SCIENTIFIC APPROACHES TO LINK THE TARGETS IDENTIFIED IN NATMAP AND NLTSF TO MEASURABLE AND COMPARABLE ANNUAL TARGETS APPLICABLE TO THE LOCAL MUNICIPALITY SPHERE OF GOVERNMENT

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ABSTRACT

The National Transport Master Plan (NATMAP) (2015) and the National Land Transport Strategic Framework (NLTSF) (2015) are aligned with the development of transportation systems and objectives included in the National Development Plan (NDP) to address current transportation issues in South Africa. Transportation plans and development without supporting decision-making systems, remains only goals and objectives and does not promote sufficient, effective and affordable transport. Therefore the implementation process must include guiding principles, i.e., well defined measuring scales for monitoring and implementation. In addition, for the realisation of long-term targets, the implementation process must include relevant, well-defined, measurable and comparable annual targets for entities on the same level and these targets must be linked to a body and/or person responsible for data basis development and management and to be accountable for targets that are not met. The aim of this paper is to link the key performance indicators (KPIs) and long-term targets provided for in NATMAP and the NLTSF in terms of measurable and comparable annual targets. This will be done by defining applicable annual measures scales for each of the NATMAP and NLTSF KPIs in attaining the transportation targets provided for in these instruments. In the case of missing targets, targets will be scientifically determined and deduced.

Keywords: Transportation planning, monitoring, key performance indicators, transportation targets, NATMAP, NLTSF.

1. INTRODUCTION

There needs to be a link between the way KPIs are measured and its associated targets otherwise, the target will never be met. Moreover, how will municipalities know their strengths, weaknesses and performance shortfalls, without assessment? It is therefore important to set annual measures in place to inform and motivate municipalities on an annual basis through formulating targets, that is attainable within five or ten years. The biggest challenge is to find an applicable way to measure KPIs to ensure that the long-term targets will be achieved.

Aim of the Paper

The paper presents a methodology towards implementing and monitoring a municipality's contribution to effective and sustainable transportation in South Africa.

Objectives of the Paper

The paper's objectives are the following:

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2. LITERATURE REVIEW

2.2 NATMAP 2015 (Update) and 2015 (Reviewed) NLTSF

The national transport goals and objectives for 2050 form part of the National Transport Master Plan (NATMAP) (NATMAP, 2011). It aims to reflect the role of local authorities in meeting provincial and national transportation needs but does not identify or prescribe in detail how to achieve these goals. NATMAP was updated in 2015 to provide more detail on the what, when and how questions in terms of weakly defined (or non-defined) measurements and targets. The National Land Transport Strategic Framework (NLTSF, 2006) contextualises and supports both NATMAP (2011) and the NDP (2012) by way of short-term goals and objectives. NLTSF was reviewed in 2015 to give more detail on short term (5 year) planning in terms of when, what and how strategy based on weakly defined (or non-existing) measurements and targets.

2.2. The Monitoring Processes in Municipalities

The monitoring of municipal performance is incomplete, fragmented and unsuccessful. This follows notwithstanding legislative and regularity framework like the Municipal Planning and Performance Management Regulations, Regulation 14 (1) of the Municipal Systems Act, MSA (2001). The MSA states that it is the Municipality's responsibility to develop and implement mechanisms, systems and processes for the auditing of the performance measurements, as part of its internal audit processes and the Performance Information Public Audit Act of 2007.

The Integrated Urban Development Framework implementation plan (IUDF, 2016) states that one of the key challenges at local sphere of government include the monitoring of municipal performance. However, currently monitoring is unsuccessful due to inadequate analytical capacity to generate real insight into actual performance and risk management.

3. METHODOLOGY

Published research by Schoeman (2017) reflects on an assessment of the effectiveness of current monitoring targets. The author utilize NATMAP (2015) and NLTSF (2015) to identify merger KPIs to guided development and transportation planning in South Africa. The essence of the current paper is thus a continuation of the line of argument as developed in the 2017 paper (Schoeman, 2017) but with the focus on development of techniques (measure scales) to link such KPIs to the long-term targets included in NATMAP and NLTSF.

4. RESULTS AND RECOMMENDATIONS: GUIDING PRINCIPLES FOR MUNICIPALITIES

The IUDF (2016) Implementation Plan priorities the 97 largest urban population municipalities and metros into nine classes. The specific classes (consider Column 6 of

Table 1 for Class 4 to Class 6) were determined by ordering the 97 municipality's (by considering the 2011 urban population statistics given by StatSA) into three different categories and inside each of these categories the municipalities were ranked into different classes by considering the urban growth rate between 2001 and 2011. Class 1 refers to the highest priority municipalities/metros, i.e. metros that need immediate intervention and therefore high on the short-term priority list and Class 9 refers to the lowest priority municipalities, which refer to municipalities on the short-term priority list, but with low priority.

This section contains scientifically determined annual targets for the omitted or weakly defined long-term targets in NATMAP (2015) and NSTF (2015). The resulting comparable and normalised measure scales to link the KPIs to the long-term targets are provided in Appendix A. The dimensionless measure scales in Appendix A can be used to determine the score for each municipality. Different municipalities can thus be compared with the other municipalities in the same class.

Rating scales used to measure the Key Performance Indicators:

Let the binary value (BV) function of the variable X_i be given as $BV(X_\mathrm{i}) = \begin{cases} 1, & if\ X_\mathrm{i} = YES \\ 0, & otherwise. \end{cases}$

Integrated Transport Planning:

Journey Time (JT)

JT refers to the journey time to work (door-to-door) by all modes. The rating scale for standardise journey time is given as 4.1.1 in Appendix A.

Urban Sprawl

This subsection will only focus on the Class 4 to Class 6 municipalities due to a restriction of space.

Table 1: Class 4, Class 5 and Class 6 municipalities

Urban Sprawl Control Result	Density priority for all the M	Density priority in population	Density priority by each class	Growth priority in population	Class	Local Municipality (LM)	Urban population	Growth 2001–2011 (%)	> 500 pp/km2 (km)
Extremely good	8	2	1	12	4	Polokwane LM	263 120	23.80	409.00
Moderate	11	3	2	13	4	Mbombela LM	207 900	23.50	310.00
Moderate	14	4	3	3	4	Rustenburg LM	356 836	42.00	240.00
Moderate	17	6	4	5	4	Madibeng LM	141 789	37.30	199.00
Moderate	22	8	5	2	4	Emalahleni LM	376 486	43.10	176.00
Moderate	26	11	6	16	4	Thembisile LM	182 469	21.00	149.00
Moderate	34	16	7	14	4	Mogale City LM	322 075	22.60	106.00
Weak	35	17	8	4	4	Kwadukuza LM	190 265	37.80	102.00
Weak	39	19	9	6	4	Govan Mbeki LM	283 362	32.80	79.00
Weak	41	20	10	1	4	Steve Tshwete LM	209 602	61.00	73.00
Weak	44	22	11	15	4	Sol Plaatjie LM	245 365	22.60	61.00
Weak	45	23	12	10	4	Metsimaholo LM	145 955	28.60	55.00
Extremely weak	48	24	13	9	4	Drakenstein LM	210 780	29.20	50.00
Extremely weak	51	26	14	8	4	George LM	169 521	29.60	45.00
Extremely weak	53	27	15	11	4	Tlokwe LM	142 533	26.80	44.00
Extremely weak	65	30	16	7	4	Stellenbosh LM	119 256	31.20	32.00
Good	23	9	1	19	5	uMhlathuze LM	142 762	15.70	176.00
Good	29	13	2	21	5	Matlosana LM	373 271	11.00	133.00
Extremely weak	49	25	3	17	5	Msukalingwa LM	119 907	19.70	46.00
Extremely weak	66	31	4	18	5	Randfontein LM	128 081	15.90	30.00
Extremely weak	69	32	5	20	5	Breede Valley LM	120 750	14.00	29.00
Extremely good	6	1	1	24	6	Thulamela LM	115 350	6.40	541.00
Good	16	5	2	27	6	Mogalakwena LM	108 579	3.10	219.00
Good	20	7	3	23	6	King Sabata Dalindyebo	153809	8.50	188.00
Good	24	10	4	34	6	Maluti-A-Phofung LM	131358	**-6.90**	169.00
Good	28	12	5	30	6	Matjhabeng LM	397313	**-0.40**	139.00
Good	30	14	6	22	6	Newcastle LM	258893	9.10	130.00
Good	31	15	7	26	6	Lukhanji LM	137911	4.90	116.00
Good	38	18	8	25	6	Emnambithi LM	126156	5.30	81.00
Good	43	21	9	33	6	Merafong LM	189284	**-6.20**	66.00
Extremely weak	58	28	10	29	6	Ngwathe LM	110293	1.40	38.00
Extremely weak	61	29	11	32	6	Moqhaka LM	142524	**-4.40**	35.00
Extremely weak	70	33	12	28	6	Westonaria LM	102641	1.80	29.00
Extremely weak	71	34	13	31	6	Dihlabeng LM	105851	**-0.50**	29.00
Extremely weak	81	35	14	35	6	Setsoto LM	100078	**-8.60**	18.00

Source: Own construction from IUDF Implementation Plan

The short-term priority list as identified in the IUDF (2016) Implementation Plan is used as input to determine the density priority for each municipality. The density priority refers to the distance in kilometres of the high density area i.e. the distance of the urban area with a density greater or equal to 500 persons/km² (consider Column 4 in Table 1). The density priority plays an import role in the determination of the public transport priority of municipalities in each class whereas the growth priority (Column 5 in Table 1) can be used as a way to determine the budget ratio for infrastructure and resources of the different municipalities in the same category. To determine the control of urban sprawl the overall density priority that was calculated by considering the high-density area of all different municipalities, Column 2 in Table 1 and the density priority in the same population category (Column 3 in Table 1) are then considered. The urban sprawl results shown in Column 1 is determined by considering the deviation between the relative density (the applicable urban population in respect with all the other municipalities' urban populations) and the true/real density.

Note that Polokwane Local Municipality (LM) has extremely good control of urban sprawl while in the Drakenstein LM there is extremely weak control of urban sprawl. This is due to the fact that the urban population in Polokwane LM (263 120 people) which is only 52 340 higher than the urban population in Drakenstein LM (210 780 people), but the distance of the high-density area in Drakenstein LM is only 50 km against 409 km in Polokwane LM. Put D equal to the value of the applicable cell in Column 1 of Table 1, then the normalised urban sprawl values are reflected in 4.1.2 in Appendix A.

It should be noted that Brickford & Khoza (2016) provide a ten-point framework for transit oriented densities. They conclude that due to the multifaceted and complexity of urban density one should also consider dwelling units/ha, number of people/ha, floor area ratio (FAR), % coverage, other land uses (m²/ha), parking bays per hectare, parking occupancy, people occupancy, building orientation and pedestrian access and the pedestrian realm. Since, the KPIs must be comprehensive, diverse and mutually disjointed, it is concluded that some of the identified variables must also be included to enhance the relationship between urban density and public transport. However, most of these variables does not form part of the KPIs and targets given in NATMAP or NLTSF therefore the discussion thereof falls outside the scope of this paper.

Traffic Network Performance (TNP)

For the TNP application the signalized intersections (s.i.) level of service (LoS) for peak hour traffic should be used. Consider the Highway Capacity Manual (HCM, 2000) to describe the delay at major signalized intersections in an urban area. Put the LoS = A for values less or equal to 10 sec; LoS = B for values from 11 to 20 sec; LoS = C for values from 21 to 35 sec, LoS = D for values from 36 to 55 sec, LoS = E for values from 56 to 80 seconds and the LoS = F for a signalized delay that is greater than 80 seconds. The signalized intersections LoS is combined with the average (peak hour) volumes to capacity (i.e. V/C) ratio to calculate the standardise Traffic Network Performance as in 4.1.3 in Appendix A.

Growth Value Add (GVA)

The GVA represents an indication of economic concentration, employment and productivity. It measures the output of a municipality area by calculating the value of goods and services produced in the municipal area. Consider G equal to "Annual GVA growth rate for the municipality". Refer to 4.1.4 in Appendix A for the GVA measure scale.

Travel Cost (TC)

TC measures the average daily travelling cost (% of income) for the urban population in the applicable municipality. Let PC be the average provincial travel cost % and NC be the average national travel cost %. For the calculation of the TC score consider 4.1.5 in Appendix A. Hence, if the travel cost for Tlokwe LM is 18%, the North West Province travel cost is 15% and the average National Travel cost is equal to 20% then by applying 4.1.5 the TC score for Tlokwe LM is equal to 0.25. Note that it will be ideal to use data on travelling cost of municipalities in the same class to compare against each other, but since these data is not readily accessible on an annual basis, the provincial and national travelling cost data are used.

Integrated Transport System (ITS)

From TRANSFORuM, 2014 follows that unintegrated and uncoordinated frameworks, policies, structures and undefined roles and responsibilities are barriers to sustainable transportation planning. Use the Strategic Road Network Plan (SRNP), Integrated Transport Plan (ITP) and Medium Term Expenditure Framework (MTEF) to calculate the ITS value. This is done by considering the value (True or False) for the following variables for each municipality: Let X_1 = Updated SRNP, ITP & MTEF; X_2 = The % of transport projects (asset management and preservation) within the last five years with a positive cost benefit ratio ≥ 95%; X_3 = The % of total municipal budget spend on ITS ≥ 30%; X_4 = The municipality then applies the principles of Engineering Service Contribution Manual for Municipal Road Infrastructure (COTO1) on all applicable projects in the last ten years; X_5 = The municipality also applies the principles of Traffic Impact and Site Traffic Assessment Manual as provided in (COTO2) on all applicable projects in the last ten years; Let ITS $= \sum_{i=0}^{5} BV(X_\mathrm{i})$ then the standardised Integrated Transport System indicator is given by 4.1.6 in Appendix A.

Transport Model (TM)

The evaluation of the Transport Model of the municipality is determined as follows: Assess (True or False) the Transport Model on the following properties: Z_1 = Annually updated traffic data that also consider (eNaTIS, OLAS data); Z_2 = The TM and updated traffic data are accessible to the public; Z_3 = Contain GIS data on transport network (including improved roads); Z_4 = Contain GIS data on current traffic assignments per link; Z_5 = Contain a signalized traffic control plan. If the TM=$\sum_{i=0}^{5} BV(Z_i)$, then the range of the rating scale for the standardised value for the Transport Model is contained in 4.1.7 in Appendix A.

Public Transport

Some of the factors include the features (physical infrastructure, operations, operating structure, customer service and technology) as listed by The Institute for Transportation and Development Policy (2007) the most successful Bus Rapid Transport are used as an indirect measure guideline where applicable. Parameters like pre-board or automatic fare collection or verification independently operated and managed fare collection system and improvements to nearby public spaces are also considered in the feature but is not dealt with in this paper. Note that public transport cannot economically be provided in urban areas with less than 5 000 people/km².

Accessibility of the Integrated Rapid Public Transport Network (IRPTN)

It represents the proportion of households in an urban area within walking distance from an IRPTN. Put P equal to the % of household in the urban area within 1km walking distance from an IRPTN service area. Calculate the IRPTN score using 4.2.1 in Appendix A.

Travel Times (TT)

Average total travel time (i.e. walking, waiting and time travelling) per day for/on public transport; Let PV be the average provincial travel time value for the applicable public transport mode and NV the applicable national value. To determine the TT score, use 4.2.2 shown in Appendix A.

Public Transport Usage (4.2.3 in Appendix A)

Public transport (referring to minibus taxi, train or bus) usage is contained by the ratio (Public transport usage in municipality area) to (Urban population of the municipality area) and the score is calculated as shown in 4.2.3 in Appendix A.

Peak Hour Frequency of Bus and Train Services (F_1)

Refer to 4.2.4 in Appendix A to calculate the score.

Off-peak Frequency of Bus and Train Services (F_2)

Refer to 4.2.5 in Appendix A to determine the score.

The Cost Effectiveness of the Public Transport Services

Put: C_1 = Annual **operating cost per employee** of the public transport services (bus, BRT or train); C_2 = Annual operating **cost per passenger** (R per passenger); C_3 = Annual operating **cost per kilometre** (R per km); C_4 = Annual operating **subsidy per passenger** (R per passenger); C_5 = The amount spends on **public transport infrastructure** (R per km) in the last ten years. Compare the above values with the applicable average value, N_i for all the municipalities in the same class, then $X_i = \begin{cases} 1, & if\ C_i < N_i \\ 0, & otherwise \end{cases}$ and calculate C = $\sum_{i=0}^{5} BV(X_i)$ to determine the Public Transport Services score as provided for in 4.2.6 in Appendix A.

Public Transport Customer Satisfaction (PTCS)

Measured by customer satisfaction index and reliability of the public transport service. Consider the value (True or False) for the following variables:

q_1 = The ride comfort and waiting facilities quality (weather-protected) level of public transport is high. q_2 = Existence of an integrated "network'' of routes or fare-integration between routes, corridors and feeder services. q_3 = The crime level on the public transport and in the waiting facilities is low. q_4 = Travel information (timetable and maps) is available and visibly placed within stations and on the public transport. q_5 = The % delayed or abandoned scheduled Public Transport Services in the past year is less than 5%.

The standardised PTCS value is reflected in 4.2.7 in Appendix A for Q= $\sum_{i=0}^{5} BV(q_i)$.

Learner Transport

Learner Transport Accessibility (4.3.1 in Appendix A)

Measures scale for the % of schools in the municipal area which provide scholar transport (with a contract that include operational requirements and performance specifications).

Learner Transport Modal Share (4.3.2 in Appendix A)

Measure scale for the % of learners in the municipal area using scholar transport.

Rural Transport

Note that rural refer to the low-density area of the municipality, thus the area with less than 2 residents or housing unit per acre.

Rural Traffic Network Performance (RTNP)

For the RTNP the quality and condition of roads (Q) describe all the rural links in the municipality area, which depend on the following 5 properties:

q_1 = level of travel comfort (depending on the need for erosion control, cleanliness, infrequent roughness or potholes); q_2 = safety of the road experience by road users; q_3 = accessibility (land-use access and network connectivity); q_4 = road user information and q_5 = appropriate road speed i.e. the optimal road speed supporting the use, design and the applicable road function.

$$Q = \begin{cases} A & \text{if} \quad \text{All 5 properties } = \text{"Very good" or "Good"}; \\ B & \text{if} \quad \text{Only 4 of the 5 properties } = \text{"Good" or "Very good"}; \\ C & \text{if} \quad \text{Only 3 of the 5 properties } = \text{"Good" or "Very good"}; \\ D & \text{if} \quad \text{Only 2 of the 5 properties } = \text{"Good" or "Very good"}; \\ E & \text{if} \quad \text{Only 1 of the 5 properties } = \text{"Good" or "Very good"}; \end{cases}$$

Combined the quality variable, Q with the average (peak hour) volumes to capacity (i.e. V/C) ratio to calculate the standardised Rural Traffic Network Performance score see 4.4.1 in Appendix A.

Rural Access to Public Transport

Consider 4.4.2 in Appendix A for information on how to score the KPI, rural access to public transport. This is done by considering the proportion of households in the rural area within walking distance from a Public Transport Service. Put P equal to the % of household in the rural area within 2km walking distance from a Public Transport Service.

Rural Access to Schools

The accessibility of schools within the rural part of the municipality area measured by the journey time to school (door-to-door) by all modes as in 4.4.3 in Appendix A.

Rural Access to Health Facilities (RA_{φ})

It represents the accessibility of health facilities to the rural population.
Let X_1 = Longest travel time in minutes via Public Transport to the nearest health facility.
X_2 = Longest (direct) distance in kilometre to the nearest health facility. To calculate the Rural access to health facilities consider 4.4.4 in Appendix A.

Freight Transport (FT)

The Road Transport Management Systems (RTMS) (refer to the Road Traffic Management Corporation) encourages transport operators engaged in the road logistics value chain to implement a vehicle management system that preserves road infrastructure, improves road safety and increases the productivity of the logistics value chain. Transport operators that invest in becoming RTMS accredited are recognised for their commitment to responsible business through a series of concessions, since accreditation is built on three principles: loading within the legal load limit, driver wellness and vehicle fitness. Let F = % RTMS accredited transport operators registered within the area of the municipality. For the FT, score consider 4.5 in Appendix A.

Road Infrastructure

Road Infrastructure (RI)

The evaluation of the road infrastructure of the **urban area** of the municipality. Let RI describe the quality and condition of all the urban links in the municipality. Determine the qualitative values ("Good" or "Very good") for the following 5 properties: q_1 = If the % of road surface in very good condition ≥ 95%; q_2 = visibility of all street markings i.e. retraced when necessary; q_3 = quick surface repairs hence the repair of potholes, utility cuts and surface irregularities is within a week; q_4 = cleaning of roadway and drainage system and if applicable the river system (with bridges in the urban area); q_5 = appropriate road speed i.e. the optimal road speed supporting the use, design and the applicable road function. The road infrastructure score is given by 4.6.1 in Appendix A.

Road Infrastructure (Non-Motorised)

Transport seldom meets the transport needs of the vulnerable groups of society (i.e. physically challenged, women, elderlies and children) these transport needs include safe and high quality sidewalks and cycle lanes (Pardo, 2010). Let supply refer to the current number of street segments and demand refer to the required number of street segments (current and future demand) with the applicable property. For the evaluation let PCI refer to the Pavement Condition Index and PT to Public Transport then calculate the value (True or False) for the following variables: X_1 = Supply/Demand ratio for the cycle lanes in the urban area ≥ 0.70; $_2$
≥ X_3 = Supply/Demand ratio for good quality sidewalks (high PCI) in the urban area ≥ 0.90; X_4 = Supply/Demand ratio for good quality sidewalks within a radius of 1km from main PT node ≥ 1; X_5 = The ratio of intersections with safe, bicycle-accessible crosswalks in all directions in the urban area ≥ 0.90. Let $RI_{\phi} = \sum_{i=0}^{5} BV(X_i)$ for the evaluation of the non-motorised road infrastructure in the municipality are. Thus, the rating for the standardised Road Infrastructure (Non-Motorised) factor is the value given by 4.6.2 in Appendix A.

Road Safety (RS)

It is measured by considering the number of fatalities (due to road accident) per 1000 inhabitants in the municipality area per annum. Fatality refers to death within 30 days due to road accident. From the work of Laych et al. (Laych, 2009) it follows that the South African per annum road fatalities for 2009 is 0.22 fatalities per 1000 inhabitants and Australia's per annum road fatalities for the same year was 0,036 fatalities per 1000 inhabitants. Moreover, from the 2015 Road Traffic Report on the RTMC webpage follows that the ratio in South Africa has increase to 0.24 fatalities per 1000 inhabitants in 2015. These values and its growth rate between 2009 and 2015 are used to determine the applicable classes to measure the road safety in South Africa by 4.7 in Appendix A. The process of measuring road accidents at a municipal level will force municipalities to analyse road accidents by considering where such accidents generally occur. Moreover, it determines the road or intersections with the majority of accidents and the type of accidents as analysed by this measure. The analysis process then leads to proposed action and improvements by considering current lane geometry, LoS and roadway deficiencies within these high accidents areas.

Transport Emissions (TE)

Greenhouse gases (GHG) affect the climate and include carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4), hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. The greenhouse effect is due to carbon dioxide which contribute (the most) 20%; other gases only contribute 5% and the remaining 75% is due (directly) to naturally occurring effects like water vapour and clouds and indirectly also due to CO_2 according to 2010 models cited by NASA. Some inventories on CO_2 emissions include only the CO_2 emissions whilst other include CO_2 equivalents where the total CO_2 equivalents is calculated by converting the CH_4 and N_2O emissions (or all the other GHG) to CO_2 equivalents. In this paper, only the CO_2 emissions will be used as the (continuous and available) data contained in the International Energy Agency (IEA) (IEA, 2015) is in terms of CO_2 emissions and not in terms of CO_2 equivalents. In 2009, South Africa committed at the United Nations Framework Convention on Climate Change (UNFCCC) to reduce GHG by 34% from the base year 2009 to 2020. Road transport contribute 12% to the total CO_2 emissions in South Africa in 2013 (IEA, 2015). From this value some 41.32% is due to motorcars, 19.03% to LDV's (bakkies) and trucks contribute some 29.25% through road transport emissions (for more information refer to Tongwanea (Tongwanea, 2014)). Hence, to reduce the exponential growth in South Africa's GHG due to road transport emissions require public transportation (services and usage) and a modal shift from freight by road to freight by rail. Let X_1 be the year-to-year growth rate in the freight transported by rail, TE_1 (4.8.1 in Appendix A) measure the increase in the percentage of freight transported by rail. Put X_2 equal to the year-to-year growth rate in the percentage or modal share of motorcars then TE_2 (4.8.2 in Appendix A) will measure the decline in the percentage contribution by motorcars.

Capacity to Deliver (CtD)

The measuring scales for capacity to deliver are determined by considering the barriers that affect Civil Engineers in the South African local government sector as provided for by Legoabe (2017).

Human Capacity to Deliver

Determine the value (True or False) for the following variables on municipality level.
Y_1 = Vacancies applicable to registered professional (Civil) Engineer(s) and professional Technologists = 0; Y_2 = Technical Director(s) held a degree(s) in a technical field = 100%;
Y_3 = Vacancies applicable to registered Traffic Engineer or Transport Planner(s) or Transport Economic(s) = 0; Y_4 = Vacancies applicable to registered Town Planner(s) = 0;
Y_5 = Municipal manager and Technical Director years of relevant work experience ≥ 10 years. Let $CtD_1 = \sum_{i=0}^{5} BV(Y_i)$ for the evaluation of the professionally registered personnel

of the municipality then the rating scale for the standardised Human Capacity to Deliver is given by 4.9.1 in Appendix A.

Structure Capacity to Deliver

Determine the value (True or False) for the following variables on municipal level for the last year. Z_1 = Municipal engineers are protected from political interference. No influence from Ward Councillor on duties of the Infrastructure Directors; Z_2 = No late approval of projects and budgets by council officials; Z_3 = Adequate infrastructure (roads, bridges and storm water) maintenance strategies and the whole budget for maintenance was spend in the last financial year; Z_4 = Transparent processes for awarding all contracts and projects.
Z_5 = Municipality poverty headcount level must be less than 4% in the last census (for data on this consider, Stats SA, MPI). Let $\text{CtD}_2 = \sum_{i=0}^{5} BV(Z_\text{i})$ and then the standardised Structure Capacity to Deliver is calculated by 4.9.2, Appendix A.

Inter-Government Relations (IGR)

Turnaround time of approvals and licenses. Consider the value (True or False) for the following variables. Y_1 = The waiting time at Traffic Department for the renewal of vehicle licenses ≤ 1 hour; Y_2 = The waiting time at Traffic Dept. to make a learner or drivers licence appointment ≤ 1 hour; Y_3 = The waiting time at Traffic Dept. for the renewal of drivers licenses ≤ 2 hours; Y_4 = The waiting time at Traffic Dept. for vehicle registration ≤ 1 hour; Y_5 = The waiting time at Traffic Dept. for a replaced driving licence ≤ 1 hour. Let $\text{IGR} = \sum_{i=0}^{5} BV(Y_\text{i})$ for the evaluation of the Inter-Government Relations, then the standardised Inter-Government Relations is calculated in 4.10, in Appendix A.

5. CONCLUSIONS AND FUTURE RESEARCH

This paper firstly provides a way to determine the standardised measure scales that can be used to determine the global performance, strengths and weaknesses of each municipality. This is only the first step in the direction of monitoring transport on municipal level. Secondly, the NTF or the DoT needs to assess and applies the methodology developed in this paper for measuring KPIs in transportation management. Thirdly, to create a data support system to measure the KPIs on all spheres of government. These data will then be applied to adjust the way of measuring the KPIs (where applicable). There after the weights for the different and refine the approach towards KPI’s. The introduction and enforcement of the normalised and an analytic method serves to as a basis to calculate the transportation performance of all municipalities and related entities.

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Appendix A: Formulas to link the targets to the KPIs

$$4.1.1 = \begin{cases} 1 & \text{if} \quad JT < 45\ min; \\ 0.75 & \text{if} \quad 45\ min \leq JT < 60\ min; \\ 0.5 & \text{if} \quad 60\ min \leq JT < 75\ min; \\ 0.25 & \text{if} \quad 75\ min \leq JT < 90\ min; \\ 0.1 & \text{if} \quad JT \geq 90\ min. \end{cases}$$

$$4.1.2 = \begin{cases} 1 & \text{if} \quad D = \text{“Extremely good control of urban sprawl”}; \\ 0.75 & \text{if} \quad D = \text{“Good control of urban sprawl”}; \\ 0.5 & \text{if} \quad D = \text{“Moderately control of urban sprawl”}; \\ 0.25 & \text{if} \quad D = \text{“Weak control of urban sprawl”}; \\ 0.1 & \text{if} \quad D = \text{“Extremely weak control of urban sprawl”}. \end{cases}$$

$$4.1.3 = \begin{cases} 1 & \text{if} \quad Avg(V/C) < 0.75\ \&\ LOS = \text{“A”}; \\ 0.80 & \text{if} \quad Avg(V/C) \in [0.75; 0.9)\ \&\ LOS = \text{“B”}; \\ 0.60 & \text{if} \quad Avg(V/C) \in [0.9; 0.94)\ \&\ LOS = \text{“C”}; \\ 0.40 & \text{if} \quad Avg(V/C) \in [0.94; 1.00)\ \&\ LOS = \text{“D”}; \\ 0.20 & \text{if} \quad Avg(V/C) \in [1.00; 1.5)\ \&\ LOS = \text{“E”}; \\ 0.1 & \text{if} \quad Avg(V/C) \geq 1.5\ \&\ LOS = \text{“F”}. \end{cases}$$

$$4.1.4 = \begin{cases} 1 & \text{if} \quad G > 2\%; \\ 0.75 & \text{if} \quad G \in (1.5\%, 2\%]; \\ 0.5 & \text{if} \quad G \in (1\%, 1.5\%]; \\ 0.25 & \text{if} \quad G \in (0\%, 1\%]; \\ 0.1 & \text{if} \quad G \leq 0\%. \end{cases}$$

$$4.1.5 = \begin{cases} 1 & \text{if} \quad TC \overset{5\%\ or\ more}{<} (PC \text{ and } NC); \\ 0.75 & \text{if} \quad TC \overset{less\ than\ 5\%}{<} (PC \text{ and } NC); \\ 0.5 & \text{if} \quad TC \overset{5\%\ or\ more}{<} (PC \text{ or } NC); \\ 0.25 & \text{if} \quad TC \overset{less\ than\ 5\%}{<} (PC \text{ or } NC); \\ 0.1 & \text{if} \quad TC > (PC \text{ and } NC). \end{cases}$$

$$4.1.6 = \begin{cases} 1 & \text{if} \quad ITS = 5; \\ 0.75 & \text{if} \quad ITS = 4; \\ 0.5 & \text{if} \quad ITS = 3; \\ 0.25 & \text{if} \quad ITS = 2; \\ 0.1 & \text{if} \quad ITS = 1. \end{cases}$$

$$4.1.7 = \begin{cases} 1 & \text{if} \quad TM = 5; \\ 0.75 & \text{if} \quad TM = 4; \\ 0.5 & \text{if} \quad TM = 3; \\ 0.25 & \text{if} \quad TM = 2; \\ 0.1 & \text{if} \quad TM = 1. \end{cases}$$

$$4.2.1 = \begin{cases} 1 & \text{if} \quad P \geq 85\%; \\ 0.75 & \text{if} \quad P \in [80\%; 85\%); \\ 0.5 & \text{if} \quad P \in [70\%; 80\%); \\ 0.25 & \text{if} \quad P \in [65\%; 70\%); \\ 0.1 & \text{if} \quad P < 65\% \end{cases}$$

$$4.2.2 = \begin{cases} 1 & \text{if} \quad TT \overset{30\ min.\ or\ more}{<} (PV \text{ and } NV); \\ 0.75 & \text{if} \quad TT \overset{between\ 10\ min.\ and\ 30\ min.}{<} (PV \text{ and } NV); \\ 0.5 & \text{if} \quad TT \overset{less\ than\ 10\ min.}{<} (PV \text{ and } NV); \\ 0.25 & \text{if} \quad TT > (PV \text{ or } NV); \\ 0.1 & \text{if} \quad TT > (PV \text{ and } NV). \end{cases}$$

$$4.2.4 = \begin{cases} 1 & \text{if} \quad F_1 \leq 10min; \\ 0.75 & \text{if} \quad F_1 \in (10min; 20min]; \\ 0.5 & \text{if} \quad F_1 \in (20min; 40min]; \\ 0.25 & \text{if} \quad F_1 \in (40min; 60min]; \\ 0.1 & \text{if} \quad F_1 > 60min. \end{cases}$$

$$4.2.5 = \begin{cases} 1 & \text{if} \quad F_2 \leq 20min; \\ 0.75 & \text{if} \quad F_2 \in (20min; 30min]; \\ 0.5 & \text{if} \quad F_2 \in (30min; 50min]; \\ 0.25 & \text{if} \quad F_2 \in (50min; 70min]; \\ 0.1 & \text{if} \quad F_2 > 70min. \end{cases}$$

$$4.2.6 = \begin{cases} 1 & \text{if} \quad C = 5; \\ 0.75 & \text{if} \quad C = 4; \\ 0.5 & \text{if} \quad C = 3; \\ 0.25 & \text{if} \quad C = 2; \\ 0.1 & \text{if} \quad C = 1. \end{cases}$$

$$4.2.7 = \begin{cases} 1 & \text{if} \quad Q = 5; \\ 0.75 & \text{if} \quad Q = 4; \\ 0.5 & \text{if} \quad Q = 3; \\ 0.25 & \text{if} \quad Q = 2; \\ 0.1 & \text{if} \quad Q = 1. \end{cases}$$

$$4.3.1 = \begin{cases} 1 & \text{if} \quad LT_1 \geq 95\%; \\ 0.75 & \text{if} \quad 90\% \leq LT_1 < 95\%; \\ 0.5 & \text{if} \quad 85\% \leq LT_1 < 90\%; \\ 0.25 & \text{if} \quad 80\% \leq LT_1 < 85\%; \\ 0.1 & \text{if} \quad LT_1 < 80\%. \end{cases}$$

$$4.3.2 = \begin{cases} 1 & \text{if} \quad LT_2 \geq 50\%; \\ 0.75 & \text{if} \quad 45\% \leq LT_2 < 50\%; \\ 0.5 & \text{if} \quad 40\% \leq LT_2 < 45\%; \\ 0.25 & \text{if} \quad 35\% \leq LT_2 < 40\%; \\ 0.1 & \text{if} \quad LT_2 < 35\%. \end{cases}$$

$$4.4.1 = \begin{cases} 1 & \text{if} \quad Avg(V/C) < 0.9 \ \& \ Q = \text{“}A\text{”}; \\ 0.75 & \text{if} \quad Avg(V/C) \in [0.9; 0.94) \ \& \ Q = \text{“}B\text{”}; \\ 0.5 & \text{if} \quad Avg(V/C) \in [0.94; 1.00) \ \& \ Q = \text{“}C\text{”}; \\ 0.25 & \text{if} \quad Avg(V/C) \in [1.00; 1.5) \ \& \ Q = \text{“}D\text{”}; \\ 0.1 & \text{if} \quad Avg(V/C) \geq 1.5 \ \& \ Q = \text{“}E\text{”}. \end{cases}$$

$$4.4.2 = \begin{cases} 1 & \text{if} \quad P \geq 40\%; \\ 0.75 & \text{if} \quad P \in [35\%; 40\%); \\ 0.5 & \text{if} \quad P \in [30\%; 35\%); \\ 0.25 & \text{if} \quad P \in [25\%; 30\%); \\ 0.1 & \text{if} \quad P < 25\% \end{cases}$$

$$4.4.3 = \begin{cases} 1 & \text{if} \quad RT_\phi < 30\ min; \\ 0.75 & \text{if} \quad 30\ min \leq RT_\phi < 40\ min; \\ 0.5 & \text{if} \quad 40\ min \leq RT_\phi < 50\ min; \\ 0.25 & \text{if} \quad 50\ min \leq RT_\phi < 60\ min; \\ 0.1 & \text{if} \quad RT_\phi \geq 60\ min. \end{cases}$$

$$4.4.4 = \begin{cases} 1 & \text{if} \quad X_1 < 30\ min.\ \text{OR}\ X_2 < 20km; \\ 0.75 & \text{if} \quad X_1 \in [30\ min., 40\ min.)\ \text{OR}\ X_2 \in [20km, 30km); \\ 0.5 & \text{if} \quad X_1 \in [40\ min., 60\ min.)\ \text{OR}\ X_2 \in [30km, 40km); \\ 0.25 & \text{if} \quad X_1 \in [60\ min., 70\ min.)\ \text{OR}\ X_2 \in [40km, 50km); \\ 0.1 & \text{if} \quad X_1 \geq 70\ min.\ \text{OR}\ X_2 \geq 50km; \end{cases}$$

$$4.5 = \begin{cases} 1 & \text{if} \quad F = 100\%; \\ 0.75 & \text{if} \quad F \in [95\%, 100\%); \\ 0.5 & \text{if} \quad F \in [90\%, 95\%); \\ 0.25 & \text{if} \quad F \in [85\%, 90\%); \\ 0.1 & \text{if} \quad F < 85\%; \end{cases}$$

$$4.6.1 = \begin{cases} 1 & \text{if} \quad \text{All 5 properties} = \text{“Very good” or “Good”}; \\ 0.75 & \text{if} \quad \text{Only 4 of the 5 properties} = \text{“Good” or “Very good”}; \\ 0.5 & \text{if} \quad \text{Only 3 of the 5 properties} = \text{“Good” or “Very good”}; \\ 0.25 & \text{if} \quad \text{Only 2 of the 5 properties} = \text{“Good” or “Very good”}; \\ 0.1 & \text{if} \quad \text{Only 1 of the 5 properties} = \text{“Good” or “Very good”}; \end{cases}$$

$$4.6.2 = \begin{cases} 1 & \text{if} \quad RI_\Phi = 5; \\ 0.75 & \text{if} \quad RI_\Phi = 4; \\ 0.5 & \text{if} \quad RI_\Phi = 3; \\ 0.25 & \text{if} \quad RI_\Phi = 2; \\ 0.1 & \text{if} \quad RI_\Phi = 1. \end{cases}$$

$$4.7 = \begin{cases} 1 & \text{if} \quad \text{fatalities per 1000 inhabitants} < \frac{0.05}{1000}; \\ 0.75 & \text{if} \quad \text{fatalities per 1000 inhabitants} \in [\frac{0.05}{1000}; \frac{0.11}{1000}); \\ 0.5 & \text{if} \quad \text{fatalities per 1000 inhabitants} \in [\frac{0.11}{1000}; \frac{0.17}{1000}); \\ 0.25 & \text{if} \quad \text{fatalities per 1000 inhabitants} \in [\frac{0.17}{1000}; \frac{0.23}{1000}]; \\ 0.1 & \text{if} \quad \text{fatalities per 1000 inhabitants} > \frac{0.23}{1000}. \end{cases}$$

$$4.8.1 = \begin{cases} 1 & \text{if} \quad X_1 > 5\%; \\ 0.75 & \text{if} \quad X_1 \in (2.5\%, 5\%]; \\ 0.5 & \text{if} \quad X_1 \in (0\%, 2.5\%]; \\ 0.25 & \text{if} \quad X_1 \in (-2.5\%, 0\%]; \\ 0.1 & \text{if} \quad X_1 \leq -2.5\%; \end{cases}$$

$$4.8.2 = \begin{cases} 1 & \text{if} \quad X \leq -5\%; \\ 0.75 & \text{if} \quad X \in (-5\%, -2.5\%]; \\ 0.5 & \text{if} \quad X \in (-2.5\%, 0\%]; \\ 0.25 & \text{if} \quad X \in (0\%, 2.5\%]; \\ 0.1 & \text{if} \quad X > 2.5\%; \end{cases}$$

$$4.9.1 = \begin{cases} 1 & \text{if} \quad CtD_1 = 5; \\ 0.75 & \text{if} \quad CtD_1 = 4; \\ 0.5 & \text{if} \quad CtD_1 = 3; \\ 0.25 & \text{if} \quad CtD_1 = 2; \\ 0.1 & \text{if} \quad CtD_1 = 1. \end{cases}$$

$$4.9.2 = \begin{cases} 1 & \text{if} \quad CtD_2 = 5; \\ 0.75 & \text{if} \quad CtD_2 = 4; \\ 0.5 & \text{if} \quad CtD_2 = 3; \\ 0.25 & \text{if} \quad CtD_2 = 2; \\ 0.1 & \text{if} \quad CtD_2 = 1. \end{cases}$$

$$4.9.3 = \begin{cases} 1 & \text{if} \quad IGR = 5; \\ 0.75 & \text{if} \quad IGR = 4; \\ 0.5 & \text{if} \quad IGR = 3; \\ 0.25 & \text{if} \quad IGR = 2; \\ 0.1 & \text{if} \quad IGR = 1. \end{cases}$$

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