter measure.	• Background information: ➢ Proposed development. ➢ Highway description and classification. ➢ Description of study area. • Existing infrastructure and conditions. ➢ Existing highway conditions. ➢ Existing intersection conditions. ➢ Existing traffic conditions. • Traffic assessment and projections. ➢ Existing background traffic. ➢ Projected background traffic. ➢ Projected development traffic. ➢ Background plus development traffic.	• Project introduction ➢ Project description. ➢ Locus map-to set context regionally. ➢ Site access and context map. ➢ Site plan. • Existing conditions: ➢ Road network. ➢ Traffic volumes. ➢ Pedestrian and bicycle counts. ➢ Air quality analysis. ➢ Crash history and analysis. ➢ Capacity and Level of Service (LOS) • Trip generation: ➢ Traffic assessment ➢ Alternative trip generation. ➢ Land use interactions. ➢ Impact of multi-use developments. ➢ Impact of growth and activity centres. ➢ Estimation of heavy vehicle traffic. ➢ Adjustments to trip generation.
Approach in case of new development: • Estimation of traffic generation with and without the project. • Estimated traffic volumes at approach routes and critical intersections with and without the project. • Identification of locations of potential traffic congestion due to the project. • Recommendation of remedial measures to overcome potential traffic problems with the project.	• Analysis: ➢ Capacity analysis. ➢ Traffic signalization analysis. ➢ Illumination warrants analysis. ➢ Pedestrian warrant analysis. ➢ Operational analysis.	• Trip distribution: ➢ Distribution patterns. ➢ Trip generation assumptions and qualifications. • Future conditions: ➢ Traffic volumes for 'no-build' or 'build' scenarios. ➢ Current projects. ➢ Capacity and LOS analysis ➢ Signal warrant analysis. ➢ Summary: LOS performance indicators for development scenarios.

Table 1: Continued.

Asia Society for Transport Studies [17]	Alberta Traffic Impact Assessment Guideline [18]	Cape Cod Commission Guidelines for Transportation Impact Assessment [19]
Other tasks: • Inventory of the physical conditions of the study area. • Conduct primary and secondary traffic count data for roads in the project and environs. • Projection of the traffic generated/attracted by the development. • Estimation of the service levels of roads and intersections. • Evaluation of impacts for future traffic.	• Conclusions and recommendations: ➢ Required intersection improvements. ➢ Pedestrian mitigation. ➢ Illumination. ➢ Signalization. ➢ Right of way requirements.	• Mitigation measures: ➢ Mitigation actions. ➢ Additional analysis-capacity analysis. ➢ Optional mitigation. ➢ Quantification of cost implications. ➢ On-site improvements. ➢ Off-site improvements. ➢ Fair-share mitigation analysis. • Trip reduction measures. • Other analysis to be included: ➢ Stopping sight distance analysis and measurements ➢ Parking analysis

Source: Own construction from sources as indicated, 2012.

Traffic impact assessment/studies internationally are fundamental as part of the EIA process as a specialist report in activity authorization. The components of the TIAs can be considered as minimum standards [19]. These elements will support the EIA in authorization to evaluate the overall impacts of a project. It will thus enhance sustainable development through the implementation of mitigation measures related to traffic and transportation impacts.

4 Case study content, approach and application

The following TIS/TIA content, approach and application (Table 2) was followed in the case study as reported on in paper [20].

If the content of Tables 1 and 2 is compared, it is evident that although it is possible to have a manual or format on the content for TIS/TIA formulation, the focus and needs for such research differs from one project to the next and from one site to the next. This implies that the research design should be developed by the TIS/TIA practitioner in cooperation with other specialists based on specific project reality and needs.

From the perspective of EIA and TIS/TIA integration, the research design should also be informed by the environmental assessment practitioner (EAP). Input into the TIS/TIA research design by civil engineers, sociologists, economist, urban and regional planners, transportation economists and air quality scientists should be considered as a non-negotiable requirement. On completion the TIS/TIA research design should be submitted to all stakeholders and affected parties for input and information.

Table 2: TIA content, approach and application related to the case study, 2011.

Research focus	Content description	Objective/purpose
Task 1	• Project approach: ➢ Research design. ➢ Assessment of existing knowledge.	• Research concept development. • Status quo assessment.
Task 2	• Locational assessment of study area	• Regional context
Task 3	• Formulation of research goals and objectives	• Research delimitation
Task 4	• Analysis of the status quo transportation and traffic analysis ➢ Socio economic profile ➢ Transportation profile ➢ Traffic distribution patterns	• Socio-economic reality • Traffic assessment and generation
Task 5	• Environmental reality.	• Alignment and impact
Task 6	• Land use and development perspective	• Regional alignment assessment
Task 7	• Quantification of traffic flow impacts ➢ Existing and projected traffic flows ➢ Traffic flows due to proposed activities ➢ Management of traffic demand ➢ Impacts on road network accommodating form intra- and inter traffic perspective	• Impact quantification
Task 7	• Land use and transportation integration ➢ Spatial Development Framework (SDF) ➢ Integrated Transport Plan (ITP) ➢ Statutory planning and land use impacts	• Alignment and integration • Coordination • Articulation
Task 8	• Future traffic flow determinants and growth patterns related to off-site impacts	• Impact assessment • Projections • Quantification
Task 9	• Trip generation and assignment of on-site traffic • Site access analysis	• Site development impacts • Traffic movement patterns
Task 10	• Transport infrastructure improvements off-site ➢ Geometric design standards and improvements ➢ Structural design considerations ➢ Road network improvements ➢ Storm water infrastructure ➢ Illumination upgrading ➢ Pedestrian lanes provision ➢ Infrastructure upgrading project scheduling	• Infrastructure upgrading • Traffic mitigation • Project integration • Traffic mode separation • Safety and security
Task 11	• Transport and traffic infrastructure on-site improvements ➢ Provision of additional parking ➢ Improvement of loading and off-loading facilities ➢ Improvement of operational measures and arrangements ➢ Provision of holding areas for heavy motor vehicles ➢ Improvement of accessibility to site	• Safety and security • Improvement of traffic flow • Addressing of transport and traffic backlogs • Improved site management

Table 2: Continued.

Research focus	Content description	Objective/purpose
Task 12	• Formulation of a transport and traffic mitigation goal achievement matrix (TTMGAM)	• Coordination and project integration • Application of performance indicators • Action plan
Task 13	• Project conclusions	• Research goal and objective realization

Source: Own construction, 2012.

5 Overview of the case study

5.1 Description of site

The TIS/TIA research is based on an existing industrial development site that is accommodating mineral processing plant and associated infrastructure in South Africa [20]. The study area forms part of the Kgangala District Municipality (GDM).

The TIS/TIA research was carried out as a specialist report for the EIA process for authorization in terms of the EIA Regulations [7] for the extension of an existing plant facility. The plant imports all of its mineral resources by road whilst the production is being transported by rail from the site. For the purposes of this paper, the approach followed will only be reported on from a generic perspective only as the EIA authorization is still in process.

5.2 Research goal formulation

The goal of the TIS/TIA for the study area is to assess the status quo position of transportation and traffic related matters in context to the present extend of core activities. This is used as a norm to determine the traffic impact of the future extended activities. Based on this determination applicable mitigation measures were recommended. The following specific objectives in goal realization are applicable:

- Objective 1: Analysis of the status quo transportation and traffic reality applicable to the site.
- Objective 2: Quantification of the traffic flow and facility impacts based on the proposed extended core activities.
- Objective 3: Optimization of land use, traffic and environmental relationships and impacts.
- Objective 4: Inter- and intra traffic movement integration and optimization.

- Objective 5: Formulation of transportation and traffic mitigation measures based on goal achievement through specific related projects.
- Objective 6: Implementation planning.

5.3 Summary of the traffic assessment results

Both the inter traffic and intra traffic movements were taken up consisting of a modal split between private motor vehicles (PMV), light delivery vans (LDV), busses (B), minibus taxis (MBT); heavy motor vehicles (HMV) and pedestrians. Figure 1 shows the traffic survey sites within the road network and intersections.

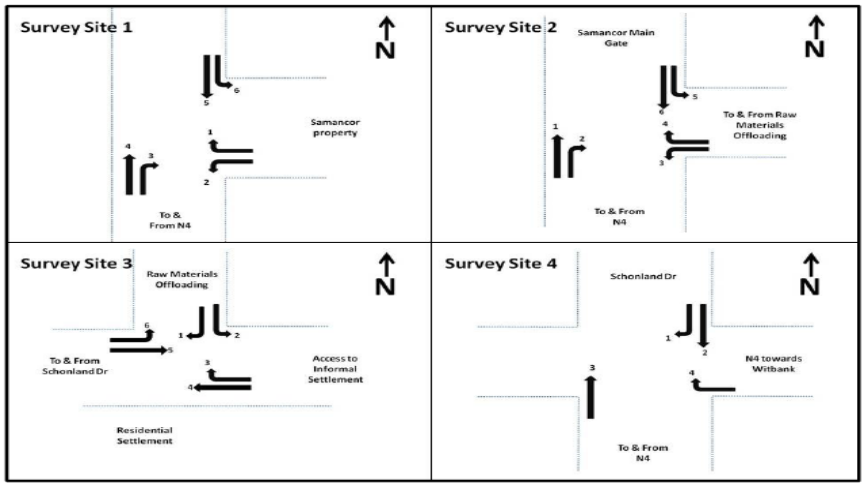

Figure 1: Traffic flow directions surveyed.

The traffic survey included in terms of modal split peak and off-peak counts for each of the survey points. The total traffic survey summary is contained in Table 3. Figures 2 and 3 show the graphical presentation of the traffic data. Table 3 clearly depicts that the daily traffic movements within the study area amounts to 18 390 movements of which some 3 822 are related to non-motorized traffic. Some 14 669 represents motorized traffic. Private motor vehicles (PMV) represent 8 075 movements (55.42%); Heavy Motor Vehicles (HMV) represents the figure of 2,950 (20.24%) of the total motorized traffic movements. As far as passenger transport is concerned, 1550 minibus-taxis (10.36%) and bus transport some 4.07% of all motorized traffic movements.

The peak hour and off-peak hour traffic within the inter-traffic movement patterns are also captured in Table 3. From an analysis of the survey data the peak and off-peak traffic patterns show clear clustering patterns. Some 74.01% of all traffic movements relates to peak hour traffic occurrence [20].

From the perspective of this TIS/TIA, the traffic flow patterns related to non-motorized traffic is of significance: some 20.78% of all traffic movements relates

Table 3: Total traffic counts within the study area.

	Traffic characteristic	PMV	LDV	Taxis	HMV	Busses	Total: Motorised Traffic	Pedestrians	Bicycles	Total: Non-motorised Traffic	Total
Total of Location 1	Total peak hour traffic	570	147	73	361	59	1210	575	12	587	1797
	Total: Off peak Traffic	241	56	33	85	18	433	181	9	190	621
	Total traffic: All movements	811	203	106	446	77	1643	756	21	777	2420
Total of Location 2	Total peak hour traffic	1714	343	209	938	86	3290	1602	79	1681	4971
	Total: Off peak Traffic	580	129	62	318	28	1117	479	19	498	1648
	Total traffic: All movements	2294	472	271	1256	114	4407	2081	98	2179	6619
Total of Location 3	Total peak hour traffic	116	13	7	95	1	232	434	43	477	709
	Total: Off peak Traffic	56	18	7	46	0	127	128	21	149	322
	Total traffic: All movements	171	31	14	141	1	359	562	64	626	1031
Total of Location 4	Total peak hour traffic	3582	451	887	807	323	6050	110	26	136	6186
	Total: Off peak Traffic	1216	242	272	300	79	2109	80	24	104	2213
	Total traffic: All movements	4798	693	1159	1107	402	8159	190	50	240	8399
Total of all Locations	Total peak hour traffic	5982	954	1176	2201	469	10782	2721	160	2881	13663
	Total: Off peak Traffic	2093	445	374	749	125	3786	868	73	941	4804
	Total traffic: All movements	8075	1399	1550	2950	594	14568	3589	233	3822	18390

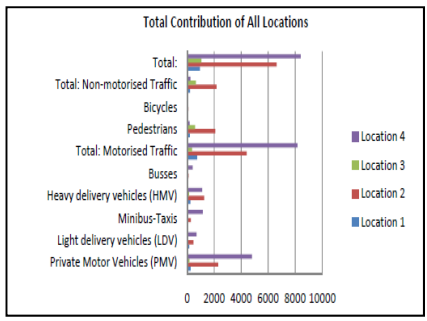

Figure 2: Total contribution of traffic.

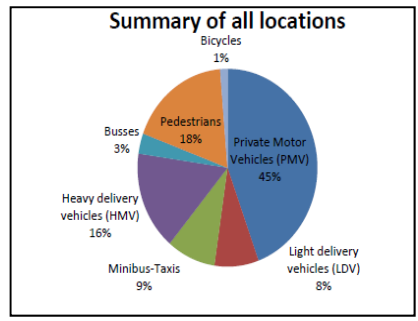

Figure 3: Summary of traffic.

to pedestrians and bicycle movements. From the survey the lack of adequate infrastructure (cycle and pedestrian lanes) to accommodate such modes of transport can be deduced [20].

6 Mitigation and intervention strategy

The following transport related topics are being dealt with extensively: inter traffic movement; access movements onto the site; and on-site traffic movements. Based on the TIS/TIA research output it is possible to assess the traffic flow impacts on the road network supported by an in depth analysis of the intra-traffic growth model based on a scenario approach within a five (5) year time horizon [20].

In the source document transportation and land use integration based on the impact of the proposed site development is aligned with SDFs for the local

sphere of government (municipalities). No ITP for the study area exists that served as an important motivation for the TIS/TIA formulation. Traffic flow determinants and growth trends related to the development of the site and its associated greater region is also included in the TIS/TIA.

The road network serving the site is assessed from both a geometric as well as structural road design standards as to determine the status quo position. Specific mitigation measures for road network upgrading are proposed [20]. Various alternatives for transportation and traffic related improvements (infrastructure) in the light of the required mitigation measures to ensure sustainable development are made. A detailed budget for road upgrading; identified project components; implementation framework; estimated cost; source of possible funding and mitigation objectives are identified.

7 Transportation and traffic mitigation goal achievement matrix (TTGAM)

Following the mitigation and intervention strategy focus (as described in point 6 above) a coordination and implementation assessment framework (Table 4) (TTMGAM) based on the outcomes of the TIS/TIA is applied. This framework is used to rank the projects, focuses, measures and projects as identified above.

Table 4: Transportation and Traffic Mitigation Goal Achievement Matrix (TTMGAM).

Transport and Traffic Fundamental (TTF)	Score/Weight		
	1	3	5
1: Effective and efficient upgrading and development of improved accessibility to the site by road	Maintaining status quo	Ensure a moderate improvement (crisis management)	Enable plant to fulfil its production targets.
2: Implementation of improved traffic safety measures	Maintaining status quo	Provide a limited improvement in traffic safety needs and requirements	Will contribute largely to the improved safe access and intra-traffic movement
3: The protection of environmentally sensitive areas, adjacent land uses to support environmental sustainability within the area	Maintaining status quo	Provide limited improvement in protection, development and enhancement of the environment.	Will contribute extensively to the protection and enhancement of the environment.
4: Actively address storm water runoff from the site.	Maintaining status quo	Will to some extend curtail storm water runoff. No provision within the access upgrading	Will greatly contribute to the elimination of polluted runoff from the site.
5: Improvement of on-site operation practices and facilities	Maintaining status quo	Will to some extend improve some of the on-site operational practices and facilities	Will implement and /or facilitate all of the recommended operational practices.

Each project as mentioned in point 6 is adjudicated in terms of how well it contributes to the set transportation and traffic fundamentals (TTF) (Table 4). The sum total of its contribution is viewed as its conformation weight and is referred to as the Transportation and Traffic Mitigation Goal Achievement Score (TTMGAM Score). Projects should be implemented based on its ranking in terms of its score assessment score.

Table 5 shows the outcome of the transportation and traffic mitigation measures (direct and indirect) as identified for the activities addressed in the TIS/TIA. From the table the priority of the transportation and traffic mitigation measures in terms of priority can be deduced.

Table 5: Transportation and traffic mitigation goal achievement in study area.

Activity	TTMGAM Score based on TTF						Status quo position	Objective	P
	1	2	3	4	5	T			
Upgrading of the N/South access road	3	3	5	3	1	**15**	Present road in poor condition. Increase in traffic flow.	Improved geometric and structural design.	**5**
Formalization of the West/East access road	5	3	3	3	3	**17**	Ownership of access road undetermined.	Formal proclamation and construction.	**3**
Storm water management strategy	1	1	5	5	5	**17**	No formal strategy exists.	Applicable design of storm water measures.	**3**
Upgrading loading facilities	5	3	5	5	5	**23**	Dedicated off-loading and loading facilities exist.	Upgrading of facility.	**1**
Protection of the adjacent land uses	3	3	3	3	5	**17**	Residential informality problematic.	Formalization required.	**3**
Promotion of traffic safety	5	5	1	1	5	**16**	Pedestrians at risk.	Improved geometric design standards	**4**
Improved accessibility	5	5	3	3	1	**17**	Accessibility is problematic.	Access formalization and upgrading.	**3**
Protection of the environment	5	3	5	3	3	**19**	IEM approach is lacking.	Environmental management practices.	**2**
Promotion of community.	3	5	3	5	1	**17**	Informality creates lack of structure.	Formalization.	**3**

8 Conclusion

From the contents of the paper it was illustrated that TIS/TIAs fulfils an important role in EIA adjudication with regard to environmental authorization for development activities. It was also illustrated that the contents of TIS/TIAs to be designed based on trans-disciplinary consultation processes and specific research and site needs. The application of goal achievement tools in project

prioritization for the implementation to address mitigation from a traffic as well as transportation perspective is a basic need to support sustainable planning and development.

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