The Administrative Challenges of Implementing Climate Change Mitigation Actions at a Municipal Level

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Abstract

The increase in temperatures associated with industrial activity and in particular, greenhouse influence can be depicted as climate change. Thus, the "anthropogenic source" is often referred to as global warming, which is fuelled by human action rather than natural actions. Using the mixed-methods approach, this study interprets data collected to draw conclusions and address the administrative challenges faced by the City of Tshwane Metropolitan Municipality (CTMM) in managing the impacts of climate change on road infrastructure. The research detects the possibility of disputes arising from integrating various methodologies, which should be overseen by carefully advancing choice, emphasizing knowledgeable methods and limiting negatively. In this research, the data gathered revealed that there were few CTMM programs for climate change and climate change mitigation activities for road transport infrastructure in its municipal area. Climate considerations must be included in transport, planning, and development strategies to control the implications of climate change impacts on the road transport infrastructure of climate change. The Statistical Package of Social Sciences (SPSS) Statistics Version 20 software tool analysed the data collected through questionnaires. For a meaningful interpretation and analysis of the information acquired via questionnaires, official documents such as the municipality's integrated transport plans and annual reports were studied.

Keywords: Climate change, adaptation, mitigation, road transport and sustainable development

Introduction

The City of Tshwane Metropolitan Municipality (CTMM) is a democratic metropolitan administration that is people-centered and prioritizes the needs of the most vulnerable. On the other hand, it recognizes anthropogenic climate change as a major global concern that is presently affecting, and will increasingly affect, all aspects of human life from an economic, social, and environmental standpoint. Municipalities of South Africa are responsible for developing methods for managing the impact of climate change on the road infrastructure. This research gathered data to analyze and interpret administrative challenges faced by the CTMM in managing the impacts of climate change on road infrastructure. The data determined the degree to which the questions raised during the investigation were answered. To provide scientific conclusions, data analysis comprises analyzing, assessing, and integrating data gathered during a project (Mertens *et al.* 2016).

According to a Draft Climate Strategy, South Africa plans to reduce emissions by about a third by 2030. South Africa's yearly greenhouse gas emissions will be limited to 398-440 million tonnes of CO2 equivalent by 2030, according to the draft plan.

When compared to predicted domestic pathways, South Africa's amended 2030 emissions reduction target is rated "Almost sufficient," but "Insufficient" when compared to its fair-share commitment to climate action. South Africa's aims and actions are insufficient to keep global warming to 1.5 degrees Celsius. The City of Tshwane Metropolitan Municipality joined the Compact of Mayors, which is now known as the Covenant of Mayors on Energy and Climate Change. The City has laid all of the necessary groundwork for a strong and well-informed climate change response. A climate risk and vulnerability assessment has been conducted, as well as a greenhouse gas emissions inventory (GHGEI) that complies with the Global Protocol for Community.

This paper began by introducing the study and then conceptualizing climate change, which was traced back to the theoretical underpinning for this research. Data acquired through questionnaires were described and graphical information was utilized for formulation to display the data that were gathered for presentation, and the contextual interpretation of the data obtained was followed by face-to-face interviews. Privacy and confidentiality were guaranteed to the respondents.

Theoretical Framework

Fayol's (1949: 45) administrative management theory was used in this research to develop a logical way to establish an institution. In general, the idea recommends a formalized management structure with a clear vision of labour and the transfer of power and authority to authorities with appropriate responsibilities. The theory was applicable for this research because it focused on an institution, CTMM, and every institution relies on management to flourish. Management is the process of directing and creating an atmosphere in which people can collaborate efficiently and effectively to achieve a set of goals and objectives (Mohaghar, Jafarnejad, Ghodsipoor, & Maleki, 2013: 1834). Various management studies were undertaken by many scholars, including Max Weber (1905), Frederick Taylor (1911), Elton Mayo (1923), Henri Fayol (1949), and Abraham Maslow (1998), who are regarded as the founders of management theory today. Their studies have led to establishing other management principles referred to as theories, such as the problem management theory.

The administrative theory was developed by Henri Fayol (1911), and it consists of 14 management principles:

1. **Division of work:** This principle is about the division of labor among the employees.
2. **Authority:** The manager must be able to give the order. Authority gives the manager this right to the subordinates.
3. **Discipline:** Employees must obey and respect the rules and regulations that govern the organization.
4. **Unity of command:** Every employee should receive an order or direction from only one upward or superior.
5. **Unity of direction:** Each group of the organization should be directed by one manager using one plan.
6. **Subordination of individual interests to the general interest:** Management

must see that the aims of the businesses are always supreme.
7. **Remuneration of personnel:** Laborers must be paid a reasonable salary for their work.
8. **Centralization:** The process of transforming and assigning decision-making authority to a higher level of an organizational hierarchy. It is the centralization that should follow this.
9. **Scalar chain:** Line of authority from top management to the lower ranks represents the hierarchy or scalar chain.
10. **Order:** People and materials should be in the right place at the right time.
11. **Equity:** A balance of kindness and justice is required when running a company.
12. **Stability of tenure of personnel:** Staff work is well if job safety and career improvement are guaranteed to the team.
13. **Initiative:** Allowing all personnel to show their initiative in some way is a source of stretch for the organization.
14. **Esprit de corps:** Promoting team spirit will build unity and harmony within the organization.

Administrative management theory focuses on management concepts, particularly controlling growth, which provides a positive impact on the managerial framework.

Conceptualisation of Climate Change

"Any change in climate over time, whether owing to natural variability or as a result of human activity" is how climate change is defined (Pielke, 2019). According to Mahmood (2012: 223), climate change is the average weather condition of an area characterized by its own internal dynamics as well as changes in external elements that affect climate. Climate change refers to the warming of the world as a result of human activity. The Intergovernmental Panel on Climate Change [IPCC] (2013: 22) defines global warming as "an unambiguous and continuous increase in the average temperature of the earth's climate system."

Various authors define climate change differently, but they all agree that climate change is a change in the climate over time caused by natural and human actions. Climate change is described as changes in the earth's weather, such as changes in the atmosphere due to increased GHGs and carbon dioxide levels in the atmosphere (Mahmood 2012: 223; McLusky & Sessa 2015: 2). A correlation between climate change and human activities can be deduced from several definitions of climate change. Climate change is caused by GHGs generated by burning fossil fuels, according to scientific studies (*see*, DEA 2011; UNEP 2016; Allen *et al*., 2018). This finding refutes the idea that climate change is only caused by the planet's biogeographical cycles.

Cyclical Link Between Climate Change and Road Transport

Petroleum products are mostly consumed by the transport sector, which is responsible for a growing share of global carbon dioxide emissions, one of the most significant greenhouse gases. Approximately 21% of global CO_2 emissions are attributed to transport. Despite anticipated efficiency gains, transport-related CO_2

emissions are expected to climb to 23% of total CO_2 emissions by 2030 (IEA 2019). Transport emissions are expected to account for an even higher portion of future GHG emissions in certain studies dedicated to the future of GHG emissions, with greater decarbonization coming from other sectors. When one considers the global expansion of transport, this conclusion is expected.

Decarbonizing transport is a big problem because it is one of the primary sectors with emissions that are substantially over 1990 levels but have continued to rise at approximately 33% over the same time. However, they have begun to fall in recent months because of rising oil prices and improving vehicle economy. Road transport accounts for more than two-thirds of all transport-related GHG emissions. South African transport-related emissions contribute 10.8% of the country's total GHG emissions. In terms of emissions volume, the transport sector is only second to the energy sector. This volume of emissions solely includes direct emissions, which mostly include emissions from tailpipes. The estimates would be more credible if indirect GHG emissions from the transport sector were included, such as GHG emissions from gasoline refineries and energy generation for transport.

Increases in numerous forms of weather and climatic extremes, such as very hot days; severe precipitation events; intense hurricanes; drought; and rising sea levels, coupled with storm surges and land subsidence, will all impact transport. The effects will vary depending on the mode of transport and locality, but they will be broad and costly in both human and economic aspects, necessitating considerable adjustments in public transport planning, design, building, operation, and maintenance. Cities can get various benefits from tackling climate change impacts through efficient transport mechanisms, such as improved air quality, less noise disturbance, and increased road safety. There will also be social and economic benefits.

Vulnerability of Road Networks to Climate Change

One or more concurrent changes in climate conditions, such as hotter summers, severe precipitation events, greater storminess, and sea-level rise, may affect transport modes and system components, depending on climate change scenarios and geographic location of places. Climate-induced events such as floods, heatwaves, and storms cause physical and operational consequences on road infrastructure. In contrast, vulnerability refers to the physical aspects and socio-economic conditions that define governments' reactivity to changes in climate. Climate change vulnerability is determined by sensitivity, subjectivity, and mitigation capacity. The degree of sensitivity to climate change, according to Komen (2016: 40), is determined by projections of changes in mean temperatures and precipitation, extreme occurrences, and climate variability.

Therefore, it is necessary to define the term 'vulnerability' since it is a relatively new concept applied in transport network studies. There are debates around its definitions (Jenelius, 2008: 48; Cochran *et al*., 2009: 2). These authors generally agree that vulnerability is connected to incidents, risks, serviceability, and reliability. Jun-qiang *et al*. (2017) define vulnerability in the road transport system as a sensitivity to occurrences that results in a significant loss in road network serviceability and

reliability. Both humans and nature are responsible for these events, which are foreseeable and caused intentionally or involuntarily. Vulnerability assessments in road transport networks have been done satisfactorily at the international and national levels. However, little has been done at the local level.

In bad weather, transport services must be established to minimize interruption and meet basic safety standards. The CTMM, like many other cities and local governments around the world, is yet to conduct a vulnerability assessment of road transport networks. It does, however, have a city vulnerability assessment based on population vulnerability to climate change in various regions, but very little on road transport (CTMM 2015: 36). As a result, vulnerability assessments in road transport networks must be carried out in the city. Extreme climate events impact the CTMM road transport system, and road transport operating systems contribute to global warming, which exacerbates extreme climate events.

Climate Change Response Measures and Sustainable Development

The CTMM's commitment to tackling climate change began when it signed the previous Compact of Mayors, currently known as the Covenant of Mayors for Energy and Climate. Since then, the municipality has laid the groundwork for a large and well-informed response to climate change, including a climate risk and vulnerability assessment and a greenhouse gas emissions inventory (GHGEI) that complies with the Global Protocol for Community-Scale GHGEIs. In September 2014, the City of Tshwane was approved as the 70th member of the C40 Cities Climate Leadership Group (C40) near the signing of the covenant. C40 has always been at the forefront of global understanding that cities and regions are critical to addressing climate change. Heatwaves and heavy precipitation events have become more intense and frequent in cities. The urban climate has been influenced by fast land surface change, increased anthropogenic heat release, and enormous aerosol emissions. These increased aerosol emissions degrade air quality, resulting in severe air quality issues in cities. The increased influence of urbanization on global and regional climate change has had increasingly catastrophic consequences for metropolitan areas' dense population, heavy traffic, huge infrastructure, and economic assets. Increased urban climate change and its consequences pose a significant threat to CTMM's social, economic, and ecological sustainability. The United Nations established the 2030 Agenda for Sustainable Development in 2015, with 17 Sustainable Development Goals at its core (SDGs). Goal 11 focuses on making cities and human settlements more inclusive, safe, resilient, and sustainable, and it directly addresses the issues that urbanization brings.

Goal 13 focuses on urgent action to combat climate change and its impacts, Goal 3 on ensuring healthy lives and promoting wellbeing, Goal 6 on ensuring access to water and sanitation, and Goal 15 on protecting, restoring and promoting the sustainable use of terrestrial ecosystems. These goals are all related to tackling climate change issues from the perspectives of human security and wellbeing. Implementing these United Nations SDGs provides urgent incentives and new opportunities for cities to respond to climate change. The effects of global climate change and urbanization

are anticipated to worsen in the future. As we foresee increased hazards, higher exposure, and susceptibility to climate change, cities will face more substantial and multifaceted climate change threats to human health, economic development, and ecological services. Climate change and urban sustainability are two of CTMM's most pressing concerns.

Systematic research on climate change in cities is lacking, especially in terms of interactions and mechanisms between global/regional climate change and urbanization processes, high-resolution climate change projections in the context of future urban development pathways, and climate change impact and risk assessments in the context of high exposure and vulnerability. Understanding the complexities and unpredictability of future climate change and related hazards in cities is essential for effective climate change measures. Following related national green development strategies and policies and utilizing science, technology, finance, and governance in cities to actively address urban climate change issues, such as enhanced adaptation and mitigation measures, properly selecting development pathways will significantly improve climate resilience in cities. Climate change responses and sustainable development in cities will benefit from a series of national efforts, such as establishing "low-carbon cities" and "sponge cities," as well as the "Action Plan on Prevention and Control of Atmospheric Pollution."

From policy and planning to execution, the CTMM has risen from strength to strength in its response to climate change, from resolute projects with climate change mitigation and adaptation at their core (CTMM, 2015a: 16). The city is a member of the C40 Cities Climate Leadership, having been recognized as the 70th member in September 2014 (CTMM, 2017: 38). C40 is a global network of megacities dedicated to addressing climate change issues and challenges (CTMM, 2018). The C40 networks are a dynamic working group of cities united by a common set of priorities and issues. They have a few core networks and host a platform where cities interact, share expertise, and advocate for quantifiable and long-term climate change mitigation and adaptation strategies and initiatives (C40Cities, 2018: Online).

The municipality formed the City Sustainability Unit in 2013 as a catalytic driver of green economy ideas, among other things, in response to climate change impacts (CTMM, 2015a: 2). As part of the transition to a low-carbon, resource-efficient, and climate-resilient city, the unit must ensure sustainability is mainstreamed throughout city operations. The city has started initiatives to boost the green economy by implementing sustainable procurement. Sustainable buying will be used to drive the green economy. The cost of maintaining road infrastructure is high. Quality road infrastructure can help to develop a sustainable economy; thus, it is important to invest in and maintain the infrastructure (CTMM, 2015b: 156). Certain areas of the city have the insufficient and outdated infrastructure, making them vulnerable to severe rainfall and flooding (ibid).

The following adaptation actions have been identified by the CTMM:

- Identify susceptible regions using information from vulnerability assessments, employ robust designs and construction materials, and relocate existing developments in high-risk areas.
- Continue with urban core projects, high-density activity nodes with economic,

social, and residential potential in integrated surroundings linked to public transport services, such as subway stations. Because users and systems are in a manageable space, investment in infrastructure provision and maintenance is reduced.

- Encourage initiatives that offer long-term road infrastructure, allowing CTMM people to see tangible socio-economic and spatial changes. In Soshanguve and Mabopane, road and storm-water infrastructure has been built.
- Increase operational budget for infrastructure maintenance, such as storm-water drainage systems, and upgrade and maintain water and sewage infrastructure to minimize backlog and meet new demand (CTMM, 2015b: 232).

Emission levels must be decreased to protect road infrastructure. However, pledges to reduce emissions that are not put into action on the ground are just a gesture. The City of Tshwane is one of South Africa's largest emitters of greenhouse gases, owing to industrial, transportation, and residential (domestic) operations (CTMM, 2018). Reduced travel demand, improved transportation technology, and a change from high-carbon to low-carbon modes of transport can all help to reduce transport emissions (ibid). According to Brendan *et al.* (2016: 6), improved urban design could minimize travel demand by putting critical facilities closer to communities, reducing the need for people to travel.

Methodology

This study adopted a mixed-method approach, whereby both quantitative and qualitative instruments, such as a structured questionnaire, semi-structured interviews, and unstructured observations, were used. A mixed-method strategy was a good fit for this study because of the benefits of both qualitative and quantitative methodologies. Quantitative research was more efficient since it could generalize broad aspects of climate change and its consequences, as well as reach a larger group of respondents. According to Cottrell and McKenzie (2011: 200), quantitative research determines the relationship between quantifiable variables. This method produces numerical findings that can be graphed and displayed in tables. It also assists in answering the questions such as "to what extent" and "how many". Qualitative research, by contrast, provided a thorough understanding of nature's mechanisms and the CTMM's road transport infrastructure and allowed the researcher to collect rich, detailed data via face-to-face interviews with a smaller group of participants.

The semi-structured mode was chosen because the questions were not restricted, had no predefined responses, and allowed participants to freely share their experiences, ideas, and knowledge. Triangulation, or the use of more than one method to investigate a topic, is a feature of qualitative research. According to Punch (2014: 118), triangulation is the process of looking at a problem from multiple perspectives to discover the best solution. Triangulation is founded on the idea that one approach cannot adequately address the research issue; thus, multiple methods must be used (Tobi & Kampen, 2018: 1213). The researcher interviewed the participants until saturation had been reached. Intuitively, the expectation was to interview eight participants per department. However, by the sixth person per department, saturation

had been achieved, and all pertinent research topics had been fully addressed. The City Sustainability Unit (CSU), which employs eight people, and the Department of Roads and Transportation in the CTMM with 57 employees are the selected population for this study. Thus, the total population of this study was 65, but 60 were chosen as the sample. All 60 respondents completed the same questionnaire, and 12 interviewees were chosen based on their departmental positions with managers as the target group. Before the respondents completed the informed consent forms, the goal of the study and their rights were explained to them to comply with research ethics.

The environmental challenges of road transport infrastructure, the road transport system, climate change policies, mitigation actions, implementation challenges, and CTMM interventions were described using a descriptive qualitative data analysis technique. Quantitative data from the surveys were used to create and record the responses, which were then analysed using the SPSS application.

Findings

Climate change is one of the most important issues confronting policymakers worldwide, providing considerable and major challenges to long-term growth. As a result, governments must focus on efficiently and sustainably addressing the impact of climate change (South Africa, 2011: 2). The aim is to evaluate the CTMM's administrative challenges in responding to climate change to offer alternative remedies. Various factors, lack of personnel, including capacity, political will, social acceptance of projects, and finance, cause problems in implementing management strategies. Excluding biographical information, six questions were asked in the questionnaire and four during the interviews to answer the study's research question. Climate change, on its own, is a burden for governments but responding to its impacts on road infrastructure is even more difficult. However, this study focuses on administrative challenges because they are fundamental to public administration as a management discipline. The study only discusses and evaluates mitigation actions in terms of administrative problems reported by the participants. Other administrative concerns may not have been noted by the participants. Thus, such challenges were not covered, but they should be addressed in future studies.

Under the biographical information, it was important to establish two factors, namely, the level of education and the number of years in employment in the CTMM. The researcher believes that the education level of an individual has an impact on how effectively that person understands concepts. At the same time, the duration of employment helps determine whether they have the necessary experience to deal with complex issues such as climate change mitigations. The results indicate that 57% of the respondents have postgraduate degrees and all have post-matric qualifications. This gives confidence that the respondents and participants are in a sound position to provide accurate and reliable information. The average working term was four years. When answering the interview questions, the researcher noted that some respondents were highly confident in their responses, elaborating and offering their own unique opinions on how to tackle climate change effectively, while others were

less certain.

Climate change creates a political conundrum, forcing policymakers to choose between reducing GHG emissions and delivering fundamental services with limited resources. Subordinates may believe their suggestions are unsupported because politicians choose to provide a basic service rather than mitigate the negative effects of climate change. The participants were asked "*What obstacles have you encountered in implementing the mitigation actions?"*

The respondents mentioned the following existing management measures: the Compressed Natural Gas (CNG), Electric Vehicles (EVs), Bus Rapid Transit (BRT) and Non-Motorized Transport (NMT). When implementing mitigating actions, the participants said they had a tough time. One of the main issues they cited from the CSU was the lack of cooperation from their colleagues in other departments within the CTMM. The CSU is a support unit; it cannot function independently. Its main goal is to assist other departments with climate change challenges. As a result, collaboration with other departments is critical. When the participants from this unit commented about a lack of cooperation, the researcher observed a level of demoralization on their faces and in their body language. Other counterparts from the Department of Roads and Transport felt that the CSU puts projects on them without understanding the nature of their business as road infrastructure service providers and the issues they confront (one participant said *"they are dictators, they don't discuss with us, they inform us"*). In contrast, others stated that the relationship is beneficial.

Another challenge is that human settlement density in the CTMM is too low to properly envision a zero or near-zero private transport network based on service levels. Owing to a lack of law enforcement personnel to police current regulations and ordinances, uncontrolled public transport providers can keep their expenses low by speeding and using substandard vehicles. This exacerbates a formal system's incapacity to compete with an informal system. CNG is now the preferred fuel for reducing emissions, according to the participants. CNG is designated as a non-conventional fuel (Kalinichenko *et al.*, 2019: 3); however, participants stated that the expenses of using CNG are a hurdle. The researcher observed that there was little mention of EVs, other than that the municipality aims to convert its fleet to EVs. Yet none of the few participants who spoke about EVs were enthusiastic about them. Many of them were sceptical about the initiative. Climate-resilient road programs and initiatives strive to mitigate the effects of climate change while also providing safe community transport. However, public funds alone will not be sufficient to accomplish this goal. Furthermore, the participants were dissatisfied with the absence of political will to overcome project and program implementation obstacles.

BRT is a specialized bus system that provides high-quality rapid mass transport. However, when pursuing this goal in the CTMM, the system encountered several hurdles. According to the participants, the system is not supported by the road public transport industry. Public transport operators such as minibus taxi owners and bus companies did not embrace the proposal since it was viewed as their competitor and so they feared losing clients. Another issue that most respondents agreed on was BRT's difficulty in recruiting customers, particularly the users of private vehicles because buses operate primarily in cities and do not reach most neighbouring locations easily

accessible by private vehicles. The BRT was also said to be an expensive project to maintain, according to the participants. Furthermore, creating a financial model for future system maintenance proved difficult. Minibus taxis are not permitted to use the BRT's designated lanes. Thus, fewer lanes are accessible than before, resulting in the minibus taxis causing traffic congestion in the impacted locations and leading to inefficient transportation and delaying commuters.

Barriers to enforcing the NMT as a mitigating action included spatial planning, which is a private vehicle that is placed within metropolitan areas. There is also a consideration for pedestrians and cyclists. Furthermore, participants answered that the general public regards walking and cycling as modes of transport used by 'poor people'. People who use the NMT are not safe. For example, cyclists and pedestrians are helpless in the face of criminality, such as robbery. NMT customers are more prone to disasters than automobile customers (IPCC, 2014). According to the participants, policies and legislations regulating NMT planning are a subject of concern. There are regulatory and institutional frameworks in place to promote and encourage NMT, as well as to ensure that it is included in planning procedures. However, due to various circumstances, including a lack of suitable and long-term funding for designing and marketing NMT, these systems are inefficient.

Most of the participants were unenthusiastic about NMT and had little faith in its successful implementation. NMT requires regions and routes to be reserved for cycling and walking. This demand cannot be met because sufficient land is not available. Finally, delivering secure and efficient NMT, as well as its excellent foundation, is costly. The expense of NMT covers the building and maintenance of cycling and pedestrian paths. An overarching issue is the prevalence of open mindfulness battles. Culture, political commitment, public knowledge, and policy efforts would all play roles in the successful implementation of NMT.

Most participants from the Department of Roads and Transport raised concerns about the Executive Mayor's office and tenure, as well as a lack of political will. They said that some projects had been left unfinished or were in the process of being completed at the time of the research due to political games played between politicians. Long-term planning is difficult because the mayoral office is a term-limited position. Obtaining funds for these initiatives was one of the challenges in adopting the management methods. Other participants reported that money was not a problem. According to the participants, there are various ways to acquire funding, but the technique and procedure seem problematic.

On the questionnaire, the respondents were required to measure on a scale of zero to ten (0-10) the extent to which they believed the mitigation actions curbed the potential impact of climate change on roads infrastructure, with zero as minimal impact and ten high impacts. Figure 1 indicates that over 65% of the respondents thought that mitigation actions in place curbed the impact of climate change on road transport infrastructure to a low extent (from 5 downwards). Furthermore, the respondents had to measure how the departments were equipped to address challenges posed by climate change on the municipal road transport infrastructure. Figure 2 indicates that only 14% of respondents believed they had all the resources necessary to handle the impacts of climate change on road transport infrastructure in the CTMM. During the

interviews, the participants stated that the resources in place were insufficient, with the majority indicating a lack of funding, experience, and political support.

Figure 1: The extent of the impact

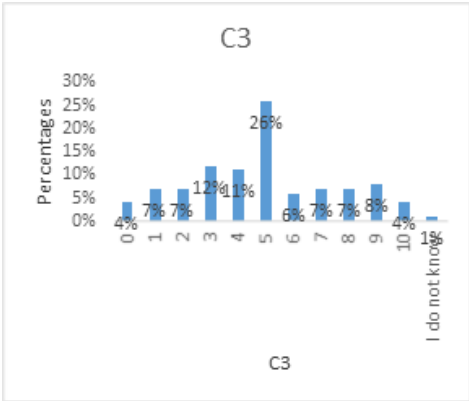
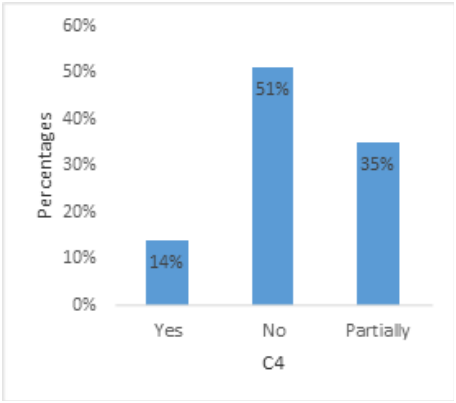


Figure 2: Enough resources in the Department



After establishing the challenges, it was important to explore the strategies to overcome the identified challenges. Therefore, the second interview question was "What are the strategies in place to overcome the identified challenges?" As previously stated, the CTMM has implemented various initiatives, including BRT, CNG, EVs and NMT projects, to reduce GHG emissions caused by the transportation sector. In particular, the aim is to decrease the growing reliance on automobiles and the associated emissions. Interview participants raised several issues in this regard. However, the same cannot be said of the measures in place to address the difficulties that have been recognized. Most participants believed it is the role of senior management and political leaders to find solutions to problems, not their own. However, under the leadership of its Executive Mayor, the CTMM aligns its climate change response with international peers, having signed the Compact of Mayors' Declaration in 2014 (now known as the Covenant of Mayors for Climate and Energy) and being a member of the C40 Cities Climate Leadership Group (C40), an international group of megacities dedicated to combating climate change. The C40 movement encourages cities and mayors to work together actively, share expertise, and take good, quantifiable, and long-term mitigation action.

The third question in the questionnaire was, "*What resources do you think you lack in trying to curb the climate change impacts on the CTMM's road transport infrastructure?*" This question is answered in Figure 3, which illustrates what respondents believed was lacking in their departments.

According to 42% of the respondents, there was no support from the political office. A second issue was gaining social acceptance at 30%, while capacity, financing and managerial issues were at 16%, 7% and 5%, respectively. This explicitly demonstrates that personnel feels that they do not have sufficient support from the political office bearers within the municipality. Participants elaborated this during the interviews. The fourth question was, "To what extent do they have political backing in their operational activities?". This question was asked with an understanding that politicians

must be supportive, resolute and comprehensive with regard to mitigation actions on climate change, given more serious and obvious climate change (Bacchus 2019:4).

Figure 3: Challenges faced in CTMM

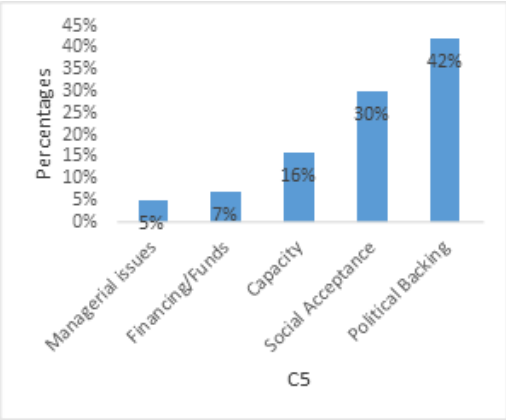
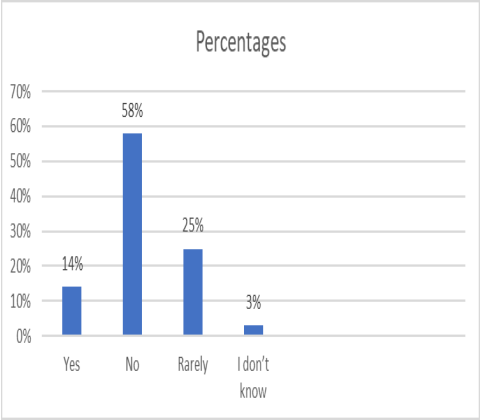


Figure 4: Synergy and communication



GHG emissions have increased, bringing humanity closer to anticipated disastrous levels of global warming (Bacchus 2019:4). Most participants answered that there was not enough assistance from politicians. They showed their discontent with "political will," indicating that some programs require political leadership, but that is lacking. In Tshwane, for example, neither *Areyeng* nor the NMT is accepted and supported by stakeholders such as taxi owners, private bus services, and the public/commuters. The quality-of-service delivery is jeopardized by a lack of or inappropriate resource allocation. The researcher discovered that in the CTMM, several events that were eventually linked to climate change were aggravated by a lack of service delivery, such as storm-water drainage canals that were not maintained. In the past, this lack of upkeep resulted in flooding when waste clogged culverts near highways and storm-water drainage systems, causing flooding.

A participant stated that one of the lacking resources is staff, which has a detrimental impact on service delivery and the implementation of mitigation actions. As a result, the participant claimed that they are unable to analyse the effectiveness of their initiatives through monitoring and evaluation. Thus, more staff should be hired and a monitoring and evaluation unit should be developed to assess the success of the initiatives. However, the City of Tshwane Climate Response Strategy (CTMM, 2017: 40) states that, in terms of monitoring and evaluation, the CSU is responsible for estimating the emission reduction potential of various projects and providing advice on how to improve emission reductions while maintaining oversight.

Figure 4 illustrates the response to the issue of synergy within the municipality regarding climate change information and mitigation measures across various departments. In this scenario, synergy allows the units to achieve a higher level of success in mitigating the impacts of climate change than if they worked in solos. In addition to reducing GHG emissions and supporting a green economy, improved resource coordination, communication, and integration would yield better results.

However, as shown in Figure 4, more than half (58%) of the respondents believe that there is no synergy with other units in addressing climate change. There is not enough synergy between the units as only 14% claim they share information, while 25% state that they rarely share information with other units.

Discussion of Main Findings and Recommendations

It was studied whether there could be administrative challenges to the development and implementation of mitigation measures at the policymaking level. As a result, CTMM is particularly vulnerable to climate change due to its alpine topography. Despite its physical vulnerability to climate change, the CTMM is still embarking on a national climate change strategy. The difficulty in efficiently implementing real policy measures was generally attributed to a variety of limiting reasons, including environmental, economic, technological, and institutional weaknesses. Two key obstacles are a lack of organizational capabilities, specifically insufficient funding for mitigation measures, and an organizational culture that restricts mitigation decision-making. These organizational characteristics could either contribute to or reveal a lack of leadership on climate change response.

The replies to the questionnaire were aimed at answering the following research question: "What are the administrative challenges of managing climate impacts on road infrastructure in the CTMM?" NMT, BRT, CNG, and EVs were recognized as four management measures. Responses showed that all these efforts face significant hurdles and are at various stages of development and execution.

A lack of political support, social acceptance and lack of expertise on climate change issues are major challenges in the municipality. Furthermore, obtaining social approval and finance makes it complex to implement mitigation measures. There are also other capacity and management issues to consider. The impacts of climate change are exacerbated by a lack of road infrastructure care, while a lack of departmental synergy slows the implementation process. Administrative issues are exacerbated by a lack of law enforcement and legislation. Conversely, a lack of law enforcement and legislation exacerbates administrative challenges. There is a lack of understanding and expertise between CTMM officials and the general public. The management procedures put in place are not monitored and assessed sufficiently. However, most respondents thought that present management practices were inadequate at limiting the consequences of climate change on road transport infrastructure.

The municipality, as previously mentioned, has strategies in place to address climate change challenges in the road transport sector. The identified initiatives are in various levels of implementation due to a range of variables, including administrative issues such as obtaining managerial and political support. Several administrative challenges, such as social acceptance, political support, and managerial issues, have been highlighted. As a result, the researcher advises that climate change implications on road transport infrastructure be addressed in the context of municipal government. One of the mitigation measures at the CTMM is the BRT public transport system, also known as *Areyeng* ('Let us move'). The study suggests that the BRT system be revised and implemented differently. The decision to build a brand-new BRT network failed miserably. Splitting the public transport system into stages, motivating, and restructuring existing public transport providers, improving and enhancing

present network efficiencies, and reinforcing existing infrastructures will be the best approaches.

NMT is a mitigation measure as well. The worldwide environmental consequences of NMT are one of its greatest theoretical benefits. Despite its significant cumulative benefits, the environmental impact of NMT is rarely considered when public transport projects are evaluated. When modernizing the road transport network, NMT should be considered. Bicyclists and pedestrians should have safe access to designated areas. Furthermore, the municipality should enter into partnerships with security firms to ensure that NMT users are safe. Education and awareness programs should be developed and implemented effectively to overcome the negative stigma of NMT use, as revealed by the CTMM respondents' interviews.

Planning and constructing climate-resistant road transport infrastructure is difficult due to the unpredictable nature of climate change (but not impossible). This is due to various factors, including a scarcity of data on various climate change threats, such as floods and heatwaves, and their economic effects, notably for the road transport business. However, the available evidence is inconclusive. For example, the intensity of climate change, the extent of climate change impacts, and the accuracy of future climate forecasts all differ. Climate change implications are expected to evolve, and historical data may not be completely accurate in anticipating them. Given budget limits, creating more efficient transport networks to address climate change incidents would likewise be costly and difficult to implement. Such considerations impact the CTMM's approach to climate change and how it is integrated into government programs such as public transport services.

The CTMM's organizational units must collaborate to find answers to the climate change problem. The CSU and the Department of Roads and Transport, for example, must work jointly to address the problem of climate change's impact on road transport infrastructure. While the separate units have their distinct mandates, the effects of climate change need them to collaborate in order to address it. Even though the literature clearly distinguishes between climate change mitigation and adaptation, responding to the dynamic issues of climate change in cities does not necessarily lend itself to various categorizations. To fully address this challenge, comprehensive and integrated solutions, including mitigation and adaptation strategies, as well as synergies between them, are required. Cities can be enticed to recognize and benefit from co-benefits through mitigation and adaptation activities. Building energy efficiency, for example, can reduce GHG emissions while also improving resilience in the face of more severe weather.

Recommendations

The principles of administrative management theory applied in addressing the findings are as follows:

- Centralization: this will increase the political backing for the implementation of the municipal program. Politicians should be entrusted with the transformation process and should be practically responsible for failure to provide services. To assure performance in the implementation of the mandates, an IPMS (IMPS)

should be applied and effective, not just as a system in place but as a monitoring tool employed by the management (Fatemi & Behmanesh 2012: 44). For instance, politicians' performance should be assessed on the progress of initiative implementation (i.e., implementing projects such as BRT).

- Subordination of individual interests into the public interest: for management, the supreme goal of the CTMM is essential to comprehend. From the point of view of this research, the CTMM is intended to tackle problems of climate change to protect public health and the infrastructure of road transport.
- Command unit. Consequently, politicians, including the municipal mayor and councilors, should be the leaders to tackle climate change challenges.
- *Esprit de corps*: Synergy is essential in promoting unity and harmony. The current study found little synergy between units in the Department of Transport and the CSU of the CTMM, as indicated in the section above.

Many administrative challenges such as social acceptance, political backing, and managerial problems have been discovered. Consequently, to limit this impact on road transport infrastructure, the researcher proposes that climate change implications be handled at the local level of government. This study recommends that the BRT system be reviewed and implemented differently. There was no success in deciding to start up a brand-new BRT network. The ideal option is to divide public transport into stages, encourage and restructure existing public transport providers, enhance and boost the efficiency of the existing network and enhance existing infrastructure.

NMT's worldwide environmental implications are among the greatest theoretical benefits. The environmental relevance of NMT is often not considered in the assessment of local transport projects despite its significant accumulated advantages. When modernizing the road traffic network, NMT should be considered. Areas intended for bikers and footballers should be safe. The municipality should also get into arrangements with security firms to protect users of the NMT. Education and awareness programs should be set up and efficiently implemented in the CTMM interviews to overcome the negative stigma of the usage of NMT.

CTMM organizational units must work together to tackle the challenge of climate change and come up with solutions. For example, in response to the effect of climate change on road infrastructure, the CSU and the Department of Roads and Transport need to address the matter collaboratively. The implications of climate change force units to work together to handle the problem, yet the different units have specialized and individual duties. Although the literature differentiates explicitly between mitigation and adjustment to climate change, reacting to dynamic climate change issues is not always a matter of mitigation or adaptation to various categories. Therefore, comprehensive and integrated solutions, including mitigation and adaptation strategy and synergies, are needed to fully address this challenge. Actions to mitigate and adapt might provide urban incentives to recognize and enjoy co-benefits. Improvements in building energy efficiency can reduce emissions of GHG and improve resilience, for example, against harsh weather conditions.

Conclusion

Fighting climate change is challenging because of the uncertainty of the time, speed and gravity of the repercussions. This study emphasized that climate change needs to

be integrated as a significant part of road authorities' planning processes. In building management methods to detect and assess the possible impact of climate change, CTMM should follow an appropriate theoretical approach. Furthermore, CTMM must clarify its commitments and duties to climate change through its transport and road network system.

References

Allen, M.R., Dube, O.P., Solecki, W., Aragón-Durand, F., Cramer, W., Humphreys, S., Kainuma, M., Kala, J., Mahowald, N., Mulugetta, Y., Perez, R., Wairiu, M. & Zickfeld, K. (2018). Framing and Context. In Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)], Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. In Press.

Bacchus, J. (2019). What Is a Climate Response Measure? Breaking the Trade Taboo in Confronting Climate Change. CIGI Paper No. 220- Centre for International Governance Innovation.

C40cities.org. The Compact of Mayors. [Online] Available: https://www.c40.org/researches/compact-of-mayors. (August 05, 2019).

Cochran, C. E., Meyer, L.C., Carr, T. R. & Cayer, N.J. (2009). American Public Policy: An introduction 9th Ed. Wadsworth: Boston.

Cottrell, R.R. & McKenzie, J.E. (2011). Health promotion and education research methods', using the five-chapter thesis dissertation model. Boston: Jones & Bartlett.

CTMM. (2015a). City of Tshwane Metropolitan Municipality. Earth hour city challenge 2015 journeys towards sustainability – City of Tshwane. Government printers: Pretoria.

CTMM. (2015b). City of Tshwane Metropolitan Municipality. Comprehensive Integrated Transport Plan. Government printers: Pretoria.

CTMM. (2017). City of Tshwane Climate Response Strategy, 2017. Government printers: Pretoria.

CTMM. (2018). Global lead city network on sustainable procurement. [Online] Available: https://glcn-on-sp.org/cities/tshwane/. (September 05, 2019).

DEA (Department of Environmental Affairs). (2011). Defining South Africa's Peak, Plateau and Decline Greenhouse Gas Emission Trajectory. Pretoria, South Africa.

Fatemi, M. & Behmanesh, M. R. (2012). New public management approach and accountability. *International Journal of Management and Social Sciences*. 1, 42-49.

Fayol, H. (1949). General and industrial management. C. Storrs, Trans. London: Sir Isaac Pitman & Sons.

IEA (International Energy Agency). (2019). World Energy Outlook 2019: Energy for All. Paris: IEA.

IPPC. (2014). Climate Change 2014: Impacts, Adaptation and Vulnerability'. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, USA.

Jenelius, E. (2008). Network structure and travel patterns: explaining the geographical disparities of road network vulnerability, Div. of Transport and Location Analysis, KTH, Sweden.

Jun-qiang, L., Long-hai, Y., Liu, W. & Zhao, l. (2010). Measuring Road Network

Vulnerability with Sensitivity Analysis. [Online] Available: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0170292. (August 12, 2019.
Kalinichenko, A., Havrysh, V. & Atamanyuk, I. (2019). The Acceptable Alternative Vehicle Fuel Price. *Energies,* 12, 1-20.
Komen, D.K. (2016). Impact of climate on health: A specific focus on malaria in South Africa's Limpopo Province. University of Pretoria: Pretoria.
Mahmood, S. A. I. (2012). Impact of climate change in Bangladesh: the role of public administration and governance integrity. *Journal of Ecology and the Natural Environment,* 4: 223-2240.
Maslow, A. (1998). Maslow on Management. John Wiley & Sons Inc. Hoboken, New Jersey.
Mayo, E. (1923). The irrational factor in human behavior: The 'night-mind' in industry. *The Annals of the American Academy of Political and Social Science*, 110: 117–130.
McLusky, S. & Sessa, R. (2015). Making it count increasing the impact of climate change and food security education programmes. Food and Agriculture Organization of the United Nations.
Mohaghar, A., Jafarnejad, A., Ghodsipoor, S.H & Maleki, M.H. (2013). Theoretical foundations of organizational problem-solving methodologies in operational research. *Management Science Letters,* 3: 1833–1838.
Pielke, R. (2019). The Incredible Story Of How Climate Change Became Apocalyptic. [Online] Available: https://www.forbes.com/sites/rogerpielke/2019/12/06/the-incredible-story-of-how-climate-change-became-apocalyptic/?sh=40289319789d. (August 7, 2019.
Punch, K.F. (2014). Introduction to research: Quantitative and qualitative approaches. 3rd ed. SAGE Publication: California.
South Africa. 2011. National Climate Change Response White Paper. 2011. Department of Environmental Affairs and Tourism. Pretoria.
Taylor, F. (1911). The principles of Scientific Management. Harper & Brothers. New York, London.
Tobi, H. & Kampen, J.K. (2018). Research design: the methodology for interdisciplinary research framework. *Qual Quant,* 52: 1209–1225.
UNEP, (2016). The Emissions Gap Report 2016. A UNEP Synthesis Report, Nairobi, November. [Online] Available: http://uneplive.unep.org/theme/index/13#egr. (July 21, 2018.
Weber, M. (1905). Bureaucratic Theory by Max Weber. [Online] Available:https://www.toolshero.com/management/bureaucratic-theory-weber/ (May 21, 2019.