ACCOUNTING FOR GREENHOUSE GAS EMISSIONS IN CITIES

By

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Master of Commerce – Accounting and Finance
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A thesis submitted
in fulfilment of the requirements
for the degree of Doctor of Philosophy
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AUGUST 30, 2019
MACQUARIE UNIVERSITY

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Abstract

Several social and environmental accounting (SEA) scholars have suggested that sustainability issues need to be explored at the regional or geographic boundary level as opposed to focusing on the legal form of corporations (Dumay et al., 2010; Gray, 2010; Milne and Gray, 2007). One such regional level is that of a city as each city has its own geographic/regional boundary. In relation to the key sustainability issue of climate change, cities are responsible for a large share of anthropogenic greenhouse gas (GHG) emissions. Cities also have the ability and capacity to reduce GHG emissions via strategies and other actions. Policies and actions already being implemented at city level have the potential to reduce GHG emissions by 1 billion metric tons annually by 2030 (Ostrander and Oliveira, 2013). Measurement is vital for managing GHG emissions and disclosure is the critical step for public accountability.

Extant accounting literature, however, is relatively silent about exploring the measurement and disclosure practices of GHG emissions at the city level. Prior studies have predominately examined the accounting and reporting of GHG emissions in the corporate sector (e.g., Andrew and Cortese, 2011a; Depoers et al., 2016; Kolk et al., 2008). These studies found that the quality of disclosure is poor and advocated mandatory reporting as well as calling for further GHG disclosure research. In responding to this call, this thesis examines the extent and quality of disclosures of GHG emissions and reduction activities at the city-level.

This thesis consists of three empirical research papers. Paper 1 (Mia et al., 2019) investigates the quality of GHG emissions disclosures of 42 cities to the Carbon Disclosure Project (CDP) and compares them with the expectations of users. The expectation gap framework is used to examine GHG disclosure quality on the premise that quality disclosure is needed to meet user expectations, and the quality disclosure should be complete, consistent, timely, accurate, reliable and comparable. An expectation gap may arise because of deficient performance, deficient standards and users' unreasonable expectations. Content analysis is conducted to analyse the expectation gap. Overall, the findings are that GHG emissions disclosures do not meet the expectations of users. In relation to performance, many cities have excluded several GHGs from emissions inventory, used multiple protocols to calculate emissions inventory, reported old emissions data and applied emissions reduction targets to a limited number of emissions sources. In relation to standards, the CDP guidelines are flexible regarding what is reported by cities, what protocols cities are using and there is no checking for accuracy and

completeness. In relation to expectations, that there are several geophysical and technical factors making it impossible to have comparable information at the city level. These findings suggest there is scope for the CDP to improve and standardise its disclosure system, working in collaboration with cities and the C40 alliance. Cities should also focus on improving their performance by providing accurate, complete, reliable and timely information. Even with standardisation, however, city-level emissions comparison is not possible. A useful disclosure is therefore likely to be the actions cities take to reduce emissions and the impact of those actions. By disclosing actions and their impact, cities can learn best practices from each other and improve emissions reductions. The central recommendation is therefore that CDP should be asking for more information at a project or activity level from cities.

A key finding from Paper 1 is that the differences between cities mean that the disclosure of emissions reduction actions will be much more useful for public accountability and peer learning than disclosure of raw emission levels. Paper 2 (Mia, et al., 2018a) investigates this issue further by exploring the quality of city emissions reduction actions and targets disclosures via traditional channels as well as social media. Three research questions are addressed. First, what communication channels are used by world megacities to disclose their emissions reduction targets and actions? Second, are these targets and actions communicated consistently across different channels? Third, what is the quality of the actions disclosed in different channels? Accountability theory is used to explain disclosures on the basis that cities are accountable to different groups of stakeholders to disclose information about their emissions reduction targets and actions which they can do by different channels. Media richness theory is used to explain why alternative disclosure might be useful especially for discharging accountability. Ten megacities are selected and their emissions reduction targets and actions are examined across different channels to identify the common disclosure channels. Document analysis is conducted to assess the consistency of disclosed targets and actions related information, and a scoring system is developed to evaluate the quality of the disclosed actions related information across different channels. The findings are that cities have taken various actions including energy efficiency programs to reduce emissions and used multiple disclosure channels including social media. Disclosed information related to emissions reduction targets is consistent, but information about emissions reduction actions is mostly inconsistent, inadequate and mainly narrative in form. Concerning social media, this study finds that despite having a large number of online followers, several cities do not use social media to disclose emissions reduction actions. The implication of these findings is that city authorities should

better exploit the power of social media to inform and educate about their actions to reduce emissions, because it offers engagements and dialogue with the citizens to improve transparency and accountability. Standard setters and sustainability auditors also need to consider multiple disclosure channels to ensure information is consistent across the different channels to improve the credibility of the disclosed information.

Paper 3 (Mia, et al., 2018b) extends the works of Papers 1 and 2 by focusing on one emissions reduction action in detail: energy efficiency. This particular action was selected as part of the findings of Paper 2 were that many cities including Australian cities are taking energy efficiency measures to reduce GHG emissions. Energy efficiency measure can reduce more than one-third of GHG emissions in the most cost-effective way (Magill, 2014; IEA, 2014). A comprehensive disclosure of the energy efficiency measures can help investors, community and other stakeholders to evaluate the cost and assess the social, economic and environmental benefits associated with energy efficiency measures. Paper 3 therefore explores the calculative practices and public disclosure about energy efficiency measures within Australia's largest cities. From an accountability perspective, it is argued that Australian cities need to provide information about their energy efficiency activities in detail to the community and other stakeholders either to legitimise their existence or to fulfill the stakeholders' need or to help in their decision-making process. In the absence of any disclosure guideline for actions, a disclosure index is developed to assess the energy efficiency measures and applied to the eight major Australian cities in the sample, for the years 2017 and 2018 (until 15 October). Findings of this study suggest that while many Australian cities are undertaking energy efficiency activities, they fall short in providing information related to costs and impacts of their energy efficiency measures and actions. Such limited disclosure makes it difficult for stakeholders to assess cities' energy efficiency measures and activities. These findings imply that a standardised and mandatory reporting requirements in relation to energy efficiency (and other emission reduction projects) would facilitate enhanced transparency and accountability.

Collectively, this thesis contributes to an understanding of the accounting and public disclosure practices of GHG emissions and reduction activities at the regional level. Beyond GHG emission disclosure research, in relation to other sustainability issues such as biodiversity or water, this thesis highlights that even with standardisation disclosures may not be comparable at the city or local government level because of different regional characteristics. Important disclosures for cities and similar type of agencies are the actions taken to reduce sustainability

harms and the impact of those actions. By making such disclosures, cities and local government can learn best practices from each other, with the aim of achieving sustainability. Therefore, policymakers and standard setters (e.g., CDP, GRI) should be asking for more information at a project or activity level. Also, standardised guidelines and verification processes are needed for actions related information to help organisations to provide complete, accurate, consistent, reliable and more comprehensive information. In addition, auditors should review the digital platform while conducting assurance service for traditional annual reports and SEA reports so that information is consistent across different channels. Standards setters also should contemplate the potentiality and popularity of digital platforms as these new form of communication channels offer both immediacy and interactivity which may be highly relevant in designing, developing and deploying SEA reporting frameworks.

Declaration

I certify that the work presented in this thesis entitled — "Accounting for Greenhouse Gas Emissions in Cities" has not previously been submitted for a higher degree to any other university or institution other than Macquarie University.

I also certify that the thesis is an original piece of research and it has been written by me. Any help and assistance that I have received in my research work and the preparation of the thesis itself have been appropriately acknowledged.

In addition, I certify that the sources of information used and the extent to which the work of others has been utilised are acknowledged in the thesis.

Parvez Mia

Aug 30, 2019

Acknowledgments

First of all, I am thankful to my creator almighty Allah who has blessed me in many ways and gave me the opportunity to meet some special people who are part of my life and helped me to come so far.

I would like to express my heartiest and most sincere gratitude to my principal supervisor Professor James Guthrie for his strong support, encouragement and care. Also, I am deeply appreciative to my associate supervisor, Associate Professor James Hazelton for all the time, cooperation and effort that he has put into this project to help me. They have given me time, patient council and inspiration. Without their careful guidance, endless support, constructive feedback and above all encouragement it would be virtually impossible to complete this thesis. It has been a great pleasure working with both of them. I would also like to convey my sincere appreciation to Fiona Crawford for excellent editorial advice. I am also grateful to academic journal reviewers, discussants and audiences in conferences I attended.

I would like to express my utmost gratitude to Macquarie University, for giving me the opportunity to take this higher degree path and for supporting me throughout my candidature. I would also like to include all of my friends, colleagues and seniors at Macquarie University who made my candidature time here memorably comfortable and enjoyable. I can never forget their pleasant behaviour and helpful attitude. Hence, I take the opportunity to convey my heartiest thank to them for such nice friendship, affection and cooperation.

Finally, I want to express my profound love, respect and gratefulness to my parents, wife and cute little boy (Ahmed). Without their endless affection, sacrifices and inspirations, I could never be at this stage. Therefore, I humbly dedicate my thesis to them.

Status of Thesis Papers

This thesis includes three papers. Supervisors contributed to the publication process of the three papers. On these three papers, my contribution was 80% and professor James Guthrie's and A/P James Hazelton's contribution was 10% and 10% respectively. The status of three papers outlined below:

Paper 1: Greenhouse Gas Emissions Disclosure by Cities: The Expectation Gap

Published as: Mia P., Hazleton, J. and Guthrie, J. (2019), "Greenhouse gas emissions disclosure by cities: the expectation gap", *Sustainability Accounting, Management and Policy Journal.*

Paper 2: Measuring for Climate Actions: A Disclosure Study of Ten Megacities

Published as: Mia, P., Hazelton, J. and Guthrie, J. (2018), "Measuring for climate actions: a disclosure study of ten megacities", *Meditari Accounting Research*, 26 (4), 550-575.

Paper 3: Energy Efficiency Public Disclosure of Major Australian Cities

Presented at the 9th Asia-Pacific Interdisciplinary Research in Accounting (APIRA) Conference in Auckland, New Zealand on 1-3 July 2019.

Also presented at the 17th Australasian Centre for Social and Environmental Accounting Research (A-CSEAR) Conference, Monash University, 5-7 December 2018.

Abbreviations and Acronyms

ABS	Australian Bureau of Statistics
C40	Alliance of World Megacities
CDP	Carbon Disclosure Project
CDSB	Climate Disclosure Standards Board
EEC	Energy Efficiency Council
ERA	Emissions Reduction Action
ERT	Emissions Reduction Target
GEI	GHG Emissions Inventory
GPC	Global Protocol for Community-Scale Greenhouse Gas Emissions
GRI	Global Reporting Initiative
IEA	International Energy Agency
IASB	International Accounting Standards Board
ICLEI	International Council for Local Environmental Initiatives (Local Governments for Sustainability)
IPCC	Intergovernmental Panel on Climate Change
KPI	Key Performance Indicators
Megacities	Any City that is Member of the C40 Alliance.
$MtCO_2e$	Metric ton Carbon Dioxide Equivalent (CO_2e – indicates all seven greenhouse gases)
NSW	New South Wales
SEA	Social and Environmental Accounting
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency

Chapter 1: Introduction

1.1 Introduction

The growing demand for sustainability information due to the concerns over the social and environmental impacts of organisational activities have raised the need to measure and disclose organisations' social and environmental performance. This has led to the development of social and environmental accounting (SEA) to manage and communicate sustainability performance (Kaur and Lodhia, 2018). SEA is critical as traditional financial statements are lacking in providing a complete description of the social, environmental and economic impacts of an organisation's operations. Corporations, government agencies and NGOs are accounting for and reporting their social and environmental performance along with their economic performance.

Numerous SEA scholars have explored sustainability information disclosed by organisations and generally find it lacking in quality (Diouf and Boiral, 2017; Deegan, 2017; Michelon et al., 2015; Ahmad and Mohamad, 2014). Prior studies have mainly focused on the corporate sector and found that the number of corporations disclosing sustainability information and amount of sustainability information has increased over the decades (Ali et al., 2017; Deegan, 2017; PWC, 2015). However, corporate social and environmental reporting practices are criticised as the "focus [is] on the narrow definition of sustainable development" (Ball and Bebbington, 2008 p. 323); the primary emphasis is profit maximisation and eco-efficiency rather than more substantive actions towards sustainable development (Ball and Bebbington, 2008; Deegan, 2017; Milne and Gray, 2007). Consequently, corporate disclosures are generally of poor quality: information is often qualitative, incomplete, inconsistent, biased and unreliable (Deegan 2017; Michelon et al., 2015; Zaini et al., 2018). Accordingly, researchers have urged for mandatory reporting for improving the quality of sustainability information (Dumay and Hossain,

2018; Ioannou, and Serafeim, 2017) and have also called for new ideas to improve the impact of sustainability disclosures (Bebbington et al., 2017; Milne and Gray, 2007). As discussed further below, this study therefore explores how sustainability disclosures might be optimised to drive improved sustainability outcomes.

Researchers have also questioned the utility of using corporate boundary for sustainability reporting. A number of scholars (e.g., Ball and Bebbington, 2008; Gray 2010; Milne and Gray, 2007) argue that sustainability is a socio-ecological system concept; hence, it will rarely coincide with corporate boundaries (Gallopín, 2003; Gray, 2010). In addition, many corporations are operating at many different locations in different countries. Hence, it would be meaningless to use corporate performance to understand the sustainability of any particular ecosystem or region (Ball and Bebbington, 2008). Therefore, sustainability issues are most usefully explored at the geographic boundary or regional level (Dumay et al., 2010; Gray, 2010; Gray and Bebbington, 2001; Milne and Gray, 2007). One way to explore sustainability at the regional level is to explore sustainability disclosure at the city level as a city has its own geographic or regional boundary. The term city refers as representing the government administrator who governs and who seeks to encourage residents within the boundaries of the city to take action.

Given that cities operate within a regional boundary, sustainability disclosure by city governments creates the opportunity to provide information on the performance of ecosystems and regions. This may also allow understanding of sustainable development performance for a particular location (Ball and Bebbington, 2008). Moreover, sustainability is concerned with equity and justice, which are core tasks of public sector organisations (Milne and Gray, 2007; Dumay et al., 2010), one example of which are city

governments. However, accounting scholars have overlooked city-level sustainability disclosure. Hence, this study explores sustainability disclosure at the city level.

Organisations mainly use annual reports and stand-alone sustainability reports to disclose sustainability information. However, recent technological developments have changed the way people engage with each other. Social media technologies in particular have changed forever the way people communicate and interact. Organisations are increasingly using social media to highlight their sustainability activity (Yeomans, 2013) as social media offer stakeholder engagement which is critical for improving transparency and accountability of sustainability disclosure (Kaur and Lodhia, 2018; Lodhia and Stone, 2017). However, sustainability disclosure through social media has received limited research attention (Manetti and Bellucci, 2016; She and Michelon, 2018). As discussed further below, this study explores cities' sustainability disclosure through different communication channels including social media.

Whilst there are many important sustainability issues such as depletion of natural resources, waste generation, pollution, deforestation, population, unemployment and poverty, the focus of this study is climate change. Greenhouse gas (GHG) emissions from human activities accelerate global climate change (Cerri et al., 2018; Cook et al., 2016), with the world's leading climate scientists warning that GHG emissions must be cut to net zero level by 2040 to avoid catastrophic climate change impact (Stern, 2018; Watts, 2018). Cities have an important role to play in tackling climate change through emissions reduction, given that activities that take place within the geographic boundaries of cities are responsible for a large share of GHG emissions (PWC, 2017). Measurement of GHG emissions is crucial for policymakers and others concerned about the issue of climate

change to develop strategies and to take actions for GHG emission reduction and to monitor, track and manage GHG emissions. As a calculative practice, accounting, in particular, social and environmental or sustainability accounting, is central to the identification, measurement and communication of emissions information to users (Sargiacomo et al., 2014; Vollmer, 2003). Therefore, the central research question of this thesis is: *"what is the extent and quality of GHG emissions and associated emissions reduction actions' disclosures at the city-level?".*

This thesis consists of three separate but inter-related empirical studies. All three papers focus on cities' calculative practices and disclosure related to GHG emissions and associated emissions reduction actions. In response to the need for GHG emissions information, the CDP has developed a database for corporate and cities' GHG emissions information (CDP, 2018). The CDP is considered the largest and most comprehensive database for GHG emissions information (Andrew and Cortese, 2013; Doda et al., 2016; Stanny, 2018). Quality information is critical for policymakers and other users in their decision-making process. Hence, Paper 1 investigates the quality of the disclosed emissions data to the CDP by cities. Once cities have their emissions data, they need to set emissions reduction targets and take actions to reduce emissions accordingly. Cities can communicate their emissions reduction targets and actions to their citizens and others through different channels, including the CDP, to show their initiatives for climate change. Therefore, Paper 2 analyses the consistency of disclosed emissions reduction targets and actions across different channels as well as the quality of the disclosed emissions reduction actions in different channels. Paper 2 finds that cities are taking a range of actions to reduce GHG emissions. One of the most pervasive and important of these actions is improving energy efficiency, which is logical as improving energy efficiency is one of the

cost-effective measures for reducing GHG emissions and also provides economic incentives (IEA, 2014; Yoon et al., 2017). However, users need comprehensive information regarding energy efficiency measures and projects to track emissions reductions and also to assess projects from financial and environmental perspectives. To explore the extent to which this information is being provided, Paper 3 explores the calculative practices and public disclosure of energy efficiency measures to understand to what extent energy efficiency information can be considered comprehensive. These three papers form the body of the thesis and are presented as Chapters 4, 5 and 6.

1.2 Cities and Climate Change

Climate change is the leading cause of rising sea levels, drought, hurricanes, tornadoes and floods and the spread of disease (Bose, 2010). It is predicted that a significant proportion of global biodiversity will be extinct before the end of this century due to climate change (Bellard et al., 2012). Climate change is also projected to increase the number of heat waves and the frequency of wildfires in Europe, and by 2030, water-security problems are expected to intensify in southern and eastern Australia (Bulkeley, 2013).

Since the GHG emissions from human activities drive climate change, it is necessary to understand and manage GHG emissions in order to address climate change. Even though the global financial crisis slowed the economic growth and hence drove emissions reduction, human history recorded the highest total anthropogenic GHG emissions in the last decade between 2000 and 2010 (IPCC, 2015). Annual GHG emissions grew on average by 1.0 gigatonnes of carbon dioxide equivalent ($GtCO_2$ eq) (2.2%) per year from 2000 to 2010 compared to 0.4 $GtCO_2$ eq (1.3%) per year from 1970 to 2000, despite a

growing number of climate change mitigation policies (IPCC, 2015, p. 6). If a timely and effective strategy to address climate change is not employed, the global mean surface temperature will increase from 3.7°C to 4.8 °C in 2100 compared to pre-industrial levels, and climate change will have significant global environmental, social and financial impacts on every country on every continent (IPCC, 2015). GHG emissions that contribute to climate change are disrupting our social, economic and environmental systems and present a significant obstacle for moving towards sustainable development. The Brundtland Report (1987) identified excessive GHG emissions as a significant threat to sustainable development. The IPCC has suggested substantial cuts (40% to 70% compared to 2010 emissions level) in man-made GHG emissions by 2050 to keep the rise of global temperatures below 2.0°C relative to pre-industrial levels (IPCC, 2015). So, a significant reduction in anthropogenic GHG emissions can help to mitigate the consequences of climate change and enable a move towards sustainable development (Dahal and Niemelä, 2017).

Over the past 20 years, there has been considerable international agreement as to the need to reduce GHG emissions. The United Nations Framework Convention on Climate Change (UNFCCC) established the Kyoto Protocol in 1997 and had attempted to stabilise GHG concentrations in the atmosphere at a level (below 2°C as compared with pre-industrial times) in order to prevent dangerous anthropogenic interference with the climate system. However, many countries struggled with this limit (Savaresi, 2016), so UNFCCC developed a new protocol, adopting the Paris Agreement on 12 December 2015. At the United Nations climate change conference in 2015 in Paris, COP 21, governments agreed that mobilising stronger and more ambitious climate action is urgently required to achieve the goals of the Paris Agreement. Action needs to be taken at all levels of society, from

governments, cities, regions, businesses and investors to individual members of society, in order to effectively implement the Paris Agreement.

The Paris Agreement establishes a set of binding procedural commitments. As of October 2017, 169 of 197 member countries of the UNFCCC had signed the Paris Agreement to limit global temperatures to below 2°C as compared with pre-industrial times (UNFCCC, 2017). Parties committed to prepare, communicate and maintain successive "nationally determined contributions" (NDCs), to pursue domestic mitigation measures aimed at achieving their NDCs; and to regularly report on their emissions and on progress in implementing their NDCs. Also, the United Nations has urged immediate action via its sustainable development goals, calling all countries to work towards reducing GHG emissions to address climate change (United Nations, 2017). While country-level agreement is vital for establishing international cooperation and setting national emissions reduction targets, cities are central to taking practical action (Barber, 2017; Lindseth, 2004), given their size and contribution to emissions.

Moreover, city-level strategies support and complement national GHG reduction goals and fulfil local climate mitigation and adaptation responsibilities (Dahal and Niemelä, 2017). Cities are leading actions against climate change through global networks such as the C40. In the 2015 Paris Climate Conference, more than 360 cities announced that by 2020 their collective efforts could reduce more than half of the world's urban GHG emissions (Chen et al., 2016).

As cities are central places for social and economic activities and consume materials that produce GHG emissions, city administrators must understand GHG emissions to develop

effective strategies. City administrators have authority over decisions that have a direct and indirect impact on GHG emissions. One such example is policy and regulation related to the energy efficiency of facilities and buildings. Therefore, it is critical to understand cities' GHG emissions and emissions reduction targets, as well as their emissions reduction programs and actions. Accounting has an important role to play in this regard, discussed immediately below.

1.3 Role of Accounting in Addressing Climate Change

Accounting scholars, as well as practitioners, have increasingly become involved in the disclosure of social and environmental information emerging from government organisations, non-governmental organisations and public and private corporations (Andrew and Cortese, 2011a; Ball and Bebbington, 2008; Lodhia and Stone, 2017). Accounting's purpose over the course of history has been to measure and disclose monetary information related to organisational economic events. However, the role and scope of accounting have changed over the years along with social change and the demand for the scope of information has broadened (e.g., Andrew and Cortese, 2011a; Ball and Bebbington, 2008; Deegan, 2017). As accounting is a social practice (Hopwood and Miller, 1994; Potter, 2005), its purpose and emphasis will change as priorities shift toward pressing social and environmental issues (Andrew and Cortese, 2011a). Consequently, social and environmental issues have received increased attention over the last three decades (e.g., Amran and Keat Ooi, 2014; Ascui, 2014; Boiral et al., 2017; Deegan, 2017; Zaini et al., 2018).

Many organisations now measure and disclose social and environmental information along with financial via the traditional annual report, sustainability report, websites and social media (Ali et al., 2017; Lodhia and Stone, 2017). The social and environmental accounting movement has emerged to encourage standardised reporting and disclosure practices through the development of the GRI, Integrated Reporting and the CDP. The accounting profession sees itself as an integral part of the development of quality disclosure practices (Andrew and Cortese, 2011a). Therefore, accounting scholars and practitioners have opportunity to play a critical role in accounting and reporting social, economic and environmental information.

The scope of SEA is broad, including, but not limited to, human rights, gender and cultural diversity, women's rights, ethical product sourcing waste management, water accounting, biodiversity and climate change (Adler et al., 2018; Haque and Islam, 2015; Perkiss and Moerman, 2018; Parsa et al., 2018; Samkin et. al., 2014; Tan and Egan, 2017; Tello and Hazelton, 2018). This thesis focuses on one aspect of SEA research, that is, GHG emissions.

Organisations, including cities, are facing pressure to provide GHG emissions information (World Bank, 2010; Hoornweg et al., 2010). As climate change threatens to have widespread impacts, citizens are demanding more environmental information to engage in debate and to put pressure on policymakers to respond (Qian et al., 2011). City governments need climate change information to evaluate progress and adopt appropriate mitigation strategies (Cortekar et al., 2016). The first and most fundamental step cities can take in tackling climate change is measuring GHG emissions and understanding their sources (C40, 2013). Credible and reliable GHG data allows cities to target their policies

and programs more precisely in an effort to reduce emissions and ensure they get "greater bang for their buck" (C40, 2013). It is also crucial that cities monitor their emissions over time so that they can track progress, evaluate performance and communicate key findings to citizens and other stakeholders.

However, it is apparent from a review of SEA research that prior studies mainly focus on corporate level climate change and GHG information. There has been limited research exploring cities' accounting and disclosure practices related to GHG emissions and emissions reduction actions.

1.4 Motivation

Cities matter for the study of climate change as they are large economies by themselves and home to more than half of the world's population. Hence cities are major contributors to GHG emissions (Hoornweg et al., 2011) and have a significant role to play in answering scientists' calls for a significant reduction in GHG emissions (Watts, 2018). Cities are both part of the problem of climate change and part of the solution (Kamal-Chaoui and Robert, 2009). They have the capacity and resources to tackle climate change problems as they are the centre of wealth and innovation (Rosenzweig et al., 2010). Thus, cities are an essential unit of analysis for the study of GHG emissions and associated climate change.

An important step towards reducing GHG emissions from organisations is to improve transparency and disclosure of such emissions has led to the establishment of initiatives such as the CDP (Qian et al., 2018). The CDP asks both corporations and cities to calculate

their GHG emissions inventories (GEIs) and disclose it to the public as part of initiatives to reduce GHG emissions to address climate change (CDP, 2018).

GHG emissions inventories help policymakers track emission trends, develop mitigation strategies and policies, and assess progress. These emissions inventories can help city governments identify their current level of emissions, as well as the sources and activities within their physical boundaries that are responsible for those emissions. Further, emissions inventories can help in setting goals and targets for future reductions and engage residents and businesses in initiatives to reduce GHGs. They can also serve as the basis for developing an action plan, or to quantify the benefits and track the progress of activities that reduce emissions (US EPA, 2017). Identifying principal emissions sources, implementing reliable emissions accounting systems, and developing emissions inventories all serve to establish robust climate strategies and actions for cities (Dahal and Niemelä, 2017). Moreover, a comparable and accurate accounting of GHG emissions, similar to financial reporting rules, is required for emissions disclosure so that stakeholders receive a true and fair representation of an organisation's carbon footprint and efforts in emissions reduction (Gibassier and Schaltegger, 2015).

This study argues that it is essential to understand cities' administration, accounting and reporting of past and projected GHG emissions, emissions reduction commitments and actions to reduce emissions. This is a calculative practice as it entails both calculation of actual GHG emissions and targets as well as outlining of policies and initiatives for reduction, more specifically policies and programs aimed at meeting emission reduction commitments.

Establishing organisations' actual accounting and disclosure practices, as well as what information stakeholders expect organisations to disclose, helps us to ascertain whether the organisations disclose information consistent with the expectations of stakeholders. This is the first step in examining the accounting and disclosure of cities' GHG emissions related information including their emissions reduction activities.

1.5 Research Objectives

The central question of this PhD thesis is *"what is the extent and quality of GHG emissions and associated emissions reduction actions' disclosures at the city-level?"* This study defines extent and quality as sufficient information for users to assess cities emissions inventory and emissions reduction activities. The primary objective is to understand how cities' administrations use accounting and reporting of past and projected GHG emissions and emissions reduction commitments. Also, to establish what policies and programs have been put in place to meet emissions reduction commitments.

The first study (Paper 1 - Mia et al., 2019a) investigates the quality of GHG disclosures made to the CDP by cities – and compares those disclosures with the expectations of their users and the public. The second study (Paper 2 - Mia et al., 2018) investigates this further by exploring the quality of megacities' disclosure of emissions reduction actions and targets via different communication channels. The third and final study (Paper 3 - Mia et al., 2019b) explores the public disclosure of energy efficiency initiatives in major Australian cities. Thus, overall this study focuses on cities' GHG-related disclosure practices, an area that to date has not been the focus of the SEA literature. Paper two used the term "megacity" which refers to world largest cities. Although there is no formal

definition of a megacity, urban areas with more than five million people are usually called megacities (Baklanov et al., 2010). Kennedy et al., (2015) defined a megacity as a large metropolitan area with a complex economy and more than 10 million people. However, in developed countries the population threshold would be lower to consider a city as a megacity (Gubry, and Le, 2002). This study did not define the megacity based on the population number. This study has selected ten cities from C40 cities and C40 is a global association of mayors of over 80 of the world's large and emerging megacities that have committed to leadership and action on combating climate change (C40, 2018). As the selected sample cities are from this C40 cities network, this study considered the selected ten cities as megacities in paper two. A megacity may have an area which extends beyond the administrative boundaries of the constituent municipalities (Gubry, and Le, 2002). However, this thesis defines a city based on the administrative boundary which has been used to collect GHG emissions related data by the CDP. Hence, this study considered the cities' GHG emissions inventories and cities' emissions reduction actions within their administrative boundaries.

The next section provides an overview of the three papers followed by the discussion of the research method used in the three papers.

1.5.1 An Overview of the Three Research Papers

This PhD thesis is by publications and includes three refereed empirical research papers. Figure 1.1 illustrates the relationship between the three papers, the steps required to meet each research objective and the research methods used to conduct the specific investigation of each paper. The three research papers are discussed separately in the following three sub-sections.

1.5.1.1 Paper 1

Paper 1 (Mia et al., 2019a) investigates the contemporary GHG-related disclosure practices of 42 global cities to the CDP and compares them with the expectations of users. GHG emissions from cities significantly contribute to global climate change. Therefore, it is essential for city authorities to reduce GHG emissions from their territory. One of the important steps to reduce GHG emissions is to improve transparency and disclosure of such emissions (Qian et al., 2018). City authorities need to account for GHG emissions and develop an emissions inventory and emissions reduction targets. GHG emissions inventories can help city administrations to identify their current level of emissions, as well as the sources and activities within their cities' physical boundaries that are responsible for those emissions. Further, GHG emissions inventories can help in setting goals and targets for future reductions and engage residents and businesses in initiatives to reduce GHG emissions. GHG Emissions information can also serve as the basis for developing an action plan, or to quantify the benefits and track the progress of activities that reduce emissions.

Few previous studies have investigated GHG emissions inventories, especially at the city level. Using CDP-provided data on city GHG disclosures, this study adds to the existing body of knowledge on the nature of climate change-related disclosure practices of global cities. Content analysis was used in the initial examination of each city's disclosures. The comparisons between the information disclosed by cities and the users' expectations of those disclosures were analysed through an 'expectation gap' framework. Users' expectations were identified based on statements by standard-setters, prior academic research and CDP-specific material. This expectation gap framework indicates that expectation gap may arise due to cities' deficient performance, the CDP's deficient

standards and users' unreasonable expectations. To meet users' expectations, disclosed GHG emissions data and emissions reduction targets related information needs to be complete, consistent, timely, accurate, reliable and comparable.

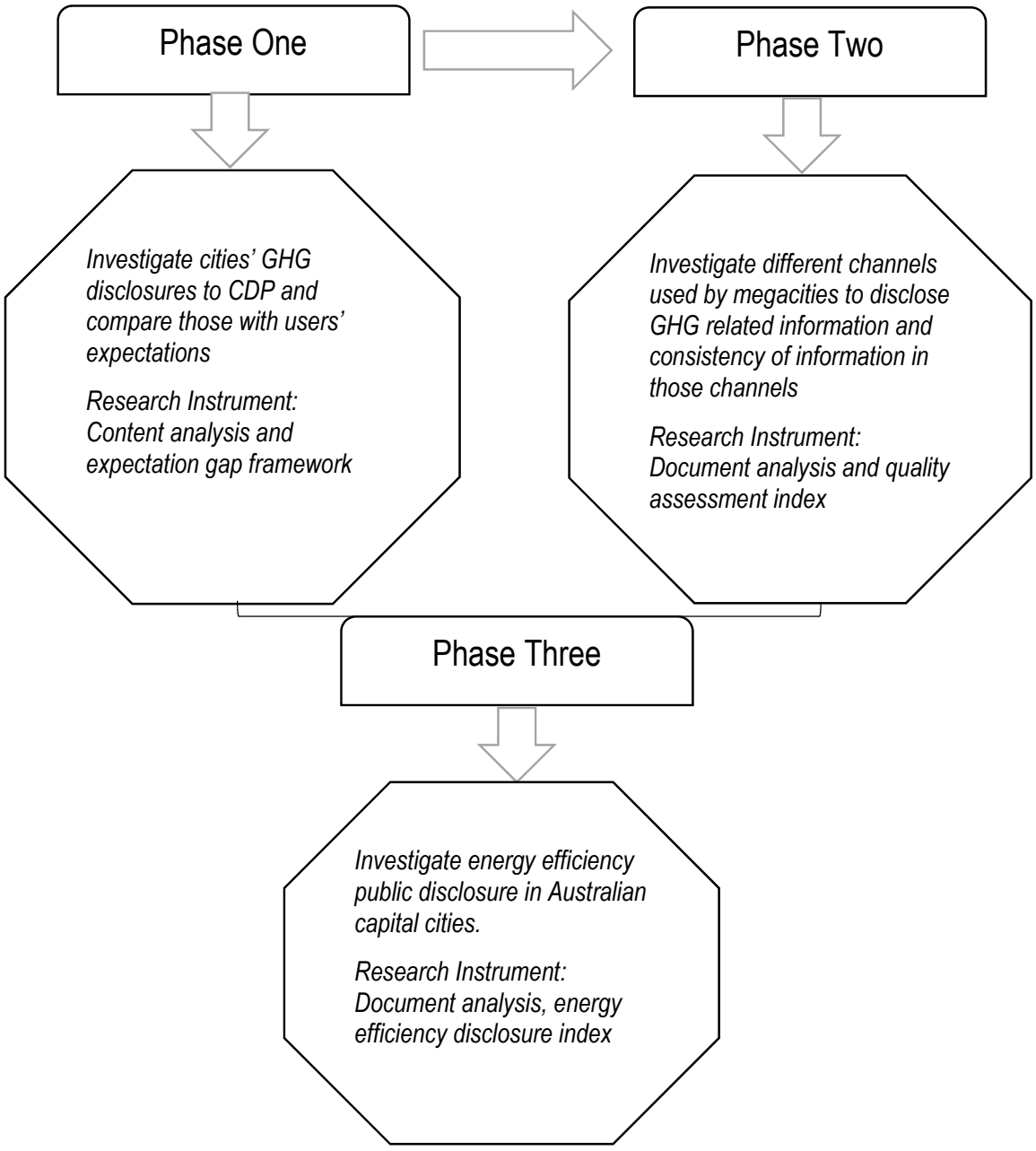

Figure 1.1: Three papers of the thesis study representing the objectives and methods

Paper 1 reveals that several cities did not disclose recent emissions data, did not disclose all seven greenhouse gases, omitted disclosure of Scope 3 emissions and, in some cases, Scope 2 emissions; and did not independently verify emissions data. In addition, there is inconsistency among cities in using protocols to calculate GHG emissions. Concerning emissions reduction targets, many cities set ambitious targets to reduce emissions. Examination of these disclosures revealed that there were differences in the baseline year, distorted application of percentages applied to the emissions sources and different targets and target dates among cities for emissions reduction. The study concludes that GHG emissions related information at the city level is outdated, incomplete, inconsistent, inaccurate and not comparable. This is the results of city authorities' deficient performance and the CDP's deficient guidelines. Therefore, GHG emissions related information may not be useful to decision makers or meet user expectations. There is room for significant improvement in the current GHG-related disclosure practices of cities by improving cities' performance and the CDP's guidelines. An important additional finding is that unreasonable expectations of users about comparable GHG emissions information also contributed to expectation gap as each city is materially different. The key implication is that the disclosure of *actions* to reduce emissions and their impacts will be more useful for accountability and peer learning than just disclosure of aggregate emissions data.

1.5.1.2 Paper 2

Activities within cities are producing a significant amount of GHG emissions. Hence, city authorities have a responsibility to take actions to reduce emissions. In addition, there is a concern among the public generally that climate change action must be undertaken by governments (Plan International, 2018; Zhou, 2018). Cities have a role to play in responding to issues that matter to the community and to communicate their actions in

relation to those issues. Paper 1 investigation of cities' GHG disclosures to the CDP showed that many cities have developed their emissions inventory and set emissions reduction targets (ERTs). GHG emissions inventories for cities are an excellent first step, but reduction of GHG emissions is not going to happen without actions. Therefore, cities also need to take actions and measure emissions reductions from those actions.

Paper 2 (Mia et al., 2018) extends the research in Paper 1 by investigating ten megacities' disclosure about emission reduction actions and explores three research questions: What communication channels are used by world megacities to disclose their emissions reduction targets and actions? Are these targets and actions communicated consistently across different channels? What is the quality of the actions disclosed in different channels? Understanding cities' emissions reduction targets and actions would help city authorities and policymakers better manage emissions. Document analysis was conducted to examine what channels city authorities used to disclose information and to assess the consistency of disclosed information among the multiple channels. A quality index was developed and used to evaluate the quality of the disclosed information relating to emissions reduction actions.

Findings of Paper 2 highlight that city authorities are undertaking multiple emissions reduction actions such as energy efficiency initiatives. They are using their own communication channels such as websites, sustainability disclosure and third-party channels, such as the CDP, to disclose emissions reduction targets and actions related information. Several cities have social media accounts with many followers. However, the use of social media to disclose GHG related information is limited. Regarding the consistency of disclosed information, cities' information about targets is consistent across

the multiple channels, but around half of the disclosed emissions reduction actions information between the third party and cities' channels is not consistent. Quality of the disclosure of emissions reduction actions also seems to be poor as mainly narrative information is provided.

1.5.1.3 Paper 3

Paper 3 (Mia et al., 2019b) extends the work of Papers 1 and 2 by investigating the public disclosure practices concerning one of the most important emissions reduction actions - energy efficiency - in the context of Australia's eight capital cities. Paper 1 highlighted that cities' GHG emissions primarily come from energy consumption. Paper 2 indicates that city authorities are taking energy efficiency measure along with other actions to reduce GHG emissions. Cities have enormous potential to save GHG emissions through energy efficiency measure as two-thirds of the total global energy consumption occurs in cities (Yoon et al., 2017; IEA, 2008; 2017). Energy efficiency initiatives are one of the most cost-effective emissions reduction measures and can save one-third of GHG emissions (Magill, 2014; Yoon et al., 2017). Policymakers, city authorities and other stakeholders require comprehensive and systematic data collection on city energy use to identify policy options and evaluate their potential impact. A robust accounting system can help to measure the energy consumption and impact of energy efficiency programs and disclose relevant information that has the potential to help internal and external stakeholders in their decision making, encouraging investment in energy efficiency projects and also promoting transparency (Dagiliene et al., 2014). Therefore, the objective of this paper is to examine cities' energy efficiency related accounting and disclosures practices. An energy efficiency disclosure index was developed to analyse the extent of cities' calculative and disclosure practices in relation to energy efficiency measures and projects. Paper 3 concludes that

Australian capital cities have provided limited information and typically in narrative form making it difficult for stakeholders to assess the effectiveness of their energy efficiency projects from an economic and environmental perspective. The implications of these findings are that standardised and mandatory reporting requirements for energy efficiency related initiatives and projects can facilitate more a comparable and transparent information for stakeholders.

1.6 Research Methods

The objective of this thesis is to explore the accounting and reporting practice of cities' GHG emissions and activities to reduce GHG emissions. As part of the investigation several cities were selected, and relevant documents were examined to understand cities accounting and reporting practices in relation to GHG emissions inventory and activities to reduce GHG emissions. This thesis includes three papers and document analysis has been the primary research method.

1.6.1 Document Analysis as a Qualitative Research Method

Document analysis is a form of qualitative research method where researchers undertake a systematic procedure for reviewing or evaluating both printed and electronic documents to give voice and meaning around an assessment topic (Bowen, 2009). Documents can be in the form of advertisements; agendas, attendance registers, and minutes of meetings; manuals; background papers; books and brochures; diaries and journals; event programs; letters and memoranda; maps and charts; newspapers press releases; program proposals, application forms, and summaries; radio and television program scripts; organisational or

institutional reports; survey data; and various public records (Bowen, 2009). Web-based document analysis is also getting popular in exploring sustainability disclosure as the web is becoming a critical tool for disseminating information (Centobelli et.al., 2017). As a research method, document analysis is applicable to qualitative studies in particular, as it produces rich descriptions of a single phenomenon, event, organisation, or program (Stake, 1995; Yin, 1994). Document analysis can help researcher to uncover meaning, develop understanding, and discover insights relevant to the research problems (Merriam, 1988). Document analysis can be used as a stand-alone research method or as a complement to other research methods (Bowen, 2009; Lodhia 2018). A large number of prior studies which explored sustainability disclosure have used a form of document analysis (Niemann and Hoppe, 2018). Several prior qualitative research studies relied solely on document analysis (Wild et.al., 2009; Ceulemans et al., 2015; Veltri and Silvestri, 2015). Thus, this thesis used document analysis as a research method.

Document analysis involves skimming, reading, thorough examination, and interpretation. This iterative process combines elements of content analysis and thematic analysis. Content analysis is the process of organising information into categories related to the central questions of the research. This analysis is a rigorous process for document analysis (Ceulemans et al., 2015). It entails a first-pass document review, in which meaningful and relevant passages of text or other data are identified. Thematic analysis is a form of pattern recognition within the data, with emerging themes becoming the categories for analysis (Fereday and Muir-Cochrane, 2006). However, this study only focused on content analysis as part of the document analysis.

A detailed planning process was developed as suggested by researchers before taking the actual document analysis to ensure reliable result (Centobelli et.al., 2017; O'Leary, 2014; Bowen, 2009). This plan involved creating a list of documents and texts to explore, searching relevant documents, manual and computer assisted analysis to identify relevant information, considering strategies for ensuring credibility of collected information. Indeed, a wide variety of documents was used, but prior studies suggest the focus should be more about quality of the document rather than quantity (Bowen, 2009). So, priority was given to understanding quality in relevant documents. Bowen (2009) suggests considering the original purpose of the document, the reason it was produced, and the target audience before beginning the document analysis. This study explores cities' GHG emissions, emissions reduction plans and activities related to reduction of GHG emissions. Hence, this study first identified several relevant documents that may contain information related to GHG emissions, emissions reduction plan and activities related to reduction of GHG emissions. CDP cities' reports exclusively focus on cities' climate change strategies including the measurement of GHG emissions inventory, emissions reduction strategies and cities' emissions reduction activities; thus, CDP cities' reports become a natural choice of document analysis. In addition, cities' annual and environmental reports, climate change related documents, social media posts and website were also considered. A reliability test was also performed.

1.6.2 Reliability of Document Analysis

A reliability test is important for document analysis. This test helps to ensure that collected data are reliable for a particular study. As there is no universal framework to conduct a reliability test, different researchers use different criteria to assess reliability (Rust and

Cooil, 1994). Bryman and Bell (2011, p. 157) state that reliability is "fundamentally concerned with the issues of consistency of measure". A study can be assumed as reliable when using same technique on same data can repeatedly provide same result. Krippendorff (1980) suggested three ways to check reliability issues which are stability, reproducibility and accuracy.

Stability is also known as intra-rater reliability means the same coder will get the same results try after try (Stemler, 2001). Hence, a coder will receive same data in two different times and the same result. Stability is achieved when coding differences are insignificant from the first coding to the second or third coding. However, differences sometimes can exist due to carelessness, ambiguities in the test or the role of coding (Krippendorff, 2012). In this study, the author performed a test and re-tested for six set of 2015 CDP reports and five sets of annual reports for 2015 and three cities social media post related to emissions reduction activities by applying the same procedures consistently. The re-test was conducted two weeks after the first test which resulted no significant difference between two sets of results. However, stability is the weakest form of reliability; thus, it is insufficient to use this as the sole criterion for reliability of the content analysis process (Krippendorff, 2012). So, this study also uses reproducibility measurement.

Reproducibility or inter-rater reliability means that the same text being coded in the same category by different people (Stemler, 2001). Hence, two or more independent coders can reproduce the results independently applying the same recording approach from the same data set. When the results of two independent coders are the same or no significant difference exists, then the content analysis technique can be assumed to be reliable. It is a stronger measure of reliability than stability (Krippendorff, 2012; Weber, 1990). Two or

more independent coders can choose the same documents such as an annual report and follow the same data recording approach to get the same data and results independently.

In this study, two independent individuals collected the data and produce the results as part of the reproducibility test. First, the author collected the data from five CDP reports and annual reports. The author then sent the same five CDP reports and annual reports to the second individual and specified which data need to be recorded and how it should be recorded. After that, the second individual, who is a university lecturer, recorded the data related to GHG emissions inventory and emissions reduction activities from the same data source by following the author's instruction. Later on, the collected data sets from both the first and second individual were checked. Milne and Adler (1999, p. 239) urged that coefficient of agreement is the simplest measure of reliability. Holsti's formula (Holsti, 1969, p. 140) of coefficient of reliability is:

$$\text{Reliability} = 2M / (N1 + N2)$$

M is the number of cases individual is agreed. N1 is the number of cases the first individual coded and N2 is the number of cases the second coder coded. Using the above formula to calculate the reproducibility gives the result of 85 per cent agreement. Setting an acceptable level of reliability is a problem (Holsti, 1969, p. 142). However, several studies suggested more than 80 per cent agreement between two individuals can be consider as an acceptable level (Hackston and Milne, 1996; Milne and Adler, 1999).

Accuracy is another reliability test that compares the preset standard with coder performance. According to Milne and Adler (1999, p. 239), "accuracy measure of reliability involves assessing coding performance against a predetermined standard set by a panel of experts or known from previous experiments and studies". This can be done

when objective standards are readily available. Hence, accuracy is hardly used in reliability assessment (Krippendorff, 2012; Weber, 1990). Therefore, most of the studies used reproducibility to test reliability. As there is no objective standard available, this study takes the stability and reproducibility measurements to test the reliability. Similar to other qualitative research methods, document analysis has both advantages and limitations.

1.6.3 Advantages and Disadvantages of Document Analysis

The document analysis research method has several advantages to researchers. First, document analysis is an efficient and effective way of gathering data because documents are manageable and practical resources. Second, many documents are in the public domain and easily accessible. They are also reliable source of data. Third, obtaining and analysing documents is often far more cost efficient and time efficient than other research methods (Bowen, 2009). Fourth, documents are stable, "non-reactive" data sources, meaning that they can be read and reviewed multiple times and remain unchanged by the researcher's influence or research process (Bowen, 2009, p. 31).

However, this method has several limitations. First, if there is a large number of documents, it can be expensive, labour intensive and time consuming when a human is collecting data (Gray. et al., 1995). Second, documents are produced for some specific purpose other than research. Hence, documents do not provide sufficient detail to answer a research question (Bowen, 2009). Some documents may not provide useful data or sometimes limited data. Other documents may be incomplete, or their data may be inaccurate or inconsistent. However, if a researcher has a clear plan regarding document

analysis, given its efficiency and cost-effectiveness in particular, it offers advantages that clearly outweigh the amount of issues that may arise (Bowen, 2009).

1.6.4 An Overview of Research Method of Three Studies

An overview of the research methods of this study is provided below and full details are in the three papers.

Paper 1 selected C40 cities that publicly disclosed their community-level GHG emissions and reported their various emissions-related information in English. Of the 83 cities in the C40 network, 24 did not make any disclosures, four cities responses were not accessible to the public, 12 did not include community-level GHG emissions information and one was not in English, leaving 42 cities as the final sample for this study. Content analysis was used to gather and assess the climate change related information from the 42 sample cities' responses to the CDP. Content analysis as a research method is frequently used in SEA research to explore the extent and quality of social and environmental disclosure (Ali et al., 2017).

As this paper is interested in information disclosed to the CDP, the CDP's 2015 questionnaire was reviewed to analyse cities' GHG emissions inventory and emissions reduction targets related information. Cities' responses include how they calculate their emissions, the guideline used to calculate total emissions, number of GHGs and types of emissions. The scopes of disclosed emissions inventories were recorded in a Word and Excel file for each city. Whether sample cities verified their disclosed emissions data was

also checked. After gathering all the information on emissions inventories, the information relating to targets was collected.

GHG emissions reduction targets' disclosures were analysed by exploring whether each city had set a target and, if so, the level of emissions reduction, the baseline used for the targeted reduction, the period to achieve the reduction, and which sources of emissions are to be reduced were recorded in a Word and Excel file for each city.

After collecting relevant information, the "expectation gap" framework was used to assess whether cities' disclosed information to meet user expectations on climate change disclosures. As there is no evidence as to what climate change information users expect from cities; this paper draws on prior disclosure studies, standards setters' guidelines for disclosures and several CDP data users to establish that users expect complete, consistent, timely, accurate, reliable and comparable information. These features were assessed through an expectation gap framework. The research method employed in this stage is detailed in Chapter 4.

Paper 2 continued the research from Paper 1. Paper 1 only investigated information disclosed through the CDP, whereas Paper 2 explored what other channels cities are using to disclose emissions-related information, in particular, emissions reduction targets and actions information. Consistency and quality of the disclosed information through different channels were also explored. Ten C40 cities were selected randomly from 42 C40 cities used in Paper 1 to investigate cities' emissions reduction targets and actions information thoroughly. These ten cities were selected based on several criteria, such as the cities' mayors have committed to take action to reduce emissions, the cities have already set their

targets to reduce emissions and the cities are in an English speaking country (with the exception of Stockholm). A literature review was conducted to identify the different channels organisations use to disclose sustainability information. Several popular channels are annual reports, sustainability reports, websites, social media, policy documents, the CDP and so on. This study categorised various disclosure media into three communication channels: 1) own channel; 2) third-party channel; and 3) social media.

Several keywords, such as climate, carbon, emission, target, greenhouse, GHG, energy efficiency, waste, solar and renewable were used to identify GHG related sections and information in different channels. Then the emissions reduction targets and actions related information was collected from these channels and assessed as to whether cities had provided similar information via all three channels. A quality index was constructed to evaluate the disclosed information in relation to emissions reduction actions, following prior studies (Brammer and Pavelin, 2008; Cormier and Gordon, 2001; Cormier et al., 2005; Wiseman, 1982). Cities' emissions reductions actions were searched from each selected channel and awarded scores (maximum 3) to each action based on the details have been provided for that action. After scoring each all the selected actions for each communication channel, and then aggregated these scores to get the total points for that channel. The points for each channel were then aggregated to obtain the total score for each city. For each action, a point was awarded if a city disclosed an action with some details. While it is essential to understand what actions cities are taking to reduce emissions, this information will have little value unless the impact (amount of emissions reduction) of that action and the cost of implementing that action is also known. Hence, a second point was awarded if the amount of emissions reduction was disclosed for an action. A third point was awarded if cost was also disclosed. As a result, if a city disclosed five

actions through a particular communication channel, the maximum quality scores that city could achieve is 15 (3 scores X 5 actions) for that communication channel. Details of every selected action for ten cities were examined for the three channels, and the score was awarded based on the information provided through each channel. The individual score was added up to get the total quality score for each city for their disclosed emissions reduction actions. The research method employed in this stage is further detailed in Chapter 5.

Paper 3 extends Papers 1 and 2, which indicated that cities are measuring and disclosing their total emissions and they have enormous potential to reduce those emissions. However, Paper 1 does not identify what actions cities are taking to reduce their emissions and to reach emissions reduction targets. Paper 2 identified that cities are taking multiple actions to reduce emissions. Paper 3 selected one particular action – the energy efficiency measure – and explored the calculative and disclosure practices of this measure in detail. This study used the Australian capital cities of Sydney, Canberra, Melbourne, Brisbane, Perth, Adelaide, Darwin and Hobart. Australian cities were selected to explore energy efficiency disclosure as the energy issue has been a dominant theme in Australia over the last several years. Energy and climate change have been debated in Australia and are a factor in political uncertainty (Financial Times, 2018). This issue is a significant concern for both business and citizens, who demanded actions to tackle this issue (Hunt, 2017; McDonald, 2018). The Australian economy is highly dependent on energy that primarily comes from fossil fuels, which are the main contributors to GHG emissions. These eight capital cities are the main engine for the Australian economy. So, these cities are critical in reducing GHG emissions through energy efficiency measures.

Since there is no prior disclosure index in previous studies to explore the quality of energy efficiency disclosures, this study developed a disclosure index. To understand the types of information users want to assess or evaluate a particular energy efficiency project, several documents (e.g., energy efficiency guidelines, energy efficiency evaluation reports, scholarly articles, GRI and CDP framework) were analysed.

The disclosure index developed evaluates both narrative and quantified (financial and non-financial data) information as well as historical and forward-looking information. After developing the disclosure index, it was sent to an energy efficiency expert for his feedback. The expert's comments were incorporated before finalising the energy efficiency disclosure instrument.

Once the final disclosure instrument was developed, document analysis was conducted to check whether any item listed in the disclosure index was disclosed in the cities' website and documents. Several documents, such as the annual report, sustainability reports and climate action plan, were reviewed to identify the information listed in the index. The research method employed in this stage is detailed in Chapter 6.

1.7 Contributions of the Thesis

This research makes several contributions to the SEA and disclosure literature. First, this research has responded to calls to explore disclosures beyond the corporate level (Gray, 2010; Gray and Milne, 2004). It is evident from the existing literature that prior SEA studies have focused predominantly on the corporate sector (Ball et al., 2014). However, corporate level accounting has failed to address the wider implications of sustainability

from a regional perspective (Dumay et al., 2010). While accounting reports indicate that corporations have significantly contributed to the wealth creation and other positive outcome, they are also responsible for the damage of social, psychological, spiritual and environmental health which are generally not accounted and reported. Corporate sustainability reporting has been seen as enhancing public image and economic gain rather than their sustainability performance (Adams, 2002; Milne and Gray, 2007; Milne et al. 2009). As sustainability is a global issue, it needs to be explored at the global and regional level (Hazelton, 2013). This thesis explores one of the sustainability issues, GHG emissions, at a regional level by exploring accounting and disclosure of GHG emissions at the city level.

Second, the thesis extends the application of an expectation gap framework, which has primarily been used in the auditing literature (Porter, 1993; Ruhnke and Schmidt, 2014; Fisher and Naylor, 2016), to the SEA literature. This expectation gap framework can help to understand users' information needs and find ways to reduce the expectation gap if it exists.

Third, prior studies in the public sector have mainly focused on annual reports and sustainability reports to explore social and environmental disclosures (e.g., Guthrie and Farneti 2008; Williams and Wilmshurst, 2011; Maria and Rodrigues, 2019). This study advances the prior literature by including three different forms of disclosure platforms, that is, own channels, third-party channels and social media channels, to explore GHG emissions related disclosure. As the use of social media is increasing, there is a call for exploring social and environmental disclosures in social media (Lodhia and Stone, 2017). This research responds to that call.

Fourth, prior studies in climate change mainly focus on total emissions reported by organisations and few of them explored the quality of the disclosed emissions data (Andrew and Cortese, 2011b; Kolk et al., 2008). There have also been limited disclosure studies exploring what particular organisations are doing to uphold their commitment or promises or to solve specific problems or challenges, such as GHG emissions. This study conducts a detailed analysis of the disclosed emissions that identifies several issues associated with disclosed emissions data. In particular, this study develops and deploys an index to evaluate the quality of the disclosure of emissions reduction actions via energy efficiency measures.

Finally, this research responds to calls for more research using CDP data (Andrew and Cortese, 2011b; Kolk et al., 2008). Also, it responds to calls for exploration of SEA issues, including disclosures and communication at the city level (Crutzen et al., 2017). Moreover, there is an argument that the objectives of the public sector often align with sustainable development objectives and researchers need to explore sustainability disclosure by the public sector (Ball and Bebbington, 2008; Guthrie et al., 2010). There has been limited focus on the public sector in relation to exploring social and environmental accounting and disclosure. This study explores influential public sector organisations– city governments' sustainability disclosure.

1.8 The Format of the Thesis

This thesis consists of seven chapters. This chapter outlines the thesis background, the objectives of the research, a summary of the three research papers, the method used to

analyse the data and the contributions of the research. Chapter 2 provides context for the thesis by discussing cities' contribution to GHG emissions and the role city authorities play in mitigating GHG emissions by setting up targets and undertaking actions. Chapter 2 shows the way cities' activities contribute to global GHG emissions and also explains why cities are critical in tackling climate change. Chapter 2 also argues that the city is an important unit of analysis to explore climate change and GHG emissions. As a robust and transparent accounting system is important to manage emissions, Chapter 2 also provides a brief discussion of the development of accounting and reporting guideline for cities' GHG emissions, the result of which is *the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)*. Chapter 2 concludes by describing city-level emissions measurement requirements as per the GPC.

Chapter 3 provides an overview of relevant environmental accounting and corporate sustainability disclosure research. Chapter 3 then discusses the prior sustainability disclosure literature in relation to the public sector, followed by a review of prior literature in GHG emissions and its associated climate change-related disclosure practices by organisations. Based on this review, Chapter 3 highlights the lack of public sector research, in particular, city level climate change-related disclosure practices, and what information stakeholder groups perceive cities should disclose about their GHG emissions and associated actions to reduce emissions.

Chapters 4, 5 and 6 comprise the three empirical studies which form the body of the thesis. Each chapter is in the form of a published research paper and includes the background of the particular research stage, theories, the research methods (including data collection and analysis method), results, discussions and conclusions. Chapter 4 focuses on cities' GHG

emissions-related disclosure practices and stakeholders' expectation. Chapter 5 focuses on the different channels cities use to disclose their emissions reduction targets and actions, and the consistency and quality of the disclosed information. Based on the results of Chapters 4 and 5, Chapter 6 focuses on one important action (i.e., energy efficiency) to reduce emissions in detail and explores the calculative and disclosure practices of this action.

Chapter 7 provides a conclusion to the study that includes the implications of the research. Research limitations are outlined, followed by further potential research within this area.

Chapter 2: Cities Lead Climate Change by Mitigating GHG Emissions

2.1 Introduction

Cities are the hub of global communication, commerce and culture. Simultaneously, they are also a significant and growing source of energy consumption and GHG emissions (Fong et al., 2015). Cities' consumption generates more than 70% of global energy-induced emissions (Dahal and Niemelä, 2017). Cities are economic stimulators and home for more than half of the world's population; more than 70% of the world's population will live in cities by 2050 (Adams, 2013). At the economic level, the world's 50 largest cities alone have a combined gross domestic product (GDP) of $9.6 trillion, more than all of China, and 75 megacities contribute to 25% of the world's GDP (World Bank, 2010). In the case of Australia, more than 80% of people are already living in urban areas (Adams, 2013). UN-Habitat (2012) estimates that around 200,000 people on average every day moved to cities between 2010 and 2015. Population and economic activities are rapidly increasing in cities, and there is a link between population growth, financial operations and GHG emissions (Hoornweg et al., 2011). The IPCC identifies economic and population growth as being the most important drivers of increasing CO_2 emissions from fossil fuel combustion (IPCC, 2015, p. 8).

Cities will require more energy, industry, transport and buildings for their growing population and economy. Annual anthropogenic GHG emissions from 2000 to 2010 have increased by 10 $GtCO_2$ eq, which directly contributed to energy supply (47%), industry (30%), transport (11%) and building sectors (3%) (IPCC, 2015). Cities meet "approximately 72% of their total energy demand from coal, oil, and natural gas—the main contributors to greenhouse gas emissions" (World Bank, 2010, p. 18). The top ten GHG emitting cities produce GHG emissions nearly equal to all those of Japan, and the 50 largest cities together rank third in both population and GHG emissions when compared to the

most extensive and wealthiest countries (World Bank, 2010). Thus, cities are significant sources of the GHG emissions accelerating climate change.

Although many sources suggest that cities are responsible for 75 to 80 per cent of all GHG emissions, cities may not be *directly* responsible for that significant amount of GHG emissions (Dodman, 2009). Therefore, consideration needs to be given before blaming cities and taking actions in reducing emissions. Agriculture, deforestation, heavy industries, fossil-fuelled power stations and high-consumption households that are not located in cities may all be significant sources of GHG emissions (Satterthwaite, 2008). The GHG emissions of cities would be higher if the emissions are measured based on the location of the person or institution who consumes them rather than where they are produced, however (Satterthwaite, 2008). There is a debate in the literature regarding which accounting approach **(**production based - PB vs. consumption based - CB) to choose to measure city-level GHG emissions (e.g., Afionis et al., 2017; Gavrilova and Vilu, 2012; Wiedmann et al., 2016). The difference can have a significant impact in compiling cities' emissions inventory (Afionis et al., 2017). For instance, Chen et al. (2017) found that more than 50% of the total carbon footprint for Sydney and Melbourne are from imported emissions. Dodman (2009) highlighted that in the UK, larger cities had lower per capita emissions than the national average and significantly lower footprints than citizens of smaller rural cities. This is typical of the PB approach as it fails to recognise and address the emissions generated from the production of commodities in one geographical area (often smaller industrial towns) is generally created primarily to satisfy the demand for those commodities in other areas - usually larger cities (Afionis et al., 2017; Rauland and Newman, 2015). Hence, what GHG accounting method cities are using will have a significant implication in emissions reduction strategies. Current international guidelines

(the GPC) for accounting and reporting of GHG emissions inventory is based on the PB approach.

Complex issues are also involved when assigning GHG emissions to cities from transport, which is a major contributor to global GHG emissions. It would be misleading to allocate all transport related GHG emissions to the cities as they move frequently inside and outside cities (Dodman, 2009). Satterthwaite (2008) suggested that the CB approach would be fairer system for allocating GHG emissions between nations because all anthropogenic GHG emissions arise from the demand for goods and services (and the corresponding disposal of wastes). Hence, the focus should be given to consumption patterns when measuring and analysis the emissions of citizens regardless of where they live. However, it is difficult to produce an accurate figure as only few cities have detailed GHG emission inventories (Satterthwaite, 2008).

Regardless of who is producing GHG emissions, cities are highly vulnerable to climate change. Climate change poses substantial social, economic and environmental risks for cities, as well as severely affecting cities' built infrastructure and urban management systems (CDP, 2017). Infrastructure, such as roads, bridges, subway systems, buildings and historical and natural sites, are critical attributes of cities and for cities' economic and social activities. Climate change poses severe threats to cities' infrastructure, quality of life and entire urban systems (World Bank, 2010). The consequences of climate change-related events (e.g., sea level rise, extreme weather events, such as, storms, droughts, floods) are harmful to cities' essential services, housing, infrastructure, human livelihoods and health (Rosenzweig et al., 2010). Therefore, cities must play a critical role in combating climate

change. As cities, and the activities within them, are the primary contributors to global GHG emissions, this makes them key players in addressing climate change.

Contemporary cities are the birthplace of invention and innovation, and the powerhouse of regional development and innovative knowledge centres, as well as a central element in the new information and communication web (Czarniawska, 2002; Prado-Lorenzo et al., 2012). Cities are not only economic stimulators, but also "social, cultural and ecological motors for sustainable development" (Prado-Lorenzo et al., 2012, p. 34). Cities have the ability to re-design themselves and have the capacity to innovate and provide employment, health and education services. Their unique decision-making capabilities can dramatically affect not only population growth, but also the amount of energy and resources consumed and emissions produced, making them a dominant force in global GHG mitigation (Dhakal, 2010; Hoornweg et al., 2011).

Cities are considered to be a vital part of the global response to climate change (Dodman, 2009; Broto and Bulkeley, 2012). City authorities and local governments have the potential to implement mitigation programmes effectively, because of the type of responsibilities they hold in relation to land use planning, local public transportation and the enforcement of industrial regulations (Doadman, 2009, p.198). Moreover, cities are uniquely positioned to respond to sustainable development at the local level in a tangible way. Cities offer more immediate and effective communication between the public and decision makers than other groups (World Bank, 2010). City authorities have a democratic mandate from citizens to address issues that affect the city (Bulkeley, 2013) and have jurisdiction over many decisions that have an impact on GHG emissions at the local level. Cities represent high concentrations of private-sector actors with a growing commitment to act on climate

change (Bulkeley, 2013). All of the above suggest that cities are in a central position to take effective action to deal with global climate change. A city's ability to take effective action to mitigate climate change, and monitor progress, depends on having access to good quality data on GHG emissions (Fong et al., 2015).

The first and most fundamental step cities can take in tackling climate change is measuring GHG emissions and understanding their sources (C40, 2013; Fong et al., 2015). Credible and reliable GHG data allows cities to target their policies and programs more accurately in an effort to reduce emissions and ensure they get higher returns for their investment (C40, 2013). It is also crucial that cities monitor their emissions over time, so that they can track progress, evaluate performance and communicate findings to citizens and other stakeholders.

Although the amount of GHG emissions from a single city are small compared with national-level emissions, but as a group they are significant. Hence, city-level strategies support and complement national GHG reduction goals and fulfil local climate mitigation and adaptation responsibilities (Dahal and Niemelä, 2017). Thus, cities should adopt robust and transparent GHG emissions accounting systems in order to plan strong and effective climate goals. There are several institutional actors have been helping cities around the world against climate change by providing supporting guidelines on emissions reduction activities and emissions calculation.

2.2 Key Institutional Actors in Climate Change Mitigations Initiatives

A number of international organisations, including C40 cities, The Compact of Mayors, Local Government for Sustainability and CDP have formed in an effort to orchestrate cities towards coordinated climate governance activities (Gordon and Johnson, 2017). As cities are a substantial source of GHG emissions, these networks are working with cities around the world to help cities to reduce GHG emissions to fight against climate change (Reckien et al., 2018). These international organisations have been playing an important role in cities' emissions reduction activities by providing guidelines related to emissions reduction actions, emissions reduction targets and emissions calculations. This section discusses several of their activities, programs and initiatives for cities.

C40 is a network of the world's cities committed to addressing climate change. The C40 network allows cities to collaborate effectively, share knowledge and drive meaningful, measurable and sustainable action on climate change (Lee and Van de Meene, 2012). The C40 network was created in October 2005 when Ken Livingstone, the mayor of London at that time, invited representatives from 18 cities to discuss collaborative measures to combat global warming (Román, 2010). Shortly thereafter, the C40 partnered with the William J. Clinton Foundation to use the newly created Clinton Climate Initiative (CCI) as the implementing partner of the C40. Through the CCI, the C40 engages in activities by providing expert assistance and technical help for cities; developing tools to measure GHG emissions; sharing of best practices; and creating financial instruments to increase access to climate-friendly technology (Román, 2010). C40 announced new partnerships in 2011 with the World Bank and ICLEI—Local Governments for Sustainability to accelerate climate action in cities through streamlined financing, GHG accounting and uniform reporting. The release of two reports developed in collaboration with the CDP and ARUP

(a multinational professional services firm), respectively, emphasised the critical role of measurement and transparency in tackling climate change in cities.

The C40 provides an example of how cities are organising themselves to confront global warming. Currently, around the world, C40 Cities connects over 80 of the world's greatest cities representing home for 700+ million citizens and one-quarter of the global economy. Their combined community GHG emissions represent 2.4 Gt of CO_2e (C40 2018). C40 cities' mayors are committed to delivering the Paris Agreement's goals at the local level.

The Compact of Mayors is the world's largest cooperative effort among mayors and city officials to reduce GHG emissions and climate risks in cities (C40, 2018). This international initiative was set up in 2014 at the United Nations (UN) Climate Summit by the UN Secretary-General and UN-Habitat in collaboration with the C40 Cities Climate Leadership Group (C40), the Local Governments for Sustainability (ICLEI) (Reckien, 2018). By establishing a common platform to capture the impact of cities' collective actions through standardised measurement of emissions and climate risk, and consistent, public reporting of their efforts, it provides evidence that cities are climate leaders, and that local action can have a significant global impact. The Compact of Mayors and the Covenant of Mayors announced the new Global Covenant of Mayors for Climate and Energy on 22 June 2016, to create meta-networks to accelerate the fight against climate change (Gordon and Johnson, 2017). Cities need to take action in three phases with requirements covering both climate mitigation and adaptation to be fully compliant with the Compact of Mayors (C40, 2018). The Compact of Mayors' cities and local governments are collectively expected to reduce 1.3 billion tons of CO_2 emissions every year by 2030. (Global Covenant of Mayors, 2019).

ICLEI – Local Governments for Sustainability, founded in 1990 as the International Council for Local Environmental Initiatives, is a global network of cities, towns and regions committed to building a sustainable future (Evans, 2013). This network has more than 1,750 local and regional governments who are committed to sustainable urban development (ICLEI, 2019). ICLEI work collaborates with local and city governments to influence sustainability policy and drive local action for low emission, nature-based, equitable, resilient and circular development. ICLEI helps cities, towns and regions anticipate and respond to complex challenges, from rapid urbanization and climate change to ecosystem degradation and inequity. ICLEI forges strategic alliances with international organizations, national governments, academic and financial institutions, civil society and the private sector to help cities, towns and regions of all sizes to reach their ambitious targets by advocating national and global sustainability policies that reflect the interests of local and regional governments and their communities. ICLEI is engaged in hundreds of activities in more than 3,500 cities, towns and regions worldwide (ICLEI, 2019).

A common goal among these international networks is to help cities to track their GHG emissions and to suggest actions to reduce GHG emissions. However, there is no common standardised guideline for cities to calculate and track their GHG emissions. Although the ICLEI was one of the first organisations to publish guidelines for accounting and reporting GHG emissions from city boundaries, other international organisations such as UNEP, the World Bank, Compact of Mayors, C40 and CDP have also offered various climate change and GHG measurement tools and programs for cities and communities over the years (Ibrahim et al., 2012; Rauland and Newman, 2015). The ICLEI, C40 and Compact of Mayors take CDP as a disclosure platform for cities GHG emissions and actions that

encourage cities to render their characteristics, ambitions, activities and effects transparent to global publics. The development for accounting and reporting guidelines for cities GHG emissions will be discussed in following section.

2.3 Initiatives to Develop a Guideline for GHG Emissions Accounting and Reporting

Guidelines for measuring and calculating GHG emissions for the national, city and corporate level started to be developed in the 1990s, soon after the publication of the First Assessment Report published by the Intergovernmental Panel on Climate Change (IPCC). The IPCC first provided significant scientific evidence that human activities are substantially increasing the atmospheric concentrations of GHG resulting in the acceleration of climate change. The Second Assessment Report of the IPCC (SAR) in 1995 published a significant report on the Guidelines for National Greenhouse Gas Inventories, which were completed and amended several times (Ibrahim et al., 2012). The IPCC guideline is the internationally recognised inventory methodology for calculating country-level GHG emissions and countries are required to disclose their emissions through the UNFCCC using this guideline (Ibrahim et al., 2012; Peter et al., 2016).

There is also a consensus among city mayors, urban leaders, businesses and civil society that city administrations need to act to reduce the impacts of climate change (Ibrahim et al., 2012). While some emissions physically occur within cities' political boundaries (e.g., transport emissions, fossil fuel combustion for heating, etc.), several emissions are released outside the city boundary and are a direct result of cities' activities (e.g., electricity generation and waste decomposition) (Ibrahim et al., 2012). Hence, cities and their

agencies have made several attempts to develop a guideline for measuring GHG emissions inventories.

One of the first organisations to embark on city-level GHG emissions accounting was the International Council for Local Environmental Initiatives (ICLEI), which began in the early 1990s (from 2003 known as Local Governments for Sustainability). In 1993, the ICLEI initiated the first campaign (Climate Protection campaign – CCP) to quantify and reduce GHG emissions in cities. It also aimed to support smaller cities' climate action planning (Rauland and Newman, 2015). Larger cities were subsequently engaged in other international campaigns, such as the C40 Cities and CDP Cities (CDP, 2017).

The ICLEI was one of the first organisations to publish the Local Government GHG Analysis Protocol (Rauland and Newman, 2015; Wiedmann et al., 2016). Several other international organisations (e.g., UNEP, UN-Habitat, World Bank, WRI and WBCSD) also undertook important developments in the field, and other important joint initiatives (e.g., Compact of Mayors, C40 cities) have offered various climate change and GHG measurement tools and programs for cities and communities over the years (Ibrahim et al., 2012; Rauland and Newman, 2015).

Having many guidelines allows different cities to use different ways to calculate GHG emissions. While this means that cities can choose the best way to calculate their emissions, it also has some disadvantages. Prior studies suggest that there is inconsistency in using GHG guidelines between cities to calculate their emissions (Andrew and Cortese, 2011b; Kolk et al., 2008). The use of different guidelines can change the amount of disclosed total emissions significantly. Moreover, variations in guidelines do not allow comparability of

an entity's emissions. It can also prohibit policy coordination among cities. Dhakal (2010) notes that having a common guideline for GHG accounting could improve the reliability of emissions comparisons and may generate a more accurate understanding of cities' contributions to global emissions. It is also difficult to identify best practices and policies if there is no comparative analysis between cities (Sovacool and Brown, 2010). The abundance of initiatives and significant overlap between GHG guidelines has led different organisations to come together and develop common GHG accounting guidelines for communities and cities called the Global Protocol for Community-Scale GHG Emissions (GPC). This is the work of organisations such as the World Bank and the C40 Cities ICLEI.

A version of the GPC was published in December 2014. It is the result of a collaborative effort among multiple organisations, including the WRI, C40, ICLEI, World Bank, UNEP and UN-HABITAT. The GPC is built upon the "worldwide-used IPPC guideline, which provides detailed guidance on data collection and calculation of GHG emissions, and it divides emission sources into scopes and sectors that have been globally adopted" (Andrade et al., 2018, p. 796). The GPC has been accepted by many substantial climate change initiative programs, including the Compact of Mayors, the Carbon Disclosure Project (CDP) reporting platform, the British standard PAS2070 and C40 Cities (Andrade et al., 2018; Mia et al., 2018). This GPC guideline will provide better comparability of emissions between cities and increase the integrity of local government information (Rauland and Newman, 2015).

The GPC requires cities to measure and disclose a comprehensive GHG emissions inventory. This guideline suggests two distinct but complementary approaches to these emissions. One captures emissions from both production and consumption activities taking

place within the city boundary, including some emissions released outside the city boundary, while the other categorises all emissions into "scopes", depending on where they physically occur (Fong et al., 2015). The GPC guideline provides direction regarding collecting data and calculating cities' total GHG emissions. The guideline has several principles similar to other accounting reporting guidelines such as IFRS, GRI and IR so that disclosed information can help stakeholders in their decision-making process. The following section provides a brief overview of the GPC framework.

2.4 Accounting and Reporting of GHG Emissions – the GPC

The GPC offers cities and local governments an international framework to identify, calculate and disclose their GHG emissions inventory (Fong et al., 2015). This includes emissions released within city boundaries as well as those occurring outside them as a result of activities taking place within the city. The GPC establishes emissions accounting and disclosure practices that support cities in developing an emissions baseline, setting mitigation goals, creating more targeted climate action plans and tracking progress over time, as well as strengthening opportunities for cities to partner with other levels of government (Fong et al., 2015).

Similar to financial reporting principles, the GPC accounting and reporting for city-wide GHG emissions has established five principles to represent a fair and true account of cities' GHG emissions. Accounting and reporting of GHG emissions information need to be relevant, complete, consistent, transparent and accurate (Fong et al., 2015).

The GPC requires cities first to define an emissions inventory boundary that includes physical or geographic area, time span, gases and emission sources (Fong et al., 2015). The physical boundary can be the administrative boundary of a local government, a ward or borough within a city, a combination of administrative divisions, a metropolitan area or another geographically identifiable entity (Fong et al., 2015; Sovacool and Brown, 2010). Regarding time span, the GPC is designed to account for GHG emissions in a single reporting year. The inventory must cover a continuous period of 12 months, ideally aligning to either a calendar year or a financial year, consistent with the time periods most commonly used by the city. Concerning GHGs, cities are required to include emissions of the seven gases covered by the Kyoto Protocol: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3. Cities also need to include emissions from six main sectors, including stationary energy, transportation, waste, industrial processes and product use (IPPU), agriculture, forestry and other land use (AFOLU) and any other emissions occurring outside the geographic boundary as a result of the city's activities (collectively referred to as Other Scope 3). A city can generate GHG emissions that occur inside the city boundary as well as outside the city boundary and can be classified into three categories: Scope 1, Scope 2 or Scope 3 emissions. Scope 1 emissions consist of emissions from sources located within the city boundary, for example, emissions from the city's waste, in boundary transportations. Scope 2 emissions come from the use of electricity, steam and heating/cooling supplied by grids, which may or may not cross city boundaries. All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary are considered Scope 3 emissions. For Scope 3 accounting, the GPC includes a limited number of emissions sources, including transmission and distribution losses associated with grid-supplied energy, and waste disposal and treatment outside the city boundary and trans-boundary transportation.

The GPC does not require specific methodologies to be used to produce emissions data; instead it specifies the principles and rules for compiling a city-wide GHG emissions inventory. The GPC recommends, where relevant, using methodologies aligned with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Fong et al., 2015, p. 14). The GPC recommends that cities update their inventory on an annual basis using the most recent data available, to provide frequent and timely progress on overall GHG emissions.

The GPC does not require cities to verify their inventory results but recommends that cities choose the level and type of verification that meets their needs and capacity. Verification involves an assessment of the completeness and accuracy of reported data. Cities may want to verify their data to demonstrate that their calculations meet the requirements of the GPC and provide confidence to users that the disclosed GHG emissions are a fair reflection of a city's activities. This can be used to increase the credibility of publicly reported emissions information with external audiences and increase confidence in the data used to develop climate action plans, set GHG targets and track progress.

A GHG emissions inventory can be used as the basis for setting goals, tracking progress over time and developing emissions reduction strategies and actions. Setting reduction or mitigation targets can help cities to focus on crucial emission sources, identify innovative mitigation solutions, demonstrate leadership and reduce long-term costs (Boswell et al., 2010; Fong et al., 2015). Once the reduction target is established, mitigation actions to reduce the city's GHG emissions must be developed and adopted (Boswell et al., 2010). To assess whether or not mitigations strategies will be adequate to reach the target, they must be quantified. For example, estimating the emissions reduction that will result from

improved bicycle infrastructure requires assumptions, such as the percentage of the population that will change behaviour, the Vehicle Miles of Travel (VMT) reduction associated with the behaviour change, and the emissions resulting from the reduced VMT.

It is also important that cities monitor their emissions over time, so that they can track progress, evaluate performance and communicate findings to citizens and other stakeholders, which is used in their decision-making process (Andrew and Cortese, 2011a). However, for information to be useful it must be complete, consistent, timely, accurate, reliable and comparable (GRI, 2016; IASB, 2015; Nobes and Stadler, 2015).

2.5 Conclusion

Several international organisations and research articles suggest that cities are responsible for significant amount of GHG emissions (World Bank, 2010; Dahal and Niemelä, 2017). However, it could be argued that cities themselves are not responsible for significant amount of GHG emissions but the activities that taken place within the cities drive the significant amount of GHG emissions. Moreover, there is still a debate about methodological approaches (CB vs. PB) regarding calculation of GHG emissions which can significantly change many cities GHG emissions inventory. An international guideline (the GPC) which follow the PB approach has been introduced to measure and report GHG emissions from cities, there are still several limitations within the guideline that needs to be improved. There are limited verification processes that can allow cities to report misleading information. The GPC guidelines also do not provide sufficient information to measure some indirect (scope 3) emissions which could add significant amount of GHG emissions in their inventories. International bodies including ICLEI, C40, World Bank,

WRI are working on developing a comprehensive guideline for scope 3 emissions which will be added in the GPC guidelines (Fong et al., 2015). However, it appears that there has been limited focus on measuring and reporting of social, economic and environmental performance of individual emissions reduction actions.

Activities are taking place within the cities are responsible for climate change; hence, cities are also crucial to the climate change solution. They measure GHG emissions, disclosing such emissions along with their emissions reduction targets and actions. This data can help city authorities, citizens and other stakeholders to understand the city's current position and future strategies regarding climate change. GHG emissions accounting has also been the subject of extensive academic research, which is reviewed in the following chapter.

Chapter 3: Literature Review on Social and Environmental Accounting Research

3.1 Introduction

A growing interest in sustainability issues in society more widely has inspired scholarly investigation over the last 40 years (Ali et al., 2017; Deegan, 2017; Mata et al., 2018). SEA research has taken a range of perspectives with a considerable amount of research focusing on the analysis of sustainability disclosure (Mata et al., 2018). This aspect of the SEA literature proposes that more and more organisations are providing sustainability information, but the disclosed information is often incomplete, inconsistent, irrelevant, not comparable and unable to address the broader implications of sustainability (Abernathy et al., 2017; Dumay et al., 2010). Prior literature also indicates that sustainability disclosure through digital platforms is growing due to the rapid expansion of the internet (Joseph et al., 2014; Lodhia and Stone, 2017). However, concerns about reliability have been raised, as well as challenges identified relating to the assurance of the sustainability information (Isenmann et al., 2007). Central discussions found in the SEA literature include the utility of mandatory reporting, geographic versus legal reporting boundaries, new forms of reporting/social media and assurance (Isenmann et al., 2007; Milne and Gray, 2007; Dumay et al., 2010; Lodhia and Stone, 2017).

This chapter aims to provide a brief overview of sustainability research in general and climate change-related accounting research in particular. The chapter begins by defining social and environmental accounting and reporting and then reviews international literature related to climate change disclosures.

3.2 SEA Research

Accounting plays a critical role in furthering sustainable development and accounting researchers contribute by identifying, measuring and communicating their investigation of sustainability issues and the role of accounting (Ball and Bebbington, 2008; Bebbington et al., 2017; Bebbington and Unerman, 2018). This movement is known as accounting for sustainable development or sustainability accounting or SEA (Bebbington and Larrinaga, 2014). While studies from the accounting discipline exploring social and environmental accounting and reporting issues emerged in the 1960s (Dierkes and Preston, 1977; Gray et al., 1988; Guthrie and Mathews, 1985; Mata et al., 2018; Parker, 2011), and the field has grown considerably, consensus as to what is SEA research has yet to be achieved.

Deegan (2017, p. 66) defines the scope of SEA as the "preparation and capture of information to inform stakeholders (within and outside the organisation) about an organisation's impact on the societies and environments in which it operates (including, past, present, and future societies and environments)". Applying this definition, a historical analysis of existing literature shows that SEA became an active research field after 1970 (Gray and Bebbington, 2001). However, social and environmental reporting in companies' annual reports can be traced back to the 1900s (Deegan and Gordon, 1996; Guthrie and Parker, 1989). It is also apparent from prior research that environmental and ethical issues often were embedded within social reporting. Social, environmental and ethical disclosures continued to increase in the 1980s, but environmental issues started to gain prominence in the 1990s (Eugénio, 2009), leading many companies to focus more on environmental issues (Adams, 2004; Gray and Laughlin, 2012).

Contemporary organisations operate in a world where government and stakeholders demand transparency and accountability (Fernandez-Feijoo et al., 2014; Milne and Gray, 2007). Stakeholders expect transparency and accountability in relation to environmental, social and governance factors and other non-financial matters through the disclosure of information (García-Sánchez et al., 2013; PWC, 2015). Both the number of organisations providing sustainability information and the volume of information has increased, as has academic research into sustainability disclosure, over the last several years (Ali et al., 2017; Deegan, 2017; KPMG, 2017; Mata et al., 2018). Almost 95% of the world's 250 largest companies now provide social and environmental information (KPMG, 2017). However, the quality of the disclosed information remains questionable (Abernathy et al., 2017; Deegan, 2017).

Academic research is generally critical of sustainability disclosure, arguing that corporate level sustainability disclosures tend to be biased, self-laudatory and frequently limited to positive information (Deegan, 2017; Hahn et al., 2017; Michelon et al., 2015). Sustainability corporate disclosures can be motivated by reputational concerns, rather than in response to stakeholders' expectations of accountability (Antonini and Larrinaga, 2017). Deegan (2017) argues that the quality of sustainability disclosure and accountability has not improved in the last 25 years, and the state of the environment and society in many parts of the world has degraded significantly over the same period.

3.2.1 Quality of Sustainability Disclosure

Prior SEA studies have raised concerns over the quality of sustainability disclosure **(**Deegan, 2017; Hahn et al., 2017). Although the number of organisations disclosing

sustainability information and the volume of their sustainability information has increased over the years, the quality of sustainability information is poor (Abernathy et al., 2017; Chauvey et al., 2015; Bouten et al., 2011; Michelon et al., 2015). The findings that organisations often provide selective and incomplete sustainability information has led to calls for improving sustainability disclosure quality (Abernathy et al., 2017).

There is limited consensus, however, on how to measure sustainability disclosure quality. Defining quality is complex and subjective as the meaning of quality often depends on context (Leitoniene and Sapkauskiene, 2015). A review of SEA literature shows that different studies have defined the quality in different ways; therefore, measurement of quality of the sustainability varies in studies. Quality measures used in prior studies include disclsoure volume and themes (see, Chauvey et al., 2015 for an overview), accounting principles (Chauvey et al., 2015), performance disclosure (Patten and Zhao, 2014), transparency benchmarks (Gao et al., 2016) and ratings, not only from GRI or Dow Jones Sustainability Index (Hąbek and Wolniak, 2016) but also self-developed disclosure indices **(**Wiseman,1982; Hooks and van Staden, 2011; Bachoo et al., 2013).

Two broad types of measures of sustainability disclosure quality have been most widely used in SEA literature **(**Michelon et al., 2015; Bachoo et al., 2013). One measure quantifies the level of disclosure in the report based on the number of pages or words; whereas the other measure assigns a particular score to qualitative factors such as the existence of environmental policies, the achievement of environmental goals and others **(**Bachoo et al., 2013). Quality measures based on volume do not consider the meaning of disclosed information and ignores the important dimensions (e.g., monetary, quantitative, and qualitative information) of the information (Leitoniene and Sapkauskiene, 2015; Michelon

et al., 2015). Hence, as opposed to the volume of information, researchers focus on what information is disclosed and how that information is disclosed in assessing the quality of the disclosure (Guthrie and Parker, 1990).

Several researchers have used self-developed quality disclosure indices to capture what is disclosed and how it is disclosed, and to assign a quality score (Wiseman, 1982; Hasseldine et al., 2005; Brammer and Pavelin, 2008; Bachoo et al., 2013; Michelon et al., 2015). Researchers have awarded a higher score for quantitative disclosure and a lower score for qualitative information. In addition, van Staden and Hooks (2007) have defined quality based on the completeness of disclosure or the degree of detail in the disclosure for a particular item.

This study focuses on what is disclosed and how it disclosed to assess the quality of sustainability disclosures. This study takes this definition to assess the quality of the disclosure and considers the "meeting stakeholders' expectations" or "satisfying the needs and preferences of its users" to assess the completeness or the degree of detail of the disclosure for a particular item (Evans and Lindsay, 2005; Stvilia et. Al., 2007). This study has explored the quality of the sustainability disclosure of public sector organisations; whereas prior studies primarily assessed the quality of the sustainability disclosure of business organisation. Ball and Bebbington (2008) have suggested that public sector organisations are in a better position to provide quality information than private sector organisations which has discussed in the following section.

3.2.2 SEA Research in Public Sector

Several researchers argue that sustainability issues can be explored better by focusing on public sector organisations as their objectives are often aligned with sustainability objectives (Ball and Bebbington, 2008; Guthrie et al., 2010). Moreover, the public sector is required to "display a greater extent of sustainability, accountability and transparency in the use of public resources" (García-Sánchez et al., 2013, p. 60). The GRI has called on public agencies to lead by example in reporting publicly and transparently on their activities to promote sustainability (Goswami and Lodhia, 2014). While prior studies predominantly explore and analyse corporate sustainability disclosure (Dumay et al., 2010; Williams et al., 2011), sustainability disclosures by public sector organisations and NGOs have started to receive increasing attention (Domingues et al., 2017; Goswami and Lodhia, 2014; Kaur and Lodhia, 2018; Parker, 2011). These disclosure studies are limited to some government organisations (e.g., Domingues et al., 2017; Farneti and Guthrie, 2009; Greiling et al., 2015; Guthrie and Farneti, 2008) and several local governments (e.g., Kaur and Lodhia, 2018; Othman et al., 2017; Williams et al., 2011).

Prior SEA studies in the public sector mainly focus on: what sustainability information is disclosed (Guthrie and Farneti, 2008; Williams et al., 2011); why sustainability information is disclosed (Bellringer et al., 2011; Farneti and Guthrie, 2009); and what media is used to disclose sustainability information (Mata et al., 2018; Williams et al., 2011). Prior studies also examine how stakeholders engage in the social and environmental accounting and reporting process, arguing that stakeholder engagement plays a critical role in this process (Kaur and Lodhia, 2018).

Examining seven Australian public agencies, Guthrie and Farneti (2008) find that disclosures are generally non-monetary and narrative. Othman et al. (2017) report similar findings in their study of the sustainability reporting practices of New Zealand's local governments. Public sector organisations generally provide more information on financial sustainability in comparison to social and environmental sustainability (García-Sánchez et al., 2013; Goswami and Lodhia, 2014). Although it is expected that public sector sustainability disclosure will be more comprehensive and of higher quality, sustainability disclosure practices are still in an early stage of development in the public sector when compared to the private sector (Dumay et al., 2010; García-Sánchez et al., 2013). The academic literature suggests that sustainability reporting practices in relation to social and environmental issues in the public sector are fragmentary (Goswami and Lodhia, 2014). It seems that the public sector is not better than its private sector counterparts when it comes to disclosing sustainability information. Researchers have argued for mandatory reporting of sustainability information in order to advance sustainability reporting practices in both private and public organisations (Dumay and Hossain, 2018; Guthrie and Farneti, 2008). Many countries are actively considering the transition from voluntary guidelines for sustainability information to mandatory reporting requirements (KPMG, 2017). Prior studies indicate that the legal obligation to supply sustainability information has a positive effect on the extent and quality of sustainability disclosure (Hąbek and Wolniak, 2016; Ioannou and Serafeim 2017).

Prior studies exploring the rationale for disclosing sustainability information indicate that public sector organisations mainly disclose information for internal stakeholders. For example, Farneti and Guthrie (2009) suggest that Australian government agencies provide sustainability information to inform stakeholders, but mainly internal ones as they are

interested in their organisational performance in this regard. Moreover, internal stakeholders (such as ministers and public sector managers) need to know their sustainability performance in order to inform general public about their actions for sustainable development (Farneti and Guthrie, 2009). Bellringer et al. (2011) interview the preparers of sustainability reports in five local government councils in New Zealand, finding that their sustainability reporting is strongly motivated by pragmatism and economic rationalism rather than by an idealistic desire to ensure a sustainable world. They also find that internal stakeholders are the primary users of sustainability information. However, public sector organisations are also responsible for providing information to external stakeholders. The public sector provides an increasing amount of information and transparency so that citizens can monitor activities undertaken by public authorities, given that the public sector operates with citizens' funds (García-Sánchez et al., 2013). So, in designing and providing sustainability information, it is crucial for an organisation to identify the types of stakeholders (internal and external) and investigate the information needs of these stakeholders (Galera et al., 2014). Several stakeholders might benefit from aggregate information (e.g., amount of total emissions from an organisation), others would prefer comprehensive information related to actions undertaken by organisations to tackle the challenges associated with sustainable development.

She and Michelon (2018) suggest that stakeholders place greater value on organisations' actions-related information. SEA researchers need to explore not only the state of social and environmental reporting but also what actions organisations are taking and what are the impact of these actions have in tackling various social and environmental problems. Prior studies predominantly examine whether information related to particular social and environmental items (e.g., total emissions, environmental policies, community programs)

has been disclosed or otherwise and what factors drive the level of disclosure (Ahmad and Mohamad, 2014; Alcaraz-Quiles et al., 2015; Ali et al., 2017; Baldini et al., 2018; Kaymak and Bektas, 2017; Khan et al., 2013). Many researchers use GRI indicators to assess the social and environmental disclosure (Alcaraz-Quiles et al., 2015; Fernandez-Feijoo et al., 2014; Guthrie and Farneti, 2008; Moratis and Brandt, 2017). Using the GRI indicators allows for assessment of a comprehensive level of social and environmental information but in aggregate form. The GRI does not require organisations to disclose detailed information about particular actions (e.g., cost and the outcome of a particular action to solve a social and environmental problem). Disclosing action-level information may benefit stakeholders to assess an organisation's actions about social, economic and environmental performance. Moreover, action-level information may be beneficial to other organisation who are interested in undertaking similar actions to tackle a similar problem.

3.2.3 Disclosure Media of SEA information

Regarding the use of disclosure media for sustainability information, sustainability reporting has progressed from annual reports to standalone sustainability reports and more recently, web-based media (Lodhia, 2018; Mata et al., 2018). Previous academic research has analysed the sustainability information disclosed by organisations in their annual reports according to its credibility, regularity, accessibility and usefulness for various stakeholders (Guthrie et al., 2008; Islam and Deegan, 2010; Loh et al., 2015; Mata et al., 2018). Several researchers also explore sustainability reports along with annual reports (Dumay and Hossain, 2018; Haque et al., 2016). Disclosure media evolve, and organisations are now using newer media (e.g., website, social media) that extends the capabilities of traditional media (Lodhia, 2012). Williams et al. (2011) survey Australian

local councils and their results show that 95% use the annual report to disclose sustainability information, while 70% use their website to do so.

The internet plays a crucial role in increasing accountability and promoting the disclosure of information by public and private organisations (Alcaraz-Quiles et al., 2015; Unerman and Bennett, 2004). Several prior studies analyse the practices of disclosure of sustainability information with specific reference to the websites (Galera et al., 2014; Joseph et al., 2014; Lodhia, 2012; Lodhia, 2004; Morhardt, 2010; Raghupathi and Raghupathi, 2019). In recent years, social media has played an essential role in disseminating information (Bellucci et al., 2017; Lodhia and Stone, 2017; Westerman et al., 2014) and researchers have identified the use of social media as a valuable method to communicate sustainability information as it allows two-way communication with stakeholders, in which both parties learn from these interactions (Bellucci et al., 2017; Lodhia, 2018). It can also help organisations to better understand stakeholders' expectations. However, few studies to date have explored the use of social media for sustainability reporting practices (Manetti and Bellucci, 2016; She and Michelon, 2018). Lodhia and Stone (2017) suggest that social media has the potential to be a useful channel for providing sustainability information.

Another issue raised in sustainability disclosure studies is the boundary problem. Sustainability concerns transcend organisational boundaries, and it is still not clear how to define the boundaries of sustainability reports to assess corporate contributions to sustainability (Antonini and Larrinaga, 2017). Prior studies argue that sustainability is not an were concept but rather a system concept (Gray, 2006, 2010; Gray and Bebbington, 2000; Gray and Milne, 2004). Sustainability, in particular, environmental sustainability

needs to be explored at the regional level and not within the individual, organisational level (Dumay, 2010; Gray, 2010; Milne and Gray, 2007). Most prior studies explore sustainability and sustainability disclosure at the corporate level (Dumay et al., 2010; Ball et al., 2014; Fusco and Ricci, 2018). However, corporations have a narrow definition of sustainability that is unable to address the broader implications of sustainability (Ball and Bebbington, 2008; Dumay et al., 2010). Whereas cities' many objectives are aligned with sustainability and sustainable development. Unlike the performance of a corporation, a city's performance is measured not only in economic terms but also in social and environmental terms. Cities are responsible for citizens' well-being and promote social, economic and environmental sustainability within their geographic boundaries.

In summary, SEA studies predominantly focus on the corporate sector and, to a limited extent, the public sector, and find that sustainability disclosure is fragmented and of questionable quality. Consequently, contemporary debates consider the potential of mandatory reporting to improve the reliability and credibility of sustainability information. While SEA studies to date have mainly explored annual reports, sustainability reports and websites, there is potential to consider the role of social media in extending the capabilities of traditional media. To date, this communication channel for sustainability information has been mostly overlooked in the accounting domain. Also, stakeholders have an interest in actions-related information, but few prior studies explore this form of disclosure. Sustainability issues need to be investigated at the regional level and exploring sustainability information at the city level may be one way to do so. Hence, this thesis focuses on one key aspect of environmental sustainability at the city level.

Prior studies have shown that organisations extend the scope of environmental information by including forests, the protection of the ozone layer, climate change, water, energy and natural resources and biodiversity in their annual reports. However, the climate change issue has received much more attention and generated particular expectations, especially in the private (or corporate sector) (Prado-Lorenzo et al., 2009). Moreover, it is apparent from existing research that climate change, in particular, has received overwhelming attention from world leaders, national and international organisations, researchers, corporations and the public (Ascui, 2014; Prado-Lorenzo et al., 2009; Tranter, 2011). Over the last few years, climate change has become a topic in many disciplines, including environmental science (Moraes Sá et al., 2017), engineering (Parson, 2017), public health (Levy and Patz, 2015; Watts et al., 2017) and accounting (Andrew and Cortese, 2011a; Engels, 2009; Liesen et al., 2015). The scientific consensus is that the consequences of uncontrolled GHG emissions will accelerate global climate change (IPCC, 2015). Therefore, it is imperative to tackle GHG emissions at both the individual and corporate levels, as well as the local, national and international levels. However, few studies focus exclusively on climate change disclosure in the public sector, despite public sector organisations critical role in reducing GHG emissions and associated climate change.

3.3. GHG Emissions Accounting and Disclosure

Issues of climate change and GHG emissions have made constant news headlines in national and international newspapers in recent decades. These issues have also received significant research attention in many different disciplines, including natural science, environmental studies, geography, urban studies as well as in business disciplines (Andrew and Cortese, 2011a; Chen et al., 2019; Webb et al., 2016; Tan et al. 2016). There is also a

consensus among city mayors, urban leaders, businesses, and civil society that cities need to act to reduce the impacts of climate change (Ibrahim et al., 2012). Some of the most critical decisions on climate change concern GHG emissions. Hence, scholars from many disciplines are working together and primarily focusing on ways to minimise the impact of climate change via reducing GHG emissions. The CDP provides a platform for organisations to disclose their GHG emissions related information (CDP, 2018). In addition, organisations are using their websites and annual reports to disclose various GHG emissions and emissions reduction related information (Mia et al., 2018).

Initially, accounting scholars explored the climate change issue as part of a broader group of SEA research. However, with attention in the broader community focusing on climate change over the last two decades, several accounting scholars have given a significant amount of attention to this issue.

GHG accounting is part of environmental accounting (Stechemesser and Guenther, 2012). The accounting discipline has made a significant contribution to a broadened debate about GHG emissions and their association with climate change over the past decade. Ascui (2014) reviewed eight accounting journals, finding that cumulative publications on climate change and GHG emissions tripled in one year (2009) compared to all previous years, and continued to grow at an average of 66% per annum thereafter, and a large number of researchers (over 220 authors) were involved in these publications. Accounting research around climate change primarily explores carbon management accounting, carbon disclosure and carbon financial accounting and carbon auditing and education, with a limited focus on the role of accounting in supporting adaptation to climate change (Ascui, 2014; Hahn et al., 2015; Linnenluecke et al., 2015; Stechemesser and Guenther, 2012). In

particular, GHG disclosure is a growing field of research. This disclosure contains a wide range of GHG and climate change-related information, including the amount of GHG emissions and its measurement process, strategies to reduce emissions and risk and opportunities associated with climate change (CDP, 2012; Kolk et al., 2008).

Prior studies indicate that organisations use multiple media (annual report, sustainability report, websites and CDP) to disclose climate change-related information (Andrew and Cortese, 2011b; Burritt et al., 2011; Depoers et al., 2016). According to Jaggi et al. (2018), investors find GHG information useful for their investment decisions. However, there are some concerns in relation to disclosed emissions data due to the various guidelines for calculating GHG emissions (Andrew and Cortese, 2011b; Kolk et al., 2008) and researchers have argued that the emissions data disclosed by corporations to the CDP is inconsistent, not comparable and not reliable (Andrew and Cortese, 2011b; Kolk et al., 2008). This raises the question of whether carbon disclosure initiatives such as the CDP are useful in the decision-making processes of investors, NGOs and policymakers. As there are limited studies examining the CDP data, researchers are urged to investigate the CDP's emissions data further (Andrew and Cortese, 2011b; Depoers et al., 2016; Kolk et al., 2008). Although several researchers explore corporate climate change disclosure to the CDP, there are limited studies focusing on cities' climate change disclosure to CDP.

Prior climate change studies related to cities mainly focus on calculating cities' GHG emissions and potential strategies they can undertake to reduce emissions (Andrade et al., 2018; Athanassiadis et al., 2018; Dhakal, 2010; Kennedy et al., 2012; Kennedy et al., 2009; Shao et al., 2016; Wiedmann et al., 2016). Most of these prior studies explored GHG emissions from global cities situated in western countries. Previous studies examined GHG

emissions from Brussels, Denver, London, Madrid, Melbourne, Toronto, New York, Geneva, Prague (Andrade et al., 2018; Athanassiadis et al., 2018; Kennedy et al., 2010; Wiedmann et al., 2016). Kennedy et al. (2009) combined the carbon accounting and urban environmental sustainability approaches and analysed the differences in emissions of ten global cities. Kennedy et al., (2012) examined the trend of GHG emission inventories for the period 2004–2009 of Berlin, Boston, Toronto, London, New York City and Seattle. Several studies also explored GHG emissions for cities from developing countries (Shao et al., 2016; Mi et al., 2016). These prior studies estimate cities' total emissions from electricity consumptions, fossil fuels used for heating in buildings, e.g., space heating, water heating and cooking, fuels used for ground transportation within cities, emissions from industrial processes and product use as well as from waste (Kennedy et al., 2010; Shao et al., 2016). Relevant data were collected from official documents of municipal and national governments, local and national statistical agencies as well as other private and public institutions and databases (Andrade et al., 2018).

Extant literature indicates that there are two major competing accounting approaches (PB and CB) to calculate and estimate cities' GHG emissions (Afionis et al., 2017; Andrade et al., 2018; Chen et al., 2019; Shao et al., 2018). Several prior studies have conducted a comparative analysis between PB and CB approaches and found significant differences in cities' emissions inventories (Andrade et al., 2018; Athanassiadis et al., 2018; C40, 2018; Shao et al., 2016). Athanassiadis et al. (2018) study, for example, suggest that GHG emissions for the City of Brussels are three times higher under the CB approach than the PB approach. Mi et al. (2016) used CB emissions for thirteen Chinese cities and found substantial differences between CB and PB GHG accounting in terms of both overall and per capita emissions. Also, C40 has conducted an assessment of the CB GHG emissions

for 79 of its member cities and found that CB represents a 60% increase in emissions estimated for the same cities mainly due to international trade (C40, 2018). Prior studies also indicated that the CB approach, when compared with the PB approach, shows smaller per capita emissions for larger and richer cities than smaller and poorer cities (Afionis et al., 2017; C40, 2018).

An important theme of previous research on GHG emissions concerns the relative merits of the CB versus the PB approach, with most studies advocating CB on the basis that the CB approach provides a more accurate representation of a city's emissions profile (Athanassiadis et al., 2018; Dahal and Niemelä, 2017; Dhakal and Shrestha, 2010). Prior studies argue that PB approach ignores emissions from international trade which can have a significant impact in compiling emissions inventory, given that 20–25% of overall CO_2 emissions are from the production of internationally traded goods and services (Afionis et al., 2017; Dahal and Niemelä, 2017; Shao et al., 2016). These issues have led to increased calls for a switch to, or an amalgamation with, CB emissions accounting (Afionis et al., 2017; Andrade et al., 2018; Chen et al., 2019).

Prior studies also identified that in addition to different accounting approaches, GHG emissions results are influenced by geophysical and technical factors (Hoornweg et al., 2011; Kennedy et al., 2009). For instance, Kennedy et al. (2009) explored the GHG emissions from some global cities, arguing that geophysical factors (climate condition, access to resources and gateway status) and technical factors (power generation, urban design and waste processing) influence cities' GHG emissions. They argue that it is crucial to explore cities' GHG emissions as they can foster learning amongst cities that will support reduction of GHG emissions on a wider scale. Moreover, GHG emissions data can

be used to track emissions and also to develop policies and programs to reduce emissions, but for this to be successful it is vital to have complete, consistent, reliable and timely emissions data.

Prior studies have acknowledged that the reduction in GHG emissions required is significant, and that cities both have the capacity to reduce GHG emissions and have policies and procedures in place to take actions to reduce emissions (Betsill and Bulkeley, 2007; Rosenzweig et al., 2010). Prior studies have identified several strategies to reduce GHG emissions, such as emissions trading, investing in renewable energy sources, focusing on energy efficiency, educating citizens, waste treatment, recycling and mass public transport systems (Dhakal, 2010; Kennedy et al., 2012). Cities also have formed alliances, such as C40 Cities, that focus on reducing GHG emissions through a range of energy-efficiency and clean-energy programmes (Rosenzweig et al., 2010). The existing literature suggests that energy efficiency is one of the actions cities are undertaking to reduce GHG emissions (Chaoui and Robert, 2009; Liu et al., 2015). Tracking and verifying cities' actions to reduce GHG emissions requires transparent data in relation to financing, emissions mitigation and so on (Hsu, 2016).

Moreover, it is not possible to evaluate the impact of emissions reduction actions without detailed information. Lack of information may prevent city authorities, citizens and investors from undertaking the most effective possible actions to reduce emissions. For example, lack of information about the energy efficiency performance of replacing conventional lights with LED light in city streets and buildings may prevent city authorities and households from optimising energy consumption. Such specific problems can be addressed by providing information about the cost of initial investment and the benefits

(e.g., energy, cost and emissions savings) that can be accrued over the years. However, few studies explore cities' public disclosure in relation to emissions reduction actions.

In summary, three key research gaps have been identified. 1: The city is an important but neglected area of research in terms of reducing GHG emissions and tackling climate change. While SEA research has increased over the years, and there has been some discussion regarding the most appropriate GHG accounting method for cities, accounting scholars have tended to overlook the accounting and disclosure practices relating to cities' GHG emissions. Paper 1 addresses this gap by exploring the quality of GHG disclosures by cities via the CDP. 2: Cities are taking actions to reduce emissions. However, prior studies mainly focused on disclosures of organisational impacts rather than disclosure related to organisational actions in tackling environmental problem such as GHG emissions. Paper 2 addresses this gap by exploring the quality and consistency of cities' emissions reduction actions related disclosure across different channels. 3: Energy efficiency is one of the major and cost-effective initiatives to reduce energy consumptions and therefore, GHG emissions reduction. However, there has been little research exploring whether cities are providing adequate information about their energy efficiency initiatives that can help stakeholders in their decision-making process. Paper 3 addresses this gap by examining cities' calculative practices and public disclosures around energy efficiency activities. Papers 1, 2, and 3 are presented below as Chapters 4, 5 and 6.

Chapter 4 – Paper 1: Greenhouse Gas Emissions Disclosure by Cities: The Expectation Gap

Mia, P., Hazelton, J., and Guthrie, J. (2019), "Greenhouse gas emissions disclosure by cities: the expectation gap", *Sustainability Accounting Management and Policy Journal*. https://doi.org/10.1108/SAMPJ-11-2017-0138

Greenhouse gas emissions disclosure by cities: the expectation gap

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Received 26 November 2017
Revised 24 May 2018
14 September 2018
Accepted 7 November 2018

Abstract

Purpose – Cities are crucial to reducing greenhouse gas (GHG) emissions. This paper aims to explore the quality of GHG disclosures by cities via the Carbon Disclosure Project (CDP) and compares them with the expectations of users.

Design/methodology/approach – The expectation gap framework is used to examine the GHG disclosure quality of 42 cities. User expectations are determined via a literature review and CDP documentation. City disclosures are reviewed using content analysis.

Findings – GHG information at the city level is outdated, incomplete, inconsistent, inaccurate and incomparable and, therefore, to meet user expectations, improvement is needed.

Research limitations/implications – The findings have implications for policymakers, stakeholders and managers. Guidelines are required for better disclosure of GHG information relating to cities, and stakeholders need to develop better skills to understand emissions information. Managers have a responsibility to measure, disclose and mitigate GHG emissions to meet the expectations of stakeholders.

Originality/value – Prior studies focus on GHG disclosures via the CDP by corporations. This is the first accounting study to examine GHG disclosures by cities via the CDP. The expectation gap framework is a novel approach to sustainability disclosure research.

Keywords Disclosure, Carbon Disclosure Project (CDP), Carbon, Emission, City, GHG, Expectation gap

Paper type Research paper

Acronyms

C40 = Alliance of world megacities;
CDP = Carbon Disclosure Project;
ERT = Emissions reduction target;
GEI = GHG emissions inventory;
GPC = Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories;
GRI = Global Reporting Initiative;
ICLEI = International Council for Local Environmental Initiatives (Local Governments for Sustainability);
IPCC = Intergovernmental Panel on Climate Change;

The authors wish to thank the anonymous reviewers of this journal and the editors of this special issue, as well as reviewers and participants at the ACSEAR 2016 conference in Adelaide.

Sustainability Accounting, Management and Policy Journal

2040-8021
DOI 10.1108/SAMPJ-11-2017-0138

MtCO2e = Metric ton carbon dioxide equivalent (CO2e – indicates all seven greenhouse gases); and
UNFCCC = United Nations Framework Convention on Climate Change.

1. Introduction

Climate change has become one of the most pressing issues of the modern era with the Brundtland (1987) Report stating that excessive GHG emissions are a major threat to sustainable development. Given the accelerating rate of climate change, driven by anthropogenic greenhouse gas (GHG) emissions (Prado-Lorenzo *et al.*, 2009), the UN Sustainable Development Goal 13 is to "take urgent action to combat climate change and its impacts" (UN, 2018). As cities are responsible for 70 per cent of the world's GHG emissions, they play a crucial role in tackling climate change (World Bank, 2018).

Climate change reduction depends on practical action and, in this regard, cities are centre stage (Barber, 2017). Owing to increasing global urbanisation, cities have become more important as they are primarily responsible for global GHG emissions. Therefore, they can play an important role in reducing GHG emissions by implementing emissions mitigation policies (Long and Yoshida, 2018).

Developing a GHG emissions inventory (GEI), defined as "an accounting of GHGs emitted to or removed from the atmosphere over a period", helps policymakers track emissions trends, develop mitigation strategies and policies, and assess progress (EPA, 2018). A GEI can help city managers identify their current level of emissions, as well as the sources and activities within their physical boundaries that are responsible for those emissions. It can help set goals and targets for future reductions and engage residents and businesses in initiatives to reduce GHG emissions.

Improving GHG performance also requires the disclosure of GHG information (Gibassier and Schaltegger, 2015). For external stakeholders to hold organisations to account, disclosure must provide a true and fair representation of an organisation's GHG footprint and efforts in emissions reduction. It therefore requires a comparable and accurate accounting of GHG emissions, similar to financial disclosure (Gibassier and Schaltegger, 2015).

An important mechanism for city-level GHG information is via the CDP, an NGO formerly known as the Carbon Disclosure Project. Following from its early focus on the corporate sector, the CDP has developed a set of climate change questionnaires specifically related to cities. The advantages of disclosing city-level data through the CDP include improved engagement with stakeholders, centralised data, progress tracking and benchmarking (CDP, 2018).

While prior research has examined GHG disclosure by companies, little is known about cities' GHG disclosure, possibly because of the lack of available data on cities' GHG emissions until recently. This study attempts to fill this gap, in response to the *Sustainability Accounting, Management and Policy Journal*'s call for exploration of sustainability accounting issues including disclosures and communication at the city level (Crutzen *et al.*, 2017). Similarly, researchers have called for further exploration of the CDP data (Andrew and Cortese, 2012; Kolk *et al.*, 2008).

This study explores the quality of GHG disclosures made to the CDP by cities. The relevant GHG disclosures are evaluated first, followed by a comparison of those disclosures with user expectations using the expectation gap framework. The premise of this analysis is that, to meet user expectations, the disclosed information should be complete, consistent, timely, accurate, reliable and comparable.

2. City, climate change and Carbon Disclosure Project cities disclosure

Cities play an important – even decisive – role in climate change. The development of city-based GHG disclosure via the CDP is discussed in this section, highlighting the recent partnership between the CDP and the C40 Cities Climate Leadership Group.

2.1 Cities' crucial role in climate change

In spite of their social and economic importance, cities were not prominent in early climate change discussions. Cities were initially disregarded in the Intergovernmental Panel on Climate Change (IPCC) process, nor were they mentioned in the Kyoto Protocol (Hebbert and Jankovic, 2013). However, according to the World Bank, cities have become the primary living, social and economic spaces for the majority of the world's population, are home to more than 50 per cent of the world's population and generate more than 80 per cent of global GDP.

This poses significant environmental challenges. Rapid urbanisations and population growth make sustainable development challenging (Crutzen *et al.*, 2017) and risk irreparably damaging the natural environment (Alusi *et al.*, 2011). The importance of meeting these challenges is not limited to city dwellers: how cities are managed is also important to tourists, business organisations and investors (Lapsley *et al.*, 2010).

It is now clear that cities play an important role in contributing to climate change. The IPCC estimates that 47 per cent of the 10 Gt increase in anthropogenic GHG emissions from 2000 to 2010 can be attributed to energy supply (the remainder are industry [30 per cent], transport [11 per cent] and buildings [3 per cent]), with the majority of these (67 per cent) consumed by cities (World Bank, 2018). Cities derive "approximately 72 per cent of their total energy demand from coal, oil, and natural gas – the main contributors to greenhouse gas emissions" (Hoornweg *et al.*, 2010, p. 18). Cities' emissions are likely to increase in line with growing populations and economic activities as the IPCC analysis suggests there is a direct link between population and economic growth and anthropogenic GHG emissions (Pachauri *et al.*, 2014).

As the impact of cities on GHG emissions becomes more evident, the World Bank reports that cities have been targeted in the global effort to mitigate climate change. As centres of wealth and innovation they have the capacity and resources to tackle climate change (Rosenzweig *et al.*, 2010). They are also "the centre of economic and political activity, and there is a growing resonance in considering city-level issues as a means to progress climate policy discussions" (Hunt and Watkiss, 2011, p. 14). City managers have jurisdiction over many decisions that have direct and indirect effects on climate change, including GHG emissions, water, waste management, education, land use, transport systems and urban forestry.

To formulate emissions reduction policies, cities require information on carbon risks, opportunities, strategies and emission levels at a city level. The CDP has been at the forefront of fostering city-based GHG disclosures, as outlined next.

2.2 City greenhouse gas disclosures via the Carbon Disclosure Project

The CDP is a not-for-profit organisation founded in 2000 and backed by over 800 institutional investors. It facilitates the disclosure of environmental information (initially GHG and more recently water) by surveying companies and other organisations (Ben-Amar *et al.*, 2017; Depoers *et al.*, 2016). Over 6,000 companies now disclose GHG emissions, climate change risks and mitigation and adaptation strategies via CDP surveys.

The CDP began to collect climate change data from cities in 2011. As of 2018, the CDP has worked with more than 500 cities around the world to manage 1.67 billion metric tonnes

of GHG emissions. Data is collected using a questionnaire that allows corporations and city governments to disclose their climate change data publicly. Respondents register with the CDP and use its online response system to disclose their climate change-related information. Substantial guidance is provided to the responding entities on how to answer each of the questions. For example, respondents are required to describe the methodology used to calculate GHG emissions, the sources of those emissions, what activities are in place to reduce emissions, and so on. The CDP also provides guidelines for standardised emission calculation rules and lists possible emission sources, along with almost 50 different activities to reduce emissions so that responding entities can select their answers from a series of drop-down menus. The content of the questionnaire and responses are "strictly managed, with prescribed-format answers" (Depoers *et al.*, 2016, p. 4), however, respondents may insert a limited amount of text and numeric values for certain questions. The platform also allows respondents to submit the same or similar responses to questions as the previous year without making major changes. Once the questionnaire has been completed, participants have the option to make the information available to the public or otherwise. Private answers are only visible to CDP staff and other selected partners.

The CDP has partnered with various global cities network such as the C40 Cities Climate Leadership Group (C40) and the Compact of Mayors to provide a preferred disclosure platform among global cities to circulate climate change-related data. These cities have the collective potential to reduce GHG emissions by 1 billion Mt annually by 2030 (C40, 2016a). C40 is a network of global cities that are taking action to reduce GHG emissions. Disclosing information has been identified as a priority for the C40: the former Chair of C40, Michael Bloomberg, states that "[g]ood management depends on good data".

Annual disclosure on emissions and climate change strategies empowers individual cities to assess past climate action and target future actions and is an important requirement for compliance with the Compact of Mayors. The CDP does not verify the disclosed data for accuracy or audit disclosed information, instead encouraging disclosure (Kim and Lyon, 2011). However, it does urge participants to obtain independent verification of their emissions data to "increase the credibility of publicly-reported emissions information with external audiences and increase confidence in the data used to develop climate action plans, set GHG targets and track progress" (Fong *et al.*, 2015, p. 146).

Disclosure of GHG information has become an important topic in accounting research, although little is yet known about GHG disclosure by cities. This research is briefly reviewed in the following section.

3. Literature review

In recent years, the accounting profession has attempted to assist public decision-making through the development of sustainability disclosures (Andrew and Cortese, 2011), consistent with broadening societal expectations of the role of firms within society (Jones and Oldroyd, 2009). Stakeholders increasingly demand greater transparency from organisations on environmental, social and governance factors and other non-financial risks (Atan *et al.*, 2018; PWC, 2015). This has motivated more organisations to provide sustainability information (Mia *et al.*, 2018) and previously disclosing organisations to provide a greater volume of information (Dienes *et al.*, 2016). This applies to both public and private organisations (Depoers *et al.*, 2016; Goswami and Lodhia, 2014) and accountants play an important role (PWC, 2015; Qian *et al.*, 2011).

Academic research has identified some weaknesses with sustainability disclosures, which also extends to work focusing on climate change, arguing that corporate level disclosures tend to be biased, self-laudatory and are often limited to positive information

(Deegan and Rankin, 1999; Michelon *et al.*, 2015). These adverse findings are echoed in studies specifically related to GHG disclosures, which have examined annual reports, sustainability reports, websites and the CDP (Depoers *et al.*, 2016; Liao *et al.*, 2015).

Climate change disclosure research has identified issues with information comparability, scope and verification. Kolk *et al.* (2008) analysed the responses of FT500 firms to the CDP and found that different organisations use different measurement protocols; Andrew and Cortese (2011, p. 131) report similar findings. Hence, the disclosures are not comparable between corporations, which is important for decision-making (Liesen *et al.*, 2015). GHG emissions information is typically disclosed in categories referred to as Scope 1, Scope 2 and Scope 3 (see Table I). Many corporations are reluctant to include and disclose Scope 3 emissions, given their inclusion in a GEI is not mandatory (Andrew and Cortese, 2011; Depoers *et al.*, 2016). This can lead to significant under-reporting of carbon metrics (Andrew and Cortese, 2011). The overall result is incomplete and inconsistent information (Depoers *et al.*, 2016; Kolk *et al.*, 2008). External verification of GHG emissions data can ensure higher quality and increase the credibility and usefulness of disclosures (Kolk *et al.*, 2008; Simnett and Nugent, 2007). Research demonstrates that many organisations are reluctant to verify or audit their GHG emissions data (Andrew and Cortese, 2012; Kolk *et al.*, 2008).

Cities are facing similar pressures to those of corporations to disclose GHG emissions. As climate change threatens widespread impacts, citizens are demanding environmental information to engage in debate and to put pressure on policymakers to develop appropriate policies to reduce emissions (Qian *et al.*, 2011). City governments need climate change information to evaluate progress and adopt appropriate mitigation strategies (Bai *et al.*, 2018; Cortekar *et al.*, 2016); for example, Qian *et al.* (2011) found that environmental management accounting helped 12 local governments in Australia to improving waste and recycling management.

Cities face particular challenges, however, in producing and disclosing GHG emissions. One of the most challenging factors is to define the boundaries for the emissions inventory of a city (Rauland and Newman, 2015; Wiedmann *et al.*, 2016). The city needs to specify its geographic and operational boundaries (Fong *et al.*, 2015). The geographic boundary can be the administrative boundary of a local government, a ward or borough within a city, a combination of administrative divisions, a metropolitan area, or another geographically identifiable entity (Fong *et al.*, 2015). Operational boundaries refer to determining which emissions are caused by a city's operational activities – that is, Scopes 1, 2 and 3 emissions. Some city activities lead to GHG emissions elsewhere (Bader and Bleischwitz, 2009), including both direct and indirect emissions.

A further challenge for cities is to measure GHG emissions consistently. A variety of protocols/guidelines exist for cities to calculate their emissions such as ICLEI, GPC and IPCC. The Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories

Scope	Definition
Scope 1	GHG emissions from sources located within the city boundary. For example, in-boundary transportation and waste
Scope 2	GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam and/or cooling within the city boundary
Scope 3	All other GHG emissions that occur outside the city boundary as a result of activities taking place within the city boundary. For example, out-of-boundary transportation or waste

Source: GPC – An Accounting and Reporting Standard for Cities (www.ghgprotocol.org)

Table I.
Scopes definitions for city inventory

(GPC) was developed in an attempt to improve consistency and transparency (Fong *et al.*, 2015). The GPC was developed by the Network of C40 Cities and Local Governments for Sustainability (ICLEI) in partnership with the World Resources Institute, World Bank, UNEP and UN-HABITAT (Dahal and Niemelä, 2017).

A different but related approach to the disclosure of GHG information by cities is the development of sustainability indicators. This reporting approach is similar to the development of key performance indicators (KPIs) to measure different aspects of sustainability in a corporate setting (Russell and Thomson, 2009). KPIs are important for policymaking as well as for assessing policy implementation (Adams and Frost, 2008). Many cities have developed KPIs to measure their progress towards sustainable development (Miller, 2017). However, most of these are limited to one particular climate change indicator, that is, total GHG emissions or per capita GHG emissions, or sometimes both. A set of climate change indicators for the city can help to direct a "more informed set of planning, more effective infrastructure investment and urban management, and more empowered city governance" (McCarney, 2012, p. 1). There is a lack of established and globally standardised climate change indicators (beyond total emissions), especially for cities. However, the CDP questionnaire offers a standardised broad set of climate change indicators for cities that allows detailed analysis on critical environmental risks, opportunities and impacts and helps users to make better decisions, manage risk and capitalise on opportunities.

In spite of the importance of sustainability disclosure by cities and the challenges cities face, only a few studies have examined public sector disclosure (Guthrie *et al.*, 2010; Mia *et al.*, 2018). Kennedy *et al.* (2009) suggested that many cities do not disclose indirect emissions comprehensively and Mia *et al.* (2018) found that several cities do not include Scope 3 emissions, possibly because of a lack of measurement guidelines. Further, there is a lack of empirical research investigating disclosures at the regional or community level. Several studies have examined the GEI of the world's largest cities (Feng *et al.*, 2015; Hoornweg *et al.*, 2011; Kennedy *et al.*, 2009). These studies primarily focused on estimating different cities' GEI from various raw data.

Baldasano *et al.* (1999) estimated GHG emissions for the City of Barcelona for the period 1987 to 1994 from fossil fuels used for transportation and generation of power for industrial, commercial and domestic use and included municipal solid waste in estimating total emissions. However, they considered only two types of GHGs – CO2 and CH4 – in estimating city-level emissions. Hoornweg *et al.* (2011) provided a detailed analysis of per capita GHG emissions of several large cities and explained the factors that could influence them, discussing possible sources of emissions and emphasising comparable estimates at the city level.

Kennedy *et al.* (2009) analysed the way different geophysical factors (climate, access to resources and gateway status) and technical factors (power generation, urban design and waste processing) influence the GHGs attributable to cities. Feng *et al.* (2015) estimated energy-related GHG emissions of Xiaolan City in China by collecting data from different sources and provided some strategic approaches to reducing GHG emissions by improving energy efficiency, optimising energy structure and developing low-carbon energy. All these studies stressed estimating the accurate amount of emissions. However, none of these studies conducted a detailed examination of emissions information that is already disclosed by cities, nor did they analyse whether disclosed emissions data is accurate, timely and complete.

Previous studies have overlooked several factors that are critical to a reliable GEI, such as the year the emissions were measured and the number and type of GHGs included in the

inventory (Andrew and Cortese, 2012; Kolk *et al.*, 2008). Moreover, while many organisations may disclose their emissions data every year, the measurements may have been taken several years ago. The UNFCCC has defined seven main gases as greenhouse gases – carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6) and nitrogen trifluoride (NF3). Although the CDP suggests its members include all seven gases in their GEIs, prior studies did not clarify whether the disclosing entities have included them all.

The limited number of studies exploring GHG disclosures at the city level may be owing to a lack of relevant GHG disclosures, but as the CDP now has the largest repository of industry- and city-specific climate data, new opportunities for future research are opening up (Andrew and Cortese, 2012). CDP data provides an opportunity to explore a city's disclosed GEI and its emissions reduction target (ERT). Hence this study investigates 42 cities disclosing emissions via CDP. In doing so it responds to calls in the literature for more research on GHG accounting and disclosure as CDP's databank has grown significantly (Andrew and Cortese, 2012; Kolk *et al.*, 2008). Further, *Sustainability Accounting, Management and Policy Journal* has called for exploration of sustainability accounting issues, including disclosures and communication at the city level (Crutzen *et al.*, 2017). Hence, this study explores the GHG disclosures made by cities via the CDP and compares them with the expectations of users. These user expectations – and the concept of the expectation gap framework used for the paper – are explored in the next section.

4. Expectation gap

This paper uses the expectation gap framework to investigate user expectations of GHG disclosures. An expectation gap can be defined as a "situation whereby a difference in expectations exists between a group with certain expertise and a group which relies on that expertise" (Deegan and Rankin, 1999, p. 136). The concept of an expectation gap has been used in accounting (Bui and Porter, 2010; Kamala *et al.*, 2015), predominantly to measure the audit expectation gap, which refers to the "difference between:

- what the public and other financial statement users perceive auditors' responsibilities to be; and
- what auditors believe their responsibilities entail (McEnroe and Martens, 2001, p. 345).

A formal definition of the audit expectation gap was developed by Porter (1993), which comprises the "reasonableness gap" and "performance gap" and is summarised in Table II.

The expectation gap framework has also been used in other contexts. For example, it was used to understand the difference in perceptions between accountants and small business

Reasonableness gap	A gap between society's expectations of what auditors can achieve and what they can reasonably be expected to accomplish	
Performance gap	A gap between what society can reasonably expect auditors to accomplish and what they are perceived to achieve. The performance gap comprises:	
	Deficient standards gap A gap between the duties that can reasonably be expected of auditors, and the duties auditors perform as defined by the law and professional promulgations	Deficient performance gap A gap between the expected performance of an auditor and their perceived performance

Source: Porter (1993, p. 50)

Table II.
Types of audit expectation gaps

clients in the UK regarding expectations of accountants' role in small business development (Kirby and King, 1997). Bui and Porter (2010) used the expectation gap framework to explore the gap in actual and perceived competencies expected by employers of accounting graduates. Deegan and Rankin (1999) explored whether an expectation gap exists in environmental reporting in Australia as a result of different perceptions about the importance of various kinds of environmental information in the decision-making processes of report preparers and users (Deegan and Rankin, 1999), finding that such a gap does exist. Several other researchers found similar results when they explored the expectation gap between the preparers and users of environmental disclosures (Kamala *et al.*, 2015; Mitchell and Quinn, 2005).

Prior studies have shown that the expectation gap is caused by both users and standard setters. On the user side, different users have a range of levels of knowledge and interests, and a lack of understanding around relevant standards by both information prepares and users (Ruhnke and Schmidt, 2014). On the standard-setter side, standard setters or policymakers fail to communicate responsibilities unambiguously and clearly to information preparers, including changes in economic environment and events and changes in public perceptions (Kamala *et al.*, 2015; Ruhnke and Schmidt, 2014).

This paper uses the expectation gap framework to analyse the gap between user expectations of climate change disclosures and the disclosures made by cities to the CDP, depicted in Figure 1. This gap may be the result of unreasonable expectations by users, deficient CDP guidelines or inadequate disclosures by cities. Unreasonable expectations are defined as users expecting something that would be difficult or impossible for a city to achieve. Deficient standards mean the information falls short of being useful in decision-making because of a lack of clear guidance provided by the CDP. Inadequate disclosures refer to disclosures cities can reasonably provide to fulfil user expectations but fail to provide.

4.1 User expectations of Carbon Disclosure Project greenhouse gas disclosure

The first step in using the expectation gap framework is to determine user expectations of CDP GHG disclosure. GHG disclosure, like any other form of accounting disclosure (including sustainability disclosure), aims to provide users with information that is useful for making decisions (Andrew and Cortese, 2011; Kamala *et al.*, 2015). A central question is therefore what characteristics of information are useful for decision-making?

Standard-setters argue that decision-useful information has certain qualitative characteristics, such as completeness, consistency, timeliness, accuracy, reliability and comparability (see Table III) (IASB, 2015; Nobes and Stadler, 2015). Similarly, the global protocol for community-scale GHG emission inventories (GPC), contends that disclosed information needs to be relevant, complete, consistent, transparent and accurate to represent

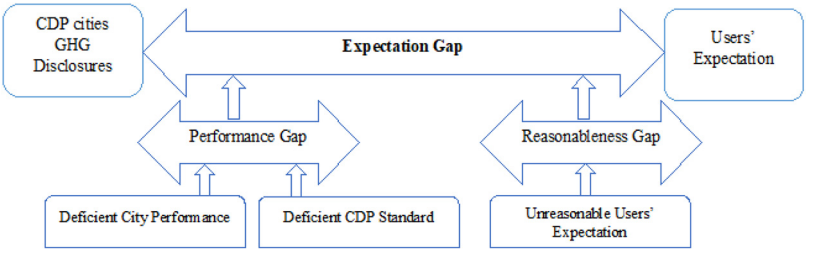

Figure 1.
Expectation gap between CDP GHG disclosure of cities and user expectations

Source: Adapted from Porter (1993, p. 50)

a fair and true account of emissions (Fong *et al.*, 2015). The Global Reporting Initiative (GRI) states that organisations need to provide balanced, accurate, reliable, timely, clear and comparable information to provide quality information (GRI, 2015). The Climate Disclosure Standards Board (CDSB) urges preparers to provide relevant, material, complete, accurate, consistent, comparable, understandable and verifiable information (CDSB, 2018).

The CDP wants to facilitate dialogue by providing quality information (Kolk *et al.*, 2008). Prior studies have also argued that quality information is vital for making good decisions (Kolk *et al.*, 2008; Liesen *et al.*, 2015) and that quality information has several essential criteria including accuracy, completeness, relevancy, reliability, timeliness and comparability (Lee *et al.*, 2002; Vaziri *et al.*, 2017) to be useful to stakeholders (Whittington, 2008). Similar to the true and fair view of financial information, users also expect a true and fair representation of an organisation's GHG footprint (Gibassier and Schaltegger, 2015). Prior studies have argued that CDP data does not meet the needs of users as the data is incomplete and inconsistent between organisations (Kolk *et al.*, 2008).

A short video available on the CDP's website contains statements by four CDP data users – two city officials, each from different cities, one analyst from Moody's Investors Service and one city manager in North America – about the way they would like to use CDP's city-level data (see, Appendix 1). These users expect the CDP's information to be comparable and useful for benchmarking and decision-making, summarised in Table IV. For example, Kerrie Romanow, the Director of Environmental Services for the City of San Jose, California, says:

> We like to use data to make decisions. We like to understand what is happening and make choices. We value the opportunity to collect our data and then to report it and see how we compare to other organisations. It helps keep us focused and gives us a good baseline understanding of where we are and opportunities for improvement.

Table III. Qualitative characteristics of information required by different standards setters for the information to be useful to the users

Standard/guideline providers	Qualitative characteristic of information
IASB	Relevance, reliability, faithful representation, comparability, verifiability, timeliness and understandability
GPC	Relevance, completeness, consistency, transparency and accuracy
GRI	Accuracy, reliability, timeliness, clearness and comparability
CDSB	Relevance, completeness, accuracy, consistency, comparability, understandability and verifiability

Table IV. User expectations of CDP city disclosures as per CDP video

Users	Users expectation of CDP cities disclosure
Christian Ward, Analyst Moody's Investors Service	Comparable data
Katie Walsh Cities Manager, North America CDP	Comparable data
Aaron Lewis, Policy Analyst, Mayor's Office for Long-Term Planning and Sustainability, New York City	Data for benchmarking
Kerrie Romanow, Director of Environmental Services, City of San Jose, California	Comparable data, Data for making decision

The CDP also wants users to use its data for making better decisions and managing risk. For decision-making, users need quality information (that is, accurate, complete, reliable and timely). Information quality is also important for comparability (Andrew and Cortese, 2012).

We have drawn on the three sources of user expectations reviewed above – statements by standard-setters, prior academic research and CDP-specific material – to arrive at the following characteristics of useful information: completeness, consistency, timeliness, accuracy, reliability and comparability. These characteristics are then used to evaluate the CDP reports provided by cities by the method described in the following section.

5. Research method

This section provides a brief description of the sample selection process, followed by a discussion on the analysis of city disclosures and the expectation gap.

5.1 Sample selection

This study uses a purposive sampling technique to derive knowledge about the behaviour of cities about their emissions disclosure practices. Previous disclosure research has focused on a particular company, rather than attempting to draw a sample that is representative of a larger population (see, for example, Gray *et al.*, 1995; Guthrie and Parker, 1990; Haque and Deegan, 2010) or selected companies with a specific purpose in mind. Islam and Islam (2011), for example, selected a multinational company to understand environmental disclosure behaviour after an environmental incident.

Cities disclosing their climate change information to the CDP in 2015 form the sample for this study. In 2015, the CDP made major changes to its questionnaires by including a section on the "Compact of Mayors" and adopting a common accounting standard for calculating the GHG emissions of a city, its C40 members, the World Bank and other international organisations. The CDP's repository is considered to be an appropriate data source as it has extensive experience in collecting GHG emissions data from corporations and cities. Doda *et al.* (2015, p. 4) argue that the CDP is "the most comprehensive data source on corporate climate change practices and performance". It is considered to be the "leading reporting initiative for large companies" by the European Commission (Marsh-Patrick, 2010, p. 77). It is also the largest repository of corporate and city GHG emissions data in the world (Reid and Toffel, 2009, p. 1163). CDP data provide a significant research opportunity for an in-depth investigation of GHG accounting and reporting (Andrew and Cortese, 2012; Kolk *et al.*, 2008). Several prior studies have used CDP data to explore climate change disclosure (Andrew and Cortese, 2012; Depoers *et al.*, 2016; Kolk *et al.*, 2008).

In 2015, 314 cities disclosed GHG information to the CDP. However, this study only selected cities that are part of the C40 network. The C40 network connects more than 80 of the world's greatest cities, representing "over 650 million people and one-quarter of the global economy"; these cities have committed to reducing their GHG emissions by a total of more than 3 Gt (C40, 2016b). According to the C40 website it members are already experiencing the effects of climate change and have started to focus on "tackling climate change and driving urban action that reduces GHG emissions and climate risks while increasing the health, well-being and economic opportunities for urban citizens".

The following criteria was used to identify sample cities:

- the city needed to be part of the C40 network;
- the city needed to provide regional/community-level emissions information, as this research examines regional-level GHG disclosures; and
- the information needed to be disclosed in English and available to the public.

There are 83 cities in the C40 network. Of the disclosures made to the CDP by all 83 cities, 24 did not make any disclosures, and the responses by another four cities were not accessible to the public. The remaining 55 responses were downloaded from the CDP database. Those that did not include community-level GHG emissions information (12) or were not in English (1) were excluded, leaving 42 cities as the final sample for this study.

5.2 Analysis of cities disclosures

After selecting the final sample of 42 responses, content analysis was used to gather and assess the GEI and ERT information they contain. According to Krippendorff (2012, p. 21), content analysis is "a method of classifying the text (or content) of a piece of written work into various categories by selection criteria". Content analysis is frequently used in social and environmental accounting disclosure research and has been frequently used as a research technique to assess GHG disclosures to CDP (Matisoff *et al.*, 2013).

The CDP's 2015 questionnaire was analysed to identify the questions relevant to a city's GEI and ERT. Several questions were selected that are relevant to GEIs and ERTs (see Table V). Then, the answers to each selected question were assessed and evaluated for each city. All responses in the final selection were read, re-read and analysed against the question before recording the responses in a word file. This process revealed several issues relating to the GEIs and ERTs of the cities.

The criteria used to analyse the GEIs included: when the city last calculated its GEI, what protocol it used, which GHGs were included, and which Scopes were measured. The responses were also examined to confirm whether the city had verified its disclosure and, if not, the reasons why were explored. After gathering all the information on GEIs, the information relating to ERTs was collected, as GEIs play an important role in setting ERTs. ERT disclosures were analysed by exploring whether each city had set an ERT and, if so, the level of emissions reduction, the baseline used for the targeted reduction, the period to achieve the reduction, and which sources of emissions are to be reduced.

CDP question ref number	GEI-related questions
C1.0	Accounting year or 12-month period for which cities are reporting a GHG emissions inventory for your community
C1.2	Primary protocol, standard or methodology used to calculate GHG emissions
C1.3	Which gases are included in emissions inventory
C1.4	Please detail total (Scope 1 + Scope 2) emissions for your community, in metric tonnes CO2e
C1.5	Please provide a breakdown of your GHG emissions by Scope
C1.9/11	Do you measure Scope 3 emissions
C1.12	Indicate if your emissions have increased, decreased or stayed the same since your last emissions inventory, and describe why
C1.13	Have the GHG emissions data you are currently reporting been externally verified or audited in part or in whole?
C1.13b	If no, please describe your plans to verify your emissions in the future
	GHG ERT-related question
7.0	Do you have a GHG ERT in place for your community?
7.0a	If yes, please provide details of your city-wide ERT, including baseline year, baseline emissions, percentages reduction target, name of the GHG sources where target will be applied
8.1	Does your city have a renewable energy or electricity target?

Table V.
CDP questions related to GEI and ERT analysed for this study

5.3 Analysis of a possible expectation gap

Following the individual analyses, the expectation gap framework was used to evaluate user expectations on climate change disclosures against the disclosures made by the cities to CDP.

We defined "users" as any stakeholder likely to use CDP cities information. Two broad user groups were identified, namely, internal and external groups. Internal users comprise the city's management and "those charged with governance", while external group were analysts, business organisations, other cities and citizens.

Using the characteristics established in section 4.1, we assessed selected cities' disclosure via CDP against these characteristics (see Table VI) to establish if there is an expectation gap.

To further refine the expectation gap into the reasonableness gap and performance gap, we performed the following additional analysis. To determine whether it is unreasonable for users to expect any of these characteristics (completeness, consistency, timeliness, accuracy, reliability and comparability) in disclosed emissions data several technical and geophysical factors were considered (Kennedy *et al.*, 2009). Geophysical factors (e.g. climate conditions, access to resources and gateway status) and technical factors (e.g. power generation, urban design and waste processing) influence a city's GHG emissions (Kennedy *et al.*, 2009). These factors may not affect the accurate and complete calculation of GEI for an individual city, but would hinder comparability of GEIs between two cities. Hence, is it unreasonable to expect comparable information from cities? To determine whether the CDP guidelines are deficient the CDP guidelines for cities' GHG disclosure was examined carefully.

The findings are outlined in the next section.

6. Research findings

Analysing the cities' responses revealed several issues associated with the disclosed GEIs and ERTs, which suggest the transparency and quality of their disclosures was deficient.

6.1 Issues associated with greenhouse gas emissions inventory

Developing a comprehensive GEI is the first step for most cities in taking action against climate change and subsequent policies and actions are primarily based on this GEI. The analysis in this study revealed five issues relating to GHG emissions in the GEI disclosures:

(1) the time gap between calculating and disclosing emissions;

(2) the diverse methodologies used to calculate emissions;

(3) the exclusion of some gases from the GEI;

Table VI. Assessment of users' expectation

Criteria for quality information (users' expectation)	Measurement
Completeness	GEIs to be complete, all seven types of GHGs are included and Scopes 1 and 2 are considered in GEIs
Consistency	GEIs to be consistent, selected cities have to use the same protocol/ guideline to measure GEIs and all cities have the same number of GHGs in their GEIs
Timeliness	Cities need to provide recent emissions data
Accuracy	Scopes 1 and 2 need to be equal to total disclosed GEIs. However, GEIs would also not be accurate if all seven GHGs were not included
Reliability	GEIs need to be verified to be reliable
Comparability	GEIs will be comparable if they are complete, consistent, accurate and reliable

(4) the exclusion of Scope 3 and, in some cases, Scope 2 emissions; and

(5) a disinclination to verify emissions data.

All these issues raise concerns about the accuracy, completeness, timeliness and reliability of the GEIs and impede the consistency and comparability of information among cities.

First, a time gap was found between the years when emission measurements were taken and when they were disclosed to CDP. Thus, the disclosed information is outdated and has little use. Only ten cities in 2015 were found to have disclosed emissions data that was calculated in or after 2014. Nearly half the cities (20) had calculated their emissions in or before 2012, yet disclosed the information to the CDP in 2015. For example, Jakarta's emission data was calculated in 2005, and Paris' data was calculated in 2009. Both cities disclosed that in 2015.

Second, there was no standardised method for calculating emissions. Although C40 encourages all its members to use GPC to measure GHG emissions a diverse range of methodologies was used. Table VII shows that 13 cities used GPC to measure GHG emissions, while nine cities, primarily from the US and Canada, used ICLEI. The IPCC and GPC protocols were popular among Australian and European cities. Our findings are consistent with prior studies that also observe diverse methodologies for measuring and calculating corporate GHG emissions (Andrew and Cortese, 2012; Kolk *et al.*, 2008). The use of different emissions guidelines can provide a different total of GEIs. A prior study has suggested that applying a different methodology can significantly change the total amount of GHG emissions (Pearson *et al.*, 2008).

A single common standard would allow evaluation of cities' relative strengths and weaknesses in dealing with climate change. According to Zoubida Allaoua, World Bank Director for Finance, Economics and Urban Development, "[a] common standard is a critical first step for cities to better understand their greenhouse gas emissions, with this knowledge cities can better target policies and inform their citizens" (World Bank, 2010). A common standard has important implications for comparison, benchmarking and policy assessment related to energy policies (Harris *et al.*, 2012) because cities "seek to reduce emissions by learning from the best practices of other cities" (Kennedy *et al.*, 2009, p.7301). This study recommends that cities use a common standard to calculate their GEIs.

Years when cites calculated GHG emissions	No. of cities
2005	1
2009	1
2010	3
2011	2
2012	13
2013	12
2014	9
2015	1
Total	42
Primary protocol	**No. of cities**
GPC	13
2006 IPCC	5
ICLEI	9
Other	15
Total	42

Table VII.
Protocol used to calculate GEI and years when cities have calculated GEI

Third, cities are urged to include seven types of GHGs in their GEIs identified by the UNFCCC, but only five cities incorporated all seven types of GHGs into their inventory (see Table VIII). Most cities (18) only included three types of gases (i.e. CO2, CH4, N2O) while four cities included just one gas (CO2). This finding compromises completeness and comparability, and raises concerns over a city's total disclosed emissions, as it potentially points to an understatement of emissions.

Fourth, issues with the disclosed GEIs were identified when breaking down a city's total GHG emissions according to Scopes 1 and 2. Although the CDP asks participants to provide a breakdown of their total emissions by Scopes 1 and 2, seven cities did not provide this information. Also, some cities only included Scope 1 emissions in their total GEI, yet ignored Scope 2 and vice versa. Most cities were reluctant to measure Scope 3 emissions, even though they can be substantial in some cases, consistent with the prior literature (Andrew and Cortese, 2012; Matisoff *et al.*, 2013).

Excluding any Scope from an emissions inventory may lead to significant under-disclosure of GHG emissions (Andrew and Cortese, 2011). Research has not examined the possible reasons for omitting Scope 3 information and this issue requires further examination. The cities in our sample cite a lack of resources and capacity, as well as the complexity involved in the calculations as reasons for not disclosing Scope 3 emissions. For example, Taipei City, the City of Dallas and the City of Stockholm all reported that Scope 3 emissions are difficult to measure.

Although 14 cities said they had measured the Scope 3 emissions, many only included emissions from waste. However, these emissions also arise from goods and services, water, aviation, road, transmission and distribution losses, railways, food, upstream emissions from energy use, and so on. A complete account of Scope 3 information could be valuable for many cities, and given the complexity of Scope 3 measurement there is potential for exchange of information. Policymakers, standard-setters, scientists and researchers have a role to play in developing a comprehensive framework to calculate Scope 3 emissions.

Further many cities did not include both Scopes 1 and 2 in their disclosures, nor all seven types of GHGs. Such exclusions not only understate the disclosed GEI but also impede comparability.

Finally, only 14 cities were found to have verified their disclosed emissions data and around 38 per cent have no short-term plans to do so. External verification of GHG emissions data can ensure higher levels of quality control and assurance and can increase the credibility and usefulness of the disclosed data (Kolk *et al.*, 2008; Simnett and Nugent, 2007). Some of the cities noted that they did not verify their emissions data because of cost, while 11 indicated that they intend to begin verifying their data in the future. Even those cities that did verify their emissions data did not report the outcome of the verification.

Table VIII.
Number of cities that included the number of gases in their GEI out of the seven GHGs

No. of GHGs included in GEI	No. of cities
1	4
2	2
3	18
4 or 5	5
6	7
7	5
Not disclosed	1
Total	42

6.2 Issues associated with emissions reduction targets

The next stage of the analysis involved exploring the cities' ERTs. As part of their strategies to reduce GHG emissions, many cities set ambitious ERTs and examination of these disclosures revealed several issues: differences in the baseline year; distorted application of percentages applied to the emissions sources; and different targets and target dates for emissions reduction.

First, it was found that different cities have different baseline years, which influences baseline emissions. The baseline year is the point in time that future emission levels will be measured against; hence, future targets for emissions reduction are sensitive to the year chosen. A slight variation in baseline year can significantly impact emission reduction strategies. For example, Australia has an ERT of 5 per cent by 2020 compared to levels in its baseline year of 2000. However, Australia had unusually high emissions in 2005. If 2005 had been chosen as the baseline, the same ERT would become a 13 per cent reduction instead of just 5 per cent (Climate Council, 2015).

Second, Table IX highlights that ERTs vary between 4 per cent and 100 per cent among the cities. For example, Mexico City aims to reduce its GHG emissions by 4 per cent compared to its baseline year emissions, whereas Copenhagen aimed to cut its emissions by 100 per cent.

Moreover, 33 cities correlated ERTs with the emission sources, but there were variations in their sources. For instance, only 13 cities declared their stated reduction percentages would apply to all emissions city-wide; most of these cities only specified three or fewer emission sources to apply these reductions to. Several cities only applied their ERTs to one specific emissions source. For example, Cape Town City only applied its ERT to emissions from electricity. London and Durban City only applied their ERTs to CO2 emissions. Other cities reported relatively high targets compared to other cities, but only applied their ERT to a limited number of sources. Additionally, different cities reported different target dates to reduce their specified emissions, ranging from 2015 to 2050. All these issues are significant in developing and implementing strategies, and a change to any of these parameters could cause significant changes to the disclosed ERT. Aligning a city's ERT with global ERTs is challenging given these inconsistencies, as is developing and applying standardised emissions reduction strategies and actions.

City GHG emissions mainly come from energy consumption and, for many cities, the primary source of this energy is fossil fuels. A renewable energy target for electricity could significantly decrease a city's GHG emissions yet two-thirds of the selected cities did not disclose a renewable energy target for electricity. Moreover, a detailed review of the third that did state renewable energy targets showed that some cities set those targets for the

Name of city	Baseline year	Baseline emissions	ERT (%)	GHG Sources to which target applies	ERT date
Sydney	2006	52,972	70	Scope 1 and Scope 2	2030
Copenhagen	2010	2,240,000	100	All sources	2025
Paris	2004	25,000,000	25	All sources, all scopes	2020
Mexico City	2012	24,516,369	4	Industrial, transport, waste, buildings	2020
Moscow	1990	63,443,619	25	Scope 1 only	2020
Cape Town	2007	20,550,172	10	Electricity	2012
London	2990	45,000,000	60	CO2	2025
Aspen and Pitkin	2004	762,829	30	Scope 1, Scope 2 and Scope 3	2020
Zaragoza	2007	1,237,553	20	Industry	2020

Table IX. GHG ERTs of selected cities

municipal boundary for their city rather than the whole city, for example, the City of Houston and the City of Hayward.

6.3 Elements of the expectation gap

Our findings show that cities' GHG related disclosure to CDP is incomplete, inconsistent, inaccurate, outdated, unreliable and not comparable and therefore, fails to meet users' expectations. This expectation gap may be owing to users' unreasonable expectations of cities' disclosure, the CDP's voluntary guidelines and cities' poor performance (see Table X).

The existing literature and statements by users (city officials and analysts) highlight that users expect a city's information to be comparable. However, different cities have different geophysical factors (Kennedy *et al.*, 2009), making comparison difficult. For example, City of Sydney's climate differs significantly from City of Toronto's, which influences the level of GHG emissions. Several technical factors also influence cities' total emissions (Kennedy *et al.*, 2009). For example, some Australian cities (e.g. Sydney and Melbourne) rely heavily on coal for energy production whereas European cities use more renewable sources, making comparison difficult. Also, cities are complex systems and their economic and governance systems differ widely (Hoornweg *et al.*, 2011), making comparison difficult. The expectation gap in relation to comparability may be reduced by educating users.

However, there is potential for a better disclosure system to be developed. Cities with similar characteristics may be able to compare information, for example, London and New York City (Kennedy *et al.*, 2009, p. 7301).

Given it developed the disclosure guidelines, the CDP has a role to play in the quality of disclosed emissions. The CDP's disclosure platform provides significant flexibility about the types of gases included in the GEI, which allows cities to choose the types of emissions they include and the protocols they use to measure their GEI. As a result, different cities have used different protocols to calculate GHG emissions, and several cities did not include all the GHGs in their GEI. Hence, the disclosed GEIs are likely to be incomplete, inaccurate, inconsistent and, therefore, not comparable. Hence there is an expectation gap.

Cities are also responsible, to some extent, for this expectation gap because of their poor performance in disclosure. Many disclosed incomplete and outdated information, used a different protocol to that recommended by the CDP, and set high ERTs but only applied them to certain types of emission sources. These issues can be overcome.

The CDP's deficiency in explicitly-stated disclosure guidelines and the selected cities poor performance has resulted in a deficient standard gap and performance gap respectively

Table X. CDP cities' GHG disclosure and expectation gaps

Expectation gap – findings suggest that there is an expectation gap between disclosed information and users' expectation as disclosed information is incomplete, inconsistent, inaccurate, outdated, unreliable and not comparable. This expectation gap can be classified as consisting of a reasonableness and a performance gap		
Reasonableness gap	While most user expectations of quality information are reasonable, it is unrealistic to expect disclosures of different cities to be comparable given differing geographic, economic and governance characteristics	
Performance gap	A deficient performance can be observed from both CDP and selected cities that led to performance gap. The performance gap comprises:	
	Deficient standards gap Flexible nature of CDP cities guideline led to deficient standards gap	Deficient performance gap Cities could perform better by including all GHGs, and all the scopes and by proving verified information

that could be reduced if the CDP and cities worked together. A review of the 2015, 2016 and 2017 CDP guidelines for city-level GHG disclosures shows that the CDP encourages cities to use GPC to calculate GHG emissions and include all GHGs into their GEI. However, the CDP remains flexible as to whether cities follow both those recommendations when preparing their GEI. Therefore, mandatory reporting guidelines would create more accurate, complete and consistent GEIs.

7. Conclusion

Users expect cities to disclose information that is complete, consistent, timely, accurate, reliable and comparable. However, the findings of this research suggest that, in many cases, cities' disclosure of GEI and ERT related information is incomplete, inconsistent, inaccurate, unreliable, and not comparable. The information disclosed may also lack relevance, as many cities disclosed old and outdated emissions data.

This study makes several contributions to the literature and has implications for both policy and practice. This research has responded to the call to explore disclosures at a regional level (Gray, 2010) with a novel application of the expectation gap framework to GHG disclosure in the public sector, that is cities, which are critical in combating climate change.

Contrary to expectations, public sector organisations are not better at providing sustainability disclosures than the private sector (Ball and Bebbington, 2008). Similar to prior studies, this study finds that disclosed information to the CDP is incomplete, inconsistent, not verified and therefore not comparable (Kolk *et al.*, 2008; Andrew, and Cortese, 2012) and hence of limited use to stakeholders.

This study expands the use of the expectation gap framework to identify whether disclosed information can meet users' expectation. This use of the expectation gap framework could be applied in other areas of social and environmental accounting research to understand whether information disclosed by different organisations meets users' expectation.

The findings of the study suggest there is scope for the CDP to improve and standardise its disclosure system, working in collaboration with cities and their alliance, C40. A particular area of weakness is in the measurement of Scope 3 emissions. The CDP needs to ensure cities follow the international guidelines GPC for emissions accounting, provide data on a timely basis and include all sources and all types of GHGs required by the UNFCCC. Also, the CDP might encourage higher quality disclosures by introducing a rating based on disclosure quality, similar that of the GRI.

An important finding of our study is that, even with greater standardisation, city-level emissions comparison is not possible because of the different characteristics of cities. Given that comparison of emissions is not possible, the most useful disclosures are likely to be the actions cities take to reduce emissions and the impact of those actions. By disclosing these, cities can learn from each other, with the aim of improving emissions reduction. To facilitate this the CDP can focus on asking for more information at a project or activity level. For example, the CDP can ask what projects are undertaken. A case in point is the "smart city" concept, which enables cities to implement an integrated business management system, where, for example, the implementation of a smart LED lighting system can reduce energy consumption, thus contributing to reduction in cities' GHG footprint. The CDP has the capacity to facilitate greater knowledge sharing amongst cities by asking for more specific information about projects and providing standardised (e.g. the quantum of emissions reduced from each project, the project cost and payback periods) and customised indicators

that will allow cities to measure and disclose the environemntal and financial perfomance of specific emissions reduction actions.

This study also reveals that many cities are reluctant to verify their emissions data, primarily, owing to a lack of funding. This finding has implications for policy, in terms of allocating funds. There are no mandatory requirements to verify data at this stage; however, verified data could increase user confidence.

This study also has several limitations. The first limitation is the small sample size. Only city disclosures were selected for analysis and the cities that disclose to the CDP are primarily located in North and South America, Europe and Australia so the total population of cities is not represented and the findings cannot be generalised. Future studies might conduct the same research with a broader sample.

The second limitation is that this study only considered disclosures made to the CDP, and further information may have been disclosed through other media such as the internet, annual reports, and so on. However, the CDP has been accumulating a large amount of climate change data about these cities since 2011; therefore, the findings should be sufficient to show the challenges with current GHG disclosures. A third limitation relates to basing the definitions of quality and user expectations on the statements of a few city officials as a proxy for all users. Those officials may not fully represent the users of the CDP's city data. Future studies can examine different media used by cities to disclose GHG emissions information and the quality of disclosure through each medium and could survey or interview users regarding what types of GHG information they want. Moreover, future study can investigate the correlation between factors affecting the expectation gaps and the size of the expectation gap.

Few studies explore the protocols and processes involved in calculating GEIs, and the type and nature of information disclosed, both narrative and quantitative, that users would like to see from various government departments, cities and local governments. This is an avenue for future research as is a longitudinal study examining whether climate change performance in cities has improved, or whether GHG emissions have reduced following their actions.

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Appendix 1

Users	Users expectation from CDP Cities disclosure
Alicia Zatcoff, Sustainability Manager, City of Richmond, Virginia	It shows to our citizens that we are very serious about our sustainability commitment
Christian Ward, Analyst Moody's Investors Service	CDP data allows us to compare cities across the nation
Katie Walsh Cities Manager, North America CDP	Cities can compare themselves with their peers and understand where they can look for a better opportunity or where they can innovate new areas
Aaron Lewis, Policy Analyst, Mayor's Office for Long-Term Planning and Sustainability, New York City	It is really exciting to have that peer to peer checking process because it is not only let you help benchmark for how you doing but also may be how far you need to come along the way
Kerrie Romanow, Director of Environmental Services, City of San Jose, California	We like to use data to make decision. We like to understand what is happening and make choices. We really value the opportunity to collect our own data and then to report it and see how we compare against other organisation. It helps keep us focus and give us good baseline understanding of where we are and opportunities for improvement. So, we like to see how we are doing, we like to see where we can make some adjustments and at the end really set the stage for not only for our community and our nation but for the world to do better

Table AI.
CDP Data users' statements from video available at CDP website

Table AII. Cities' GHG emissions related information

				GEI details							ERTs			
Cities	Country	Reporting period	Primary protocol	GHGs included	Total emissions	Scope 1	Scope 2	Scope 3	Verified	ERTs	Baseline year	Ba seline emission	% Reduction target	Target date	ERAs reported
Addis Ababa	Ethiopia	2012	GPC	CO2, CH4, N2O	3,708,292	3,708,292	NA	Yes	No	No					No
Cape Town	South Africa	2012	GPC	CO2, CH4, N2O	22,683,041	10,554,025	12,860,112	Yes	Yes	Yes	2007	20,550,172	10	2012	Yes
Durban	South Africa	2013	Oth	CO2, CH4, N2O	7,008,647	6,625,542	38,3105	Yes	No	Yes	2006	21,413,906	24.5	2020	Yes
Johannesburg	South Africa	2015	GPC	CO2, CH4, N2O, SF6, HFCs, PFCs, NF3	2,6226,549	7,963,896	18,262,653	Na	No	No					No
Lagos	Nigeria	2014	GPC	CO2, CH4	NA	29,426,266	NA	Na	No	No					Yes
Tshwane	South Africa	2013	ICLEI	CO2, CH4, N2O, SF6, HFCs	11,984,729	1,195,282	11,984,729	No	No	No					Yes
Hong Kong	China	2011	2006 IPCC	CO2, CH4, N2O, SF6, HFCs, PFCs	4,2700,000	NA	NA	No	No	Yes	2005	42,000,000	55	2020	Yes
Seoul	Korea	2013	2006 IPCC	CO2, CH4, N2O, SF6, HFCs, PFCs	48,550,952	48,550,952	48,550,952	Yes	Yes	Yes	2005	49,467,000	25	2020	Yes
Tokyo	Japan	2013	2006 IPCC	CO2	14,364,400	6,339,900	8,427,100	No	Yes	Yes	1990	10,362,700	60	2050	No
Yokohama	Japan	2012	Other	CO2, CH4, N2O, SF6, PFCs	21,039,000	12,780,000	8,259,000	No	No	Yes	2005	19,540,000	16	2020	Yes
Amsterdam	Netherland	2014	Oth	CO2, N2O	4455000	1386000	3069000	No	Yes	Yes	1990	4134000	40	2025	Yes
Berlin	Germany	2010	Other	NA	21,299,000	NA	NA	No	Yes	Yes	1990	29,330,000	40	2020	Yes
Copenhagen	Denmark	2014	Other	CO2, CH4, N2O	1,626,573	NA	NA	No	No	Yes	2010	2,240,000	100	2025	Yes
London	UK	2012	GPC	CO2, CH4, N2O	40,750,490	20,405,378	20,345,112	NA	No	Yes	1990	45,000,000	60	2025	Yes
Madrid	Spain	2012	Other	CO2, CH4, N2O, SF6, HFCs, PFCs, NF3	11,980,000	6,849,000	5,131,000	No	No	Yes	2005	11,527,000	35	2020	Yes
Moscow	Russia	2014	GPC	CO2, CH4, N2O, HFCs, PFCs	74,753,792	67,750,580	7,003,212	Yes	No	Yes	1990	63,443,619	25	2020	Yes
Oslo	Norway	2013	GPC	CO2, CH4, N2O	1,298,000	1,298,000	NA	No	Yes	Yes	1991	1,200,000	50	2030	Yes
Paris	France	2009	Other	CO2, CH4, N2O, SF6, HFCs, PFCs, NF3	7,413,300	5,922,600	1,490,700	Yes	Yes	Yes	2004	25,000,000	25	2020	Yes
Rotterdam	Netherland	2014	Other	CO2	28,202,000	28,202,000	1,573,000	No	no	no					Yes
Stockholm	Sweden	2012	Other	CO2, CH4, N2O	2,511,000	NA	NA	No	Yes	Yes	1990	3,668,000	24	2020	Yes
Warsaw	Poland	2012	Other	CO2	12,706,696	NA	NA	No	No	yes	2007	12,952,984	20	2020	Yes
Bogota	Colombia	2014	2006	IPCC	CO2, CH4, N2O	13,217,521	10,463,010	2,754,511	No	No	No				Yes
Buenos Aires	Argentina	2013	GPC	CO2, CH4, N2O	11,438,694	696,455	4,471,238	No	Yes	Yes	NA	NA	30	2030	Yes
Caracas	Venezuela	2014	GPC	CO2, CH4, N2O	17,621,788	14,310,457	3,311,332	No	No	No					Yes
Mexico City	Mexico	2012	GPC	CO2, CH4, N2O	24084942	16266732	7818210	No	No	yes	2012	24516369	4	2020	Yes
Quito	Ecuador	2011	2006 IPCC	CO2, CH4, N2O, SF6, HFCs	5,164,945	4,589,061	575,884	No	No	Yes	2011	5,164,946	30	2025	Yes

(*continued*)

Table AII.

				GEI details						ERTs					
Cities	Country	Reporting period	Primary protocol	GHGs included	Total emissions	Scope 1	Scope 2	Scope 3	Verified	ERTs	Baseline year	Ba seline emission	% Reduction target	Target date	ERAs reported
Rio de Janeiro	Brazil	2012	GPC	CO2, CH4, N2O	20,268,045	16,171,534	4,096,511	Y	Yes	Yes	2005	11,933,280	20	2020	Yes
Boston	USA	2013	ICLEI	CO2, CH4, N2O, SF6, HFCs, PFCs	6,135,026	3,711,516	2,423,510	No	No	Yes	2005	744,000	25	2020	Yes
Chicago	USA	2010	Other	CO2, CH4, N2O, SF6, HFCs, PFCs, NF3	33,500,000	NA	NA	No	Yes	Yes	1990	32,300,000	20	2020	Yes
Houston	USA	2014	ICLEI	CO2, CH4, N2O	33,428,301	18,917,039	14,511,262	Yes	No	No					Yes
Los Angeles	USA	2013	ICLEI	CO2, CH4, N2O, SF6, PFCs, HFC	32,289,089	23,161,143	8,998,155	No	Yes	Yes	1990	54,100,000	45	2025	Yes
New York	USA	2013	Other	CO2, CH4, N2O, SF6	45,993,429	29,104,659	16,888,770	Yes	No	Yes	2006	59	30	2030	Yes
Philadelphia	USA	2012	ICLEI	CO2, CH4, N2O, SF6, PFCs, HFC	19,212,870	12,397,594	6,815,276	Yes	No	Yes	2006	22,837,228	20	2015	Yes
Portland	USA	2013	ICLEI	CO2, CH4, N2O	7,601,940	4,659,398	2,942,542	Yes	No	Yes	1990	8,989,460	40	2030	Yes
San Francisco	USA	2012	ICLEI	CO2, CH4, N2O	4,574,578	2,073,988	2,500,590	Yes	Yes	Yes	1990	6,201,949	25	2017	Yes
Seattle	USA	2012	ICLEI	CO2, CH4, SF6	5,129,000	5,038,000	91,000	No	Yes	Yes	2008	3647,000	100	2050	Yes
Toronto	Canada	2012	GPC	CO2	20,313,061	20,313,061	9,787,093	No	No	Yes	1990	27,051,617	80	2050	Yes
Vancouver	Canada	2013	ICLEI	CO2, CH4, N2O	2,625,609	2,553,825	71,784	No	No	Yes	2007	2,805,000	33	2020	Yes
Jakarta	Indonesia	2005	Other	NA	43,860,000	NA	NA	No	No	Yes	2005	34,670,000	0	2030	No
Melbourne	Australia	2014	GPC	CO2, CH4, N2O, SF6, PFCs, HFC	5,805,437	1,359,830	4,445,607	Yes	No	Yes	2009	4,934	100	2020	Yes
Singapore	Singapore	2010	Other	CO2, CH4, N2O, SF6, PFCs, HFC	46,831,860	46,831,860	NA	No	No	Yes	Other	77.2	11	2020	Yes
Sydney	Australia	2013	Other	CO2, CH4, N2O, SF6, HFCs, PFCs, NF3	5,052,256	30,8060	4,005,053	Yes	No	Yes	2006	52,972	70%	2030	Yes

Notes: ERA = emissions reduction actions; NA = not available

Chapter 5 – Paper 2: Measuring for Climate Actions: A Disclosure Study of Ten Megacities

Mia, P., Hazelton, J., and Guthrie, J. (2018). Measuring for climate actions: a disclosure study of ten megacities. *Meditari Accountancy Research*, 26(4), 550-575

Measuring for climate actions: a disclosure study of ten megacities

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Abstract

Purpose – This paper aims to explore the disclosure of greenhouse gas (GHG) emissions by megacities. Three dimensions were considered. First, what communication channels are used by world megacities to disclose their emissions reduction target (ERT) and emissions reduction actions (ERA)? Second, the consistency of disclosed ERT and ERA across different channels. Third, the quality of the disclosed ERA in different channels.

Design/methodology/approach – Ten megacities selected for review were in Australia, Europe, the USA, the UK and South Africa. First, ERT and ERA information was searched in different disclosure media to identify the common communication channels used by the megacities. Second, the documentary analysis was undertaken to assess the consistency of reported ERT and ERA information across the identified channels. Third, a scoring system was developed and applied to evaluate the quality of the disclosed ERA information, based on the extent to which megacities provided descriptions of emission reduction actions and reported the impact of the actions and the cost to implement them.

Findings – Megacities primarily used third-party channels and their channels to disclose ERT- and ERA-related information. Social media use to provide climate change information is also growing. The study also finds that ERT information is consistent between third-party channels and megacities' channels. However, around half of the disclosed ERA between third-party and megacities' channels are not consistent. Quality assessment for the disclosed ERA in different channels shows that megacities have provided limited information regarding the impacts and the cost of their ERA, which raises a question about the usefulness of disclosure.

Research limitations/implications – The findings are important for policymakers and city officials designing cities' GHG reporting standards and developing policies for programs to reduce emissions. Also, for stakeholders' understanding of cities' commitment and actions to reduce emissions, as well as the impact of their actions, and for managers responsible for measuring, reporting and mitigating emissions from current and future actions.

Originality/value – Prior studies primarily focused on corporate greenhouse emissions disclosure to the carbon disclosure project, whereas this paper examines emissions disclosure at the geographic level. Moreover, prior studies of the public sector focused on the scope of climate change disclosure but did not evaluate the consistency and quality of the disclosure. However, this study explores three different disclosure

Meditari Accountancy Research
Vol. 26 No. 4, 2018
pp. 550-575

2049-372X
DOI 10.1108/MEDAR-08-2017-0192

The authors wish to thank the anonymous reviewers for their helpful comments and the participants at the RMIT Governance and Sustainability Conference and Meditari Accountancy Research Conference in 2017.

channels and assesses consistency and quality. A further novel aspect of the study is its focus on the disclosure of emissions reduction targets and actions.

Keywords Climate change, City, Disclosure, Public sector, Emission

Paper type Research paper

1. Introduction

Sustainable development (SD) is a topic of national and international importance. Although there are many issues around SD, the climate crisis has generated the significant attention (Dwyer *et al.*, 2009). The climate crisis poses a serious threat to society and the environment, and since the mid-twentieth century, greenhouse gas (GHG) emissions from human activities are the leading cause of observed climate change (IPCC, 2013).

GHG emissions (hereafter emissions) from cities are the single largest human contribution to climate change (Duren and Miller, 2012). In cities, more than 70 per cent of the world's emissions are produced (Bulkeley, 2010; CDP, 2016). Therefore, cities have a vital role to play in implementing international agreements and national policies on emissions reduction (Bulkeley and Betsill, 2005).

Cities are the centre of wealth and innovation, as well as the hub of political and economic activity, and thus have the ability and resources to tackle climate change (Hunt and Watkiss, 2011; Kennedy *et al.*, 2012; Rosenzweig *et al.*, 2010; World Bank, 2010). Cities generate over 70 per cent of the world's GDP and accommodate more than half of the world population according to the UN[1]. They have jurisdiction over many decisions that may have a direct and indirect effect on climate change, including emissions reduction. Cities have the potential to take a central role in moving communities towards a more sustainable future by implementing policies at the local level to reduce emissions. They have the unique ability to tackle any global issue, including climate change, at a local, more visceral level, as they offer more immediate and effective communication between the public and decision makers (Hoornweg *et al.*, 2011). City administrations and their citizens together can achieve the largest share of emissions reductions (Hoornweg *et al.*, 2011). Moreover, city mayors are accountable to their constituents for their decisions and can take decisive action – often with immediate and impactful results. What cities do alone and together to tackle climate change can set the agenda for communities and governments everywhere[2].

Cities began to engage with climate change issues in the early 1990s and are increasingly aware of the need to mitigate emissions (Bulkeley, 2010; Heidrich *et al.*, 2013). To date, many cities have undertaken a climate change risk assessment; set ambitious emissions reduction targets (ERTs); and introduced policies, strategies, plans and programmes to reduce emissions (CDP, 2016; Heidrich *et al.*, 2013; Reckien *et al.*, 2014). The alliance of world megacities, C40, announced that policies and actions already being implemented at city level "have the potential to reduce emissions by 1 billion metric tons of carbon dioxide equivalent (CO2e) annually by 2030" (Ostrander and Oliveira, 2013, p. 7). The C40 has formed a partnership with the carbon disclosure project (CDP) and encourages its members to disclose various climate change-related information to CDP. Disclosure is essential for the effective management of carbon and climate change risk and the CDP disclosure system provides the opportunity for cities to learn from other cities, identifying opportunities, giving access to tracking and analysis and providing visibility to the key issues (CDP, 2016). Disclosing is also an important requirement for compliance with the Compact of Mayors[3]. City leaders and stakeholders need information to make decisions and drive effective action, and CDP disclosure provides that information[4]. Many cities have reported their ERT to the CDP and articulated their actions to reduce emissions (CDP, 2016; Mia *et al.*, 2016).

Moreover, being primarily responsible for GHG emissions, cities bear varying responsibilities in formulating and implementing policies to promote management of emissions and provide a better living environment for present and future generations. Cities are accountable to citizens (as well as to the state and federal government) regarding the management of emissions. Therefore, it is expected that they disclose their emissions and actions to the public. Several media are available for cities to disseminate their emissions information. Hence, exploring city-level disclosure provides an understanding of cities' emissions, their ERT and their emissions reduction actions (ERA).

Emissions disclosure has received significant research attention in recent decades, indicating the importance of GHG disclosure studies (Ascui, 2014). However, prior studies predominantly focused on corporate-level GHG disclosure (Bui and de Villiers, 2017; Depoers *et al.*, 2016). There has been limited research, especially in accounting, exploring cities' GHG disclosure. A recent study by Mia *et al.* (2016) investigated megacities' GHG disclosure to CDP and showed that many megacities have developed their emissions inventory and set ERTs, which are the first and vital steps for developing policies and actions to cut emissions. This paper extends previous research by investigating city-level disclosure and investigates what channels are being used to disseminate megacities' ERT and ERA information? Is there any consistency in reported ERT and ERA information across different channels? What is the level of quality of disclosed ERA information across different channels? Understanding cities' ERT and ERA could help cities and policymakers better manage emissions.

This paper focuses on the different channels that megacities can use to disseminate GHG information regarding ERT and ERA. Megacities can use, for example, their channels, for example, annual reports and website. They can also disclose emissions information through a third-party channel, such as the CDP, as well as via social media channels, such as Facebook and Twitter. By providing GHG information using multiple disclosure channels, megacities can reach a wide range of stakeholders to communicate their actions and commitment to climate change. This paper also examines the consistency of reported ERT and the proposed date to reach that target across different channels. Consistency for ERA is also measured. Furthermore, this study has assessed the quality of disclosed ERA based on the extent of disclosed information. More information around disclosure channels and the assessment of consistency and quality is available in the research method section.

The remainder of this paper is structured as follows. Section 2 reviews the existing literature and identifies gaps. Section 3 discusses the theoretical frameworks, followed by a discussion on the research methods in Section 4. Section 5 provides the findings of this study. Finally, Section 6 provides a discussion of findings and concludes the paper with the limitations of this study and an outlook for possible future research.

2. Literature review

Disclosure studies have received attention from accounting academics and have been dominating SD accounting research over the past three decades. This section provides a review of disclosure studies within the SD accounting research literature, which were used in this study for identifying research gaps and constructing the research questions.

Prior studies have explored various issues around SD disclosure. They have investigated and analysed the motivation for SD disclosure (Bebbington *et al.*, 2008; Boesso and Kumar, 2007; Cowan and Deegan, 2011; Deegan, 2002; Farneti and Guthrie, 2009). Also, the scope of reporting boundaries (Buniamin, 2012; Comyns and Figge, 2015; Dwyer *et al.*, 2009; Guthrie and Farneti, 2008). The impact of SD disclosure on capital markets (Guidry and Patten, 2010; Lee *et al.*, 2015; Zhou *et al.*, 2017) and the quality of SD disclosure (Andrew and Cortese, 2012; Brammer and Pavelin, 2008; Buniamin, 2012; Kolk *et al.*, 2008). This prior literature on

disclosure studies has predominantly focused on the corporate sector, while the public sector has been largely ignored (Dumay *et al.*, 2010; Guthrie and Farneti, 2008). City or geographic level disclosure remains largely unexplored. Moreover, there have been limited studies especially in the public sector and at the city level that explore multiple disclosure media together. Furthermore, it is very rare to find any disclosure study that explores what particular organisations are doing to uphold their commitment or promises or to solve specific problems or challenges. Finally, although many studies are focusing on the private sector that assesses the quality of disclosure, few studies to date examine other sectors, such as, NGOs, the public sector, local governments or city governments.

Cities are an important area of research but have been largely overlooked by accounting academics (Lapsley *et al.*, 2010). Although city-based SD has received a considerable amount of research attention, city-based disclosure studies have mostly been ignored by researchers. While studies (Guthrie and Farneti, 2008; Hopwood and Unerman, 2010; Milne and Gray, 2013; Parker, 2005; Patten, 2012; Ascui, 2014; Comyns and Figge, 2015; Depoers *et al.*, 2016; Mia and Al Mamun, 2011) have made significant contributions to the disclosure literature by exploring various economic, social and environmental issues. However, most have had a corporate focus. Corporate disclosure practices have been criticised for being predominantly self-laudatory, too general, limited in nature, often inconsistent and incomplete (Deegan *et al.*, 2000; Gibson and Guthrie, 1995; Gray, 2010; Gray *et al.*, 1996; Harte and Owen, 1991). It is argued that corporate level accounting "does not address the wider implications of sustainability from a global or ecosystems perspective" (Dumay *et al.*, 2010, p. 535). Therefore, the issue of SD, including climate change, needs to be explored beyond the corporate level (Dumay *et al.*, 2010). Moreover, SD objectives are often aligned with the objectives of public sector organisations (Ball and Bebbington, 2008); therefore, they have more opportunity than private corporations to communicate SD issues to broader stakeholders. However, public sector disclosure studies are limited to some government organisations (Grossi *et al.*, 2015; Guthrie and Farneti, 2008) and some local governments (Goswami and Lodhia, 2014; Joseph *et al.*, 2014; Williams *et al.*, 2011). Hence, other public sector organisations, such as cities, remain relatively unexplored. This study advances the prior literature by extending the literature of disclosure studies to the city level.

Prior studies have explored mostly annual reports, sustainability reports and websites to investigate SD disclosure in the private and public sectors (Depoers *et al.*, 2016; Dwyer *et al.*, 2009; Lodhia, 2014; Mia and Al Mamun, 2011; Williams *et al.*, 2011). Also, the CDP is becoming a popular medium for cities and corporations to disclose climate change information. Thousands of corporations and hundreds of cities disclose various climate change information to the CDP[5]. Several prior studies explored corporate disclosure to the CDP (Andrew and Cortese, 2012; Depoers *et al.*, 2016; Kolk *et al.*, 2008), but did not specifically focus on cities. Social media may be a valuable communication channel for SD, as it has rich features and capabilities that are available to stakeholders (Lodhia and Stone, 2017). However, to date, it has received little attention from SD accounting research. Social media has significant potential to enhance communication with stakeholders about various SD issues (Bellucci *et al.*, 2017; Lodhia and Stone, 2017). Hence, this study fills a research gap identified by exploring megacities' GHG disclosure. It extends the prior literature by considering a range of available communication channels available to cities, such as megacities' own channels, third-party channels and social media channels. Therefore, the following research question was formulated:

RQ1. What channels are being used to disseminate megacities' ERT and ERA information?

The use of different channels may allow cities to reach mass users. Several media, such as Facebook and website forums, can provide broader stakeholder engagement (Bertot *et al.*, 2012; Unerman and Bennett, 2004). It is argued in the literature that media that allow broader stakeholder engagement enhance transparency and promote new forms of accountability (Bonsón *et al.*, 2012). Exploring this question will provide information regarding whether megacities are taking the opportunities of alternative channels along with traditional channels to disclose their ERT and ERA. Moreover, exploring different channels for megacities' GHG disclosure allows for the analysis of the consistency of disclosed information across different channels.

Analysis of information consistency is important because several prior studies explored SD disclosure and found that information is inconsistent among the reporting entities, both private and public organisation (Andrew and Cortese, 2012; Kolk *et al.*, 2008; Williams *et al.*, 2011). Prior studies assessed the consistency of information among the organisations but did not assess the consistency of reported information among the different communication channels. Because there have been limited attempts to assess the consistency of disclosed information across different channels (Depoers *et al.*, 2016), this study assesses the consistency of reported information among the different communication channels for selected megacities. Therefore, following research question was formulated:

RQ2. Is there any consistency in reported ERT and ERA information across different channels?

Exploring *RQ2* will help to understand whether megacities have disclosed similar ERT and ERA through different channels. Having similar information through different channels has the potential to increase public confidence in megacities' ERT and ERA. It is argued that providing similar information through different channels may reduce the cost of disclosure and increase users' confidence (Depoers *et al.*, 2016).

Regarding the quality of disclosure, prior studies found that although the amount of SD disclosure has increased significantly over time, the quality of disclosure remains questionable (Brammer and Pavelin, 2008). Several prior studies measured the quality of disclosure. However, there is more than one way to define and measure quality. The definition of quality varies widely and measuring quality is debatable. There is no specific guideline to measure quality, particularly when qualitative information is being assessed. Moreover, data are frequently hand collected, and techniques applied by researchers varies; thus, the measurement of quality is inevitably subjective (Hooks and van Staden, 2011).

Many prior studies assessed the quality of disclosure based on a simple binary record of the extent (presence or absence) of an item or based on some measure of the extent of disclosure (e.g. the number of word, sentence, page and proportions), particularly for qualitative information (Deegan and Gordon, 1996; Guthrie *et al.*, 2006; Unerman, 2000). In this case, the amount (volume) of information is considered to be a proxy for quality. However, this form of measurement is subject to variation across companies and time in writing style and page and font sizes (Brammer and Pavelin, 2008). Moreover, some high-quality reports may be concise and to the point, but not very long (van Staden and Hooks, 2007). Some prior studies explored corporate-level disclosure and assessed the quality of the disclosure by using a quality index (Brammer and Pavelin, 2008; Cormier and Gordon, 2001; Cormier *et al.*, 2005; Wiseman, 1982). These prior studies have argued that having quantitative information indicates higher quality information.

The prior literature suggests that quantification is the most important aspect of quality, as most researchers awarded the highest score for any disclosures that have quantitative information (Brammer and Pavelin, 2008; Hasseldine *et al.*, 2005; Wiseman, 1982). Many

standard-setting bodies, such as the Global Reporting Initiative (GRI) and the Association of Chartered Certified Accountants, also emphasise providing quantitative information (Brammer and Pavelin, 2008). For example, the GRI requires companies to provide "total energy consumption", "amount of water consumption", "total GHG emissions" and much more quantified information around various social, economic and environmental issues (GRI, 2013). However, prior studies suggest that qualitative (narrative) information dominates the disclosures and fewer organisations provide quantitative information (Ahmad and Mohamad, 2014; Guthrie and Farneti, 2008).

Prior disclosure studies within the public sector suggest that public sector organisations are disclosing various social, economic and environmental information (Guthrie and Farneti, 2008; Lodhia, 2010; Williams *et al.*, 2011). A study conducted by Guthrie and Farneti (2008) found that disclosure was non-monetary and narrative. However, this paper only recorded the incidence of disclosure but did not measure the quality of SD disclosure. Other disclosure studies on the public sector (Cooper and Pearce, 2011; Goswami and Lodhia, 2014; Joseph *et al.*, 2014; Marcuccio and Steccolini, 2005; Williams *et al.*, 2011) did not explore the quality of the disclosure. Prior work at the corporate level has shown that it is possible to evaluate reporting quality rigorously but that this approach has not been adopted within public sector reporting. This paper addresses this gap by constructing a quality framework for city-based emissions and evaluating the quality of disclosure by the megacities in the sample. Thus, the following research question was formulated:

RQ3. What is the level of the quality of disclosed ERA information across different channels?

There are different ways to define and assess quality. In this paper, quality is the extent of information that is disclosed. In other words, quality is based on the extent to which megacities provide descriptions of ERA, reported the impact of the actions and the cost to implement the actions. Therefore, understanding the quality of the disclosed ERA would benefit city officials, policymakers and citizens in evaluating, assessing and monitoring megacities' ERA.

To explore the research questions established in this literature review section, this study adopts two theoretical frameworks, which will now be discussed in the next section.

3. Theoretical framework

This study uses accountability theory and media richness theory (MRT). Accountability theory explains the importance of disclosures and MRT explains why alternative disclosure might be useful especially for discharging accountability.

3.1 Accountability

Cooper and Owen (2007) state that accountability is discharged by providing information to various stakeholders. The financial disclosures provide a mechanism to discharge financial accountability; likewise, SD disclosure provides a mechanism to discharge social and environmental accountability (Aziz and Coulson, 2010; Tan and Egan, 2017). Organisations attempt to establish their SD credentials by producing print- and internet-based SD disclosures (Cooper and Owen, 2007). For public sector organisations or government entities, the publication of annual reports is considered to be a primary medium of accountability (Rosair and Taylor, 2000). However, public reporting will only satisfy accountability when the information provided reflects stakeholders' needs (Coy and Dixon, 2004). Dialogue or consultation with stakeholders allows managers to understand their stakeholders' needs, and governance and accountability should focus on addressing these social, environmental,

economic and ethical needs (Unerman and Bennett, 2004). Disclosures have limited value without stakeholder dialogue. According to the leading standard on social and environmental disclosure, the GRI's corporate sustainability reporting guidelines,

> A primary goal of reporting is to contribute to an ongoing stakeholder dialogue. Reports alone provide little value if they fail to inform stakeholders or support a dialogue that influences the decisions and behaviour of both the reporting organisation and its stakeholders (GRI, 2002, p. 9).

Different disciplines define accountability in different ways. For instance, within the accounting discipline, there is a distinct lack of consensus as to what is accountability (Cooper and Owen, 2007). Accountability can refer to the obligation "to provide an account (by no means necessarily a financial account) or reckoning of those actions for which one is held responsible" (Gray *et al.*, 1996, p. 38). Therefore, accountability can be the duty of an entity to use (and prevent the misuse of) the resources entrusted within the boundaries of the moral and legal framework of society. Also, to provide an account of its actions to accountees who are not only the persons who provided it with its financial resources but to other groups within society and society at large (Ibrahim *et al.*, 2004).

Several authors argue that the concept of accountability as an accounting and reporting function and others refer to it as a range of loosely defined political jargons incorporating equity, democracy, transparency and integrity (Tan and Egan, 2017). According to Pollitt (2003), the concept of accountability is predicated on a social relationship between at least two actors, whereby one party (the account-giver) to the relationship assumes the duty to provide an account of actions to another party (the recipient). In this accountability relationship, the recipient has the right to receive information, and the account-giver has the responsibility to provide details (Aziz and Coulson, 2010).

Conventional print-based communication media, such as annual report and stand-alone SD disclosure, provide mainly a unidirectional flow of information and limit stakeholder dialogue (Lodhia, 2004). While internet-based communication media (e.g. website forums and social media) is useful because of a large number of stakeholders who can be reached at relatively little marginal cost and because of their ability for interactive communication (Unerman and Bennett, 2004). Therefore, there are several conventional and alternative disclosure media available to organisations to facilitate communication and discharge their accountability to the broader group of stakeholders.

3.2 Media richness theory

Organisations use a variety of communication mechanisms in their attempts at overcoming the difficulties of identifying, reaching and engaging in dialogue with a wide range and a large number of stakeholders (Unerman and Bennett, 2004). This paper examines the features and capabilities of several different media by applying MRT. This theory allows understanding of the rich features and capabilities possessed by different disclosure media or channels that have potentially significant application in enhancing external communications with stakeholders.

MRT explains that rich media is more effective for communicating equivocal issues than leaner media (Daft and Lengel, 1986). Rich media refers to those media that have advanced features, compared to the less sophisticated features of lean media. Based on prior research (Daft and Lengel, 1986; Sproull, 1991; Valacich *et al.*, 1993), Lodhia (2012) argued that the richness of a medium is dependent on several factors: immediacy, language variety, multiple cues, personal source, multiple addressabilities, external recordability, computer-processable memory and concurrency.

Lodhia (2012) briefly explained each of these elements. Immediacy refers to the ability to enable timely communication. Language variety is a medium's capacity to organise information in various formats to enhance the understanding of the information receiver. Understanding may also be enhanced by the multiplicity of cues that a medium is capable of providing for presenting information. Personal source refers to the level of personalised communication enabled by a medium. Multiple addressabilities refer to the global reach of technologies to access a potential mass audience. Externally recordable features enable amendments and additions to be easily made to existing information and a record of the communication process to be obtained to identify and monitor user trends. Computer processable memory refers to the technological features that facilitate search and analytical capabilities. Concurrency refers to the use of technologies to facilitate interaction. This can help a range of stakeholders to interact with the organisation, which in turn may improve transparency.

Disclosure studies to date have primarily focused on conventional print media, especially annual reports and stand-alone SD reports as a communication medium. They are accepted as common media for environmental communication (Lodhia, 2004). However, conventional print media has several limitations in disseminating SD information. For instance, it is argued in the literature that this media provides periodic generalised historical information, has limited accessibility and may not provide information to less powerful stakeholders. Also, there are issues associated with limited credibility and the legal standing of reports largely because of a lack of guidelines and attestation, a lack of integrated information on economic, social and environmental performance and limited means of presenting and organising information (Isenmann *et al.*, 2007; Lodhia, 2004). Communication through conventional print media is also unidirectional, leading to limited interaction with stakeholders (Lodhia, 2004). While issues such as the authenticity and credibility of SD information are also associated with the internet, it has certain features that could assist in providing more useful information to external stakeholders regarding an organisation's interaction with its physical environment (Isenmann *et al.*, 2007; Lodhia, 2004).

Because of advancements in information technology over the past several decades, there has been an emergence of SD disclosure through the internet. Hence, several studies have explored the use of the internet for communicating SD information. As indicated by Lodhia and Stone (2017), the internet has several benefits over conventional print media about disclosing SD information. It allows information to be disseminated conveniently and on a timely basis to a wide range of stakeholders. Various approaches to presenting the information (multiple cues) based on different formats (language variety) and needs (personal source) can be used. Information can be well organised through hyperlinks and search tools to allow ease of navigation for stakeholders (computer processable memory). The extent to which SD information has been used by various stakeholders can also be accessed by internet technology, while archived information can also be disclosed (externally recordable). It facilitates two-way interaction and feedback through discussion forums, bulletin boards and email lists. Another internet tool, social media, is also able to provide timely information and facilitates dialogue (Lodhia and Stone, 2017).

As per the literature and theoretical arguments, private and public organisations, including cities, could use different communication channels to discharge their accountability. Conventional print media, such as the annual report, continues to be considered a primary medium of accountability for public sector organisations (Rosair and Taylor, 2000), as the internet may not be accessible to all stakeholders or they may prefer not to use it. There are also issues such as cost, technical expertise, poor website design,

advertising, security and authentication that may deter stakeholders from using the internet (Lodhia, 2004).

The benefits of internet reporting indicate that it is a rich medium that can facilitate stakeholder dialogue and enhance accountability. Moreover, the internet is getting cheaper and more accessible to city dwellers in particular. Therefore, it is expected that organisations, including cities, will increasingly opt for internet-based media (e.g. website and social media) to disseminate information to a range of stakeholders.

4. Research design

To tackle the climate change, it is important to establish an emissions inventory and set ERT for emissions reduction (CDP, 2016). Mia *et al.*'s (2016) study showed that most megacities have a GHG emissions inventory and set ERT, which they then use to develop policy and take action. To answer the research questions, this study uses documentary analysis of megacities' disclosure about ERT and ERA. A quality index is developed to assess the quality of the disclosed information. The following subsections outline the sample selection procedure, data sources and the process of data analysis used to answer the research questions.

4.1 Sample selection

Megacities have been publicly disclosing their GHG emissions inventory and their actions to reduce GHG emissions via the CDP platform since 2011 as part of their ongoing commitment to tackling climate change. Megacities were selected as the focus of this study, as they have more people and larger economies, which are contributors to climate change, but also sizeable resources and talented people to tackle climate change. To be selected for the study's sample, a megacity must be a member of C40 cities, as this group is committed to lead climate change action, as well as having adequate levels of disclosure, that is, provides city-level information. Also, we chose megacities from English-speaking countries (Australia, Canada, South Africa, the USA and the UK), as other megacities might not provide their information in English and those that had made a commitment in the CDP to reducing emissions by establishing an ERT.

Based on the above criteria, ten megacities were selected: from Australia (Sydney and Melbourne), Canada (Toronto and Vancouver), the UK (London), the USA (San Francisco and Seattle), South Africa (Cape Town and Johannesburg) and Sweden (Stockholm). London was the only city from the UK that is part of the C40 alliance and provided emissions information at the city level. One European city (Stockholm) was chosen although it is not from an English-speaking country; it does, however, provide its emissions information in English. The mayors of the selected megacities have provided a commitment to take action to reduce emissions and have already set their ERT. The following paragraphs provide a brief profile of the selected megacities.

The City of Sydney is Australia's leading global city and is a vital economic hub and tourism gateway for Australia. The city is responsible for 22 per cent of NSW's economy and 7 per cent of Australia's GDP. It is expected that the future climate of the Sydney region will be hotter and drier than it is today and the city will experience a significant increase in extreme heat events. The city reported its total GHG emissions at 3,556,529 metric tons (mt) to the CDP in 2016. The city has set up an ambitious plan to reduce GHG emissions by 70 per cent by 2030 based on 2006 levels.

Melbourne is Australia's second largest city and one of the fastest growing in Australia. The city reported its total GHG emissions at 4,372,420 mt to the CDP in 2016. The city acknowledges that current and anticipated effects of climate change present a significant

risk to the city. Its ERT is zero net emissions by 2020, which it expects will help in meeting the national target.

Toronto is Canada's largest city and, in 2015, was ranked as the best place to live in the world. The city expects that it will face extreme winter conditions, including heavy snow, as well as extreme heat during summer, because of climate change. The city reported its total GHG emissions at 18,320,966 mt to the CDP in 2016. The city plans to reduce its GHG emissions by 80 per cent by 2050 compared to 1990 levels.

In 2010, Vancouver ranked second on the EIU Greenest City Index. Vancouver was one of the first cities in the world to recognise the gravity of the threat posed by climate change. It adopted its greenest city action plan in 2010 as a comprehensive climate action plan (CAP) to support the city's transformation to a low-carbon, thriving economy. Vancouver reported its total GHG emissions at 2,442,602 mt to the CDP in 2016. It plans to reduce GHG emissions by 33 per cent by 2020 compared to 2007 levels.

London is home to nearly nine million people. It reported 40,190,000 mt CO2e in CDP in 2016. The mayor has set an ambitious target to reduce London's emissions by 60 per cent on 1990 levels by 2025. London has developed a suite of innovative programmes to reduce emissions across the city. These include programmes to increase home and building energy efficiency, develop and fund decentralised energy projects, invest in clean waste infrastructure and roll out electric vehicles across London.

San Francisco has highlighted that the effects of climate change present a significant risk to the city. The city reported its total GHG emissions at 5,381,687 mt to the CDP in 2016. San Francisco has officially adopted ambitious emission reduction goals, including 40 per cent by 2025 and 80 per cent by 2050.

The city of Seattle is a leader in reducing GHG emissions and has a long-standing commitment to energy efficiency and conservation. In 2011, Seattle adopted the goal of becoming carbon neutral by 2050, and on Earth Day released its 2013 CAP, which includes actions towards achieving its carbon neutral goal. Seattle reported total emission of 5,222,000 mt to the CDP in 2016.

Cape Town is a coastal city situated near the southern tip of Africa and is South Africa's second most populous city. The city has a carbon footprint of 5.6 tonnes per person and consumes 6 per cent of national electricity. The city reported 22,643,846 mt CO2e to the CDP in 2016. The city is committed to reducing its emissions by 13 per cent by 2020 compared to the base year 2012.

The City of Johannesburg (CoJ) generates approximately 16 per cent of South Africa's GDP and uses 12 per cent of the national workforce. CoJ aims to contribute to the global effort to stabilise GHG concentrations in the atmosphere by reducing its emissions by 20 per cent by 2020 compared to the base year 2007. It reported 26,226,549 mt CO2e to the CDP in 2016.

Stockholm is the capital of Sweden and was the first city to receive the European Green Capital Award by the EU commission in 2010 because of its commitment to be fossil fuel free by 2050. It has reduced emissions by 25 per cent since 1990 (EU Commission, 2010) and reported 2,511,000 mt CO2e to the CDP in 2016. The city aims to cut its emissions by 40 per cent by 2020 compared to 1990.

These ten megacities reported 130,867,599 (0.13 billion) mt CO2e to the CDP in 2016. As significant contributors to emissions, they also, in working together, can have a significant impact on global emissions reduction. Around 187 cities disclosed their total emissions around 1.45 billion mt to the CDP in 2016. Of these, the C40 cities (54 megacities information was available) reported 0.87 billion mt of GHG emissions in 2016 to the CDP. In 2016, Global

GHG emissions remained static, a sign that the world is making at least some progress in the battle against global warming by halting the long-term rising trend.

4.2 Data source

As highlighted in the literature, organisations can disclose information through many different media, for instance, annual reports, sustainability reports, websites, social media, policy documents, the CDP and so on. This study categorises various disclosure media into three channels: own channel, third-party channel and social media.

This study uses megacities' channel, third-party channel and social media as data sources. Own channel refers to any disclosure medium that is mainly produced and controlled by the megacity itself. This study categorised megacity's annual report, sustainability report, CAP documents and website as own channel. Annual reports and sustainability reports are considered primary disclosure channel for many public and private organisations (Rosair and Taylor, 2000). Many megacities also prepared a CAP to formulate their strategies and actions to reduce emissions, and websites are widely used for disclosure. Use of a website is popular for many organisations as a disclosure medium (Lodhia, 2012; Williams *et al.*, 2011).

Third-party channel refers to any disclosure medium primarily managed and controlled by third parties to disseminate megacities' information to users. They have certain disclosure guidelines, and they decide what information to collect and disclose. This study includes the CDP and Compact of Mayors' website (COM) as third-party channels. The CDP is a comprehensive data source for cities' and companies' climate change-related information (Doda *et al.*, 2016; Rauland and Newman, 2015). The Compact of Mayors' website was chosen, as this coalition is the world's largest coalition of city leaders addressing climate change, launched at the 2014 United Nations Climate Summit. This organisation collects and disseminates cities' GHG-related information.

Social media is considered as a separate channel in this study as, while third parties provide this platform, megacities have some control over what information is disclosed. Social media also provides other parties to comment on the disclosed information. This study focuses on Facebook and Twitter as the most commonly used social media channels for SD information (Bellucci *et al.*, 2017; Lodhia and Stone, 2017; Williams *et al.*, 2011).

4.3 Data analysis

To address *RQ1*, we searched megacities' channel, third-party channel and social media for ERT and ERA information. Documentary analysis (Cooper and Pearce, 2011) was applied to collect the ERT and ERA information, including annual reports, sustainability reports, CAPs and megacities' responses to the CDP for 2015 and 2016. Several keywords such as climate, carbon, emission, target, greenhouse, energy efficiency, waste, solar and renewable were used to identify GHG-related sections in the form of downloaded documents. The COM website and relevant sections of each megacities' website were explored during October 2016 and June 2017. The same keywords were also used to search any information posted by megacities related to ERT and ERA on Facebook and Twitter over the past seven years. If any ERT and ERA information was disclosed in any channel, "Yes" was recorded for that channel; otherwise, "No" was recorded.

To address *RQ2*, ERT and ERA data were collected from different media identified in *RQ1*. Collected data were exported to an excel file under the relevant channels and compared among the three channels. Regarding the consistency of ERT, this study examines whether reported ERT and the date to reach that target are similar across different forms of media.

ERT information was compared to the three channels: megacities' channel, third-party channel and social media.

Regarding the consistency of disclosed ERA, first, ERA was selected for each megacity from data disclosed to the CDP. Cities voluntarily report the details of their ERA with a description of the action, the amount of emissions reduction from that action and the cost to undertake the action. We analysed the megacities' 2015 and 2016 responses to the CDP regarding ERA and selected five ERAs for each megacity to explore in detail. Most of the selected megacities reported more than five ERAs to the CDP, and in selecting the five ERAs for our study, priority was given to those ERAs that had detailed information about the cost of the action and the amount of emissions reduction. The five selected ERAs from the CDP for each megacity was searched and collected from different media and grouped according to their channels. Collected ERA data for each megacity was then compared across three different channels to analyse the consistency of disclosed information.

If any megacity has disclosed one (two, three, etc.) similar ERA in its channel, third-party channel and social media, then this megacity was considered to have consistent information for one (two, three, etc.) ERA across three different channels. For example, Cape Town disclosed in the CDP that it was promoting the installation of over 60,000 solar water heaters in the city. If Cape Town also reported the same action (promotion of solar heating/hot water) in its channel (e.g. website, CAP or annual report) and also in social media (e.g. Facebook or Twitter), then this study considered that Cape Town provided consistent information across different disclosure channels. Similar name or type of action was considered for consistency, as the name of the action does not change every year. For consistency, details of the action need not be the same as the details may change every year. Therefore, it may not be possible to measure the consistency to that extent. For example, one of Sydney's ERA was "replacing the conventional light with LED", which was disclosed through different channels. Although the action was the same, the details were not, regarding the timing and different ways of measuring and presenting data, as illustrated below. The third-party channel disclosure to the CDP was:

> The City of Sydney is replacing 6,048 conventional lights and reducing greenhouse gas emissions in City-owned street lights by 40 per cent.

While on the city's channel (its website), it was:

> The LED lighting project has been completed resulting in a reduction of more than 48 per cent in carbon emissions.

Moreover, on social media it was:

> The first city in Australia to roll-out new energy-efficient LED street and park lights installing the first batch of new LED lights on George Street, in front of Sydney Town Hall. Replacing 6,450 conventional lights. Reduce energy consumption by 40 per cent.

Based on the above information, we have concluded that the City of Sydney has consistent information across different channels for an ERA.

To address *RQ3*, the quality of the disclosed information about ERA was analysed based on the extent of the information provided. This study argues that the quality of the disclosed ERA would be higher if ERA provided information regarding the action that includes the impact and the cost of the action. Therefore, each ERA should provide qualitative (description of the actions) and quantitative (impact and cost) information.

In our paper, we evaluate the quality of the ten megacities' ERA across three different disclosure channels. Quality can be defined based on the completeness of disclosure or the

degree of detail in the disclosures for a particular item (van Staden and Hooks, 2007). Prior researchers argued that investigating only the volume of the disclosure can be misleading and measuring the quality is important (Toms, 2002; van Staden and Hooks, 2007). Assessing the quality of the disclosure involves more complex analysis beyond counting the amount of disclosure. A quality index can be constructed by including an assessment scale. It will still have a degree of subjectivity because of the techniques used by the researchers to collect data and allocate score. However, several prior studies assessed the quality of the disclosure by using a quality index (Brammer and Pavelin, 2008; Cormier and Gordon, 2001; Cormier *et al.*, 2005; Wiseman, 1982). For instance, Wiseman (1982) assessed disclosure on a three-point scale assigning three for an item described in quantitative forms, two for specific information in non-quantitative forms and one for an item discussed in general terms. Other researchers have also followed these assessment criteria (Brammer and Pavelin, 2008; Cormier and Gordon, 2001; Cormier *et al.*, 2005). Hasseldine *et al.* (2005) measured quality on a six-point scale: 0 for non-disclosure; 1 for general information; 2 for the specific endeavour, the policy only; 3 for specific endeavour or intent, policy specified; 4 for implementation and monitoring but not mention of quantified results; and 5 for quantitative data. Quantified information for a particular item was rated with the highest quality in previous studies.

However, our study argues that both qualitative and quantitative information is important and without one or other of these, a full picture of the disclosed information may not be provided. The relative importance of qualitative or quantitative may also differ based on users' needs and the intended purpose of the disclosure. Several other measures assess quality, but this study primarily focuses on the extent of disclosed information as the proxy for quality information because of the nature of the information (ERA) that is under investigation, rather than distinguishing the level of quality of disclosed information for a particular item based on the qualitative or quantitative information. To determine the extent of disclosure, it is important, first, to understand each of the ERAs. Information in this regard will be mainly descriptive or qualitative. Second, the impact of the ERA is expected, as it provides some indication of how much (amount) emission may be reduced as a consequence of this action. This information will be mainly quantitative and allows for evaluation and monitoring of the performance of the action, as well as comparison with other actions. Third, cost to implement this action is quantitative information that is used to prepare budgets and to make funds available to complete the action to reduce emissions. This information can also be used to compare (from a cost perspective) actions. Based on these three types of information, which together form the extent of disclosure, this study adopted the following scoring systems to measure the quality of disclosed ERA across the three different communication channels:

(1) 1 = action is reported in some detail;

(2) 1 = amount of GHG emissions reduction is reported from the action regarding numerical value or percentages; and

(3) 1 = cost ($) of implementing the action reported.

Score 1 is awarded if a mega city has disclosed an action with some detail. While it is important to understand what actions megacities are taking to reduce emissions, this information will have little value unless the impact of that action and the cost of implementing that action are also known. Therefore, Score 1 is awarded if the impact is disclosed and another Score 1 is awarded if cost is disclosed.

In this way, each ERA could achieve a maximum score of three if details of the action, its impact and cost to implement the action are disclosed. Hence, the maximum quality score a

megacity can achieve is 15 (3 scores × 5 actions) for each form of communication channel. After developing the scoring system, details of every selected action for all megacities were examined for the three media against the scoring system. Scores for each megacity's actions were tracked via an excel file to assess the quality of the reported ERA among megacities' channel, third-party channel and social media.

5. Findings

About information availability, ERT and ERA information was available through three different form of channels. About consistency, our analysis shows that reported ERT and ERA across megacities' channel and third-party channel for most of the megacities was consistent. ERT and ERA information through social media was very limited. About quality, we found that megacities predominantly provided qualitative information and only a limited amount of quantitative (impact and cost) information. The following subsections summarise the findings according to the research questions.

5.1 Disclosure media (RQ1)

Regarding the use of communication channels, this study found that ERT information (Table I) is available mainly through megacities' channels and third-party channels. There is only one megacity (Sydney) that also used social media to disclose ERT information.

Regarding the disclosure media used for ERA information (Table I), the findings are that ERA information is available mainly through two different media: own channels and third-party channels. Four megacities also used social media to disclose ERA. However, use of social media to report ERT and ERA is limited (Table I). It seems that use of Facebook and Twitter to disclose ERA for some megacities (Sydney, Cape Town) is emerging but to date is limited.

However, we have observed that megacities are using social media to discuss several SD issues, including climate change. They posted or tweeted information about the impact of emissions in a narrative form, including ERTs, asking citizens to help cities to fight climate change and encouraging citizens to participate in some climate change-related activities such as "Earth Hour". We find that this media has more potential to establish direct communication with megacities' stakeholders as many citizens now follow the information posted or tweeted via social media. For example, the City of Sydney has more than 214,000 Twitter followers, and the City of Vancouver has more than 63,000 Facebook followers. Citizens can easily express their views on Facebook or Twitter in response to social media

	ERT			ERA		
List of megacities	Own channel	Third party channel	Social media	Own channel	Third party channel	Social media
Cape Town	No	Yes	No	Yes	Yes	Yes
Johannesburg	Yes	Yes	no	Yes	No	Yes
Sydney	Yes	Yes	Yes	Yes	Yes	Yes
Melbourne	Yes	Yes	No	Yes	Yes	No
Toronto	Yes	Yes	No	Yes	Yes	No
Vancouver	Yes	Yes	No	Yes	Yes	No
San Francisco	Yes	Yes	No	Yes	Yes	Yes
Seattle	Yes	Yes	No	Yes	Yes	No
London	Yes	Yes	No	Yes	Yes	No
Stockholm	Yes	Yes	No	Yes	Yes	No

Table I. Disclosure channels used by megacities to disclose ERT and ERA

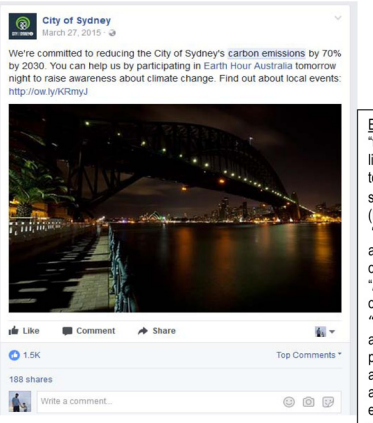
posts, for example, see Figure 1, in which 1,500 "liked" the City of Sydney's post, 20 people commented and it was shared 188 times.

Following that post, some citizens express support for Earth Hour, and others raised concerns about the city's actions that were perceived as not in line with emissions reduction. It seems that social media provides an opportunity for city officials to directly engage with citizens, although it is less clear the extent to which such views influence decision makers.

Social media provides an opportunity for megacities to disclose their ERA, as it has rich features and allows for timely dialogue.

5.2 Consistency of reported emissions reduction target and emissions reduction actions (RQ2)

We find that there is some consistency for ERT and ERA between megacities' channels and third-party channels (Figure 2). In particular, megacities disclosed ERT and a target date to reach the promised ERT in their channels and third-party channels consistently. There has been limited use of social media to disclose ERT- or ERA-related information, with Sydney the only megacity disclosing ERT information through all three channels and disclosing



Examples of citizen comments are:
"then why oh why were soooooo many lights still on all over town?! I went into town for Earth Hour tonight and must say I was quite disappointed ... (March 28 2017)
"...thanks for sharing I haven't heard anything about this ...this year....lights out..."
"And then you'll let off how many tonnes of fireworks"
"I hope these people who think making a difference in one hour aren't the same people who burn their Christmas lights all December on their house while they are asleep. Get real people, save everyday day. Not one hour once a year!"

Figure 1.
Facebook post by City of Sydney, 27 March 2015

List of Megacities	Own Channel		Third Party Channel		Social Media	
	Target	Year	Target	Year	Target	Year
Cape Town	NP	NP	13%	2020	NP	NP
Johannesburg	65%	2040	65%	2040	NP	NP
Sydney	70%	2030	70%	2030	70%	2030
Melbourne	4.5%	per year	100%	2020	NP	NP
Toronto	80%	2050	80%	2050	NP	NP
Vancouver	33%	2020	33%	2020	NP	NP
San Francisco	25%, 80%	2017, 2050	25%	2017	NP	NP
Seattle	100%	2050	100%	2050	NP	NP
London	60%	2025	60%	2025	NP	NP
Stockholm	24%	2012	24%, 100%	2020, 2050	NP	NP

NP = Not Provided

= Shading indicates consistency across different channels.

Figure 2.
Consistency of megacities' ERT disclosed through three different channels

consistently across these three channels. Other megacities did not provide ERT data in social media. On the other hand, a limited number of the disclosed ERA between megacities' channels and third-party channels was consistent (Table II and Appendix).

Half of the selected megacities have at least three actions out of five that are disclosed to the megacities' channels and disclosed through third-party channels. The only City of San Francisco have all five actions disclosed to megacities' channels and disclosed through third-party channels. Only one city (Sydney) has two actions that are similar among megacities' channels, third-party channels and social media. London did not have any similar ERA across the three different channels.

5.3 Quality assessment of reported emissions reduction actions (RQ3)

Regarding quality, as shown in Figure 3, quality scores varied significantly among the megacities. Although the CDP asked megacities to report on their ERA with the description, amount of emissions reduction and cost for the actions, most of the megacities did not disclose that information. ERA reported through megacities' channels have higher scores (73 vs 65) in total than ERA reported through third-party channels. Social media by default had the lowest total quality scores (17), as only three megacities' disclosed ERA in social

List of megacities	Consistency of reported information in megacities' own channel, third party channel and social media channel
Cape Town	Four actions are similar between megacities' own channels and third-party channel
Johannesburg	Two actions are similar between megacities' third-party channel and social media
Sydney	Three actions are similar between megacities' own channels and third-party channel. Two actions are similar among megacities' own channels, third party channel and social media
Melbourne	Four actions are similar between megacities' own channels and third-party channel
Toronto	Two actions are similar between megacities' own channels and third-party channel
Vancouver	Three actions are similar between megacities' own channels and third-party channel
San Francisco	Five actions are similar between megacities' own channels and third-party channel
Seattle	Two actions are similar between megacities' own channels and third-party channel
London	No similar action reported across the different form of media
Stockholm	Two actions are similar between megacities' own channels and third-party channel

Table II.
Consistency of disclosed ERA across three different channels

List of Megacities	Total Score	Quality Score											
		Total Score for each Channel			Own Channel (Annual & sustainability report, CAP, website)			Third Party Channel (CDP & COM)			Social Media (Facebook & Twitter)		
		Own Channel	Third Party	Social Media	Action Detail	Emission	Total cost	Actio n	Emission	Total cost	Action Details	Emission Reductio	Total cost
Cape Town	19	5	11	3	5	0	0	5	2	4	2	1	0
Johannesburg	13	8	0	5	5	3	0	0	0	0	4	1	0
Sydney	29	11	9	9	5	4	2	5	2	2	5	2	2
Melbourne	6	4	2	0	4	0	0	2	0	0	0	0	0
Toronto	13	8	5	0	5	2	1	5	0	0	0	0	0
Vancouver	19	9	10	0	5	2	2	5	5	0	0	0	0
San Fransisco	20	10	10	0	5	5	0	5	5	0	0	0	0
Seattle	5	0	5	0	0	0	0	5	0	0	0	0	0
London	14	7	7	0	5	2	0	5	1	1	0	0	0
Stockholm	17	11	6	0	5	5	1	5	0	1	0	0	0
Total Quality	155	73	65	17	44	23	6	42	15	8	11	4	2
Average	15.5	7.3	6.5	1.7	4.4	2.3	0.6	4.2	1.5	0.8	1.1	0.4	0.2

Figure 3.
Quality score for ERAs related disclosed information through different channels

media. However, narrative information contributed more than 60 per cent of the quality scores for both own channels and third-party channels, indicating that limited quantitative information was disclosed. Altogether for the ten megacities, 50 ERAs from megacities' channels and 50 ERAs from third-party channels were identified, but the impact was reported for only 23 and 15 ERAs, respectively. The lowest scores were about total cost information: only six ERAs in the megacities' channels and eight ERAs in third-party channels disclosed total cost to implement an ERA.

Quality assessment for individual megacities showed that some megacities perform better than others. The quality scores for megacities about third-party channels ranged from 11 (for City of Cape Town) to 0 (for CoJ) and about own channels from 11 (for City of Sydney and City of Stockholm) to 0 (for City of Seattle). Figure 3 shows that almost every megacity provided details (mainly descriptive) of their actions. However, regarding disclosing the impact of their actions, only half of the megacities did so. Two megacities (Vancouver and San Francisco) reported the amount of emissions reduction (impact) from all five of their ERA and Cape Town, and Sydney reported the number of emissions from only two ERAs via third-party channels. Cape Town and Sydney reported the cost of implementing four and two ERAs, respectively. London and Stockholm only reported the cost of one ERA, while the others six megacities did not provide any information on ERA implementation cost when reporting via third-party channels. Figure 3 also shows that only two megacities (Stockholm and San Francisco) reported the amount of emissions reduction from all of their ERAs when they disclosed information via their channels. Three megacities (Cape Town, Seattle and Melbourne) did not provide the impact of their ERA. Only four megacities provided the cost for the actions via their channels but not for all of their actions. When individual actions were analysed, a small number of ERA received the full three scores. One such example is the City of Sydney's (CDP, 2016) ERA to install LED street and park lights reported through third-party channels:

> The City of Sydney is replacing 6,048 conventional lights; saving nearly $800,000 a year in electricity bills and maintenance costs and reducing greenhouse gas emissions in City owned street lights by 40 per cent. A joint venture of GE and UGL Limited, selected by tender, is installing LED street lights in the City of Sydney LGA, as part of a $7 million three-year project.

6. Discussion and conclusion

This study found that megacities are using all three channels to disclose their target and actions to reduce emissions. Similar to prior studies, this study also found that megacities' own channels, such as websites and third-party platforms, such as the CDP, are important disclosure media (Kolk *et al.*, 2008; Lodhia, 2014; Patten and Crampton, 2003). Although social media has potential to provide ERA-related information and given that all the megacities have accounts with social media and a large number of followers, they can easily reach a significant number of citizens to inform them what actions are being taken to tackle climate change via social media. Social media channels also provide an opportunity for dialogue between citizens and city officials about proposed actions that can increase transparency and improve accountability. However, most megacities in our sample were not active in disseminating their ERA via social media, perhaps because of a perceived reputational or legitimacy threat. Megacities may be reluctant to engage in social media because it provides an opportunity for citizens to counter claims of climate action. For instance, when the City of Sydney asked its citizens via social media to participate in Earth Hour to reduce emissions, some people provided counter posts (e.g. by arguing that climate change action should be ongoing not just for one hour). Understanding the reasons for limited use of social media by megacities is an avenue for future research.

Regarding having consistent information across different communication channels, our analysis showed that reported ERT is largely consistent between channels (though it is rarely disclosed via social media). However, about ERA information, similar ERA (at least one similar action) can be found in both the channels. However, only one megacity had five similar ERAs disclosed through its own and third-party channels. Other megacities have a similar ERA in both the channels but for a small number of actions. Megacities can use more than one channel, and there is no obligation to provide consistent information across all the channels. However, it is argued that providing consistent information through different channels can increase the credibility of the reported information, and it can also reduce the cost associated with the disclosed information (Depoers *et al.*, 2016). Therefore, it is important for megacities to disclose consistent information through all channels.

Regarding quality, we found that most quality scores for each megacity came from narrative information that describes actions taken. There is very limited information regarding the impact of megacities' actions; however, it is important to understand the impact of actions to justify their success. Moreover, information regarding the cost of implementing the project was frequently missing. Reasons for not disclosing the impact and cost could be because of legitimacy, or other issues, or simply lack of robust supporting data; however, establishing reasons for non-disclosure is outside the scope of this paper. Without cost information, it is difficult to prepare a budget for future action. Cape Town's Climate Change Think Tank (a group of academics, specialists and city officials) argued in support of good quantitative information on current and future energy consumption and on carbon emissions, as it is required by the city and partners to be able to assess climate risk accurately and prioritise the Energy and CAP (City of Cape Town, 2011). Moreover, measuring and sharing the actions and its impact can increase awareness and provide the information needed to make cost-effective decisions.

This study makes several contributions. First, it explores megacities' disclosure, which is an important but neglected area of research. Second, prior studies have mainly focused on SD disclosure in the private sector, with the public sector receiving only limited attention and only about government departments or local government. This study extends prior studies by exploring disclosure at the geographic level. Third, prior studies in the public sector mainly focused on annual reports to explore SD disclosure. This study extends public sector disclosure research by including three different forms of disclosure platform, that is, own channels, third-party channels and social media. This research also responds to the call to explore disclosure via social media (Lodhia and Stone, 2017) and at the regional level (Gray, 2010; Milne and Gray, 2007). Moreover, it undertakes a novel approach to study megacities' ERAs, as well as targets, developing a quality framework.

The findings of this study have several practical and policy implications. We have identified that social media may be an important communication channel to communicate with citizens because it engages citizens in a dialogue in which they are willing to express their views. Hence, megacities could further exploit the power of social media to inform and educate about their actions to reduce emissions and, in particular, in relation ERT adopted by megacities. City officials and policymakers can use social media to provide updated information, as timely information is crucial for decision-making.

It is also vital for megacity officials, policymakers and other stakeholders to understand the level of impact that particular actions may have in reducing megacities' emissions. Being able to monitor, evaluate and compare megacities' current policies and actions may help to reach ERT. Our findings show that megacities provide only limited quantitative information about the impact of their actions to reduce emissions. Although the CDP specifically asks

megacities to report their impact and the cost of the ERA, in most cases, this information is missing.

The CDP has a role to play in supporting emissions reduction by working with cities to encourage them to provide more information. Further, the CDP, C40, governments and other policymakers could work together to support adequate disclosure. Our findings suggest that there is a place for regulation and standardisation of the disclosure. For example, the CDP could apply a grading system based on the extent and level of disclosure provided to it. Also the CDP, C40, governments and other policymakers could ask megacities to provide more quantified information, especially about impact and cost of ERA, which would allow for performance measurement that evaluates, monitors and compares policies and actions regarding emission reduction. It also can help other megacities to learn from other cities successes in ERA.

We also suggest that the CDP should collect emissions inventory at a policy or action level, as this is useful for evaluating, comparing and sharing with other megacities. The GRI is a global reporting platform that provides guidelines on disclosing sustainability information, including climate change-related information. Currently, the GRI does not require organisation to disclose action-level information. There is potential for the GRI to work with the CDP to develop guidelines on disclosing the extent of ERA information. It is acknowledged that total emissions at organisational level have limited comparability. However, the CDP and GRI can work together to help organisations to disclose more detailed information regarding the actions (e.g. amount of emissions reduced as the result of an action, cost to implement the action, future savings derived if action is implemented) they are taking to reduce emissions. Action-level information allows megacities to learn from each other about best practice.

We found inconsistency among the organisations in our sample about using a common protocol for measuring GHG emissions. The Global Protocol for Community-scale Greenhouse Gas Emission Inventories (GPC) establishes comprehensive global standardised frameworks to measure and manage GHG emissions. Many corporations and megacities are using this protocol to measure their total emissions. Megacities may find it useful to adopt this protocol to calculate GHG emissions at the action level.

While the findings of this study have certain theoretical and practical implications, there are also some limitations, which need to be addressed. The first limitation is small sample size. Only ten megacities are selected, focusing on one area of climate change. Moreover, selected megacities are from mainly English-speaking countries, and the findings may not be broadly generalisable. Another limitation relates to the periods of collected data. We have minimised this limitation by considering the name of actions rather than details of the actions for measuring the consistency of ERA.

Our findings also provide several future avenues of research into GHG emissions disclosure at the city level. Given our finding of limited use of social media despite its potential for stakeholder dialogue, future research could further examine the reasons for not using social media to disclose ERT and ERA by interviewing several city officials. Also, the reasons for inconsistency between disclosure channels could be investigated in future research. The findings of this study also indicate that information regarding impact and cost has been disclosed for a limited number of ERA, and future research could further examine the reasons for this by interviewing city officials. Such interviews could also establish an understanding of the way megacities govern and measure their climate change performance in greater depth. Future accounting research could also focus on further precision in measuring the impact of climate change on megacities and hence the "business case" for taking appropriate action.

Notes

1. https://unhabitat.org/urban-themes/economy/
2. www.c40.org/
3. www.c40.org/
4. www.c40.org/
5. www.cdp.net

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Appendix

	List of disclosed ERA through three different channels				
	Third Party Channel		**Megacities' Own Channel**		**Social Media**
CAPE TOWN	Installation of solar heating / hot water	1	Installation of solar heating / hot water	1	
	Improve transport infrastructure, services and operation	2	Improve transport infrastructure, services and operation	2	Electric bus service
	Commercial buildings and facilities: Energy management system	3	Commercial buildings and facilities: Energy management system	3	Upgrade city buildings
	Solar electricity	4	Solar electricity	4	Robots are fitted with LED lights
	Residential and private housing: Insulation	5	Electricity savings campaign	5	Encourage to use public transport
JOHANNESBURG	No ERA reported		1 Implementation of the Rea Vaya Bus Rapid Transit System		ReaVayaBus to save 1.6 million ton
			2 Municipal buildings retrofitted with energy efficient lighting		
			3 Translate waste into energy		
			4 LED lighting for Nelson Mandela Bridge		LED lighting for Nelson Mandela Bridge
			5 Planted 200 000 trees since 2006		
SYDNEY	Commercial buildings and facilities: Building energy management system	1	Commercial buildings and facilities: Building energy management system	1	Energy management system in commercial building and facilities
	Audit and advice to commercial buildings about energy efficiency	2	Audit and advice to commercial buildings about energy efficiency	2	.....
	More efficient lighting (e.g. LED)	3	More efficient lighting (e.g. LED)	3	More efficient lighting (e.g. LED)
	Improve public transport	4	Local electricity generation	4	50% renewable energy by 2021
	Single waste stream collection	5	Install renewable energy onto cities properties	5	Power buildings with low carbon energy
MELBOURNE	Installation of efficient lighting systems at residential / private housing:	1	Install energy efficient equipment and renewable energy technology in existing buildings	1	No ERA reported
	Reducing emissions from waste	2	Reducing emissions from waste	2	
	More efficient lighting (e.g. LED)	3	More efficient lighting (e.g. LED)	3	
	Improve public transport infrastructure	4	Purchase carbon neutral goods and services	4	
	Improve fuel economy for public transport	5	Improve fuel economy for public transport	5	
TORONTO	Lighting retrofits to city buildings	1	LED lighting retrofits	1	No ERA reported
	Solar electricity generation	2	Residential solar hot water heating program	2	
	Switch buses to hybrid engines	3	Switch buses to hybrid engines	3	
	Improve fuel economy of city vehicles	4	Idle-Free Policy –	4	
	Recycling all types of waste:	5	Toronto Hydro Solar Photovoltaic (PV) Program	5	
VANCOUVER	Commercial buildings and facilities: Energy performance rating for new construction	1	Building Energy Retrofit Fund	1	Mainly general info rather than action
	Commercial buildings and facilities: Heating and cooling efficiency	2	Buildings Retrofit programs	2	
	Electric vehicle charging infrastructure	3	Electric vehicle charging infrastructure	3	
	Landfill gas management/ Landfill gas to energy	4	Landfill gas management/ Landfill gas to energy	4	
	Green Bin organics pickup program	5	Green Bin organics pickup program	5	
SAN FRANCISCO	Supply low or zero carbon energy to residential and commercial customer	1	Supply low or zero carbon energy to residential and commercial customer	1	Some actions are reported -
	Building performance rating and reporting	2	Building performance rating and reporting	2	Example -
	Energy performance rating for new construction	3	Energy performance rating for new construction	3	New construction use solar energy for heat
	Improve rail, metro and tram fuel economy	4	Improve rail, metro and tram fuel economy	4	Installation of efficient street lighting (LED)
	Waste generation awareness and minimisation programs	5	Waste generation awareness and minimisation programs	5	Use Alternative Fuels by taxi fleet
SEATTLE	Smart meters for commercial and residential buildings	1	Smart meters for commercial and residential buildings	1	No ERA reported
	Energy Benchmarking reports	2	Energy Benchmarking reports	2	
	Restricting parking spaces in new development	3	Make driving expensive including higher parking fees	3	
	Improve public transport service	4	Improve public transport service	4	
	Improve fuel efficiency	5	Improve fuel efficiency	5	

Figure A1. Summary of the megacities emission reduction actions (ERA) through different channels

(*continued*)

LONDON	Improve rail, metro and tram fuel economy	1	Carbon free bus	1	No ERA reported
	Incentivise energy efficiency through voluntary competitions	2	Retrofitting the existing building stock	2	
	Installation of efficient lighting	3	25% energy supply from local sources	3	
	District energy with renewable energy source	4	15 per cent of total energy to be generated by renewable sources	4	
	Establish a revolving fund for low carbon or green projects	5	Decentralised energy network	5	
STOCKHOLM	Low or zero carbon energy supply	1	Promote green car and bio gas	1	No ERA reported
	Incentives/ rebates to switch personal vehicles to electric vehicles	2	replacing diesel buses with ones powered by renewable energy sources	2	
	conversions from oil heating to heat pumps	3	conversions from oil heating to heat pumps	3	
	Audit and advice to municipal buildings about energy efficiency	4	Improve Energy efficiency in the City's properties	4	
	heating/cooling efficiency	5	heating/cooling efficiency	5	
	Shading represents similar ERA				

Figure A1.

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Chapter 6 – Paper 3: Energy Efficiency Public Disclosure of Major Australian Cities

Mia, P., Hazelton, J., and Guthrie, J. (2019), *"Energy efficiency measures and public disclosure of major Australian cities",* paper presented at the 9th Asia-Pacific Interdisciplinary Research in Accounting (APIRA) Conference in Auckland, New Zealand on 1-3 July 2019.

Also, paper presented at the 17th Australasian Centre for Social and Environmental Accounting Research (A-CSEAR) Conference, Monash University, 5-7 December 2018.

Energy Efficiency Public Disclosure of Major Australian Cities

Abstract

Purpose –Climate change poses a severe threat to this planet. Cities are attempting to address climate change by undertaking a range of emissions reduction actions, in particular those focused on energy efficiency. The objective of this paper is to explore cities' calculative practice and public disclosure around energy efficiency activities.

Design/Methodology/approach – We select a sample of eight Australian capital cities and use documentary analysis to evaluate energy efficiency disclosure. A disclosure index is developed to explore the chosen cities' calculative practice and the quality of their energy efficiency disclosure.

Findings – Cities are undertaking energy efficiency projects to save energy and cost and to reduce emissions. However, cities have provided limited (quantified) information about the cost and the impact of their energy efficiency projects, making it difficult for stakeholders to evaluate their effectiveness.

Research Implication - Our findings are important for policymakers and city officials responsible for developing and implementing policies and programs for energy and greenhouse gas emissions. Also, for stakeholders seeking to understand a city's commitment and actions to reduce emissions and for managers responsible for measuring, reporting and mitigating emissions and energy consumptions from current and future activities.

Originality/Value – This disclosure study focuses on an initiative that plays a critical role in reducing GHG emissions, as well as cost reduction. Prior studies have primarily focused on social and environmental disclosure rather than what organisations are doing to overcome social and environmental challenges. This study has developed a disclosure index that allows us to explore the calculative practice and quality of disclosures. Moreover, sustainability accounting research to date has limited focus on cities yet they play a critical role in the development of global sustainability activities.

Keywords: climate change, emission, city, energy efficiency measures, public sector, public disclosures

Energy Efficiency Public Disclosure of Major Australian Cities

1. Introduction

The recent Paris Agreement at the 21st Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC) saw a push for stronger actions to address climate change. These actions include mitigation policies, such as greenhouse gas (GHG) emission reductions and adaptation policies for sustainable development (Yoon *et al.*, 2017). Since GHG emissions are accelerating global climate change, their reduction is critical. Recent targets include stopping GHG emissions growth by 2020, and reducing the 2010 levels of GHG by 60% by 2050 (EU Climate Action, 2017; Gao *et al.*, 2017).

Cities are responsible for 80% of global GHG emissions (Hoornweg *et al.*, 2011; Nejat *et al.*, 2015). Hence city authorities have an important role to play in formulating and implementing policies and actions to reduce GHG emissions. Cities consume 75% of global energy, with their power primarily coming from coal, oil and natural gas – the main contributors to GHG emissions (World Bank, 2010; Dulal and Akbar, 2013). Given emissions mainly result from the consumption of fossil fuels, reducing energy consumption has the potential to make a significant different to GHG emissions (Soytas and Sari, 2009). Moreover, city authorities are significant energy users in their own right and also directly and indirectly influence others through their urban planning functions (IEA, 2008).

Energy efficiency is increasingly a policy priority for countries around the world as it is the most cost-effective and readily available means to address a range of energy-related issues, including energy security, the social and economic impacts of high energy prices and concerns about climate change (IEA, 2014).

Prior studies highlight that energy efficiency measures, both in the short and long term, are one of the main options for mitigating climate change and a key strategy to reduce GHG emissions (see, Napp *et al.*, 2012; Yoon *et al.*, 2017). According to the International Energy Agency (IEA), energy efficiency measures alone can make a significant difference in reducing GHG emissions, possibly contributing 38% of total global CO2 emissions reductions by 2050 (see Magill, 2014). Studies show that cities around the world are taking a range of actions, including energy efficiency measures, to reduce GHG emissions (Reckien *et al.*, 2014; CDP, 2018; Mia *et al.*, 2018).

Measurement and disclosure of emissions reduction actions is useful internally for decision making and externally to encourage investment in energy efficiency improvements projects, to build trust, to provide transparency to stakeholders (Dagiliene *et al.*, 2014), to promote debate (Baeumler *et al.*, 2012), and to monitor public sector use of public resources (García-Sánchez *et al.*, 2013). Disclosure facilitates open, accessible and transparent government (Dawes, 2010) and allows city authorities to both learn from and share their experiences with other cities (IEA, 2008).

Moreover, making sustainability strategies public is considered an essential part of the sustainability process (Schaltegger *et al.*, 2012), and allows for analysis of energy efficiency disclosures in order to understand the extent and quality of the disclosed information. This view is supported by the United Nations' 'Sustainable Development Goals' (Niemann and Hoppe, 2018) and by the (World Bank, 2010), which argues that any action to address climate change should include citizens as an integral part of future responses to climate change and strengthened trust between city administrations and their citizens.

Given the importance of GHG emissions reductions specifically and that of sustainability more generally, in particular the role that cities can play in measuring and disclosing emissions reduction actions, this study aims to examine and evaluate major Australian cities' energy efficiency related public disclosure.

2. Background

Australia's per capita GHG emissions are the highest in the OECD and among the highest in the world (Garnaut, 2008), and Australian emissions for 2018 are the highest on record (*The Guardian*, 2018). Australia is a signatory to the Paris Agreement on climate change and has committed to reduce its total emissions by 26 to 28% below 2005 levels by 2030, and reach net zero emissions by 2050 (Skarbek, 2018). However, current trends of emissions data suggest that Australia is not on track to meet the 2030 Paris Agreement under the current trajectory (Fernyhough, 2018; The Guardian, 2018). Drastic action is needed to reduce Australia's global share of GHG emissions if it is to meet its target.

The energy sector is the largest source of GHG emissions, comprising more than 70% of Australia's net emissions (Talberg and John, 2013). Australian energy consumption rose

by 2% in 2015–16 to 6,066 petajoules, its highest ever level and average energy consumption has grown by 0.6% a year over the past ten years (Department of the Environment and Energy, 2017). Although there is no robust data available on energy consumption of Australian cities, as cities consume over two-thirds of the world's power (C40, 2017; World Bank, 2017) it is reasonable to assume that a large share of Australia's energy is consumed by major Australian cities. Moreover, energy consumption is driven by population growth and economic development (Dincer, 1998; Yeager *et al.*, 2012). According to the Australian Bureau of Statistics (ABS) most Australians (71%) live in cities, with the five major cities (Sydney, Melbourne, Brisbane, Perth and Adelaide) home to more than 60% of the Australian population as of June 2017 (ABS, 2018). In terms of economic activity, 80% of the value of all goods and services produced in Australia is generated in cities (Kelly and Donegan., 2014). So, Australian cities can be a crucial strategic space in Australian energy politics and the governance of energy systems.

As the energy sector is the largest source of Australian GHG emissions, the bulk of Australia's GHG emissions reduction efforts are likely to come from the energy sector. There are three ways to cut GHG emissions from energy use (Talberg and John, 2013). The first is to use less energy (energy efficiency*)*. The second is to use energy sources that do not emit GHGs (renewable energy*)*. The third is to capture the GHGs generated before they are released into the atmosphere (carbon capture and storage). Better alignment of energy and climate change policies can deliver lower energy costs and more GHG emissions reduction.

Energy efficiency measures have been identified as playing a vital role in reducing GHG emissions, yet they have received very little attention in Australia (Pears, 2011). The Australian Energy Efficiency Council (EEC) suggests that energy efficiency can deliver a stronger and more dynamic economy, cheaper energy bills, healthier buildings and a cleaner environment (EEC, 2016). Yet, the public debate around energy in Australia has almost entirely focused on 'supply-side' technologies and the per unit cost of energy (Whigham, 2018). Much less attention has focused on the 'demand-side' of the market, despite smart energy use offering the fastest, cheapest way to cut energy bills and reduce environmental impact (Pears, 2011; EEC, 2016). As a result, Australia has gone backward on energy efficiency, leaving it ranked as the worst performing major developed country in the world (Whigham, 2018).

Hence, the case for action on energy efficiency is strong and urgent in Australia. Australian governments have recognised the importance of improving energy efficiency for many years, and several national strategies for energy efficiency have been developed, but many proposed actions have not been implemented (EEC, 2016). While federal governments are essential for making international agreements and setting national emissions reduction targets, cities are centre stage when it comes to practical action on the ground (Barber, 2017). City authorities can facilitate energy efficiency improvements both for themselves and for other operators in their geographical area because they operate in multiple roles as energy consumers, service providers, buyers of products, planners, developers, regulators, advisors, motivators, energy producers and suppliers (IEA, 2017).

Part of a city authority's role is to disclose information. As argued by the New South Wales (NSW) State Government, providing information (disclosure) by local authorities to the community on social, economic and environmental issues is an essential part of accountability to the community (NSW Government, 2017). While, disclosure and accountability have played a critical role in measuring and disclosing various social and environmental issues (see, Watson, 2015; Bennett *et al.*, 2017), cities' sustainability disclosure has been mostly overlooked in the literature. This paper aims to fill this gap by exploring cities' energy efficiency disclosure and hence contribute to the sustainability accounting literature. The following section gives a brief overview of the existing literature.

3. Literature review

Research on sustainability disclosure can be traced back to the early 1980s and has continued to grow significantly from that time (Wiseman, 1982; Guthrie and Parker, 1989). Sustainability accounting and disclosure research are also frequently known as sustainable development accounting research, social and environmental accounting research, integrated reporting and triple bottom line reporting. Sustainability disclosure research has particularly focused on environmental issues (Ali *et al.*, 2017), with climate change receiving greater attention (Ascui, 2014). This section provides a brief literature review of prior disclosure studies with a specific focus on the quality of the disclosure.

3.1 Sustainability disclosure studies in general

Disclosure studies have dominated sustainability accounting research over the last three decades exploring a number of aspects, including: disclosure practices (Gray *et al.*, 1996; Guthrie *et al.*, 2008; Depoers *et al.*, 2016); factors motivating sustainability disclosure (Ali *et al.*, 2017; Dumay and Hossain, 2018); and the relationship between capital market (financial) performance and sustainability disclosure (Zhou *et al.*, 2017; Lu and Taylor, 2018). Researchers have also examined and evaluated the extent and quality of such disclosure (Ahmad and Mohamad, 2014; Michelon *et al.*, 2015; Boiral *et al.*, 2017).

Organisations provide disclosure on various sustainability issues in order to legitimise their activities, fulfil their responsibility to stakeholders, manage public impressions and improve their image and reputation (Leitoniene and Sapkauskiene, 2015; Diouf and Boiral, 2017). In response to demands from the public (García-Sánchez *et al.*, 2013) and regulators (Cox, 2018) the number of organisations providing such disclosure has grown substantially over the decades (Ascui, 2014; Leitoniene and Sapkauskiene, 2015). However, the quality of disclosure remains questionable (Hąbek and Wolniak, 2016).

Relatively few studies have investigated sustainability disclosures in the public sector (Dumay *et al.*, 2010; Greiling *et al.*, 2015; Mia *et al.*, 2018). In recent years, public sector disclosure studies have started to receive growing attention (Fusco and Ricci, 2018; Niemann and Hoppe, 2018), mostly focusing on aspects such as: the number of items are disclosed as per the GRI or a self-developed disclosure matrix (see Guthrie and Farneti, 2008; Goswami and Lodhia, 2014; Greiling *et al.*, 2015); the factors driving sustainability disclosure (see Lodhia *et al.*, 2012; Persson and Vingren, 2017); and types (social, economic and environmental) of sustainability information disclosed (Williams *et al.*, 2011).

Public sector organisations, including local and city governments, have a significant impact on national and global progress towards sustainable development and are expected to lead by example in managing and disclosing sustainability issues (Lodhia and Kaur, 2017). Compared to the corporate sector, accountability expectations and obligations of the public sector are higher; hence, more comprehensive disclosure is expected from them (Greiling *et al.*, 2015). Moreover, as organisations establish communication by disclosing information, the quality of the disclosed information needs to be evaluated (Boesso and Kumar, 2007) because it affects the usefulness and credibility of the disclosed information

(Wolniak and Hąbek, 2016). However, there have been limited studies that evaluate the quality of public sector organisations' disclosure. This study aims to fill this gap by evaluating cities' energy efficiency related public disclosure.

3.2 Assessment of disclosures

Sustainability disclosure practices have become a norm among organisations (Diouf and Boiral, 2017). However, limited studies explore the quality and comprehensiveness of such disclosure. A literature review undertaken by Ali *et al.* (2017) suggest that prior studies often focus on the amount of disclosure rather than what is disclosed; hence there is a call for much needed research examining the details of sustainability disclosure. Several earlier studies have evaluated corporate sustainability disclosure (Leitoniene and Sapkauskiene, 2015; Hąbek and Wolniak, 2016) but few examine what and how information is disclosed by public sector organisations. Therefore, this section focuses on prior studies examining the quality of corporate sustainability disclosure.

Defining quality is complex and subjective, and the meaning of quality can change depending on context (Leitoniene and Sapkauskiene, 2015). van Staden and Hooks (2007) have defined quality based on the completeness of disclosure or the degree of detail in the disclosure for a particular item. This study takes this definition to assess the quality of the disclosure.

The extant literature suggests that there is no consistent framework to measure and evaluate the quality of sustainability disclosure. Prior studies have assessed the quality of sustainability disclosure based on the volume of information, scope of the report, disclosure style, the nature of the disclosure, the way in which news is published, reporting frequencies and so on (Leitoniene and Sapkauskiene, 2015).

Many prior studies have evaluated sustainability disclosure based on the number of items disclosed and the amount of space assigned to the disclosure themes (Michelon *et al.*, 2015). So, quantity is often used as a substitute for quality (Beretta and Bozzolan, 2004; Leitoniene and Sapkauskiene, 2015). Measurement of volume takes place based on the number of pages, sentences, words, phrases and lines in the annual report and sustainability report (Dagiliene *et al.*, 2014). Methods based on volume do not consider the meaning of disclosed information, but instead focus on the amount of information in a particular area of interest (Leitoniene and Sapkauskiene, 2015) and therefore do not take into account other important dimensions (e.g., monetary, quantitative, and qualitative information) that

characterise the information disclosed (Michelon *et al.*, 2015). Hence, just investigating only the volume of disclosure to measure quality can be misleading (Plumlee *et al.*, 2015; Melloni *et al.*, 2017). More complex analysis is required to measure quality. Guthrie and Parker (1990) suggest that researchers should focus on what and how disclosure is made. Similarly, Boesso and Kumar (2007, p. 275) argue that "many researchers have gone beyond only counting the number of disclosures made, and have assigned weights to the information based on the type of information disclosed".

To evaluate disclosure many researchers use a disclosure quality index to capture what is disclosed and to assess the quality of the disclosure (see Wiseman, 1982; van Staden and Hooks, 2007; Michelon *et al.*, 2015). A disclosure quality index can be constructed by including an assessment scale to evaluate disclosure (Leitoniene and Sapkauskiene, 2015; Mia *et al.*, 2018), in which a score is assigned based on the nature (descriptive vs. numeric) of the disclosed information. For instance, Wiseman (1982) assessed disclosure on a three-point scale, assigning three for an item described in quantitative forms, two for specific information in non-quantitative forms and one for an item discussed in general terms. Several other researchers have followed a similar approach (e.g., Hasseldine *et al.*, 2005; Brammer and Pavelin, 2008; Hooks and van Staden, 2011). Hooks and van Staden (2011), for example, assessed disclosure on a five-point scale from 0 for non-disclosure to 4 for providing benchmarking information. This weighted scaling method helps to capture the details of the disclosed information. However, this approach is unable to evaluate the provision of narrative information along with quantitative information. Another disadvantage with this scoring method is that it does not separate monetary or other forms (e.g., physical count) of quantitative information.

The method of quality assessment suggested by Boesso and Kumar (2007) overcomes the above issues. They assessed the quality of disclosure based on the type of information (qualitative and quantitative), nature of information (financial and non-financial) and information outlook (forward-looking and historical). In their analysis, quantitative, financial and forward-looking information received a higher weight than qualitative, non-financial and historical information. The weighting of this information is questionable given that all types of information have value. It is ultimately for users to say which information is more valuable to them as different users have different expectations. For example, quantitative information is of greater use when coupled with narrative

explanation and vice versa; the same applies to historical and forward-looking information. Therefore, we argue a good mix of narrative information with quantitative information and historical information with forward-looking information will contribute to improving overall disclosure quality. Examining a particular item in detail allows for the inclusion of narrative explanations, quantitative and monetary figures, as well as forward-looking and historical information. Hence, this study selected one particular disclosure item – energy efficiency disclosure.

Energy efficiency disclosure is the final product of identifying the energy consumption sector, calculating the energy consumption and taking measures to reduce the energy consumption. There are several theoretical explanations for why organisations need to disclose sustainability information that includes energy efficiency.

4. Theoretical Framework

Prior disclosure studies have applied several theoretical lens to develop insights into why organisations communicate economic, social and environmental information, especially information that is voluntary. Among them, legitimacy theory and stakeholder theory are the most cited theories in explaining sustainability disclosure (Hahn and Kühnen, 2013; Ali *et al.*, 2017). However, prior studies using these theories mainly explain voluntary corporate disclosure, and the use of these theories in the public sector is limited to date. Decision-usefulness theory has played a vital role in the evolution of accounting thought (Staubus, 2013) but it too has seen limited use in sustainability disclosure studies. This study utilises these three theories to understand the energy efficiency public disclosure of a group of Australian cities.

Legitimacy theory positions that organisations respond to demands of different interest groups and act to legitimise their actions (Tilt, 1994). Suchman (1995, p. 574) defined legitimacy theory as "a generalised perception or assumption that the actions of any entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and definitions". Legitimacy theory is mainly used in the private sector, but legitimacy notions are also relevant to public sector research (Burritt and Welch, 1997). However, few studies have applied legitimacy theory to public sector disclosures (Lodhia *et al.*, 2012). For example, Burritt and Welch (1997) used legitimacy theory and found that government entities that faced higher pressure for public accountability (and therefore for

legitimacy) reported environmental information more so than entities with less public visibility.

Organisations' actions aimed at convincing society of the organisations' social responsibility are part of the legitimation process (Gray *et al.*, 1995). Lodhia *et al.* (2012) argue that government organisations, as part of their legitimacy, are expected to disclose environmental information to address public concerns with environmental performance. They explored annual reports and sustainability reports of 19 Australian Commonwealth Departments using a legitimacy approach and found that Departments disclosed environmental programmes and activities in their reports, which the researchers considered evidence of 'legitimacy generating' activities (Lodhia *et al.*, 2012). Providing disclosure even to "educate and inform the readers" can be viewed as an act of improving legitimacy (Lodhia *et al.*, 2012). Frost and Seamer (2002) utilise legitimacy theory, finding that New South Wales Government entities reported both an increase in environmental practices and environmental disclosure due to increased political visibility and also to "educate and inform the readers".

Because of their political sensitivity and public visibility government organisations face demands for legitimacy (Burritt and Welch, 1997). As major consumers of energy and stewards for environmental responsibility, cities may face demands for legitimacy. Moreover, government organisations are accountable to their citizens and others for their actions, and therefore have obligations to explain and justify their conduct (Greiling *et al.*, 2015). There is increasing concern and recognition in the Australian community about climate change, GHG emissions and energy prices that require the Federal Government, as well as city governments, to take action and communicate their actions. For example, a survey undertaken by the City of Sydney found that Sydney residents are concerned about climate change and would like to see the City take action against climate change (City of Sydney, 2018). Moreover, city governments are elected and their primary responsibility is to focus on development of policies and undertake activities in the public interest. Therefore, cities need to legitimise their position by conducting and communicating activities that matter to the community.

Stakeholder theory has also been used in disclosure studies. Freeman (1984, p. 46) defines stakeholders as "any group or individual who can affect or are affected by the achievement of the organisation's objectives". Just as in private sector organisations, public sector

organisations have a range of stakeholders, including citizens, business organisations, governmental bodies, supervisory boards, public scrutiny committees, consumer councils, audit offices, public sector watchdogs and so on. And in government organisations, citizens are the ultimate stakeholders (Greiling *et al.*, 2015). According to stakeholder theory, "an organisation's management is expected to undertake activities deemed important by their stakeholders and to report on those activities back to the stakeholders" (Guthrie *et al.*, 2006, p. 256).

Stakeholder theory often overlaps with the term "accountability", which, from an accounting perspective, refers to the responsibility of an organisation to disclose information about its performance, financial position, financing and investing, and compliance to assist users to make appropriate decisions (Cooper and Owen, 2007; An *et al.*, 2011). Organisations also need to disclose social and environmental information as part of discharging accountability to their stakeholders. As stated by Guthrie *et al.* (2006, p. 256) "stakeholder theory highlights organisational accountability beyond simple economic or financial performance".

The third theory applied in this study is decision usefulness theory. Traditional decision-usefulness theory had a narrow focus on the information needs of investors (Staubus, 2013), positing that the primary objective of accounting disclosure is to provide information that is useful in making investment decisions (Tom, 2014). An extended view incorporates users other than investors to include various stakeholders who demand social and environmental information along with financial information. (Haque *et al.*, 2016; Mia *et al.*, 2018). There is evidence that decision makers use cities' environmental disclosure in their decision-making process (Niemann and Hoppe, 2018). Decision usefulness theory can help disclosure preparers to incorporate various social and environmental data along with financial information that is necessary for making decisions.

These three theories can be inter-linked. In the context of this study, legitimacy theory indicates cities' need to act as per society's expectations. Citizens are essential stakeholders so cities' disclosures of GHG emissions can be seen as part of their legitimising process. Citizens and other users can use that information to monitor and make decisions in relation to energy efficiency. Therefore, this study utilises these three theories to explain a group of Australian cities' energy efficiency disclosure.

5. Research Design

The research approach adopted in this article requires an analysis of existing disclosure practices of major Australian cities. The primary research method adopted was documentary analysis, which is a well-established approach to the study of disclosures in the sustainability accounting literature and provides a way to analyse rather than present the disclosure produced by the various organisations (Lodhia, 2015). Document analysis "is a systematic procedure for reviewing or evaluating documents both printed and electronic (computer-based and Internet-transmitted) material" (Bowen, 2009, p. 27). It allows to examination and interpretation of data to elicit meaning, gain understanding, and develop empirical knowledge (Strauss and Corbin, 1998). This study conducted documentary analysis to evaluate energy efficiency disclosure of Australian eight major cities – Sydney, Melbourne, Brisbane, Canberra, Adelaide, Perth, Darwin and Hobart.

We mainly focus on the quality of the cities' energy efficiency disclosure, which we define as the completeness of disclosure or the degree of detail in the disclosure for a particular item, as well as the nature (qualitative vs. quantitative; financial vs. non-financial; historical vs. forward-looking) of the disclosed information (see, Boesso and Kumar, 2007; van Staden and Hooks, 2007). We have developed a disclosure index, which we use to capture the data and evaluate the sample cities' energy efficiency disclosures.

5.1 Research instrument and data analysis

The aims of this study were not to assess any energy efficiency program or project, but to explore the quality of the public disclosure of energy efficiency program and projects. As the study defines quality of the disclosure based on the degree of detail provided in the disclosure for a particular item, as well as the nature disclosed information, it is important to capture what information cities' has disclosed and the nature of the disclosed information related to energy efficiency program and projects. A research instrument (disclosure index) is developed to capture energy efficiency program and projects related information. Several prior studies used disclosure index to capture social and environmental information from various reports such as annual report and sustainability reports (Boesso and Kumar, 2007; van Staden and Hooks, 2007; Michelon et al., 2015). However, there is no existing instrument specifically aimed at energy efficiency disclosures. Hence, a research disclosure index is developed based on multiple national and international energy efficiency program evaluation guidelines, energy efficiency

program evaluation reports and previous studies related to assessing energy efficiency program. Also, the GRI and CDP's reporting frameworks for energy efficiency were reviewed. The rationale behind examining energy efficiency program evaluation guidelines, reports and scholarly articles is that they provide a useful set of criteria for evaluating energy efficiency cases.

This study has substituted degree of details with the information requires for evaluating EE program or project. To identify the information needed to evaluate EE program or project, several energy efficiency programs, evaluation reports, frameworks and scholarly articles were examined (see, Table 1). Analysis shows that energy efficiency program usually consists of information related to the name of the program, cost of the program, amount of energy savings, amount of cost saving, amount of emissions reductions and payback periods. Several documents also stated that the benefits of the energy efficiency program are hard to quantify but need to be considered in evaluating the program. valuable to the public in evaluating cities' energy efficiency programs and projects. Hence, this study considered all types of information to develop the disclosure index that may be valuable to the public in evaluating cities' energy efficiency programs and projects.

We also argue that cities need to explain why they need particular energy efficiency measures as it is vital to understand cities' rationale. Therefore, we have two stages in our energy efficiency disclosure index (see, Table 2). In the first stage, we explore whether cities provide their reasons for undertaking energy efficiency measures and if so, what are those reasons and what are the planned energy efficiency programs undertaken. In the second stage, we assess how much detail cities disclose to the public about a particular energy efficiency program. We select a specific project for a city based on which provides the most detailed information. Information disclosed by cities is categorised as forward-looking or historical.

It is also important to acknowledge that there are several challenges in quantifying energy savings. For instance, measuring energy efficiency is an estimate as savings represent an absence of energy use, and therefore it is impossible to measure energy efficiency impacts directly. There is also limited availability of energy data, which is also frequently of poor quality, making it difficult to measure energy efficiency impacts (IEA, 2014). Therefore, we include any information on challenges faced by cities in their energy efficiency measurement.

Table 1: EE programs evaluation reports, frameworks and scholarly articles

Guideline / Document	Information required for program / project evaluation
Community Energy Efficiency Program (CEEP) – Evaluation Report	Appropriateness of the programme Effectiveness of the programme Co-benefits that have been realised through the programme Number of project available under the program For individual projects: Energy saving Life expectancy Emissions reduction Payback period Comparison between cost and savings
NSW Energy Efficiency Programs: 2012, Evaluation Report	Program name Project description Measuring and valuation methodology Baseline period Saving analysis period Actual savings (Electricity (kWh), Cost, (GHG emissions) Implementation timeframe
Promoting Energy Efficiency Best Practice in Cities, International Energy Agency.	Energy savings GHG emission reductions Return on investment Transferability.
Energy Savings Measurement Guide (ESMG) version 2.0: Australian Government Department of Resources, Energy and Tourism	Title of the project Project description, Capital cost of the project Amount of energy savings from the project Key assumptions and risks associated with the project and recommendation
A Guide to Monitoring and Evaluation of Energy Efficiency Measures	Program - Title of the measure Objectives of the measure Description of the measure Implementing agency Stakeholders involved Target group Program cost Total resource cost Cost/KWh saved Reduction of subsidies Source of funding Financial instruments Awareness, monitoring & evaluation
GRI	Direct and indirect energy consumption Energy savings Initiatives to save energy consumption
CDP	Amount of fuel consumption Amount of electricity, heat, steam, and cooling purchased for consumption Investment cost
Peer reviewed articles	Energy savings, Environmental impact GHG reduction Cost saving Payback period Duration under the life cycle point of view

After developing the energy efficiency disclosure index, all the sample cities' websites to collect energy efficiency related information was reviewed. We have also downloaded several documents, such as annual reports, environmental reports, climate action plans and any material related to energy plan from their respective websites. These documents have examined to find energy efficiency related information that is listed in the disclosure index. The collected data was recorded in a word file and sorted according to our disclosure index. This process allowed evaluation of the cities' energy efficiency disclosure details and nature of their disclosed information.

In order to address issues of document analysis reliability (Milne and Adler, 1999) several steps were undertaken. To ascertain the reliability of the research instrument, after initial development the disclosure index was sent to several energy efficiency experts to ensure its validity and usefulness. Based on their feedback, the disclosure index was amended and finalised. In order to demonstrate the reliability of the data collected, testing was conducted on data from the three cities' websites, annual reports, climate action plans. Two coders performed a pre-test of the coding activity using the research instrument. Two coders then compared the pre-test results and found several minor discrepancies. Two coders discussed these discrepancies in coding and reached common agreement on correct information. Inter-coder reliability was tested using Holsti's formula (Holsti, 1969, p. 140) of coefficient of reliability. Prior studies suggested more than 80 per cent agreement between two individuals can be considered as an acceptable level (Hackston and Milne, 1996; Milne and Adler, 1999). Using the Holsti's formula to calculate the reproducibility gives the result of 85 per cent agreement, which supports the robustness of the coding. Findings of the document analysis are discussed next.

Table 2: Energy Efficiency (EE) public disclosure index

Stage 1: Disclosure Related to City's Overall Energy Efficiency (EE) Measure	
Disclosure Items	**Information Provided Yes/No**
Statement (narrative) about the rational for EE measure (qualitative)	
Identify high energy consumption sectors (qualitative)	
Stated any challenges with EE measure	
Historical Information -	
Amount of energy saving to date (quantitative)	
Total cost saving to date (quantitative & financial)	
Total emissions savings to date (quantitative)	
List of past or current EE projects (qualitative)	
Forward Looking Information -	
Expected amount of energy saving (quantitative)	
Expected total cost saving (quantitative & financial)	
Expected total emissions savings (quantitative)	
List of potential or future EE projects (qualitative)	
Stage 2: Disclosure related to a city's EE project or action	
Stage 2.1: Disclosure related to a city's past or current EE project or action (historical)	
Disclosure Items	**Information Provided Yes/No**
Title of the project (qualitative)	
Project description (qualitative)	
Name of the responsible authority (qualitative)	
Funding body/source	
The total cost of the project (quantitative & financial)	
Impact of the project Actual amount of energy savings (quantitative) Actual amount of cost savings (quantitative & financial) Actual amount of emissions savings (quantitative) Any other benefits that may not be quantifiable (e.g., level of comfort,)	
Payback period (quantitative)	
Stated any challenges with EE measure	
Stage 2.2: Disclosure related to a city's future EE project or action (forward looking)	
Title of the project (qualitative)	
Project description (qualitative)	
Name of the responsible authority (qualitative)	
Funding body/source	
The total cost of the project (quantitative & financial)	
Impact of the project Expected amount of energy savings (quantitative) Expected amount of cost savings (quantitative & financial) Expected amount of emissions savings (quantitative) any other expected benefits that may not be quantifiable (e.g., level of comfort)	
Payback period (quantitative)	
Stated any challenges with EE measure	

6. Findings

Our findings (see Appendix 1) suggest that all the sample cities are undertaking energy efficiency measures and that they publicly disclosed various levels of energy efficiency information. According to our sample cities the reasons for energy efficiency measures were GHG emissions reductions, energy savings and financial savings. As stated by the City of Adelaide "improving energy efficiency and switching to renewable energy are complementary policy measures that will deliver significant cuts in emissions and financial savings to the community". The cities also disclosed that energy efficiency is the cheapest way to cut GHG emissions from energy. As stated by Canberra "improving energy efficiency is one of the cost-effective ways to minimise our overall energy demand, and therefore reduce emissions associated with energy use" (ACT Government, 2019).

However, many of the cities did not quantify the benefits of taking energy efficiency measures to date nor the potential benefits they may realise in future (see, Table 3). It may be difficult for cities to calculate the cost and the benefits of energy efficiency measures. However, none of the cities disclosed any challenges they faced or might face with their energy efficiency measures.

Sydney, Canberra, Hobart and Perth released a limited amount of quantitative infromation about their energy efficiency measures. Canberra is the only city that disclosed the amount of energy savings, financial savings and reductions of GHG emissions to date (historical data) and potential savings (forward-looking data) of energy and cost in future through energy efficiency measure. Through its energy efficiency scheme, the City of Canberra has achieved GHG emissions reduction equivalent to removing 144,000 cars from Canberra roads. The city has also saved 4.5 million gigajoules of energy and A$240 million energy bills to date. In future, Canberra is expected to save 8.6% of energy consumption per year, and its residents are expected to save A$3.2/ energy bill per week in 2020. Sydney has provided an estimate of its future GHG emissions reduction and financial savings as a result of energy efficiency measures. As stated by the City of Sydney "energy efficiency measures would cost around $396 million, resulting in savings of $604 million, meaning a net benefit of $208 million". Sydney's energy efficiency would slash nearly 2 million tonnes of GHG emissions a year city-wide by 2030. Hobart is expecting to save 30% reduction in its emissions from its energy efficiency measures and Perth is hoping for 384,000 tonnes of emissions per year by 2031. It seems that different cities have disclosed their benefits in different ways.

Table 3: Cities

Stage 1: Disclosure Related to City's Overall Energy Efficiency (EE) Measure								
Disclosure Items	Information Provided							
	Sydney	Melbourne	Canberra	Adelaide	Hobarts	Darwin	Perth	Brisbane
Historical Information								
Amount of energy saving	12%	No	4.5M GJ	No	164700GJ	No	No	No
Amount of cost saving	No	No	$240M	No	No	No	No	No
Amount of GHG emissions saving	No	No	Equivalent to removing 144,000 cars off Canberra roads	No	No	No	No	No
Forward Looking Information								
Amount of energy saving	No	No	8.6% pa	No	No	No	20% by 2021	No
Amount of cost saving – energy related	> $600M	No	$3.2 pw per household in 2020	No	No	No	No	No
Amount of GHG emissions saving	2M mt pa by 2030.	No	No	No	30% from its energy	No	0.38 mt pa by 2031	No

It is essential to identify significant energy consumption sectors in order to target those sectors to reduce energy consumption. Five cities disclosed their major energy consumers and recognised buildings and transport sectors as some of their primary energy consumers and significant source of GHG emissions.

Regarding past and future energy efficiency projects, every city disclosed its previous as well as future energy efficiency projects. However, several cities, such as Hobart and Darwin, did not provide any details of their past energy efficiency projects; whereas, Canberra and Adelaide did not provide any details of their future energy efficiency projects. None of the cities provided all

the details that users may need to evaluate cities' energy efficiency projects. Cities that have disclosed aspects of their past energy efficiency projects focused on information about energy cost and emissions savings but did not provide information about the cost of the project. Many energy efficiency projects require substantial upfront cost and users may compare the cost with the realised benefits. There was also no information provided about the funding source and payback period that might be relevant for other cities and investors interested in investing in similar energy efficiency projects.

Although seven cities mentioned future projects, only three disclosed a limited amount of information about these projects. Only Hobart and Darwin provided information about expected energy and cost savings; whereas Sydney and Darwin have information about the potential amount of GHG emissions reductions.

The disclosure score is built on some items disclosed by each city. There are 35 items in total in the disclosure index; hence the possible maximum score that any city could achieve is 35. Sydney had the highest score (17), with Melbourne, Canberra and Hobart receiving the second highest score of 11 each. Adelaide and Brisbane both scored 6, the lowest score.

7. Discussion and conclusion

Accounting plays a critical role through its calculative and disclosure practices to measure, monitor and disclose organisational social, economic and environmental activities. In this paper, we have explored calculative and disclosure practice of a group of major Australian cities on their disclosed energy efficiency measures.

Australia has a binding commitment as per the Paris Agreement to reduce GHG emissions and, as energy is the primary source of Australian GHG emissions and activities in cities consume a large share of power (Dunstan *et al.*, 2009; Talberg and John, 2013), reduction of cities' energy consumption may play a critical role in reducing Australian GHG emissions.

Our findings suggest that Australian cities are undertaking energy efficiency measures and considering that improving energy efficiency is one way to reduce GHG emissions. Energy efficiency measures are also helping Australian cities and citizens to save energy related costs. However, while cities disclosed energy efficiency measures relating to emissions reductions, financial savings and amount of reduction of energy consumption, most cities did not provide

quantitative and financial data, nor did they disclose the challenges they encountered. Cities (such as Sydney, Canberra, Hobart) that disclosed information did so in different formats, makng the information difficult to compare. This suggests that it would be useful to have an Australian standardised guideline for accounting and reporting of energy efficiency measures.

The cities identified that the building and transport sectors are the primary energy users and a significant source of GHG emissions. Australian cities usually have direct control over the building sector but limited control over the transport sector within their geographic region. Where cities have limited authority, they can influence and raise concerns in relation to undertaking energy efficiency measures (City of Sydney, 2018).

Most cities provided some information on their past energy efficiency projects, which can be viewed as part of the legitimising process, whereas only three provided details on their future energy efficiency projects. Among them, several quantified their energy savings, financial savings and emissions savings from their energy efficiency projects, indicating that it is possible for cities to quantify the benefits of the energy efficiency projects, and that those facing difficulties can learn from cities who have quantified them.

Moreover, this information is of benefit to citizens and other stakeholders to assess cities' energy efficiency projects, at least from an economic and environmental perspective. However, it would be difficult to conduct a cost-benefit analysis as none (except Hobart for its future energy efficiency project) provided the cost of the project. Energy efficiency guidelines also suggest using payback periods and ROI in evaluating projects but limited information on these was provided by our sample cities. So, there is a lack of comprehensive data for users to make an informed judgment or decision about cities' energy efficiency projects, that is, there is limited decision usefulness.

Although it is claimed that government organisations are in a better position to undertake sustainability activities it could be expected that they would provide more comprehensive information about their actions. Prior studies examining the quality of disclosure suggest that organisations need to provide quantified and financial information along with narrative information (see, Brammer and Pavelin, 2008; Michelon *et al.*, 2015; Melloni *et al.*, 2017), and that quality information or disclosure is essential for decision making (Mia *et al.*, 2018).

However, we find that several cities are providing information that is very limited and mostly narrative.

This study makes several contributions. First, it extends prior disclosure studies by exploring disclosure at a government level, whereas previous studies have mainly focused on the corporate sector. Second, previous disclosure studies primarily examine the number of disclosures (see, Moratis and Brandt, 2017; Parsa *et al.*, 2018) rather than what organisations are doing to mitigate GHG emissions. This study explores disclosure in relation to initiatives to reduce energy consumption and emissions reductions. Third, this study developed a disclosure index that can capture the different forms of data such as qualitative, quantitative, historical and forward-looking to allow more in-depth understanding of a disclosure item and to assess calculative practice and the quality of the disclosure.

The findings of this study have several practical and policy implications. We have identified that major Australian cities are undertaking energy efficiency measure to reduce emissions and energy consumption. While they have several energy efficiency projects in place, the benefits of these projects are rarely quantified. Hence, accountants, energy efficiency experts and city authorities can work together to quantify the benefits of energy efficiency projects and disclose that benefit. There is also no universal framework for cities to measure the benefits of energy efficiency opportunities and the impact of energy efficiency projects. Use of a common framework can help stakeholders to compare the performance of energy efficiency projects (Mia *et al.*, 2018). City authorities, policy makers and other organisations, such as the CDP, could work together to develop a framework that allows cities to measure and report climate change related actions, including energy efficiency measures, in detail. This can help to produce comparable information that will enable city authorities to share the knowledge gained from their projects. Information provided by such a framework is also useful to stakeholders in monitoring cities' performance and keeping track of energy consumption and emissions reduction.

Similar to other studies, this study also faces several limitations, which need to be addressed. The first limitation is the small sample size. This study only focuses on a group of Australian cities and considers only one initiative for emissions reduction, so the findings may not be broadly generalisable. The second limitation relates to the time periods of collected data, especially from the cities' websites. We reviewed cities' websites between May and October 2018, therefore, past energy efficiency projects disclosed previously may have been discontinued. We have

minimised this limitation by considering other published documents such as annual reports, environmental reports and climate action plans available from cities' website.

Our findings also provide several future avenues of research. For example, future research might explore energy efficiency disclosure from other cities around the world. Researchers may interview city authorities to understand issues that prohibited cities from disclosing quantified and financial information. As cities have multiple energy efficiency projects, future research may also explore the factors that allow city managers to prioritise certain energy efficiency projects over other projects.

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Appendix 1:

Energy Efficiency Related Public Disclosure

Stage 1: Disclosure related to City's Overall Energy Efficiency (EE) Measure									
Disclosure Items	Information Nature	Information Provided							
		Sydney	**Melbourne**	**Canberra**	**Adelaide**	**Hobart**	**Darwin**	**Perth**	**Brisbane**
States rational for EE measure	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Identify high energy consumption sectors	Qualitative	Yes	Yes	No	Yes	Yes	Yes	No	No
Challenges with EE measure	Qualitative	No	No	No	No	No	No	No	No
Historical Information									
Amount of energy saving	Quantitative	No	No	Yes	No	Yes	No	No	No
Amount of cost saving	Quantitative	No	No	Yes	No	No	No	No	No
Amount of GHG emissions saving	Quantitative	No	No	Yes	No	No	No	No	No
List of EE projects currently in place	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Forward Looking Information									
Amount of energy saving	Quantitative	No	No	Yes	No	No	No	Yes	No
Amount of cost saving	Quantitative	Yes	No	Yes	No	No	No	No	No
Amount of GHG emissions saving	Quantitative	Yes	No	No	No	yes	No	Yes	No
List of EE projects	Qualitative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Stage 2.1: Disclosure Related to a City's Particular EE Project or Action (historical)									
Disclosure Items	Information Nature	**Sydney**	**Melbourne**	**Canberra**	**Adelaide**	**Hobart**	**Darwin**	**Perth**	**Brisbane**
Title of the project	Qualitative	Yes	Yes	Yes	Yes	No historical project details available	No historical project details available	Yes	Yes
Project description	Qualitative	Yes	Yes	Yes	Yes			No	Yes
Name of the responsible authority	Qualitative	Yes	Yes	Yes	No			No	No
Cost of the project	Quantitative & Financial	No	No	No	No			No	No

Funding body/source	Qualitative	No	No	No	No			No	No
Amount of energy saving	Quantitative	Yes	Yes	No	Yes			Yes	Yes
Amount of cost saving	Quantitative & Financial	Yes	Yes	Yes	No			No	No
Amount of GHG emissions saving	Quantitative	Yes	Yes	No	Yes			Yes	Yes
Any other benefits	Quantitative&Qualitative	Yes	No	No	No			No	No
Payback period	Quantitative	No	No	No	No			No	No
Return on investment (ROI)	Quantitative	No	Yes	No	No			No	No
Challenges with EE project	Qualitative	No	No	No	No			No	No
Stage 2.2: Disclosure Related to a City's Particular EE Project or Action (forward-looking)									
Disclosure Items	Qualitative	**Sydney**	**Melbourne**	**Canberra**	**Adelaide**	**Hobart**	**Darwin**	**Perth**	**Brisbane**
Title of the project	Qualitative	Yes	Yes	No forward-looking project details available	No forward-looking project details available	Yes	Yes	No forward-looking project details available	No forward-looking project details available
Project description	Qualitative	Yes	Yes			Yes	Yes		
Name of the responsible authority	Qualitative	Yes	No			Yes	Yes		
Cost of the project	Quantitative & Financial	No	No			Yes	No		
Funding body/source	Qualitative	No	No			No	No		
Amount of energy saving	Quantitative	No	Yes			Yes	Yes		
Amount of cost saving	Quantitative & Financial	No	No			Yes	Yes		
Amount of GHG emissions saving	Quantitative	Yes	No			No	Yes		
Any other benefits	Quantitative&Qualitative	No	No			No	No		
Payback period	Quantitative	No	No			No	No		
Return on investment (ROI)	Quantitative	No	No			No	No		
Challenges with EE project	Qualitative	No	No			No	No		

Chapter 7 – Conclusion

7.1 Introduction

Growing concern about environmental sustainability and the impact of climate change on society more broadly have prompted calls for social and environmental accounting information to be disclosed by corporations, government agencies and NGOs. In the academic literature, three key discussions are the utility of mandatory sustainability reporting, reporting boundaries and new forms of disclosure through digital media.

In terms of mandatory sustainability reporting, although organisations increasingly provide sustainability information, prior research has found the disclosed information to be frequently incomplete, inconsistent, unreliable, biased and self-laudatory (e.g., Andrew and Cortese, 2011a; Deegan 2017; Michelon et al., 2015; Gray, 2010; Zaini et al., 2018). As the credibility of the disclosed information remains questionable (Abernathy et al., 2017), several studies have argued that mandatory standardised reporting would improve the credibility and quality of sustainability information (Dumay and Hossain, 2018; Ioannou and Serafeim, 2017).

In relation to sustainability reporting boundaries, there has been discussion in the academic literature about whether sustainability, which can be viewed as a systems concept, should be explored at the regional level, rather than just at an individual and/or organisational level (Dumay et al., 2010; Gray, 2010; Gray and Bebbington, 2001; Milne and Gray, 2007). One such approach to exploring sustainability issues at the system level is to use the city as a unit of analysis.

More recently, academic research has begun to investigate sustainability reporting disclosure using digital media. Technological advancement has changed the way people communicate and engage with others (Lodhia, 2018). Social media (e.g., Facebook, Twitter) is now a mainstream communication tool and source of information. Social media has provided an opportunity for organisations to be more transparent about their sustainability information.

This thesis contributes to these three academic discussions by exploring the quality of voluntary greenhouse gas (GHG) emissions, using the city as a unit of analysis, and by examining their disclosure via different communication channels including digital media.

GHG emissions contribute to global warming and therefore sustainability. The impact of climate change is recognised at a global as well as local level (Mah and Hills, 2016; World Bank, 2017; Perkiss and Moerman, 2018), with the IPCC recently announcing that GHG emissions must be reduced to net zero level globally by the middle of this century to have a reasonable chance of limiting global warming to 1.5^0 C (Stern, 2018). Without direct action against climate change, potentially hundreds of thousands of lives will be lost (Elder, 2018).

Cities are important to reducing GHG emissions. As a large proportion of GHG emissions are within city boundaries, city managers can potentially significantly reduce emissions (C40, 2018). Indeed, cities around the world are reducing emissions through hundreds of emissions reduction activities (Barber, 2017; Rosenzweig et al., 2010), such as energy efficiency initiatives (IEA, 2014; Yoon et al., 2017).

Information related to GHG emissions is a key element of effective GHG emissions management (Burritt et al., 2011; Gibassier and Schaltegger, 2015) and various frameworks guide the accounting and reporting of this information (Ibrahim et al., 2012). Consequently, GHG related disclosure is an area of interest to SEA researchers (Haque et al., 2016). Although cities are critical players in tackling climate change through the reduction of GHG emissions, SEA research has previously mainly focused on corporate GHG disclosures (Dumay et al. 2010; Ascui, 2014; Depoers et al., 2016). The extant literature suggests that the volume of corporate disclosure related to various sustainability issues, such as biodiversity, GHG emissions and human rights, has increased, but the quality of the disclosure remains questionable (Abernathy et al., 2017; Deegan, 2017).

In order to better understand city-based GHG disclosures, the primary research question of this thesis is: "what is the extent and quality of GHG emissions and associated emissions reduction actions' disclosures at the city-level?". This study defined the extent and quality of disclosure based on the completeness and degree of details provided about GHG emissions inventory and emissions reduction activities. To assess the completeness and degree of detail of the disclosure for a particular item, this study has considered stakeholders' expectations or needs. High quality GHG emissions inventories and complete information about these inventories is critical to develop policies and programs related to emissions reduction targets and actions. Quality information on emissions reduction actions is also important as city managers and policymakers need to evaluate and benchmark the economic and environmental performance of the actions. A comprehensive disclosure index has been developed to assess the quality of the disclosure. Theories (e.g., accountability, decision usefulness, legitimacy and stakeholder theory) used in this study

layouts the rational behind the disclosure which provided an initial basis for the development of the disclosure index to assess the quality. Prior research and several publicly available documents assessing the performance of sustainability actions helped to identify the information expected by stakeholders.

The findings of the thesis highlight that the disclosed emissions inventory for many cities might be misleading due to the CDP's deficient standards and cities' poor performance. In terms of emissions reduction actions, inadequate information is provided about the outcome of cities' actions, and there is no standardised framework for reporting actions. This has broader implications for SEA research, where specific areas (e.g., water and biodiversity) face similar issues.

This thesis includes three empirical research papers that investigated the accounting and reporting practices of cities' GHG emissions and associated emissions reduction actions. The three studies enhance and advance social and environmental accounting research using various methodological lenses and perspectives, as well as indicating directions for future research in the accounting and reporting of GHG emissions. The following section reviews the main findings of the three studies and discusses their collective implications.

7.2 Major Findings of the Thesis

Paper 1 (Mia et al., 2019a) explores the quality of cities' GHG emissions disclosures to the Carbon Disclosure Project (CDP) and compares them with users' expectations, using the expectation gap framework. An expectation gap may arise because of deficient

performance, inadequate standards and users' unreasonable expectations. Quality information is essential to meet users' expectation, and in Paper 1, quality is defined by completeness, consistency, timeliness, accuracy, reliability and comparability. GHG emissions information forms a basis for action on climate change (Ibrahim et al., 2012; Kennedy et al., 2012) but in order to be effective an accurate, comparable, comprehensive, and complete accounting and reporting of GHG emissions from cities is required. This information can then be used for setting meaningful targets, designing successful policies and implementing effective emission reduction strategies (Ibrahim et al., 2012; Wiedmann et al., 2016). To assess the quality of cities' GHG emissions disclosures to the CDP, Paper 1 analyses cities' responses to the CDP in 2015 associated with GHG emissions inventories (GEIs) and emissions reduction targets (ERTs).

Paper 1 highlights that there are several issues relating to emissions inventory disclosures by cities, including: the time gap between calculating and disclosing emissions; the use of diverse methodologies to calculate emissions; the exclusion of several gases from the GEI; the non-reporting of Scope 3 and, in some cases, Scope 2 emissions; and a disinclination to verify emissions data. Regarding emissions reduction targets, there are differences in the baseline year and distorted application of emissions reduction percentages to the emissions sources. Therefore, cities' disclosed GHG emissions data is incomplete, outdated, unreliable and not comparable. These issues may be attributed to the city authorities' deficient performance.

The CDP guideline is flexible regarding what is reported by cities and what protocols cities use to calculate emissions, and there is insufficient checking for accuracy and

completeness. Also, there is currently no quality check and no rating or grading system based on the extent and level of cities' disclosure to the CDP. Paper 1 also reveals that many cities did not independently verify their emissions data, which is encouraged (but not required) by the CDP.

In relation to expectations, Paper 1 indicates that expecting comparable GHG emissions information is unreasonable because there are several physical and technical characteristics that are unique to each city. While the elements relating to performance and standards can be addressed, a key finding from the first phase of the study is that, even with standardisation, GHG emissions between cities will not be comparable. Therefore, the disclosure of emissions reduction *actions* will be much more useful for accountability and peer learning than just disclosure of emission *levels*.

Paper 2 (Mia et al., 2018) extends Paper 1 by investigating the disclosure quality of emissions reduction actions and emissions reduction targets via three research questions. First, what communication channels are used by world megacities to disclose their emissions reduction targets and actions? Second, are these targets and actions communicated consistently across different channels? Third, what is the quality of the actions disclosed in different channels? Paper 2 explores social media as a GHG disclosure channel, responding to prior research that suggests that social media has the potential to improve transparency, accountability and reach (Lodhia, and Stone, 2017). Paper 2 also investigates the consistency of information provided across channels, responding to prior research that suggests information may not be consistent (Depoers et al., 2016).

The findings of Paper 2 highlight that city authorities have taken multiple actions, including energy efficiency measures to reduce GHG emissions and used multiple disclosure channels. Disclosed information related to emissions reduction targets is consistent, but information regarding emissions reduction actions is inconsistent, inadequate and mainly narrative in form (Mia et al., 2018). Regarding social media, this study finds that despite having a large number of online followers, most cities do not use social media to disclose emissions reduction actions (Mia et al., 2018). Paper 2 therefore calls for city managers to realise the opportunities for engagement available by using social media.

Paper 3 (Mia et al., 2019b) extends the work of previous papers by examining the calculative and disclosure practices pertaining to energy efficiency - a critical emissions reduction action - in the context of Australian capital cities. Paper 1 reveals that cities' GHG emissions mainly come from energy consumption as the primary source of Australian energy is fossil fuel. Paper 2 indicates that many city authorities, including those of Australian cities, take energy efficiency-related actions in order to reduce GHG emissions. Prior research suggests that improving energy efficiency is one of the most effective ways of reducing GHG emissions while simultaneously providing economic benefit (EEC, 2016; Yoon et al., 2017). In the EU, improved energy efficiency and the energy mix are the main factors behind a fall of more than 22% of total GHG emissions since 1990 (Eurostat, 2018). Given the prevalence and importance of energy efficiency initiatives, related disclosures are relevant to city authorities, the public, investors and other stakeholders to assess past, current and future energy efficiency related projects.

Paper 3 confirmed that Australian capital city authorities are undertaking numerous energy efficiency projects. Reduction of GHG emissions, saving energy and costs are the key driver for major Australian cities to undertake energy efficiency initiatives. However, there has been limited quantified information from the cities except Canberra regarding how much GHG emissions, energy and cost cities can save from their energy efficiency initiatives. Regarding energy efficiency projects, every selected city has disclosed their past and future energy efficiency projects but provided inadequate information related to cost of the project, source of the fund, amount of energy, cost and emissions savings, payback periods, return on investment and challenges associated with the projects. Therefore, stakeholders who are seeking to assess cities' energy efficiency program or projects have access to limited public information. In addition, it is also difficult to compare project level information among the cities as different cities have disclosed their information in different ways. Hence the study calls for the reporting of energy efficiency projects to be standardised and enhanced.

7.3 Implications of the Findings

Considered collectively, the thesis findings provide valuable insights for standard setters, policy makers, city authorities, citizens and SEA researchers. This study has demonstrated that comparable information of cities' aggregate GHG emissions is not possible. Therefore, a key implication is that standard setters and policymakers should focus on emissions reduction actions and impacts in developing disclosure frameworks. This study also suggests that there is room for city authorities to improve their performance concerning the measurement and disclosure of GHG emissions inventories and emissions reduction

actions. For SEA researchers, this thesis highlights that sustainability issues need to be researched using at a geographic boundary, and it would be more valuable to examine sustainability actions related disclosure in detail than aggregate sustainability information. These are expanded upon in the following sub-sections.

7.3.1 Focus on Actions and their Impacts

By demonstrating that it is not possible to provide comparable information of cities' aggregate GHG emissions this study highlights to standard setters and policymakers that their focus should be on emissions reduction actions and impacts in developing disclosure frameworks. Standard setters and policymakers should focus on actions and their impacts to reduce emissions rather than just develop frameworks that take stock of factors. As the comparison of GHG emissions is not possible between cities due to several physical and technical factors, it would be useful to have standardised guidelines for reporting emission reduction actions and their impacts in order to facilitate mutual learning.

In particular, as the CDP has already established a database for collecting cities' GHG emissions related information, it could facilitate knowledge sharing amongst cities by asking for more specific information about the actions and impact of those actions. Providing standardised and customised indicators would allow city authorities to measure and disclose the environmental and financial performance of specific emissions reduction actions. Currently, the CDP mainly focusses on the state of total emissions, rather than cities' emissions reduction activities and the outcome of those activities. Although the CDP asks for information about cities' emissions reduction actions, most cities do not provide

any information about their actions. The CDP could develop a rating system based on the extent and level of information provided by cities about the success of actions to reduce emissions in order to encourage improved disclosures.

This study also suggests that there is room for city authorities to improve their performance concerning the measurement and disclosure of GHG emissions inventories and emissions reduction actions. Actions are the fundamental building blocks of creating change and therefore it is of value for cities to disclose the actions they are taking to reduce emissions and the outcomes of those actions. Further, cities can reduce emissions by learning from the "best practices" of other cities (Kennedy et al., 2009). When cities fail to disclose information about their actions, they deprive other cities of the opportunity to learn. Mandatory reporting would increase the extent of the information disclosed (Ioannou and Serafeim, 2017) and hence the opportunity for shared learning.

7.3.2 Cities' Emission Accounting and Disclosures

The second implication is that city authorities need to improve disclosures relating to GHG emissions inventory and actions to reduce GHG emissions. The findings of Paper 1 suggest that cities' disclosed emissions inventories are incomplete, inconsistent and outdated. However, users want complete, consistent and timely information. Therefore, city authorities need to provide complete, consistent and timely emissions information about their emissions inventories.

Papers 2 and 3 indicate that cities' disclosures related to emissions reduction programs and actions are mainly narrative in form and lack detail about the actual impact of emissions reduction actions. For example, several cities mentioned replacing streetlights as a means to save energy and reduce emissions, but provided limited information about the financial costs, energy savings for emissions reduction. City authorities need to identify, measure and communicate the impact of their actions to reduce emissions for the benefit of all stakeholders seeking to evaluate the effectiveness of actions.

7.3.3 Verification of Emissions Inventory and the Impact of Emissions Reduction Actions

The third implication is that city authorities need to verify their emissions inventories and the outcomes of the emissions reduction actions. This study indicates that many cities did not independently verify their emissions inventories and outcomes of emissions reduction actions. Reliable emissions inventories are critical for setting meaningful emissions reduction targets, designing successful policies and implementing emissions reduction actions (Wiedmann et al., 2016). Accurate GHG emissions data is also essential to monitor and track emissions levels. Assurance services are used to increase the reliability and credibility of financial information. Many organisations, including Big 4 firms, now provide assurance services for sustainability disclosures to improve the reliability and quality of the sustainability information (Cohen and Simnett, 2014; Fuhrmann et al., 2017). Likewise having a third-party verification for cities' disclosed emissions data to the CDP would advance the reliability and credibility of emissions inventories.

Verification is also necessary when assessing the outcomes of actions to reduce emissions. Independent verification of actions helps cities to understand the impact of the actions and can help in selecting the best possible actions for emissions reduction. Verification is also essential to check the consistency of disclosure across different communication channels including social media.

7.3.4 Social Media and Stakeholder Engagement

The fourth implication is that city authorities need to seize the opportunities offered by social media to communicate information about their GHG emissions and actions they are taking to reduce emissions. This study finds that only four out of ten cities use social media to communicate their actions to reduce emissions (Mia et al., 2018). This study also reveals that cities have many followers on social media who communicate with cities and share cities' information through Facebook and Twitter. However, many cities are not fully utilising the benefits social media offers. These findings have practical implications for city authorities as they provide evidence that stakeholders are willing to engage in dialogue with city authorities about climate change issues, which provides city authorities with an opportunity for meaningful stakeholder engagement.

As an example of the use of social media to get information and raise concerns about climate change, when the IPCC released its Fifth Assessment Report discussing the impact of climate change, there were more than 52,000 tweets about climate change in less than a week, mostly from the general public (Newman, 2017). Many private corporations are now building and maintaining social media profiles to share information and build relationships

with the public (Parveen et al., 2015). City authorities should actively consider this platform as a disclosure media to reach more people and provide timely information.

Also, social media provide a platform for stakeholder engagement that can help organisations to understand the extent and level of information expected by the different group of stakeholders. This study highlighted that city authorities have failed to provide the information expected by the public and other stakeholders. Stakeholder engagement allows organisations to build relationships with stakeholders and hence "to improve their overall performance, accountability and sustainability" (Gao and Zhang, 2006, p. 726). Stakeholder engagement and dialogue are increasingly crucial elements of sustainability reporting (Unerman, 2010). Meaningful engagement needs to have two-way communication (Gao and Zhang, 2006) and social media provides a mechanism to achieve that. Hence, cities should fully utilise the benefits offered by social media.

7.3.5 Theoretical Implications

This study has also theoretical implications in extending an "expectation gap" framework used in the auditing literature. This study has demonstrated that use of an "expectation gap" framework is valuable in comparing the information stakeholders expect and that provided by an organisation. Using the framework may assist preparers to improve the extent and quality of disclosed information by identifying what contributes to an expectation gap and how the gap can be closed.

This study also employs media richness theory to explore the rich features and capabilities offered by different disclosure media. This theory indicates that social media has features that can help to improve organisational communication. Researchers and organisations can employ this theory to identify and compare different disclosure media to communicate their information to the stakeholders.

7.3.6 Broader Implications for SEA Research

This thesis has implications for SEA research. For SEA researchers, the findings of this study highlight that sustainability issues need to be researched at the geographic/regional level and require to consider the organisational impacts on the biophysical environment. However, corporate level accounting has narrow focus on sustainability (Dumay et al., 2010). Corporate accounting reports on the enterprise's wealth contribution to a nation but does not record the damage the same enterprise has done to the social and environmental health during the process of wealth creation. Also, as many corporations operate their business in multiple locations it is difficult to measure and understand the sustainability performance (Ball and Bebbington, 2008). Being a regional organisation, a city government would be an option to explore sustainability issues at the geographic level. Hence, this study uses 'city' as a unit of analysis to study a sustainability issue. This study also indicates that it is important to examine sustainability actions related disclosure in detail rather than aggregate sustainability information.

In particular, SEA research would benefit from exploration of organisations' sustainability actions and the outcomes of those actions. This study demonstrates that comparing

aggregate level information between cities or similar organisations such as local governments may not be possible and therefore, actions related disclosure is of particular value for public accountability and peer learning. This study reveals that there has been inadequate information about the outcome of the cities' actions, and there is no global standardised framework for reporting actions. The implication for SEA research is that within each specific area (e.g., water, biodiversity) of focus there are likely to be similar issues that future researchers might consider.

For effective accounting and disclosure of sustainability actions, policymakers and standard setters need to develop a global guideline for measuring and disclosing sustainability actions and the outcomes of those actions. One of the most used sustainability reporting frameworks is the Global Reporting Initiative (GRI). Prior studies have mostly used the GRI reporting framework to assess social and environmental disclosure (e.g., Guthrie and Farneti, 2008; Hahn and Kühnen, 2013; Lozano, 2011; Maria da Conceição and Rodrigues, 2019). The GRI provides guidelines on disclosing sustainability information, including emissions, energy and biodiversity-related information, but does not focus on actions to reduce emissions, save energy or to protect biodiversity. For example, the GRI asks for information about reduction of GHG emissions (305-5), suggesting that disclosure focus on GHG emissions reduced as a direct result of reduction initiatives. In doing so it requests aggregate emissions reduction data rather than individual emissions reduction actions (e.g., the quantum of emissions reduced from each action, the cost of undertaking the action and payback periods). Given the potential value of such individual information, international organisations such as the GRI and CDP have a role to play in developing a global framework that provides greater transparency in

relation to organisations' actions and contributions towards sustainable development. By disclosing actions, organisations can share stories of success or failure that provide valuable lessons for other organisations and policymakers.

This study indicates that stakeholders are interested in quality information from organisations. Prior studies examined sustainability reporting have raised their concern about the quality of the disclosed information (Abernathy et al., 2017; Deegan, 2017; Parker, 2011). Therefore, it is vital for SEA researchers to assess the extent and quality of sustainability information. This study identifies that stakeholders want qualitative and quantitative, financial and non-financial, and historical as well as forward-looking information. They also want complete, consistent and reliable information. This study has developed a disclosure index for assessing emissions reduction actions related disclosure. A key feature of this index is that it examines both the extent of disclosures and compares the quality of action related disclosure practice. In this aspect, it differs from prior studies.

Although focusing on sustainability issues is an ethical and moral responsibility, assessment and disclosure are important in managing and making decisions about sustainability-related risks and opportunities (Burritt and Christ, 2017). Quality disclosure provides stakeholders, including management, with the information needed to choose the most cost-effective actions with the best possible outcomes. It is important for accountants, managers, sustainability experts and researchers to work together to understand the cost and benefits of sustainability actions. This study argues that mandatory reporting will improve the extent and quality of sustainability information.

This study also demonstrates that social media can be beneficial for stakeholder engagement that is critical to improve accountability and sustainability reporting. As discussed above, social media has now become a mainstream communications channel and source of information. The findings of this study demonstrate that the public is willing to engage with organisations and share information. This finding in relation to cities' emissions reduction actions has implications for sustainability information disclosure more broadly. Academic research may investigate the opportunities offered by social media, and the way organisations can fully utilise it to engage with stakeholders. It may also explore the implications for auditing and the challenges presented in relation to providing assurance services.

7.4 Limitations and Areas for Future Research

This thesis is subject to several limitations. First, the cities used in this research are mainly from developed and English-speaking countries, limiting the generalisability of the findings. Future research examining disclosures from cities in non-English-speaking countries (particularly developing nations) could provide additional insights. Future research could also compare the calculative and disclosure practices around GHG emissions and associated emissions reduction actions between wealthy cities and less wealthy cities.

Second, user expectations were identified based on prior studies, several online videos and project evaluation reports, which may not fully represent users' expectations. Future

research could adopt other research methods such as user surveys or interviews in order to obtain a more nuanced understanding of user needs and expectations.

Third, disclosure quality was assessed via a disclosure scoring system. While this system was based on prior literature and thoroughly tested, it is inevitably subjective, particularly in relation to scoring more qualitative disclosures. To reduce the subjectivity of assigning a score, future researchers could ask an independent body not associated with their research to score and assess quality, which could then be cross-checked by researchers.

Fourth, the scope of this thesis focuses on the limited economic (cost and financial savings) and environmental (e.g., the amount of emissions reductions) outcomes of the emissions reduction actions. Depending on the action, however, there may be more other benefits or costs associated with the emissions reduction actions, such as social impacts. Future research could explore specific actions in more depth and measure the social, economic and environmental benefits of those actions in greater detail so that city officials have more complete information to justify their emissions reduction actions. Such comprehensive information would also help cities to determine which projects to prioritise.

Future research could also usefully examine whether cities' existing emissions reduction actions and targets have any significant impact on cities' overall emissions. This will help city authorities and policymakers to understand whether their current actions and targets are sufficient to deal with climate change or whether they need to redesign and redevelop policies related to emissions reduction actions and targets. Researchers might also investigate what drives city officials to undertake these actions and the challenges they

face in measuring and disclosing emission related information. Identifying challenges can help city authorities to work with researchers to mitigate those challenges that will improve measurement and disclosure of emissions related information.

Finally, this study uses an expectation gap framework, which could be utilised and further modified by future researchers to examine sustainability issues in other jurisdictions or study other public entities. This will help disclosure preparers to better under users' need and disclose information accordingly.

7.5 Final remarks

Human activities are the cause of the changes in the concentration of GHGs in the atmosphere, leading climate changes that are increasingly disruptive and harmful to humans and all other living creatures. The only reasonable solution to the problem of this human-induced climate change is for society to reduce GHG emissions. A significant proportion of anthropogenic GHG generating activities are concentrated within the cities' boundaries (Wright et al., 2011). Consequently, cities have a major role to play in monitoring and reducing GHG emissions and mitigating climate change (Bader and Bleischwitz, 2009).

Cities around the world are stepping up on climate action taking hundreds of emissions reduction actions (CDP, 2018). Any action to reduce GHG emissions at the local level, however, requires that local or city governments to understand their emissions sources and emissions inventory. An accounting and reporting guideline – GPC has been developed by

the cities' coalitions such as C40 and other international organisations such as World Bank, UNEP, ICLEI. The CDP provides a platform for cities to report their emissions inventory as well as their emissions reduction targets and actions to the public. There are also other media or communication channels available for cities to disclose their emissions and their actions to reduce emissions.

Disclosing information about cities GHG emissions help to improve GHG performance (Gibassier and Schaltegger, 2015). Disclosure also can help both private and public organisations to be more transparent and accountable about their actions and performances regarding GHG emissions, climate change and other sustainability issues such as water, biodiversity, women empowerment and human rights. Some citizens are asking for more environmental information so that they can participate in environmental debates and put pressure on policymakers (Qian et al., 2011). GHG related disclosure is important for city governments to evaluate progress and adopt appropriate mitigation strategies (Cortekar et al., 2016).

International literature indicates that there is a growing demand for accountability and transparency mainly concerns social and environmental issues from companies, non-profit organisations and public administration (Fusco and Ricci, 2018). This has led to an increasing interest in non-traditional and non-financial reporting practices that are able to account for the social and environmental impact of organisations and their contribution to sustainable development (Unerman et al., 2007). Many scholars to date have explored the non-traditional and non-financial reporting practices which is also called SEA reporting, sustainability reporting, triple bottom line reporting (Ali et al., 2017; Deegan, 2017). Prior

studies mainly focused on corporate sector and explored the state of the social and environmental disclosure. As several scholars argue that sustainability issue needs to explore at a regional level rather than corporate level (Milne and Gray, 2007; Dumay, 2010); this study explores GHG emissions disclosure at the regional level where city is a unit of analysis. Unlike many previous studies, this study examines what information stakeholders demand from organisations and what information is disclosed by the organisations. One key finding from this examination is that stakeholders prefer comparable GHG information, but it may not be possible at the city level. The key implication is that the disclosure related to emissions reduction actions will be more useful for accountability and peer learning than disclosure of aggregate emissions data. This study also indicates that social media can be a useful disclosure channel that can help to build stronger stakeholder engagement and promote better accountability. This study also shows that cities in particular Australian major cities have disclosed limited information about their energy efficiency initiatives (an emissions reduction action) and disclosed information are presented inconsistently in the absence of any standardise framework or guideline related to energy efficiency measure. Therefore, this study suggests developing a standardised accounting and reporting framework for energy efficiency measure and other emissions reduction actions with the hope that this might play a small, but still significant, part in global efforts to mitigate climate change.

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