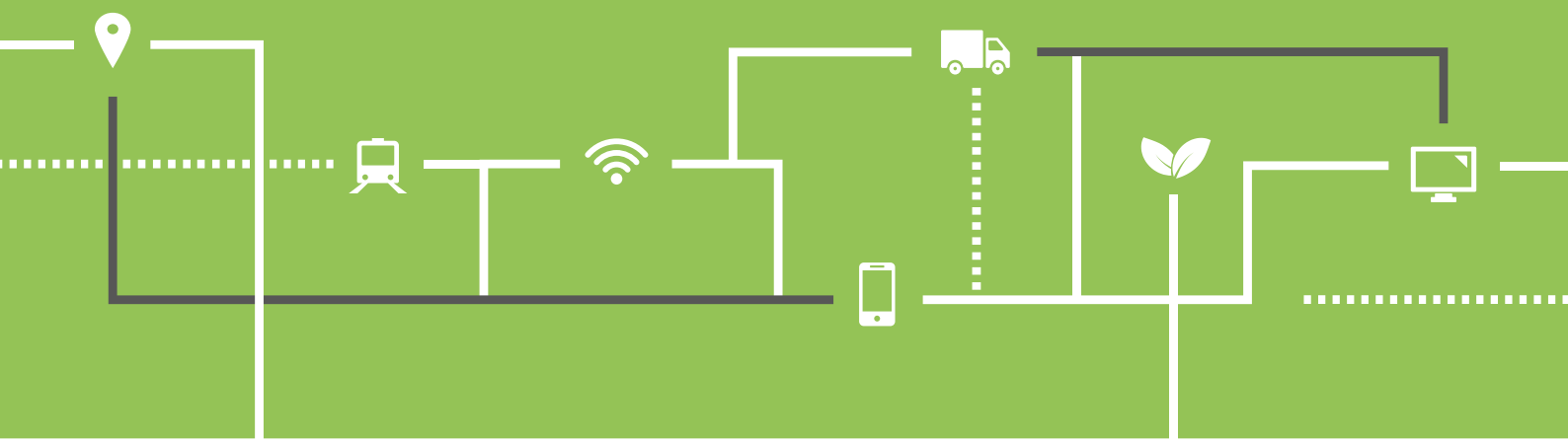
GLI:X

Green Logistics Indicators for Gauteng, South Africa



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Executive Summary

Mobility and transportation are the circulatory system of the economy and are crucial for the organization of the everyday lives of people, for social participation, and for economic exchange processes. The freight logistics sector is an integral part of transportation, as it enables production and everyday consumption, thus adding to and ensuring quality of life. However, it causes negative side effects such as congestion of roads, emissions, and other dangers to the environment and people. An efficient, reliable and sustainable freight logistics sector is therefore essential to economic growth and competitiveness, and to the quality of life.

Cities and metropolitan regions as agglomerations of people, industries, and service providers have an especially large demand for freight movement. Additionally goods move through cities that do not originate from or serve these cities themselves. Thus, many cities and urban regions today face the challenge of making freight logistics faster, more efficient and reliable, and at the same time socially and ecologically sustainable to meet their goals and respond to future trends and reduce negative effects of freight logistics.

The **metropolitan region of Gauteng** has been selected as the **first region to develop and test the GLI:X Green Logistics Indicators**. It is the economic heart of South Africa and a major logistics hub with a fast-growing freight transport sector. Its growing urban population and the rising standards of living require a steady supply of consumer goods. This growth comes with **major challenges**, such as a fragmented spatial system, growing car ownership, noise and pollution, a missing integration of public transportation modes and high income and social inequality. The freight logistics sector has to cope with sector-specific challenges, such as an ongoing shift from rail to road transportation, causing congestion, bottlenecks in inner city districts, high emission levels from logistics vehicles, and, last but not least, safety and security issues. Additionally, freight logistics are underrepresented in policy processes and public discourse. Therefore, dealing with the challenges in freight logistics is of growing importance for the region.

Thus, the **GLI:X Green Logistics Indicators provide a tool for policy-makers and the industry** to enable the measurement and quantification of the state of freight logistics in Gauteng in a structured and manageable form, facilitating the monitoring of the success of policies pertaining to freight logistics, without prescribing solutions, ensuring openness to new and innovative approaches.

In order to provide an integrated picture of freight logistics and its socio-economic effects, the GLI:X Indicators System is **structured into five key goals**, which were identified during the collaborative GLI:X-process and represent **a broader trans-sectoral perspective on freight logistics**. The GLI:X Indicators System brings the immediate goals of freight logistics – cost-effectiveness, speed, reliability and competitiveness – in line with broader, but no less important development goals, such as environmental protection, socio-economic development, and the safety and security of the people and the urban environment. Hence, the five key goals of the GLI:X Indicators System are: **greener logistics, more cost-effective logistics, faster logistics, safer and securer logistics**, and **more equitable logistics**.

For each of these goals, the GLI:X Indicators System contains 6-15 sub-indicators, chosen to optimally describe the goals of the region and measure target attainment. Contrary to most other indicator systems that compare cities or regions with each other, the GLI:X Indicators System compares the present state with a future (or past) state (**present2future benchmarking**), thereby tracking the development process. The sub-indicators are aggregated with weights chosen in cooperation between the stakeholders included in the process, which form the composite indicators for the five key goals and provide a condensed perspective on each of the five goals. The five composite indicators are then aggregated again to form the GLI:X Index, further reducing complexity.

The GLI:X Green Logistics Indicators have been developed in a **deliberative co-creation process with relevant cross-sectoral stakeholders** from the public and private sector, and academia in Gauteng. These stakeholders were included in the development process through interviews and a series of participative seminars in Johannesburg, which provided the platform for a discussion of goals, challenges, measures and suitable indicators for freight logistics in Gauteng. The development and design of the GLI:X Green Logistics Indicators is therefore fundamentally built on the participation and input of these stakeholders, in order to achieve a result that is tailored to local interests and needs.

The structured nature of the GLI:X dialogue process makes the development process **transferable to other regions, cities, and scenarios of application**, while the results are unique for the respective context.

1 Why Logistics Indicators?

Why Logistics?

Mobility and transportation are crucial for the organization of the everyday lives of people, for social participation, and for economic exchange processes. They are thus directly linked to the development of sustainable and viable cities. While science, politics, and public discussion most often focus on the movement of people when thinking about mobility, the movement of goods is often rather neglected. The movement of goods, however, is just as essential for sustainable socio-economic development.

Freight logistics[1] are the circulatory system of the economy. Thus, an efficient, reliable, and sustainable logistics sector is essential to economic growth and competitiveness. Otherwise, countries', regions', and cities' economies and societies are burdened with high transportation costs and unreliable logistics operations, as well as outsized negative externalities.

Freight logistics is about delivering goods and products to their destination in a fast and reliable way. However, this is not only an economic issue. Freight logistics is also an integral part of the production and consumption chain, and thus plays an important role in raising living standards, especially in countries with population growth. The organization and efficiency of freight logistics ensures and enables everyday consumption, influences consumer prices of products, and creates job opportunities, thus adding to and ensuring quality of life. On the other side, it causes side effects such as congestion of roads, emissions, and other dangers to the environment and people. Cities and metropolitan regions as agglomerations of people, industries, and service providers have a large demand for freight movement.

Cities are also nodes of transportation; thus, goods move through cities that do not originate from or serve these cities themselves. Increasing amounts of traffic caused by freight movement burden cities and diminish the quality of life of inhabitants. Especially in rapidly growing cities with a high population influx, inadequate infrastructures, diminishing resources, and environmental degradation, the negative agglomeration effects can seriously hamper efficient supply and distribution of goods. Thus, growing cities risk losing their advantages of being economic centres, and more specifically, hubs for local, regional, and global logistics.

Therefore, many cities today face the challenge of making logistics smarter and more sustainable in order to meet their goals and respond to future trends. And cities and urban regions in particular offer a lot of potential for innovative mobility and transport services in both passenger and freight transport, which are both enabled by digitalization to a large extent.

However, when addressing the issue of freight transport, cities and urban regions have to take a trans-sectoral perspective at freight logistics, taking into account not only economic, but also environmental and social issues that are associated with the sector. Furthermore, transsectoral approaches and collaborative action can help identify and exploit synergies between people and institutions. Through the formation of new partnerships and the joint implementation of innovative organizational models, existing infrastructures and capacities can be used more efficiently. In a joint effort by all stakeholders, environmental and social risks and costs can be assessed and included into budget calculations, thereby reducing overall financial burden in the long run.

It is the objective of the GLI:X Green Logistics Indicators to look at freight logistics from a broader perspective and, in a collaborative process with the participation of stakeholders from different fields, bring the immediate goals of freight logistics – cost-effectiveness, speed and competitiveness – in line with broader, but urgent development goals, such as environmental protection, socio-economic development, and the safety and security of the people and the urban environment.

Why Indicators?

Indicators are measurable values that describe a certain phenomenon and indicate the change of this phenomenon over the course of time. Composite indicators, i.e. the aggregation of individual or sub-indicators, are designed to enable the measurement and quantification of complex phenomena, such as freight logistics, in a simplified manner. Composite indicators, when well designed, offer a condensed view on a certain phenomenon or topic. By condensing complex phenomena into one or few easily digestible figures, composite indicators provide a tool for communicating complex topics in a structured and simplified way. Although their design involves some subjective judgments, e.g. concerning the selection of the indicators, the weighting of indicators, the choice of the aggregation model etc., they are very useful for visualising developments and the dependencies between developments.

For policy-makers, a composite indicator facilitates measuring the success of policies and initiatives, while it leaves open which strategies to use for achieving the objectives set within the composite indicator. It therefore leaves room for the development of innovative or unusual strategies for achieving the set targets. Also, the design process itself fosters deliberation and cooperation between the relevant stakeholders, which is an integral part of the GLI:X approach.

In the context of the rapid global urbanization tendencies, city indices (composite indicators) that analyse, measure, and compare cities or regions with each other are becoming increasingly important. Many city indices have been developed in recent years, and more indices will be created in the coming years.[2]

However, contrary to most existing city indices, the GLI:X Indicators System is not designed to compare cities or regions among each other, but rather as a progress indicator, which tracks the development of one region or city across time. Thus, it can assist cities and regions in benchmarking their own future, comparing the present state with a future (or past) state (present2future benchmarking), thereby illustrating the state of the development process.

Furthermore, the GLI:X Indicators System provides a tool for a holistic view of the state of logistics: This includes its economic and organizational performance as well as safety and security in the sector, environmental impact and socio-economic effects. The GLI:X Indicators System quantifies and illustrates to what extent the self-set targets for the key goals of the indicator system have been attained in a specific time-frame and enables a cost-benefit analysis of different solutions for smart and sustainable logistics (see chapter 3).

The GLI:X Indicators System is made up of five composite indicators that together form the GLI:X Index. The key goals and indicators for the GLI-X Indicators System have been determined in a deliberative co-creation process with relevant stakeholders from the public and private sector, civil society, and academia in Gauteng in order to achieve a result that is tailored to local interests and needs. The structured nature of this dialogue process makes this process transferable to other regions, cities, and scenarios of application, while the results are unique for the respective context (see chapter 4).

1 While logistics could be defined in a broader sense as a smooth organisation of a complex operation, in the context of the GLI:X Green Logistics Indicator System it is defined in the narrower sense of the movement of goods from their place of origin or production to their designated place of delivery in an intended time by means of transportation (road, rail, air and ship).

2 E.g. the ISO/TS 37151:2015: Smart community infrastructures, the ISO/TC 268: Sustainable development of communities, ISO 37120: City indicators for service delivery and quality of life, the SIEMENS Green City Index or the Smart City Index by Boyd Cohen

2 Challenges, Goals and Strategies of Freight Logistics in Gauteng

The metropolitan region of Gauteng has been selected as the first region to develop and test the GLI:X Green Logistics Indicators. The region is comprised of three metropolitan municipalities, Johannesburg, Tshwane, and Ekurhuleni, and two district municipalities, Sedibeng and West Rand. It is the economic heart of South Africa and a major logistics hub with a fast growing freight transport sector, as the growing urban population and the rising standards of living require a steady supply of consumer goods. This growth comes with major challenges and therefore tackling the topic of freight logistics is of growing importance for the region. Additionally, Gauteng is leading in the field of smart city development in Africa and is a pioneer in the development of sustainable solutions. Johannesburg serves as a model city for the development of indicator systems by the International Standardization Organization (ISO) and the International Electrotechnical Commission (IEC).

2.1 Gauteng Region as a Major Logistics Hub

Gauteng is a major distribution and consolidation centre for goods within South Africa. The dry port of City Deep and other important freight terminals are located in Gauteng Province. It is furthermore an important source and destination for international trade.

The source and destination of freight to and from Gauteng are mostly the port cities, particularly Durban, but also Cape Town and Port Elizabeth. The Durban-Gauteng freight corridor handles most of the country's high-value freight. The development of this freight corridor is part of the National Development Plan and the first priority. It shall be a model for shifting freight from road to rail and improving freight movement, e.g. through improved intermodal facilities along the corridor.

The automotive industry is located mostly in the Tshwane metropolitan municipality. However, because many suppliers are not located in the region, a substantial amount of automotive parts must be imported. A second important industrial cluster is the steel and metal processing industries in the south of the province, in Sedibeng district municipality, particularly the municipality of Emfuleni. Important mining areas are in the vicinity of Gauteng, resulting in bulk freight being transported through the region.

A large share of freight entering and leaving Gauteng is handled at City Deep, the major intermodal inland container terminal in the mining belt of Johannesburg and one of the largest inland container terminals in Africa. In City Deep mostly fast-moving consumer goods (FMCG) are handled – consumables like soft drinks, toiletries, and processed foods, but also electronics, clothing, and other consumer goods. As City Deep capacity will soon be exhausted, new terminals are currently being developed at the periphery of Gauteng: Tambo Springs in the south of Gauteng, Pyramid and Rosslyn in the automotive manufacturing belt of Tshwane.

Africa's busiest airport, O.R. Tambo International Airport, is an important freight hub for the southern hemisphere. The Aerotropolis in Ekurhuleni municipality will further integrate the Gauteng Region into international trade flows, fostering economic development and job creation in the region.

Gauteng Province and its Municipalities

Source: by authors based on wikipedia.org

2.2 Challenges and Goals connected to Freight Logistics in Gauteng

Overarching Challenges and Goals in the Gauteng Region

As mentioned before, the freight logistics sector has to be looked at in the greater context of a sustainable economic and ecologic and social development. As the population and freight movement are growing, the region is struggling with sluggish economic growth and the consequences of high population growth and socio-economic inequality due to the legacy of apartheid and its consequences on the social and spatial level. Fast urban development has caused urban sprawl and a fragmented urban landscape, causing long commuting times and congestion, especially for historically disadvantaged population groups. Rising living standards have led to an increase in car ownership and growing pollution. Accordingly, the restructuring of the spatial system overcoming apartheid spatial planning towards a compact urban development, the increase of resource efficiency, and equitable social development and economic empowerment of historically disadvantaged population groups are some major overarching goals. These goals which must be considered when looking at the freight logistics sector from a more holistic per-spective. This holistic perspective, which is the approach of the GLI:X Green Logistics Indicators, is necessary to understanding the interactions of logistics with the socio-economic system as a whole, thereby enabling an alignment of sectoral policies with the overarching policy goals of the region.

In such a setting, a growing industry such as the freight logistics sector, assumes a key role for the long-term sustainable development of the region. Balancing the goals of cost efficiency and reliability with these overarching development goals can contribute to a better quality of life in the region, enhance policy efficiency, mitigate the risk of unintended consequences, and position the sector as a model for inclusive development.

Challenges and Goals of Freight Logistics in the Gauteng Region

In addition to the overarching challenges the region must tackle in connection with the growth of the freight logistics sector, other challenges that directly concern the freight logistics sector must also be addressed. The rapid growth of freight movement in the region is associated with different challenges, some of which are detailed below:

Increasing volume of freight movement burdens infrastructure: The volume of freight movement is projected to increase substantially in South Africa in the years to come. This will have a decisive impact on the road and rail infrastructure. For the Province of Gauteng, heavy trucks and other freight vehicles using common roads are a major problem, because most roads are not suited to bear the weight of heavy trucks. Particularly when overloaded, they cause considerable damage to the roads. Weighing bridges are installed all over the province, but the network is not sufficient and overload control is virtually non-existent in the province. [3]

Trucks, private individual vehicles, and other modes of transportation use the same roads, contributing to congestion especially in peak hours. Many intermodal terminals for freight are located in or close to the CBDs of Gauteng, which have inadequate access roads and nearby residential quarters, causing congestion in these neighbourhoods.[4] Adequate loading bays are missing, especially in areas with high retail density. Congestion contributes to air pollution, negatively affects the everyday commute of citizens, and eventually causes economic losses.

Increasing share of road transportation: For long distance freight movement, especially bulk freight, rail has a considerable market share (about 30 percent of the total tonne-kilometres in South Africa). Since the railway sector was deregulated in 1988, the share of rail in logistics has been decreasing and the bulk of general freight has shifted to road transportation. For containers, rail now accounts for less than 20% of tonne-kilometres nationally. For last mile freight logistics, road vehicles with combustion engines are the exclusive mode. According to some stakeholders in the sector, the rail system lacks reliability and is less suitable for the movement of time-sensitive goods. The current rail network is not equipped to supply the current and future demand of freight transport.[5] However, particularly for long-distance transportation along specific corridors, freight movement by rail has substantial cost advantages and environmental benefits. Thus, the South African government and Transnet have developed programs to invest into the rail infrastructure in order to increase the share of freight movement on rails.

Logistics costs: Nationally, logistics costs as a percentage of GDP are at a stable level of 12.5% for 2011 – 2013. However, provincial logistics costs are particularly high for Gauteng in comparison to the rest of South Africa. Although, according to the World Bank, South Africa's road system is comparatively well developed, inadequate and damaged infrastructure nevertheless contribute to high logistics transportation costs for the private sector. Unreliability of freight movement poses difficulties for manufacturers and service deliverers to operate efficiently and competitively. With the projected growth of population and traffic, the challenge of high transportation costs is likely to become even more significant.

Safety and security problems: For freight logistics operators, safety and security in logistics procedures is a major concern. Hijackings of trucks and warehouses are encountered frequently, causing not only financial losses but also affects the wellbeing of drivers and other personnel. For both the province and its municipalities, improper roadworthiness of vehicles, especially heavy trucks, is a major challenge resulting in heavy vehicles being disproportionately involved in accidents in the CBDs and on freeways. Accidents causing severe injuries and fatalities are not uncommon, particularly when pedestrians are involved. Apart from the social burden, inadequate safety and security standards can negatively affect the investment climate and competitiveness.

Lack of low-emission standards: Because of the high traffic volumes the region is struggling with high levels of pollution. Low-emission standards are not yet developed for freight vehicles.

Lack of data: The lack and inadequacy of data becomes important when developing freight strategies. For example, current data does not cover informal transportation of goods, inter-metropolitan or long-distance transportation – e.g. the amount of goods that is carried in long-distance, cross-border passenger transport is substantial.

3 Gauteng 25-year Integrated Transport Master Plan (ITMP 25) 2013, Annexure I: Freight Strategy
4 Ibid.
5 Ibid.

Linking overarching and freight-related goals and challenges to develop a comprehensive indicator

In order to move in the direction of a freight logistics sector that is not only economically, but also socially and ecologically sustainable, it is necessary to take a holistic perspective, which considers the overarching development goals and challenges of the Gauteng region as well as the sector-specific challenges and goals in the region. Therefore, freight-specific goals like cost effectiveness, speed and reliability, and safety and security have to be connected with social development goals as well as environmental and resource conservation. This approach has been taken up in the GLI:X Green Logistics Indicators to create a comprehensive indicator system for a cost-effective, fast, safe, secure, and reliable freight logistics that is in balance with environmental and social goals.

A comprehensive understanding of freight logistics and the distribution of responsibilities for the freight logistic sector among the province and the municipalities calls for a multi-stakeholder approach to tackle the challenges facing the sector. The GLI:X process has been successful in fostering cooperation between the different political entities and other stakeholders, thereby opening up new options for tackling the challenges surrounding logistics in the region.

Summary of Challenges and Goals connected to the Freight Logistics Sector

Overarching challenges

- Fragmented **spatial system**, disperse urban growth
- High income and social **inequality**
- Growing car ownership and pollution
- Missing **integration of public transportation** modes

Overarching goals

- **Compact urban development**, alter spatial system, **overcome apartheid planning**
- Create an integrated public transportation system, incl. non-motorized transport
- Create skilled jobs, foster youth development and black entrepreneurship

Key challenges of freight logistics

- Growth of freight logistics sector, capacity
- Shift to road transport in freight logistics
- Safety and security in freight movement
- Congestion particularly in peak hours
- Bottlenecks in inner city districts
- Access to workplaces by public transport
- High emission levels
- Freight movement underrepresented in policy processes

Goals for freight logistics sector

- Freight logistics foremost need to serve the accommodation of trade, spur economic growth and prosperity and secure competitiveness.
  → **Logistics need to be cost-effective, fast, efficient, safe, secure and reliable.**
- **Freight movement needs to be in balance with the requirements** of other transport users, conservation of the **environment, quality of life and social developments**

2.3 Strategies and Initiatives for Freight Logistics in Gauteng

Although some new strategies and initiatives for freight logistics have been developed by the provincial government and the municipalities in Gauteng in order to handle the growing freight movement, freight transport is still rather neglected as a topic and mostly handled as only one marginal part of the greater topic of transportation. So far, there are hardly any indicators or numbers developed to measure freight transport.

Some of the existing strategies to tackle the topic of freight transport in the region are described below.

Gauteng Province

The Province of Gauteng has prepared a Freight strategy as an annexure of the Integrated Transport Master Plan 2013[6], which takes the following principles as departure points:

- Identify freight growth corridors and nodes;
- Decrease the number of heavy freight vehicles in the CBDs
- Establish freight intermodal facilities on the eastern periphery of Gauteng;
- Adequate linkages outside the province (i.e. Gauteng – KZN Corridor);
- Align freight intermodal facilities with Transnet's Container Strategy for Gauteng and Durban port developments;
- Provide supporting infrastructure to freight intermodal facilities;
- Provide adequate overload control mechanisms at freight intermodal facilities;
- Provide for adequate public transport to the planned freight intermodal facilities and associated developments around it;
- Provide for adequate levels of safety and security.

Furthermore, the Durban-Gauteng freight corridor as a priority strategy of the National Development Plan is seen as the basis for the Gauteng Freight Strategy. As per the Freight Strategy for the Province of Gauteng, major strategies for freight at the provincial level are:

- **Freight bypass road concept:** In order to improve freight movement infrastructure and decrease heavy freight vehicles in the CBDs and reduce congestion there, a freight bypass road and a rail bypass will be established. The freight bypass road concept shall be accompanied by strategies to design infrastructure to support abnormal loads. Furthermore, freight intermodal facilities to support the freight bypass concept shall be established.

- **Support move of freight from road to rail:** An upgrade of the rail network is envisaged to ensure a predictable rail service; differential tolling/ road pricing mechanisms will also be implemented. To support the bypass concept and efficient transloading from road to rail and vice versa, intermodal facilities will be upgraded. Sufficient public transport capacity at freight intermodal facilities will also be established.

- **Improve safety and security situation:** A track and trace system to monitor consignments shall be implemented and measures of overload control will be improved and expanded. The introduction of intelligent traffic management systems will improve traffic safety and further measures will target the reduction of accidents involving trucks.

6 Gauteng 25-year Integrated Transport Master Plan (ITMP 25) 2013, Annexure I: Freight Strategy

- **Reduce environmental impact of freight logistics**: Limiting heavy freight vehicles (5 or more axles) into the Gauteng CBDs and shifting freight transportation from road to rail will reduce CO2 emissions, as well as noise and air pollution. Further externalities, such as the impact of noise and loss of open spaces and greenfield sites, need to be addressed.

Metropolitan Municipalities

Johannesburg's freight logistics strategies are mostly in line with those of the Province of Gauteng.[7] However, apart from introducing smaller, less polluting and more energy efficient vehicles, Johannesburg specifically mentions the opportunities of freight bikes for intra-city logistics. In the long term, Johannesburg pursues the creation of Low Emission Zones (LEZs). Furthermore, real-time freight information and maps of vehicle location and traffic incidents shall be provided in the longer term through navigation systems. Deliveries to retailers and shops in the inner-city area could be restricted to night hours. Beyond that, an important strategy for the City of Johannesburg is the Corridors of Freedom. This strategy aims at the alteration of the spatial system in order to overcome the apartheid spatial planning that has been deepened by a process of urban sprawl and suburbanization by middle classes after apartheid. It does not specifically focus on freight and logistics, but rather on transit-oriented development (mixed-use development, passenger transport and non-motorized transport, linking places of living and places of work, better access to economic opportunities, social and cultural infrastructure).

The growth of freight movement in Gauteng will also affect the metropolitan municipality of **Tshwane**, whose transport plan foresees a couple of measures for freight transport for the short, medium, and long term. These measures include, among others, the establishment of a Freight Working Group in Tshwane and a technical workgroup to manage hazardous goods, the implementation of weighing bridges and dedicated freight routes, and the development of a freight transport plan and an intelligent transport system. [8]

For the Province of Gauteng as well as the City of Johannesburg, new strategies for the freight logistics sector are currently being developed: the GP Freight Master Plan and GP Freight Implementation Strategy for Gauteng Province and the City of Johannesburg Freight Plan for the City of Johannesburg.

7 Strategic Integrated Transport Plan Framework 2013
8 See Tshwane Comprehensive Integrated Transport Plan 2015

Major projects to strengthen Gauteng's position as logistics hub

Several projects are currently in the planning and development phase designed to strengthen Gauteng's position as logistics hub.

- The container terminal **City Deep** is expected to reach capacity by 2018 and is currently being expanded. Further logistics hubs are being developed in Tambo Springs (south of Ekurhuleni), Sentrarand (east of Ekurhuleni), and Pyramid (north of Tshwane).

- The **Tshwane Automotive City** is a major project that started in 2008. It aims at globally positioning Tshwane as a leading automotive investment destination. The Automotive City is a joint venture by the City of Tshwane Metropolitan Municipality, the Tshwane Economic Development Agency, and the Automotive Industry Development Agency (AIDC) of the Gauteng Growth and Development Agency (GGDA). The Automotive City project comprises the development of a major logistics hub.

- Furthermore, the Ekurhuleni Metropolitan Municipality and Province of Gauteng have implemented a 25-year plan for developing OR Tambo International Airport into a 1,975 sq. km **Aerotropolis**, estimated to generate 581,000 additional jobs. The Aerotropolis will also provide vocational training in the logistics and automotive sectors.

Apart from major projects, the province and the municipalities engage in several initiatives to foster developments in the freight sector.

The Gauteng Department for Roads and Transport hosts a regular **Provincial Freight Forum**, which involves the departments of the provinces and the municipalities as well as industry representatives and takes a first step towards fostering co-operation across the region.

In terms of environmental protection and climate change mitigation and adaptation, the Department of Environmental Services of the City of Johannesburg closely collaborates with the National Business Institute (NBI) on logistics and freight issues, e.g. solar power on trucks and other innovations. There is also a **Business Forum** with a subcommittee on Environmental Sustainability. The Automotive Industry Development Centre (AIDC) of the Gauteng Growth and Development Agency (GGDA) convenes a **Tshwane Automotive Green Forum** in order to showcase new developments towards a greener automotive industry. The province and the City of Johannesburg already experiment with new energy sources in the transport sector, like natural gas or methane gas from waste dumps.

3 The GLI:X Green Logistics Indicators

The GLI:X Green Logistics Indicators together form a **composite indicator (the GLI:X Index) consisting of five composite indicators describing five key goals** relevant for a smart and sustainable freight logistic sector. These goals have been set by the stakeholders in the region in a co-creation process, namely **greener logistics, more cost-effective logistics, faster logistics, safer and securer logistics and more equitable logistics**.

By taking these trans-sectoral goals as departure points, the GLI:X Indicators System provides an instrument to gain a holistic insight into the current state and the progress made in freight logistics. Furthermore, the GLI:X Indicators System shall enable the assessment and comparison of different solutions for smart and sustainable freight logistics in order to better meet the objectives set by the city or region.

3.1 Core principles

The GLI:X Indicators System is based on **three core principles** that were deemed important for its development: **collaboration, innovation, and adaptability**.

1. Innovation

Contrary to most existing city indices, the GLI:X Indicators System is not designed to compare cities or regions among each other. While comparing cities or regions leads to attractive rankings and stimulates competitive dynamics between cities, this approach is often criticized for comparing entities with strongly differing challenges and conditions on the ground. **The progress indicator** developed in the GLI:X-Project takes another approach, which does not focus on interregional comparability, but instead on tracking the development of one region or city across time. Thus, it can assist cities and regions in benchmarking their own future, comparing the present state with a future (or past) state (present2future benchmarking), thereby illustrating the state of the development process. **Present2future benchmarking** also highlights that these targets can be achieved by many different, sometimes surprising ways, leading to **innovative solutions**. the indicator deliberatively leaves open, which measures should be used to achieve the goals, leaving room for different policies and strategies.

2. Collaboration

The GLI:X Green Logistics Indicators have been developed in a **deliberative co-creation process** with relevant cross-sectoral stakeholders from the public and private sector, civil society, and academia. These stakeholders were engaged in the development process through interviews and a series of participative seminars in Johannesburg, which provided the platform for discussion of goals, challenges, measures and suitable indicators for freight logistics in Gauteng. The development and design of the GLI:X Green Logistics Indicators therefore fundamentally built on the participation and input of these stakeholders.

3. Adaptability

The structured nature of the dialogue process to create the GLI:X Indicators System makes the process transferable to other regions, cities, and scenarios of application. Thus, the principle of adaptability refers both to 1) the **applicability and manageability** of the indicator system for the local context, and to 2) the **transferability of the methodology** and experiences to other cities and regions.

Applicability and manageability of the indicator system: A crucial quality criterion of the final indicator system, which had to be borne in mind during the process, is the manageability and usa-

bility for public administrations and other institutions implementing the indicator. One important goal was therefore to reduce the complexity of the tool while not compromising on its validity and accuracy. This also implied reducing the number of indicators to include only the most significant and precise ones for the phenomena to be captured, while at the same time accounting for data availability, accessibility, and quality.

Transferability of the approach: The indicator development process relies essentially on local stakeholders. Thus, while the results of the indicator development are unique to the specific context, the iterative design of the seminar process can be repeated in different locations, producing (potentially) very different results. Each new process benefits from the experiences made in previous indicator development projects and encourages exchange between metropolitan regions and cities.

The Core Principles of the GLI:X Green Logistics Indicators Process

3.2 Structure of the GLI:X Indicators System

While indicator systems are commonly designed to provide metrics for discrete sectors of the economy or socio-economic phenomena in isolation, the GLI:X Indicators System takes a holistic or system-oriented approach. For the development of the GLI:X Indicators System, freight logistics were not regarded as a closed system. As mentioned above, good freight logistics is not a goal in and of itself. Freight logistics is about delivering goods to their destination fast, reliably, and at the lowest costs possible, and thus should contribute to quality of life. Therefore, negative side-effects such as emissions, congestion, or environmental damage should be reduced, and positive socio-economic effects should be increased. The objective was to bring the immediate goals of freight logistics – cost-effectiveness, speed, and competitiveness – in line with broader, but urgent development goals, such as environmental protection, socio-economic development, and a safe and secure urban environment. Therefore, the following five key goals were defined for the GLI:X Green Logistics Indicators in a collaborative process.

The 5 Key Goals of the GLI:X Green Indicators System

In order to provide an integrated picture of freight logistics, the GLI:X Indicators System is **structured into five goals**, which were identified during the collaborative GLI:X-process as the most relevant goals for smart, efficient, and green logistics.

These goals are **greener logistics, more cost-effective logistics, faster logistics, safer and securer logistics**, and **more equitable logistics**.

Environment: Greener Logistics

This key goal aims fundamentally at ecological sustainability, thus developing the freight logistics sector in a way that is less harmful to ecological systems and natural resources. An intact urban metabolism eventually has positive impacts on the quality of life and resilience of an urban region, and thus is a prerequisite for the functioning of a metropolitan region in the long run. Key aspects for ecological sustainability are the reduction of GHG emissions, preservation of biodiversity and natural resources like water and soil, the efficient use of energy, and the reduction of air pollution. The aim is not only to make the freight logistics sector greener, but also to promote ecological sustainability in adjacent sectors through a visible role model.

Cost-Effectiveness: More Cost-Effective Logistics

The cost of freight movement is a major factor for the competitiveness of both the logistics sector and the manufacturing industry in the region. For end-customers, lower logistics costs reduce the overall price of goods and thus increase the availability of consumer goods for larger parts of the population. Thus, the goal of cost-effectiveness calls for an investigation of the existing capacities. Rather than constantly enhancing capacities, the key approach will be a more efficient and effective use of existing capacities by means of stakeholder collaboration and innovative (digital) solutions.

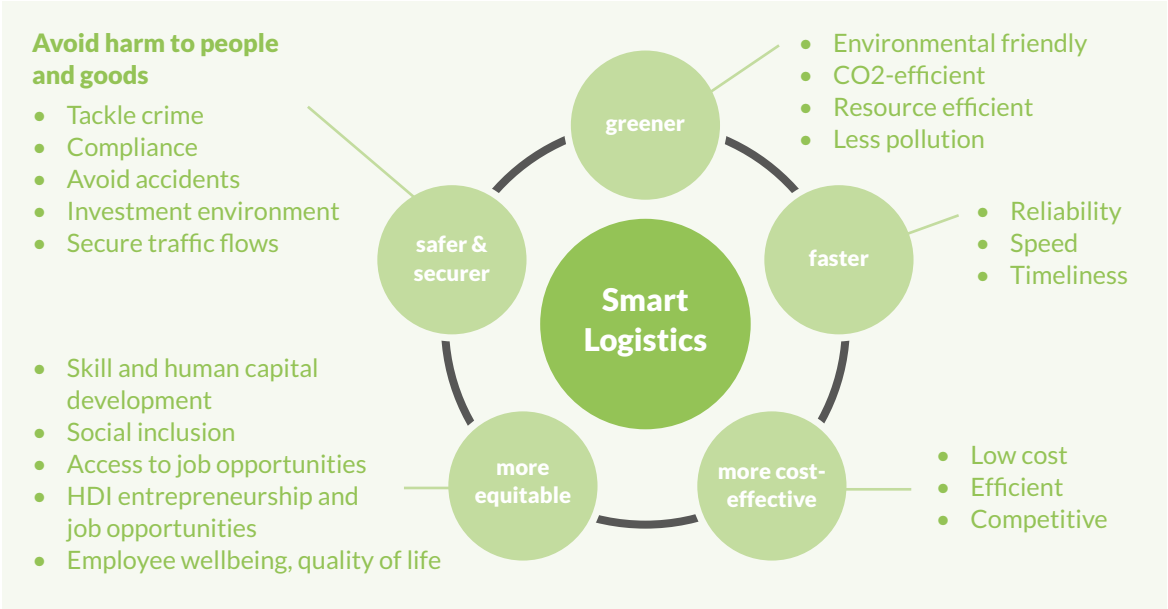
Speed and Time: Faster Logistics

A highly competitive freight logistics sector relies on fast processing at all stages of the value chain, be it storage, transloading, movement, identification, documentation, or communication. However, for some goods, it is more decisive that they be delivered at the right time and with high predictability – both for the industries and the citizens. Thus, not only speed but also timeliness and reliability are aspects that are focused on in this goal.

Safety and Security: Safer and Securer Logistics
The goal of safer and securer logistics is fundamental to the future development of Gauteng's logistics sector. It aims at avoiding harm to goods and people. The safety aspect deals with people and materials involved in freight logistics and how negative impacts on these and external actors and materials can be avoided. The safety aspect also includes the technical fitness of infrastructures and vehicles. A foremost objective needs to be the avoidance of deadly and serious accidents. The security aspect relates to the negative impact of crime with serious consequences for people and goods. A safer and securer logistics sector is conducive to the overall business and investment environment of Gauteng and secures competitiveness in the long run.

Equitable Development: More Equitable Logistics
This goal is particularly important for the Gauteng region and comprises two major aspects: first, a more equitable and socially inclusive freight logistics sector, and second, a freight logistics sector that provides new (skilled) employment and entrepreneurship opportunities. The first aspect encompasses the well-being of drivers and other employees in the sector and includes access to the workplace, income distribution and standards for working hours, as well as the assessment of future prospects for employees regarding skills enhancement and career opportunities. The second major aspect of this goal is that the sector provide new (skilled) employment and entrepreneurship opportunities. With continuing immigration into Gauteng, a growing population, and an increasing demand for freight transportation, the sector needs to ensure the creation of new job opportunities, especially skilled jobs. The growth of the logistics sector needs to be accompanied by a fostering of black entrepreneurship and job opportunities in logistics and the economic and social development of townships. As with green development, the logistics sector can be a role model for equitable development with positive effects for other economic sectors.

The 5 Key Goals of Smart Logistics for Gauteng



How does the GLI:X Indicators System Work?

The GLI:X Indicators System is composed of five composite indicators for each of the above described goals. These five composite indicators together form the composite GLI:X Index. The GLI:X composite indicators measure the progress in target attainment for these five goals. Each of the composite indicators is based on 6-15 sub-indicators, which can best describe and measure the extent to which the goals can be achieved. For example, the specification of the environmental impact indicator includes the sub-indicators CO2 emissions, PM10 emissions, NOx emissions, the land use of the freight logistics sector, the primary energy use of the freight logistics sector and the freight modal split. Altogether the GLI:X Indicators System is comprised of 51 individual indicators.

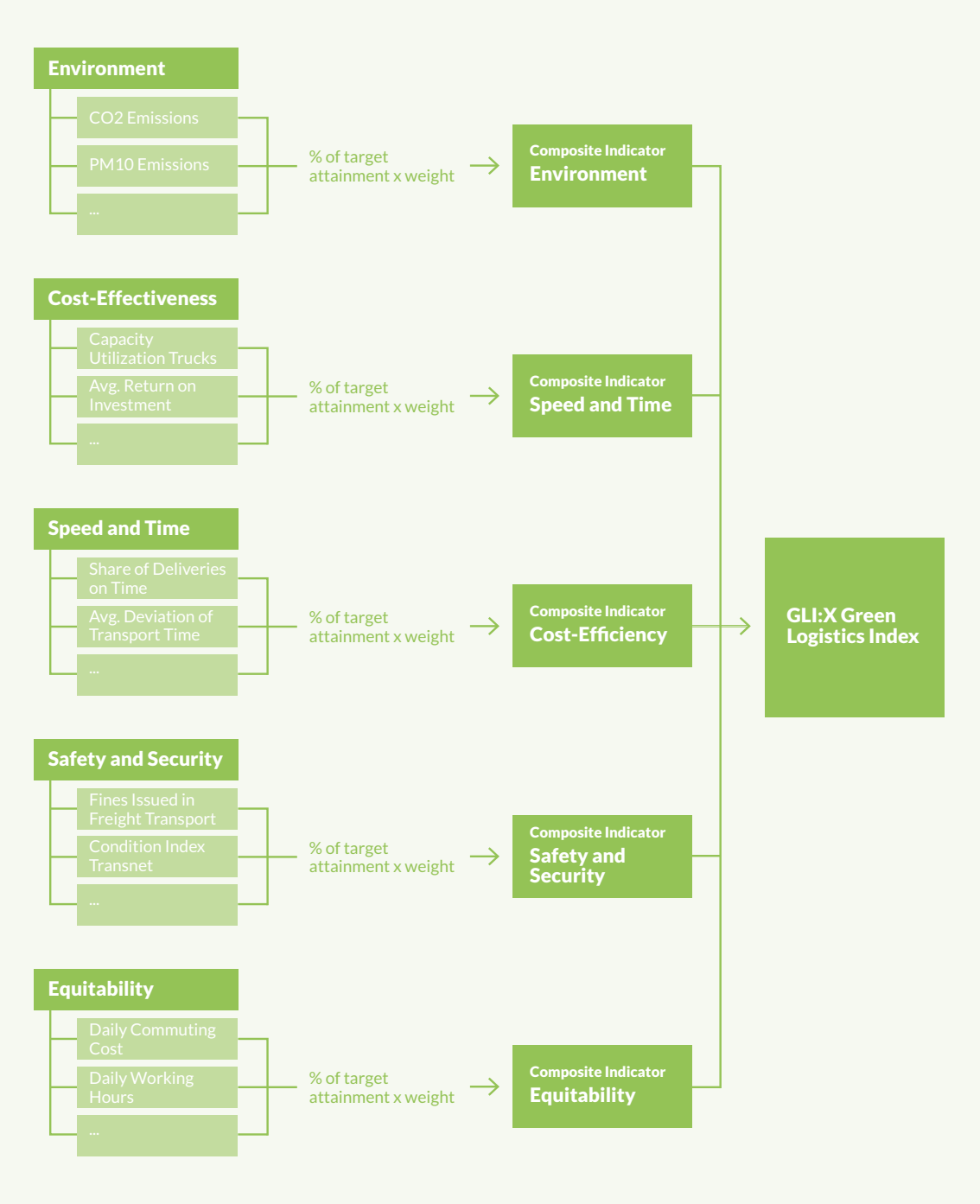
In order to be able to combine the individual sub-indicators into one composite indicator, a normalization procedure has to be performed, as the different sub-indicators are measured in different units and accumulating over or averaging across different units of measurement is devoid of meaning.[9] Thus, to normalize the sub-indicator values, i.e. to convert the different units into one identical unit, a base value (e.g. today) and target value (in the future) have to be defined for each sub-indicator, where the target value is 100%. Normalization is then carried out by calculating the target attainment in percent starting from the base value for each of the sub-indicators.

In a last step, the normalized sub-indicators are weighted and then aggregated linearly. As the sub-indicators describing a key goal might not all be of equal importance to reach the goal, they were weighted using a Budget Allocation Process. The Budget Allocation Process was determined by means of a survey among the participating stakeholders. Each stakeholder was allocated 100 points for each key goal composite indicator. These could be distributed among the respective sub-indicators according to their subjective relative importance. The weights for aggregation were then readily derived from this scoring. Eventually, target attainment is measured as an aggregated number for each goal and as an aggregated number for all goals together, i.e. the aggregated GLI:X Index is the (non-weighted) average of the five key goal composite indicators. More details regarding this allocation process can be found in the appendix. The procedure of the GLI:X Indicators System is visualised below.

By eschewing a cross-sectional comparison across regions and adapting a present to future benchmarking approach involving an assessment of both the status quo and targets set by local stakeholders, the GLI:X Indicators System can be tailored to local goals and circumstances. At the same time, the indicator creation process fosters cooperation and communication between local stakeholders.

9 While for cross-sectional indicators this normalization can be carried out utilizing techniques like z-transforms, i.e. transforming absolute values into positions of these values on the cross-sectional distribution, this approach is infeasable the GLI:X Indicators System due to its present-to-future benchmarking nature.

The Structure of the GLI:X Indicators System



3.3 The Indicators for the 5 Key Goals

One of the main tasks within the process of developing the GLI:X Green Logistics Indicators was to define a manageable number of individual indicators for each goal that are most suitable to capturing the most important phenomena and criteria of this goal. It was important to limit the number of indicators for each goal to a manageable number in order to reduce complexity and enhance applicability. The difficulty in finding suitable indicators lies in judging whether the indicator effectively measures the intended phenomenon, whether it is measurable, and whether it contradicts or correlates too strongly with other indicators (although correlation of indicators is not fully eliminated in the GLI:X Indicators System). To decide on the most suitable indicators, possible indicators were brainstormed as well as taken from literature and from existing indices. These indicators were then discussed, integrated, and grouped or condensed, and the remaining indicators were then again discussed, assessed, and finalized. The resulting indicators for each of the key goals are explained and listed below.

Indicators for the Goal Environment

This goal aims at ecological sustainability and thus at reducing harm to the environment and natural resources as well as to people through pollution.

The indicators “Land Use” and “Primary Energy Use” refer to the reduction of the use of resources by the logistics sector.

Another key aspect of this goal is the reduction of emissions through freight logistics. This includes CO2 as the main green-house gas and pollutants which directly affect air quality. This is captured by the indicators “CO2 Emissions”, “PM10 Emissions”, and “NOx Emissions”.

The indicator Freight Modal Split was deemed to be very important to the participating stakeholders. It represents the shift of freight transport from road to rail and thus a shift to a mode of transport that reduces emissions, primary energy use, and road congestion. It must be noted that this indicator captures several phenomena that are also partly captured in other indicators, such as pollution.

The following table presents the sub-indicators comprising the composite indicator for the environment goal together with the respective weights assigned by the stakeholders who participated in the development process. Each sub-indicator will then be discussed in turn.

Environment

Category	Indicator	Unit	Weight (%)
Emissions	CO2 Emissions	t / (TEU*km)	21,92
	PM10 Emissions	t / (TEU*km)	13,46
	NOx Emissions	t / (TEU*km)	13,07
Resource Efficiency	Land Use Logistics Sector	km^2/TEU	12,69
	Primary Energy Use	BTU / (TEU*km)	9,23
Transport Mode	Freight Modal Split	%	29,61

CO2 Emissions
This indicator gives information about CO2 emissions per unit of output in the logistics sector.

PM10 Emissions
This indicator gives information about the emissions of particulate matter with a diameter below 10nm per unit of output in the logistics sector.

NOx Emissions
This indicator gives information about the emissions of nitrous oxide per unit of output in the logistics sector.

Land Use Logistics Sector
By measuring the land use of logistics facilities (excluding roads and tracks) the soil sealing burden of the logistics sector is quantified per unit of output. This indicator accounts for measures to reduce soil-sealing impact, like the use of permeable lawn-checker bricks by utilizing correction factors.

Primary Energy Use
This indicator measures the primary energy consumption of the logistics sector per unit of output (BTU = British Thermal Units), thus accounting for raw resource efficiency irrespective of the source of the energy input.

Freight Modal Split
This indicator captures the share of goods moving on rail as opposed to road, reflecting both a commonly accepted measure for increasing energy efficiency and reducing environmental impact of transport, as well as a prominent policy goal in South Africa.

Indicators for the Goal Cost-Effectiveness

As mentioned before, the costs of freight movement are a major factor for the competitiveness of the logistics sector. A key aspect of the goal of cost-efficiency is therefore a more effective use of capacities: Rather than constantly enhancing capacities, the key approach will be a more efficient and effective use of existing capacities. Other key aspects are the return on investment and an assessment of the costs that are generated by logistics – on the one hand for the customer as represented as part of the price of the end-product, and on the other hand the external costs for public infrastructure for logistics, which are borne by the public sector.

The following table presents the sub-indicators comprising the composite indicator for the cost-efficiency goal together with the respective weights. Each sub-indicator will then be discussed in turn.

Cost-Effectiveness

Category	Indicator	Unit	Weight (%)
Efficiency	Capacity Utilization Trucks	%	13,4
	Capacity Utilization Rail	%	18,1
	Capacity Utilization Hubs	%	18,2
Economic Sustainability	Average Return on Investment (ROI)	%	14,6
Costs	Share of Logistics Cost in Producer Price of End-Product	%	15,5
	Public Infrastructure Cost Due to Logistics	ZAR/(TEU*km)	11,2
	Share of Logistics Cost in GDP	%	8,9

Capacity Utilization
The capacity utilization indicators for each of the transportation modes are aimed at capturing the efficiency of the logistics sector in using its real capital. Capacity utilization is measured as the percentage of capacity used compared to the theoretically available capacity under technological and regulatory constraints. Attainable and used capacity are measured according to the mix of goods transported. For enterprises that predominantly transport low-density goods such as parcels where the real constraint is volume, TEU*km provided / TEU*km available is used. For enterprises predominantly transporting high-density and bulk goods, t*km provided / t*km available is used. By including indicators for the two transportation modes, rail and road, as well as hubs, changes in efficiency can be gauged individually.

Average Return on Investment
The return on investment informs the user of the indicator system about the efficiency of investment in the transport sector – and thus economic viability – by measuring the average return on investments taken in the sector. The crucial question here is the appropriate target value. International comparison can help to inform this decision.

Share of Logistics Cost in Producer Price of End-Product
This indicator aims at informing the efficiency of the logistic sector in terms of the cost borne by consumers and thus social welfare. By utilizing producer prices instead of consumer prices, this indicator is designed to be isolated from market structures in the retail sector.

Public Infrastructure Cost Due to Logistics
This indicator quantifies the dimension of costs generated by the logistics sector that are externally borne by society. It simultaneously captures efficiency of infrastructure investments.

Share of Logistics Cost in GDP
This indicator captures the aggregate cost of logistics in the economy. Given that this indicator is an international standard, this sub-indicator provides a base for international comparisons where desired.

Indicators for the Goal Speed and Timeliness

This indicator captures the speed at which goods move through the system, as well as the reliability and timeliness of the delivery of goods. For a competitive freight logistics sector, it is important that the delivery of goods is fast, but also predictable and at agreed-upon delivery times. Therefore, besides measures for the transport time, measures for reliability and timeliness have been included.

As in the above section, the following table presents the individual indicators together with the assigned weights.

Time and Speed

Category	Indicator	Unit	Weight (%)
Timeliness	Share of Deliveries on Time: Road	%	11,2
	Share of Deliveries on Time: Rail	%	15,2
	Share of Deliveries on Time: Aggregate	%	5,8
	Avg. Standard Deviation of Transport Time: Road	Avg. % / (TEU*km) per Route	6,3
	Avg. Standard Deviation of Transport Time: Rail	Avg. % / (TEU*km) per Route	7,9
	Avg. Standard Deviation of Transport Time: Aggregate	Avg. % / (TEU*km) per Route	4,4
	Avg. Standard Deviation Trans-Loading Time: Bulk	% / t	4,4
	Avg. Standard Deviation Trans-Loading Time: Container	% / TEU	4,9
	Avg. Standard Deviation Trans-Loading Time: Packages	% / TEU	4,0
Speed	Avg. Transport Time: Road	h / (TEU*km)	6,8
	Avg. Transport Time: Rail	h / (TEU*km)	9,2
	Avg. Transport Time: Aggregate	h / (TEU*km)	5,3
	Avg. Trans-Loading Time: Bulk	h / t	5,2
	Avg. Trans-Loading Time: Containers	h / TEU	5,5
	Avg. Trans-Loading Time: Packages	h / TEU	4,0

Share of Deliveries on Time
This indicator captures the reliability of deliveries. For a great many economic processes, reliability is more important than pure speed. The share of deliveries on time is defined as the percentage of deliveries that arrive on time as defined by the customer, thus controlling for differing operational necessities across different parts of the economy.

Average Standard Deviation of Transport Time
The standard deviation of transport times meas-ures the reliability of transportation mostly determined by semi-external factors like congestion. The higher the standard deviation, the higher the difference of transport time between e.g. congested and uncongested conditions. Furthermore, this indicator captures reliability caused by breakdowns and accidents, albeit to a very limited extent. By including indicators for different transport modes, the GLI:X Indicators System informs about relative reliability.

Standard Deviation Trans-Loading Time
This indicator provides information on the reliability of trans-modal hubs, analogous to the indicators capturing the standard deviation of transport times. The GLI:X Indicators System includes indicators for bulk goods, containers, and packages.

Transport Time
The average transport time per unit of output of the logistics sector as measured by TEU*km provides information regarding the average speed of deliveries. Combined with the corresponding standard deviations, a fairly comprehensive picture of the distribution of transport times is provided.

Trans-Loading Time
As a corollary to the combination of average transport time indicators and the corresponding standard deviations, the average trans-loading time informs on the average efficiency of trans-modal hubs. Together with the standard deviation indicator, a fairly comprehensive picture of the distribution of trans-loading times is given.

Indicators for the Goal Safety and Security

This composite indicator includes indicators designed to capture safety and security in the freight logistics sector. The indicators have been selected to capture on the one hand damages and harm done to goods, logistics infrastructure, or logistics employees, e.g. through theft or hijacking, and on the other hand damages or injuries caused by logistics, such as through traffic accidents. Furthermore, the indicators capture the culture of compliance, i.e. to what extent rules, laws, and standards in the transport sector are being followed, which is relevant for safety within the transport sector and for traffic users. Particularly the inclusion of indicators pertaining to hijacking illustrates the adaption of the indicator system to local circumstances and challenges.

The table below presents the indicators and their corresponding weights.

Safety and Security

Category	Indicator	Unit	Weight (%)
Compliance & Standards	Fines Issued in Freight Transport	# / Year	12,6
	Condition Index Transnet	Index	9,0
Culture of Compliance	Share of Fines in Transport Paid	%	7,0
	Share of Cases Solved	%	10,2
Security	Share of Security Costs in Logistics Chain	%	12,8
	Value of Insurance Claims	ZAR / Year	5,5
	Security Incidents (e.g. Heists) @ Warehouses and Logistics Hubs	# / Year	7,4
	Security Incidents (e.g. Hijacking) @ Road Transports/Trucks	# / Year	10,5
	Security Incidents (e.g. Theft) @ Rail Transport	# / Year	9,0
Safety	Avg. Response Time to Incidents	Minutes	11,8
	Workplace Incidents & Injuries Caused by Truck Accidents	# / Year	4,3

Fines Issued in Freight Transport
The number of fines issued in the context of freight transport gives an indication of the adherence to laws and regulations in the sector. Obviously, this indicator is influenced by the investigative pressure.

Condition Index Transnet
The Transnet condition index gives an indication of the state of the rail system as employed by Transnet.

Share of Fines in Transport Paid
The share of fines issued in transport which are actually paid provides information on stringency of law enforcement practices.

Share of Cases Solved
This sub-indicator provides information on the efficacy of law enforcement in solving cases connected to the transport sector.

Share of Security Costs in Logistics Chain
The share of security costs in the logistics chain, including cost of insurance, is indicative of the economic impact of the security situation. This particular indicator is of great importance in South Africa given the comparatively high costs due to security problems.

Security Incidents
The number of security incidents, differentiated by location/mode, provides a picture of the security situation in the logistics sector. The indicator is not normalized by output since the impact of security incidents on social welfare correlates predominantly with the number of incidents and less so with their intensity.

Avg. Response Time to Incidents
The response time of authorities to incidents is another performance measure of the public sector. The response time is of special importance since it has been shown to correlate substantially with the perception of the efficacy of law enforcement as well as having a great impact on measures of success, like the share of cases solved.

Workplace Incidents & Injuries Caused by Truck Accidents
As with the number of security incidents, this indicator is not normalized by output owing to the same reasoning regarding the societal impact.

Indicators for the Goal Equitable Development

The inclusion of indicators pertaining equitable development, which capture socio-economic di-mensions connected to the logistics sector through the social system, is a unique feature of the GLI:X Indicators System for Gauteng. This goal is particularly important for Gauteng and comprises two major aspects: first, a more equitable, socially inclusive, and socially desirable freight logistics sector, which comprises aspects that enhance quality of life like commuting times, daily working hours, well-being, and income of logistics employees, as well as the inclusion and promotion of historically disadvantaged individuals, and second, a freight logistics sector that provides skill enhancement, as well as skilled, secure, and formalized job opportunities. As such, this composite indicator aims at garnering attention regarding the effects of interventions and policies with regards to the development of society as a whole.

Equitable Development

Category	Indicator	Unit	Weight (%)
Quality of Life	Daily Commuting Cost	% (Daily Expenditure / Daily Wage)	8,9
	Share of Jobs Within Regular Reach	%	14,0
	Daily Working Hours	Average Working Hours /Workday	9,3
	Share of Employees with Health Insurance	%	5,4
Inclusion	Relative Turnover of HDI SMME Against Non-HDI SMME in Logistics Sector	%	11,0
	Share of HDI/BBBEE in Manage-ment	%	12,1
	Shift from Informal to Formal Occu-pation	# of Workers / Year	4,6
Income	Median Real Wage	ZAR (Constant Prices)	8,5
Job Security	Share of Jobs Retained	%	6,1
	Average Tenure	Months	6,5
Skill Develop-ment	Completed Trainings	# of Completed Trainings / Employee / Year	9,0
Skill Intensity	Share of Employees with Specialized Education	%	4,5

Daily Commuting Cost
This indicator aims at highlighting the economic burden placed on employees in the logistics sector arising from commuting to and from work, abstracting from the time spent commuting.

Share of Jobs within Regular Reach by Public Transportation
By quantifying the share of workplaces that are within reach of public transportation, this indicator gives an indication of not only freedom of choice for employees regarding the mode of transportation used for commuting, but also the socio-economic impact of workplace locations owing to the generally lower cost of public transportation.

Daily Working Hours
This sub-indicator indicates not only adherence to labour regulations, but also aims at providing information regarding the viability of employment in the logistics sector with respect to factors influencing individual and societal well-being outside work. Especially where parents are concerned, a high number of hours worked per day is likely to not only negatively impact the employee, but also their spouses and children.

Share of Employees with Health Insurance
The share of employees with health insurance captures life quality as indicated by non-wage benefits, as well as giving an indication of potential negative externalities affecting the health care system where employees are not covered.

Relative Turnover of HDI SMME Against Non-HDI SMME in Logistics Sector
This sub-indicator aims at quantifying the relative importance of Small, Micro, and Medium Sized Enterprises (SMME) owned by Historically Disadvantaged Individuals (HDI) in the region. The turnover measure is chosen for reasons of data availability.

Share of HDI in Management
This indicator quantifies the integration of Historically Disadvantaged Individuals into the executive structures of companies in the logistics sector.

Shift from Informal to Formal Occupation
The number of workers shifting from informal to formal occupation provides information on the development of the economy towards an ordered system, providing tax revenues and security, as well as rights for employees.

Median Real Wage
The median real wage is a standard measure of income that is less sensitive to outliers than the average real wage.

Share of Jobs Retained
This sub-indicator aims at capturing job security for employees in the logistics sector.

Average Tenure
By measuring average tenure in logistics jobs, this sub-indicator gives a direct indication of job security, which is generally perceived as advantageous.

Completed Trainings
This indicator aims at quantifying the effort geared towards increasing the skill-level and education of the work force in the logistics sector, which are also likely to provide positive externalities when workers shift out of the sector after receiving training.

Share of Employees with Specialized Education
The share of employees with specialized education as defined by education pertaining specifically to the employee's occupation in the logistics sector with a duration of more than, for example, 3 months (TBD), gives an indication of the skill intensity in the sector. As skill intensity is highly correlated with both income and efficiency, this indicator provides a measure of the sophistication of the transport sector.

4 Process and Methodology of Developing the GLI:X Green Logistics Indicators

4.1 The Iterative Co-Creation Process

One of the core principles of the development process of the GLI:X Green Logistics Indicators was the **participative co-creation approach**, which is fundamentally driven by the engagement of a wide range of cross-sectoral participants from the public and private sector, and academia in order to achieve a result that is tailored to the interests and needs of the Gauteng region.

Approaching freight logistics from a holistic perspective means that stakeholders involved in the process have to represent this holistic perspective. Because of the importance of efficient, fast and cheap movement of freight for economic well-being and competitiveness, logistics experts and transport economists and planners are usually involved in the advancement of the freight industry. However, when freight logistics are approached from a more holistic perspective, taking into account systemic interactions of the topic, this circle of experts has to be expanded to include other fields such as urban spatial planning, social development, environmental planning etc. To ensure comprehensive treatment of the subject matter, the GLI:X process took the sustainable development of freight logistics as starting point and invited a broad range of stakeholders of different sectors and backgrounds to engage in the development process.

Therefore, at the heart of the process were a **series of participative seminars**, which took place in Johannesburg, providing the platform for an open discussion about the future of freight logistics in the Gauteng Region.

These seminars were designed in an iterative way, each building on and recapturing the discussions and results of the previous session. The seminar cascade corresponded with the development stages of the indicator system:

1. Understanding the status quo, identification of issues and challenges (seminars 1, 2)
2. Defining the goals of freight logistics in Gauteng (seminars 1,2)
3. Selection of suitable indicators for measuring the goals (seminars 1, 2, 3)
4. Data assessment (seminars 2,3)
5. Weighting of indicators (seminars 2, 3)

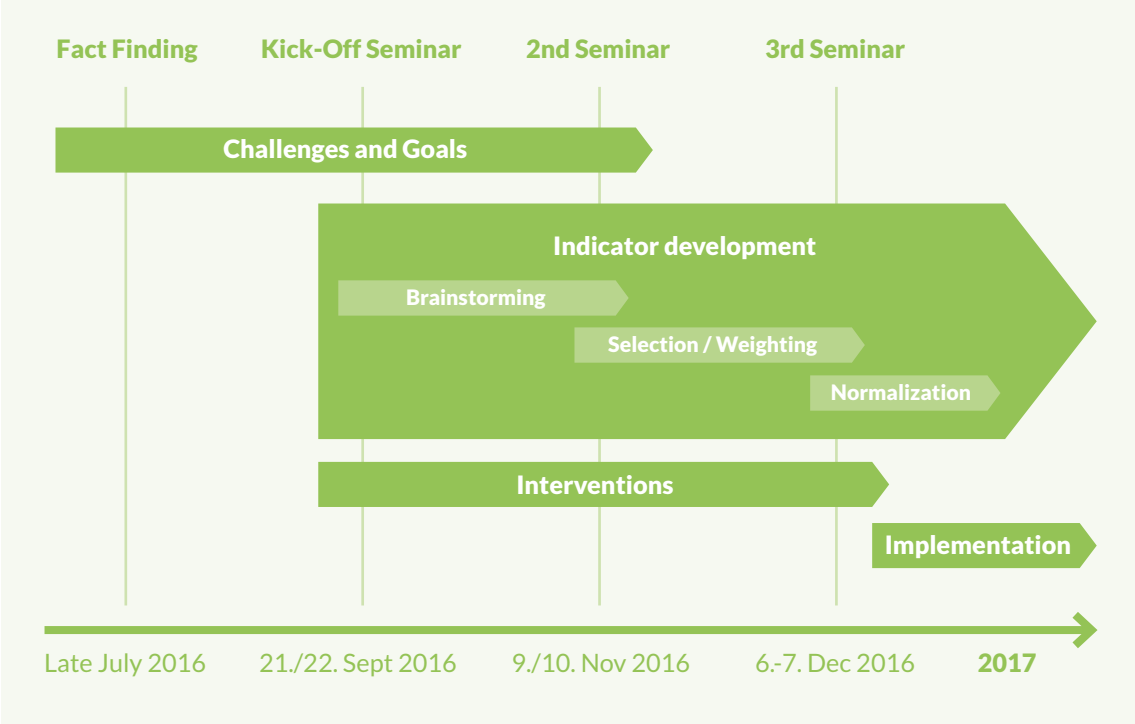
The implementation of the indicator system will occur in the second project phase.

Although indicator development is a linear process with a clear target conceptually, methodologically an iterative approach was necessary to reach the project target within the short time frame. **Iteration in indicator development** points to two different aspects:

1) Different stages of the process overlapped and took place in parallel. Each stage of the development process opened up new perspectives on the topic and brought new aspects to the table. These new perspectives required the refinement or even refusal of conclusions that were drawn at a previous stage of the development process. Such a procedure was crucial in order to attain a holistic picture of the highly complex topic. It was also required due to the heterogeneity of seminar participants. Valuing the contributions of each participant in his or her role as expert in freight logistics, the process was designed to be as open as possible for new perspectives and standpoints, facilitating a comprehensive treatment of the subject matter and its systemic implications beyond standard indicators.

2) Iteration also refers to the interaction between the project organizers as facilitators of the process, and the seminars participants as experts. The relationship was characterized by constant bidirectional input and feedback loops. During the seminars, the experts were asked to contribute in brainstorming sessions. The project team's task was to document and organize the contributions. The next step was then to review, summarize, and then prepare these results to serve as feedback for the participants and as input for the next round of deliberations. The next iteration would validate and consolidate the previous results, and, where necessary, further elaboration. After processing the results of a session, conclusions were drawn in the last session. In this manner, the project facilitators were actively involved in driving the agenda and ensuring the efficiency of the process. Furthermore, they assure that every contribution by the participants was represented in the project results. However, the facilitators abstained from influencing the discussions with their own knowledge as far as possible, instead providing assistance and suggestions when it supported the workflow.

The Iterative Co-creation Process of the GLI:X Green Logistics Indicators Development



The iterative process was applied to the **three major processual aims** of the GLI:X project: First, to the **identification and definition of goals and challenges**; second, to the **discussion on solutions, technologies, interventions and measures**; and third, to the **development of the indicator** itself. The methodology of iteration is best illustrated by the development of the indicator system. When the identification of the goals and challenges of the Gauteng Province was still to be finalized, a brainstorming about possible indicators was conducted at the Kick-Off Seminar. The suggestions made by the participants were consolidated, refined, and prepared for an in-depth discussion at the 2nd GLI:X-Seminar. At this seminar, due to the participation of new participants, new focal points and indicators were added, especially for the goal of equitable development. In group discussions and a Budget Allocation Process, the most important indicators identified so far were selected. This selection was conducted taking into account the availability and quality of data. As the indicator system still had to be reduced in complexity in order to make it manageable, the GLI:X team prepared suggestions for further consolidation of the indicator set. In group and plenary discussion at the 3rd GLI:X-Seminar, an agreement could be reached on the final selection of the indicators. At the last seminar, particularly the private sector stakeholders suggested the addition of important further indicators, which were agreed on by the group. The last step of this first phase of indicator development was the weighing of the sub-indicators among the goals by means of a budget allocation process.

The GLI:X process comprised of three seminars conducted over four months, supplemented by numerous additional meetings and consultations, has proven to be very efficient for the development of a comprehensive indicator system. Not only the final product, but the co-creation process itself – enabled by a highly engaged and motivated circle of experts from the freight logistic and other sectors – has to be considered a great success. Feedback from various participants indicated that the facilitation of communication and cooperation among previously insular stakeholder organizations was a central feature and advantage of the process. It has been said that the GLI:X process has initiated a new era of collaborative and creative action in the freight sector in Gauteng, fostering discussion and development of a topic that has long received comparatively little attention.

The participative nature of the development process achieved a result that is tailored to the interests and needs of the Gauteng region. However, as mentioned above, this structured process can be transferred and adapted to other cities and regions, as well as to other topics.

Participants of the 3rd GLI:X Seminar

4.2 The GLI:X Seminars

Based on the above principles, the seminar process consisted of three seminars, complimented by an initial fact-finding mission and various accompanying meetings with stakeholders.

Fact-Finding Mission

During their first stay in Gauteng at the end of July/beginning of August 2016, the project team was able to meet with a variety of local stakeholders in urban logistics from both the public and the private sector. The meetings focused on obtaining an overview of local circumstances, challenges, and objectives of the respective counterparts in order to facilitate planning and frame setting for the first GLI:X seminar in South Africa. Another objective was the presentation of the project idea to the stakeholders active in the province and municipalities of Gauteng and the raising of support for the process.

GLI:X Kick-Off-Seminar

The GLI:X Kick-Off Seminar was the first in a series of three seminars held in Johannesburg and was designed to bring together stakeholders in the field of freight logistics from the public and private sector in the Gauteng region. The seminar served to start the co-creation process to develop the GLI:X Indicators System. During the seminar, 5 key aims of smart logistics in the Gauteng region were established: Stakeholders wished for an urban freight logistics sector that is greener, faster, safer, more cost-effective, and more equitable.

2nd GLI:X-Seminar

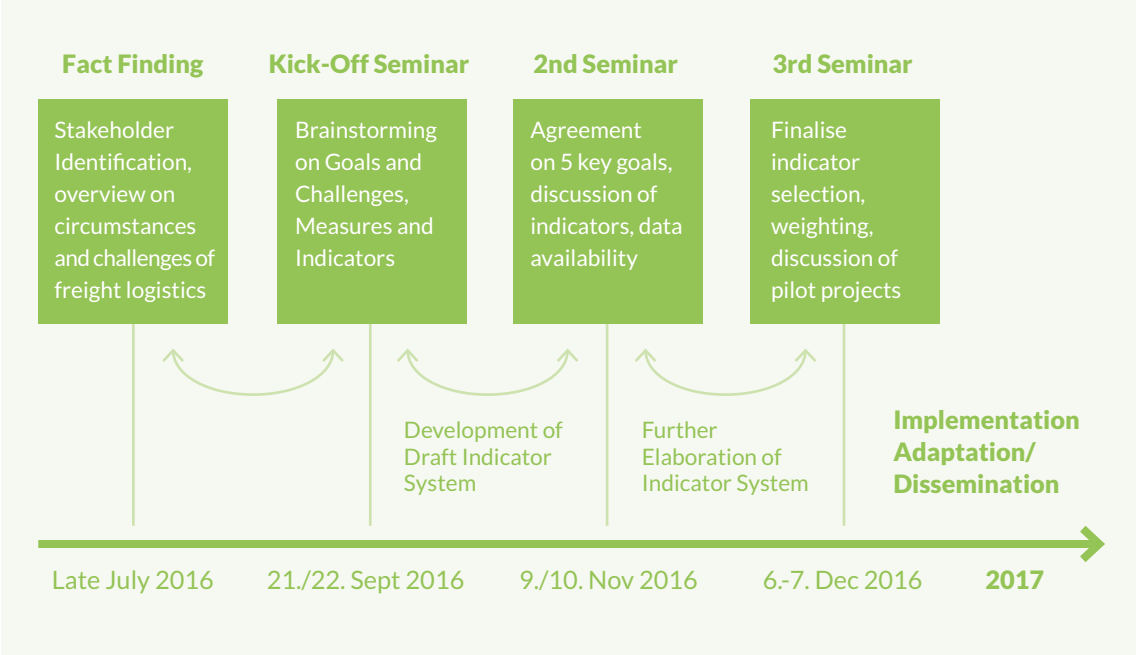
The second seminar under the headline "Designing the GLI:X Indicators System" served to revisit and validate the challenges and goals identified in the Kick-Off Seminar and collectively agree on the five key goals that the GLI:X Green Logistics Indicators should focus on. Furthermore, suitable indicators for goal attainment were discussed and the provision and availability of necessary data were assessed. Furthermore, the participants brainstormed about suitable measures to achieve progress towards the identified goals.

3rd GLI:X-Seminar

The seminar "Finalising the GLI:X Indicators System" was the last in the series and served to finalize the indicator selection and assign weights to the individual sub-indicators based on a Budget Allocation Process in two rounds. After the first round, the results of the weighting were discussed and then a second weighting round was conducted to arrive at a more consensual outcome.

Furthermore, the proposed measures, ideas, and interventions of the previous brainstorming session during the 2nd GLI:X-Seminar were presented. Based on these ideas, potential pilot projects for a possible next project phase have been developed and discussed.

The GLI:X Seminar Timeline



4.3 Involved Stakeholders

In the GLI:X seminar series, participants were drawn from a diverse group of participants from various fields connected to freight logistics. The process was accompanied by a core group of participants with new actors entering during the process. The development of a core group and the constant interaction between the project team and members of this core group in Gauteng ensured continuity of the process. Due to the tight sequence of the seminars and rapid progression of the indicator development, the stakeholders were encouraged to stay involved in the process. Whenever perspectives on freight logistics turned out to be missing in the debate, further stakeholders were identified; and, through the communication channels and networks of the core partners, these stakeholders were contacted and encouraged to contribute to the project, either by participating in the seminars or through separate meetings. Through the invaluable support and guidance of the Gauteng Department of Roads and Transport, a significant broadening of the stakeholder network between the Kick-Off Seminar and the second seminar was achieved. Without this support, the GLI:X process would not have been the success it turned out to be.

Among the stakeholders were representatives of the public administrations of the Gauteng Province, the three metropolitan municipalities and the two district municipalities, as well as the South African National Department of Transport. Representatives from major state owned companies, such as Transnet and Airports Company of South Africa, provided their perspectives on the topic in the seminars and separate meetings. Further major companies from the logistics sector (e.g. WorldNet Logistics) and manufacturing sector (e.g. Volkswagen South Africa) regularly participated in the seminars. Experts from the field of freight transport and economic research in South Africa[10] provided valuable expert knowledge about freight logistics in South Africa, and assessed the resulting indicator system.

Stakeholders involved in the GLI:X Green Logistics Indicators Development Process

10 University of Stellenbosch, University of Johannesburg, Council for Scientific and Industrial Research (CSIR), ARUP

4.4 Next Steps: Look into the Future

The GLI:X indicator is planned to go into a next phase, which will focus on two aspects. First, the implementation of the indicator system. This comprises (a) the final identification of data sources and the collection of data, (b) the calibration of the indicators and the quantification of target values for the indicators, (c) the implementation of an assessment matrix which is designed to enable a Cost-Benefit-Analysis for interventions, (d) the implementation of the process design, which deals with integrating the indicators into decision-making and administrative processes of the entities of the Gauteng region, and (e) the dissemination of the results of the first phase. The second aspect will be the implementation of pilot projects in the municipalities of Gauteng that will implement and test a part of the indicator set on the ground.

5. The GLI:X Project

The GLI:X Green Logistics Indicators were developed within the framework of the GLI:X Green Logistics Indicators project, which was funded and commissioned by the German Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety (BMUB).

The GLI:X Project was executed by the nexus Institute for Cooperation Management and Interdisciplinary Research (Berlin, Germany) and GESI System Innovation (Berlin, Germany) with the great support of the Province of Gauteng and its Department of Road and Transportation, represented in particular by Mr. Fuad Hendricks and Mr. Freeman Masuku.

We thank all seminar participants and contributors for their engagement and invaluable contributions to the development of the GLI:X Green Logistics Indicators! (See appendix for the names of all participants.)

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Appendix

List of Participants of the GLI:X Green Logistics Indicators Development Process

(in alphabetical order)

We thank all seminar participants and contributors for their engagement and invaluable contributions to the development of the GLI:X Green Logistics Indicator!

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- Kelly Gavin (Road Freight Association)
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- Craig Heckrath (T-Systems/Intervate)
- Fuad Hendricks (Office of MEC Vadi)
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GLI:X Indicators System Construction

Normalization for the GLI:X Green Logistics Indicator

Since the GLI:X Indicators System is tailored to the aims and challenges of each city or region it is applied to and designed to measure target attainment, the structure of the indicator system will be somewhat different for each version of the system, containing differing goals and sub-indicators. Furthermore, both status quo or base value, as well as the targets, are bound to differ. These facts necessitate a normalization strategy which is not based on the features of the cross-sectional distribution of a sub-indicator across regions. Hence, normalization in the GLI:X Indicators System is based on target attainment as follows for each of the composite indicators:

For each of the N_j sub-indicators in composite indicator j, let X_{it} denote the un-normalized value of the i'th sub-indicator at time t, X_i^b denotes the base value or status quo, and X_i^T denotes the target value. The normalized value for the i'th sub-indicator, x_{it} is then given by:

$$x_{it} = \frac{\left(X_{it} - X_i^b\right)}{\left(X_i^T - X_i^b\right)}$$

Thus, the normalized value of the sub-indicator gives target attainment in %, starting from the base value.

Aggregation of the GLI:X Green Logistics Indicator

The individual sub-indicators are aggregated using a simple linear weighted average given by

$$CI_{jt} = \sum_{i=1}^{N_j} w_{ij} x_{it}$$

with CI_{jt} denoting the value of the j'th composite indicator at time t and w_{ij} denoting the weight of the i'th sub-indicator in composite indicator j.

Weighting of the Sub-Indicators of the GLI:X Green Logistics Indicator

The weights w_{ij} are obtained through a Budget Allocation Process (BAP). The BAP entails a survey among stakeholders and experts. During the survey, each of the participants is allocated 100 points for each of the composite indicators, to be distributed among the sub-indicators according to their subjective relative importance. With K participants, the weights are then readily derived:

$$w_{ij} = \frac{\sum_{k=1}^{K} s_{ijk}}{100K}$$

With s_{ijk} denoting the number of points allocated to sub-indicator i contained in composite indicator j by participant k. Obviously, $\sum_i w_{ij} = 1$ for all j.

List of Abbreviations

#	Number
AIDC	Automotive Industry Development Agency
ARUP	Arup Group Limited
Avg.	Average
BMUB	German Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety
BTU	British Thermal Unit
CBD	Central Business District
CO2	Carbondioxide
CSIR	Council for Scientific and Industrial Research
GDP	Gross Domestic Product
GEYODI	Gender, Youth, and Disabled Individuals
GGDA	Gauteng Growth and Development Agency
GLI:X	Green Logistics Indicators
GP	Gauteng Province
h	Hours
HDI	Historically Disadvantaged Individuals
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
ISO/TC	ISO Technical Committee
ISO/TS	ISO Technical Specification
LEZ	Low Emission Zone
NOx	Mono-Nitrogen Oxides
PM10	Particulate Matter < 10nm
ROI	Return of Investment
SMME	Small, Micro- and Medium-Sized Enterprises
TBD	To Be Determined
TEU	Twenty-Foot Equivalent Unit
WS	Workshop
ZAR	South African Rand

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