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Grading Climate Action Plans in the Midwest

Megan Baker
University of Nebraska-Lincoln

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GRADING CLIMATE ACTION PLANS IN THE MIDWEST

By

Megan Baker

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PREFACE

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ABSTRACT

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Megan Baker, B.A.

University of Nebraska-Lincoln, 2024

Advisor: Martha Durr

Abstract

As agreed upon by international climate scientists, decarbonization in the American Midwest is critical to keeping the planet below the 1.5C increase in global temperature from pre-industrial levels. However, most previous research that evaluates climate action plans (CAPs) to find their weaknesses and provide policy recommendations neglects this crucial region of the United States. To fill this gap, this paper replicates Deetjen et al.'s (2018) review of CAPs in 29 US cities by applying their CAP rubric to 11 Midwestern cities. The results of both quantitative analysis were used to analyze the differences in plans in the Midwest versus the Non-Midwest. Since the original data set was expanded, CAPs from cities with state plans and without state plans were also compared. Analyzing the compiled data reveals that the Midwest is lacking in policies relevant to density, but excelled in policies relevant to appliance efficiency and architectural form. However, there was no significant difference in average scores between Midwestern cities and other, more studied cities' CAPs, and cities from states with state CAPs did slightly better on average.

Introduction

The consequence of failing to reduce emissions to the international goals set are irreversible and lead to an inhospitable planet (Chu, 2023). At a global level, adequate climate planning that encapsulates mitigation and adaptation policies is vital to keeping the Earth's temperature rise from pre-industrial levels below an average of 1.5 C (2.7 F), the goal agreed upon internationally by climate scientists (Chu, 2023). This benchmark is used for the Policymakers Guide created by the Intergovernmental Panel on Climate Change (IPCC, 2023) and is mentioned as the ultimate goal of the Paris Agreement (Chu, 2023.; *The Paris Agreement, n.d.*). Because of the urgency for effective climate policy, this paper seeks to explore how to make climate action plans (CAPs) effective for midwestern cities to serve as a resource for midwestern cities that have or are making a CAP. The results will also address a significant gap in the literature that evaluates the effectiveness and comprehensiveness of CAPs in the Midwest region.

The current level of progress in addressing climate change is both concerning and disappointing. As highlighted in the Fifth National Climate Assessment (Jay et al., 2023), a recent update on the progress of climate change mitigation and adaptation,

> "US net greenhouse gas emissions remain substantial and would have to decline by more than 6% per year on average . . . to meet current national mitigation targets and international temperature goals; by comparison, US greenhouse gas emissions decreased by less than 1% per year on average between 2005 and 2019".

On April 4th, 2022, the UN Secretary-General António Guterres shamed the world's leaders and pleaded for action in a speech, notably saying "We are on a pathway to global warming of more than double the 1.5-degree (Celsius, or 2.7-degrees Fahrenheit) limit", a direction that would lead to a climate disaster, an inhospitable planet (UN Climate Report, 2022).

This is partially attributable to national leaders' failure to keep their climate promises made in the Paris Agreement in 2016 and the Glasgow Climate Pact in 2021, and even those who are accomplishing their goals did not set them ambitious enough to make any significant progress (UN Climate Report, 2022). The withdrawal of the US, one of the world's largest emitters, from the Paris Climate Agreement in 2017 further underscores this issue (Madhani, 2017). The world's leaders are failing to appropriately react to the issue at hand, which makes studying local governments trying to pick up the slack more important. Existing literature on this subject aims to evaluate climate policy performance so the global average temperature increase can stay below 1.5 C, and the effects of climate change can be reversed.

As extreme weather events become more pronounced across the US, extreme drought from higher temperatures, more frequent flooding due to shifts in timing and intensity of rainfall, increased pest and disease transmission, and crop failure are climate change consequences more unique to the Midwest (Wilson et al., 2023). Midwestern communities are affected by impaired transportation, degrading infrastructure, weakened electrical grids, and decreasing water quality, all of which affect communities of color at higher rates (Wilson et al., 2023). The rest of the US relies on the Midwest's production of agricultural goods, and unsuccessful mitigation and adaptation in this region will be felt across the US and beyond because it will lead to crop failure and thus increased food prices (Coleman, 2012).

Most cities with populations high enough to be paid attention to by researchers are outside of the Midwest, leaving this area out of the conversation around the effectiveness of

CAPs. Therefore, it is necessary to study this substantial part of the US, to find what needs to be done for this area in particular to lower emissions.

Many states, especially coastal ones with higher populations, can reference academic literature to support their path toward lower emissions (Hui et al., 2019; Tang et al., 2013). While the Midwest certainly has much to learn from this literature, they need research specific to their area to refer to so they can make the best decisions for their unique environments and capabilities. There are cultural differences to consider as well that previous works ignore, since it is an entirely different region of the US with different political ideologies and priorities for legislation.

One limitation of this area of study is policy variety. Cities may have policies that address issues like clean air, land, water, and energy efficiency which are separated from their CAP. They may have these policies yet no CAP at all. Judging a city on its contribution towards mitigating climate change solely on a CAP would be unfair if they have all the qualities necessary to hit its goals, just with different policies. Adaptation policies are frequently placed in disaster or emergency operation plans; instead, a city may separate its focus on emissions and focus on natural disaster relief and prevention, which would also affect its perceived comprehensiveness (Qiao et al., 2018).

Another limitation is the lack of specificity inCAPs, as goals and strategies differ greatly in their level of planning, priorities, and clarity. Vague language makes them harder to quantitatively evaluate. Lastly, time and information are limited. A truly concrete assessment of the proposed research questions could potentially take years, whereas the timeline for this paper is months. This study will have to continue for much longer to show substantial improvements to the problem definition. The information needed is limited by UNL libraries as well as what is publicly available, as the academic articles and other sources listed in this paper are from those resources.

This paper is a replication of the Deetjen et al. (2018) study to expand the possibilities for comparison with the previous literature and therefore contribute to filling the gap in literature despite the limitations. I will apply their methodology only to Midwestern cities to make comparisons between the Midwest and the rest of the US. By expanding the data set of the original study, I will also be comparing cities with state CAPs to cities without state CAPs.

Literature Review

The existing literature on climate policy prioritizes different aspects of locality and evaluation methods. Most study countries as a whole, less limit their research US states, and even less limit their research to US counties or cities. These cities or counties may be confined to a certain region of the US. When counties or cities are studied, highly urban areas are most often chosen. To evaluate these policies, most researchers will either create an original evaluation framework or modify to at least some extent an existing framework. However, most analysis is quantitative despite the variations in evaluation frameworks.

Location Variation

The largest variation in the existing literature on this subject is in the locations studied. A substantial body of literature relevant to the US has evaluated state climate action plans (CAPs) at the city level, with a smaller portion dedicated to state-level CAPs. Literature that focused on country-wide policies was not researched because of the decrease in relevance to local policies. Literature that evaluates state CAPs often leaves out the Midwest because the Midwest did not have any state-level CAPs at the time the research was done (Alexander, 2020; Gallivan et al., 2011; Hui et al., 2019). Iowa has the oldest plan from 2008, Wisconsin is from 2020, Illinois is from 2021, and Minnesota and Michigan's is from 2022. The Dakotas, Ohio, Kansas, Indiana, and Nebraska still do not have state CAPs, though Nebraska's is in the process (Center for Climate and Energy Solutions, 2023). Tang et al. (2013) purposefully focus on coastal states to find a connection between extreme climate conditions and the strength of disaster preparedness policies.

Most sources evaluate climate policy at the city or county level. Their more intimate knowledge of their environmental needs means they have a greater ability for impact which fills the voids of state plans, there is a larger sample size available, and a more recent shift in focus to local over global impacts of climate change in the literature makes them more appealing for research subjects (Qiao et al., 2018; Yi & Feiock, 2015; Boswell et al., 2019; Ulpiani & Zinzi, 2021). The recent shift to local action is due to the sharp increase in city-level CAPs after the US withdrew itself from the Paris Climate Agreement in 2017 (Switzer & Jung, 2022; Madhani, 2017). Shifting some research focus to cities and counties is important because "overlooking regional and local specificities will contribute to inaccurate and inefficient action plans", making smaller-scale research a vital part of climate change mitigation and adaptation (Ulpiani & Zinzi, 2021). This idea is supported by the fact that Local governments control the vast majority of building construction, transportation investments, and land use decisions in the US", so they must have the frameworks in place to manage these sustainably (Boswell et al., 2019).

Some sources dedicated parts of their analysis to the relationship between states and cities in their environmental policy. Agana (2019) found that the political dynamics of states and the changes that happen within them "impact local climate action plans in both positive and negative directions". While local climate policy can be more impactful to emission reductions, state attitude, directly and indirectly, affects the support that policy at the local level gets through mandates, technical support, incentives, etc. (Agana, 2019; Alexander, 2020). This supports the importance of pro-environmental leaders because local governments often fall short of the planning necessary to meet their emission reduction goals and would benefit from extensive support (Qiao et al., 2018; Deetjen et al., 2018; Stone et al., 2012). Leadership attitude is also important because Bery & Haddad (2023) found that the financial capability of a city is less important than the presence of "city staff dedicated to environmental/energy policy and the presence of an institution of higher education". This means that the ambition of a CAP is not as affected by financial capabilities as it is by the willingness of cities to implement them in the first place, which is influenced by political attitudes.

The findings of Millard‐Ball (2013) support this idea when they concluded that "city decision-making takes place in the context of residents, staff, and elected officials who are eager to contribute to greenhouse gas reduction" regardless of whether they have a CAP or not. The findings of (Hui et al., 2019) also attribute ideology to the chances of adopting a CAP and the ambition of that plan but connect additional variables of the size of the city and institutional capacity to the chances of adopting a plan, and air quality to the plan's ambition.

Previous research has also organized their focus on specific geographic locations or types of geographic locations of the US. Since CAPs and environmental policy can vary so drastically in their comprehensiveness across the US, this approach may help researchers to make clearer connections and conclusions in their studies (Soni et al., 2022). Tang et al. (2013) limited their research to coasts, Horney et al. (2012) looked at rural versus urban southeastern counties in the US, while Millard-Ball (2013) and Hui et al. (2019) both only looked at California cities. Koski

& Siulagi (2016) and Stone et al (2012) both had population minimums in their studies to only capture a highly urbanized data set. Urban counties performed worse than rural counties in Horney et al.'s (2012) comparison and hypothesized that this was due to a greater capacity for quality planning, but did not investigate the influence of ideology or leadership as other works in this field have highlighted.

The literature on environmental policy does not have much to say about the Midwest specifically. The only source that has looked at climate policy in the Midwest was Qiao et al. (2018) but limited their definition of the Midwest to FEMA Region 7, which only includes Missouri, Nebraska, Iowa, and Kansas. This source also did not look at CAPs, but local comprehensive plans (CPs), hazard mitigation plans (HMPs), and local emergency operations plans (EOPs).

Natural Hazards and Ideology Impacts

The Midwest has lagged until recently because the area has less variety of natural hazards that are a result of climate change, which is a key driver of local action (Soni et al., 2022). Since coastal areas with many more natural hazards have been proactive about climate change and thus started on CAPs sooner than the rest of the US, this type of policy has taken longer to diffuse to the Midwest (Switzer & Jung, 2022; Hui et al., 2019). The Midwest still faces its fair share of environmental hazards, such as the recent drought beginning in 2023 and the disastrous 2019 floods, which have been worsened by climate change, but it has not been enough to generate a significant amount of new climate policy (Vasilogambros, 2023b; Moore, 2019). This is in part due to ideological differences between the Midwest versus coastal areas. Switzer & Jung (2022) found that while the coast's impressive track record for tackling natural hazards through policy is connected to the amount and variety of natural hazards they face, it is also a side effect of higher rates of liberal ideology. This means that even if the Midwest had more variety of natural hazards caused by the climate other than drought and flooding, this would still not spur any significant change in climate policy due to the predominant conservative ideology in the Midwest (Switzer & Jung, 2022).

This conclusion is supported by the findings of Hornsey et al. (2018), who link conservative ideology to anthropogenic climate change skepticism that is unique to the US. If conservatives are more likely to be skeptical about climate change, then it makes sense that their representatives are less likely to enact climate policy despite the threat of natural hazards. These factors are partly responsible for the lack of CAPs and climate policy in general in the Midwest, which reduces the amount of data that researchers can use to analyze policy trends, thus contributing to the gap in the literature.

Evaluation Variation

Previous literature also varies in how the environmental policy they are focusing on is evaluated. Each study has a unique evaluation framework that was either an original research design or was heavily modified to reflect the researchers' opinion of what indicators should be prioritized in policy. If they did use an existing evaluation method, it was one or multiple indicators that they deemed most useful and telling to evaluate with. For example, Millard-Ball (2013) argued that "planning should primarily be evaluated on the extent to which it changes outcomes such as the spatial pattern of development, expenditure decisions by local governments, and the transportation and housing choices of individuals" and combined eight different existing indicators to do so with. On the other hand, Hui et al. (2019) only chose one existing indicator, time-series temperature trend analyses. Soni et al. (2022) utilized the Shannon diversity index, which is a mathematical way to measure the diversity of species in a community and has been previously used to study policy diversity, but was heavily modified to measure the breadth of climate action specifically (Zach, 2022). Tang et al. (2013) developed 32 of their own original indicators with which to evaluate CAPs. Deetjen et al. (2018) created a rubric of 22 different indicators based on an extensive literature review of policy recommendations and current policy weaknesses. Tang et al. (2013) and Deetjen et al. 's (2018) similar approaches allowed both of them to include an analysis of the breadth and depth of the policies they were evaluating, and tailor the evaluation to specific locations or types of areas for future research if needed.

Though most perform a quantitative analysis of a large data set, case studies of specific cities have been able to point out unique and innovative policy solutions that provide a valuable contribution to this field of study, such as Gallivan et al. (2011) and Agana (2019). Basset and Shandas (2010) and Soni et al. (2022) both acknowledge the best plans are the ones with the most variety and depth of policy, so I chose to replicate Deetjen et al.'s study because their methodology allows for a wide variety of subjects to evaluate opportunities and comprehensiveness analysis in a quantifiable way. This also allows me to connect my findings to the previous research more easily and clearly. One flaw with the existing literature is that the diversity of evaluation methods makes findings difficult to compare and contrast with each other.

This rubric makes policy recommendations easier to employ because of the specificity of the conditions for points awarded. This rubric is also beneficial to use because of its emphasis on density which is not stressed so heavily in previous works. I agree with Deetjen et al. in their assessment that the density of cities is an underrated indicator. This indicator is important when evaluating the Midwest because of how detrimental urban sprawl has been to its reliance on cars for transportation, and thus difficulty in lowering emissions.

Density is important to address in Midwestern cities because they are "consuming land at a much greater rate than they are adding population", and even though western cities are consuming land at a similar rate, they are accommodating a much higher population (Fulton et al., 2001). This study is from 2001, however, the city planning that this study was analyzing still exists today, meaning that inefficient consumption of land is still a pressing issue that deserves attention. It should also be noted that this study's definition of sprawl was "in terms of land resources consumed to accommodate new urbanization" to prioritize simplicity, where land "consumed at a faster rate than population growth" is sprawling, but this definition was criticized by Burke (2002) for being "idiosyncratic" (Fulton et al., 2001). Nevertheless, the findings still point to a concern about sprawl as a particularly high barrier to reducing energy use in the Midwest.

My research aims to evaluate climate action plans across the Midwest. This evaluation will consider various factors that are listed below. This is to address the research gap in the existing CAPs, as they often center on highly urbanized and populated cities and states situated outside of the Midwest. This is crucial since the Midwest makes up about a fourth of the US in land mass and significantly contributes to the overall emissions from the US (Lawrence et al., 2021). Grading these CAPs will serve as a resource for Midwestern cities and scholars to understand and reference what is working and what needs to be improved upon for climate action in the Midwest.

Definitions

Legislation is commonly inspired by already existing legislation from other cities or states. This is called policy diffusion, where the main actors are the legislature, operating under the assumption that "decisions are the result of fact-based assessments", acting by learning from previous successful policies in order to learn how to implement similar ones (Gilardi & Wasserfallen, 2019). However, it is an assumption of this paper that state and city-wide governments can't borrow policies modeled from different areas of the US as easily for policy aimed at lowering emissions. This is because widely applicable policies such as labor laws can be implemented from state to state and work roughly the same. Environmental law needs to be implemented according to factors like emissions, preferred types of energy, geography, and population, which are unique to each city.

Climate action plans are a form of climate policy that describe state or city-wide goals to mitigate or adapt to climate change and are "planning documents that have few binding requirements, but nonetheless act as a policy due to their function as guiding documents for decision-makers regarding climate change." (Koski & Suilagi, 2016). For some cities, such as Lincoln, NE they are not actually policy, just goals, and understanding why is important. It is safely assumed that different areas of the US have different priorities when it comes to environmental action due to their ecological and industrial differences, and the Midwest may be opposed to fully committing to the bit due to regional ideology and a priority for successful crop yields, not emissions when it comes to the environment.

'Mitigation' and 'adaptation' are key terms that show up regularly in environmental literature; they are classifications of methods used to target climate change. Mitigation describes methods used to reduce greenhouse gas emissions or take them out of the atmosphere.

Adaptation describes methods used to prepare for living in a world suffering from the effects of climate change. Different types of policy should also be differentiated in the following ways. Climate policy has two types: "'external' climate policies (policies impacting the electorate), and 'internal' climate policies (policies impacting the internal operations of the local government)." (Hui et al., 2019). This should not be confused with environmental policy, which pertains to regulating humans' effect on the environment but does not specifically aim to mitigate or adapt to climate change, though it could regulate air, soil, and water quality.

Conclusion

While previous works have varied greatly in their method of analysis of climate action plans and environmental policy, the vast majority arrive to the same conclusion that nearly all current plans for emission reduction are insufficient. When looking at the threat of extreme heat specifically, lowering greenhouse gas emissions "by themselves will yield no protective benefits to cities" (Habeeb, Stone, & Vargo, 2012). This means that comprehensiveness is lacking when honing in on emissions production and failing to consider temperature decrease as a priority as well. Building quality and transportation are also heavily focused on and for the right reasons, but climate action plans "neglect the building compactness, urban form, and automobile disincentives" necessary to avoid undermining their emission goals (Deetjen et. al., 2018). A transition to walkable cities is one of the best kinds of goals for a climate action plan to meet its emission goals from research, but it seems most fail to be so ambitious because of restrictive development policies (Glaeser and Kahn, 2010, Leibowicz, 2017). The policies enacted to reach these goals must also "1. Be enacted as stated, 2. Be implemented as stated or assumed and 3. Achieve results consistent with quantitative estimates" (Gallivan et al., 2011). They also state the policy itself must also be well-informed and follow research recommendations, so while a climate action plan may appear strong, it is only as good as its implementation, which is more difficult to grade. However, these conclusions about climate action plans as a whole were reached in studies that mostly neglected the Midwest.

Methods

This study adopts a descriptive design, focusing on the characteristics of CAPs rather than delving into the reasons for their outcomes. It is being used to obtain information as a precursor to more qualitative analysis that can lead to important recommendations. While this paper includes assumptions, it does not aim to prove or disprove them. Instead, the data that results (Appendix B) will be employed to find the similarities and differences between the Midwestern and Non-Midwestern cities studied and cities that have and don't have state climate action plans (CAPs), thus classifying this paper as a form of comparative research.

This study will utilize an analytical scoring rubric used by Conger, Deetjen et. al. (2018), shown in Figure 1. Their rubric was inspired by previous works from Heidrich et al., (2013) and Reckien et al. (2014). These previous rubrics scored mitigation and adaptation strategies for cities in the United Kingdom and Europe respectively, by "each city's assessment, planning, action, and monitoring" (Conger, Deetjen et. al., 2018), and since these actions are the heart of lowering emissions, it is a good basis for scoring environmental legislation. The Heidrich et al. and Reckien et al. rubrics were changed to better fit the needs of evaluating CAPs in the United States in the Conger et al. study, thus making it an even better fit for this paper's objective. The key difference was the division of mitigation strategies into 22 policy types, which were then scored individually using the rubric and statistically analyzed with visual aids to find correlations in emission reduction strategies data. The policy types were also developed from a literature review to better fit the needs of the United States (Conger, Deetjen et. al., 2018). This adjusted version is what will be used in this paper to score and analyze CAPs for the Midwest.

However, the regions grouped from this previous work do not align with the definition of the Midwest established by the US Census Bureau. The rationale for this was due to grouping areas that had comparable scoring results. Nevertheless, this approach is not helpful for states in the Midwest when building and adjusting their CAPs, since many will be left out and could potentially produce inaccurate results. The Midwest comprises the states of Wisconsin, South Dakota, North Dakota, Ohio, Nebraska, Minnesota, Missouri, Kansas, Michigan, Indiana, Iowa, and Illinois, and as such, this study will examine CAPs from these states, as reported by Census Reporter (2022).

There are twenty-two policy types included in the scoring rubric. They are further separated into three categories (essential, priority, and additional), which are awarded different amounts of points based on their importance and comprehensiveness.

Scoring System

The scoring system used in this study is directly adapted from the rubric developed for the original research that this paper seeks to replicate.

The highest tier, which consists of *essential policies*, is composed of policies promoting building quality, parking restrictions, and dense development. These policies are classified as essential because it is very unlikely a CAP can meet ambitious reduction goals without them. Nine points are awarded to fully comprehensive policies with specific plans of enactment and multiple ways of achieving goals, six points are awarded to policies that have specific goals but are otherwise vague and have fewer ways to achieve goals, and three points are awarded to policies that mention relevant goals but do not go in-depth (Conger, Deetjen et. al., 2018).

The second tier, defined as *priority policies*, is the default and the largest one. These policies are classified as priorities because they “represent important policies whose exclusion would limit a climate action plan's effectiveness” (Conger, Deetjen et. al., 2018). The tier encompasses policies relating to mass transit, automobile independence, non-motorized transport, mixed land use zoning, regional planning, strategic growth, transparent assessment, consumption-based analysis, consumer habits, appliance efficiency, and smart-grid management. Given that these policies are less critical than the *essential policies*, they receive fewer points. Six points are awarded to fully comprehensive policies with specific plans of enactment and multiple ways of achieving goals, four points are awarded to policies that have specific goals but lack detailed strategies to achieve goals, and two points are awarded to policies that mention relevant goals but do not go into further detail (Conger, Deetjen et. al., 2018).

The lowest tier, designated as *additional policies*, is awarded fewer points as they are considered the least important. While these policies contribute to emission reduction goals, their absence would not significantly affect the overall goals. It consists of policies promoting water infrastructure, green spaces, architectural form, district energy systems, vehicle electrification, clean power sector, local renewables, and solid waste emissions. These policies are less important because they either have trade-offs or they heavily rely on another goal. For example, lowering emissions via electric vehicles relies on renewables to feed the electric grid, thus making it less important. Three points are awarded to fully comprehensive policies with specific plans of enactment and multiple ways of achieving goals, two points are awarded to policies that have specific goals but are otherwise vague and have fewer ways to achieve goals, and one point is awarded to policies that mention relevant goals but do not go into further detail (Conger, Deetjen et. al., 2018).

Interactions

Some of these policies interact with each other negatively, some positively, and some depend on each other. Incentivizing electric vehicle use with better parking or fuel taxes disincentivizes alternative modes of transportation such as biking or public transport. The effectiveness of electric vehicles as a way to reduce GHG emissions is also dependent on a clean electric grid, yet local renewables have a trade-off with dense development because of the space they require. There are also possible tradeoffs with vehicle electrification and parking restrictions. District energy systems also need high urban density to be successful (Grubler et al., 2012). However, if the grid is not already fueled mostly by renewables, electric cars can increase GHG emissions (Conger, Deetjen et. al., 2018). Green spaces are necessary to eliminate heat islands but have a trade-off with dense development as well because of the space they require.

Positive interactions where aspects of a CAP satisfy requirements for more than one policy type in the rubric are more common than these negative interactions and dependencies listed above. Smart grid management policies support the clean power sector, district energy development, and local renewables. Mixed-use land zoning supports dense development and strategic growth. Automobile independence supports mass transit, regional planning, and non-motorized transport. Building quality supports appliance efficiency and architectural form.

Figure 1: Rubric

Policy Type	Points Awarded
Essential Policies	
Building quality	3 – communicates intentions to improve building quality, but mentions no specific policies or building code updates 6 – plans to update building codes to promote higher efficiency new construction and retrofits 9 – promotes urban regeneration, net zero energy, and/or embodied energy accounting for construction and demolition materials
Parking restrictions	3 – includes one of restructured zoning requirements (e.g. revised parking minimums/ratios), improved pricing (e.g. increased off-street parking rates and unbundled parking), or high-efficiency incentives (e.g. preferential parking for EVs or carpools) 6 – contains two of restructured zoning requirements, improved pricing, or high-efficiency incentives 9 – contains all three of restructured zoning requirements, improved pricing, and high-efficiency incentives
Dense development	3 – mentions goals to increase density without specific policies 6 – develops specific policies for one of density bonuses, repurposing existing buildings, minimum floor area ratios or building heights, or urban growth boundaries 9 – develops multiple urban containment and density promoting policies
Priority Policies	
Mass transit	2 – mentions goals to expand transit network without specific policies or development plans 4 – includes specific plans for transit-oriented development, increased bus lines, expansion of transit network, etc. 6 – outlines a complete overhaul of the current transit system and/or expands the transit network to include rail
Automobile independence	2 – mentions a need for congestion management and includes one specific policy including ride-sharing/carpool support, fuel taxes, higher parking prices, congestion charges, optimized traffic light timing, etc. 4 – includes two specific policies 6 – includes more than two policies and/or goals to reduce vehicle travel by substantial amounts
Non-motorized transport	2 – mentions need to increase non-motorized transport without specific plans 4 – includes specific plans for pedestrian paths, bike lanes, and/or complete streets 6 – develops an ambitious program for expanding bike/sidewalk infrastructure, traffic free zones, adding bike racks to buses, etc.
Mixed land use zoning	2 – mentions mixed-use planning without specific policies, or implements small-scope plans 4 – develops city-wide plans for mixed-use and affordable development, financial incentives, and specific targets for proximity 6 – includes land use survey for entire city to guide policy
Regional Planning	2 – mentions regional transportation planning without specific policies 4 – includes policies for transit between surrounding towns/suburbs, and/or mentions airport GHG emissions 6 – includes policies for transit between other metro areas or states
Strategic growth	2 – plans mention “smart growth” or other verbiage allowing for

Policy Type	Points Awarded
	future population growth 4 – includes either policies focused on affordable housing (e.g. inclusionary zoning) or streamlined development (e.g. redesigned processes for approving permitting and zoning changes) 6 – includes both affordable housing and streamlined development policies
Transparent assessment	2 – regularly updates climate action plan but city-level emissions data are not available on the city website 4 – provides city emissions data on a scheduled basis 6 – verifies city emissions data via an independent, third-party
Consumption-based analysis	2 – emissions accounting incorporates one consumption-based metric such as air travel emissions, construction emissions, life-cycle analysis, fuel processing, food packaging, waste disposal, etc. 4 – emissions accounting incorporates two consumption-based metrics 6 – emissions accounting incorporates multiple consumption-based metrics including life-cycle analysis
Consumer Habits	2 – online resources, pamphlets, and suggestions in the climate action plan for consumers 4 – workshops available for consumers, such as retrofit and appliance efficiency education – training for city employees 6 – advertising and outreach to connect design professionals and commercial sector with educational tools – quantifiable outreach goals for engaging the public with educational tools
Appliance efficiency	2 – focuses on low-impact, city owned assets, such as street lighting or government buildings 4 – also includes larger scope policies such as rebate programs and efficiency mandates 6 – also includes aggressive strategies, such as Energy Star building leadership or plans for retrofitting majority of city's homes
Smart-grid management	2 – includes basic grid infrastructure updates, installing AMI infrastructure without describing future policies for its use, or energy management plans only include city government buildings 4 – encourages one of smart grid technology, real time pricing, demand response, energy storage, or microgrids 6 – includes more than one policy implemented at the city-wide level
Additional Policies	
Green spaces	1 – mentions green space development with no specific policies 2 – develops specific policies for increasing green space in the city 3 – develops aggressive goals relative to other plans (e.g. everyone within a 5-minute walk to a park or 1 million trees planted)
Architectural form	1 – mentions only one policy, or promotes efficient architectural form without specific policies mentioned 2 – mentions multiple policies and attempts to engage the design community through education and outreach 3 – also actively promotes education and involvement of the design community through professional workshops and organizations
District energy systems	1 – promotes district energy integration with no specific plans or policies 2 – identifies district energy or combined-heat-and-power projects, develops district energy financing plans 3 – city already utilizes district energy systems
Vehicle electrification	1 – plans to transition city vehicle fleet towards hybrid vehicles 2 – plans for EV charging infrastructure, EV incentives, electrification of transit, fuel taxes, etc.

Policy Type	Points Awarded
	3 – plans for aggressive vehicle electrification with four or more policies mentioned
Clean power sector	1 – supports renewable energy, lobbies utilities for more renewables without specific policies in mind, or has low renewable goals 2 – pursues coal divestment, renewable PPAs, RECs, and/or working with utility to develop new, utility-scale renewable projects 3 – includes future goals for 100% renewables
Local renewables	1 – incorporates renewable energy technology in government buildings 2 – includes policies that incentivize or remove barriers for one type of local renewable energy technology 3 – promotes selling back to grid, maps out ideal locations, mentions incentives for multiple types of renewable energy technology
Water infrastructure	1 – limits policies to city government buildings, or plans to use renewable energy sources for powering the water system 2 – plans for water infrastructure improvements, water audits, leak detection, stormwater capture, etc. 3 – plans for city-wide real-time monitoring of water system (SCADA), thermal hydrolysis for wastewater treatment, decentralized water treatment
Solid waste emissions	1 – mentions waste reduction without specific policies, or only includes recycling policies 2 – includes multiple policies covering composting, improved recycling, pay-as-you-throw, and/or consumer education 3 – includes zero waste goals, waste-to-energy plants, landfill gas recapture

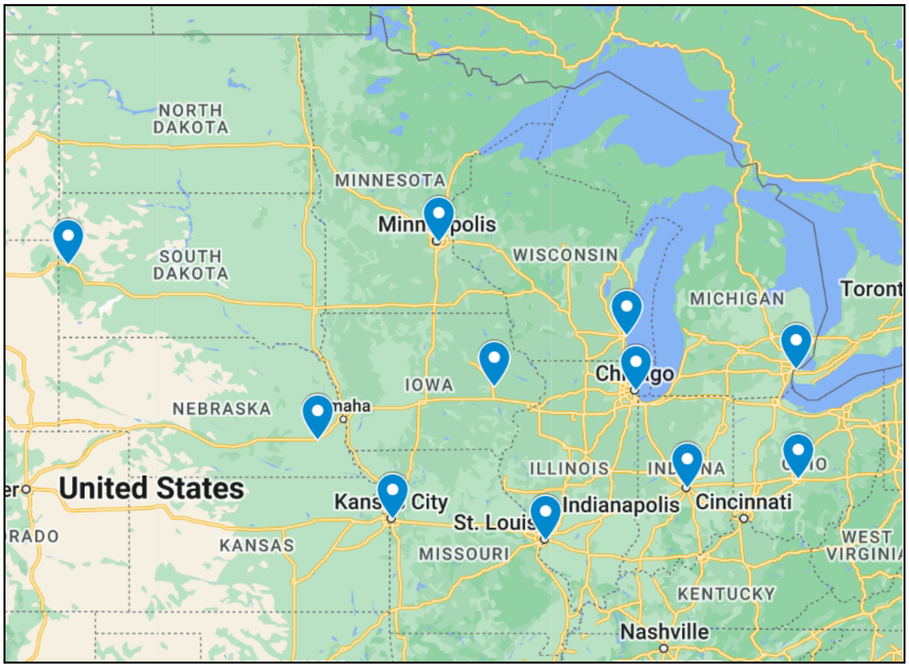
How CAPs are Selected:

The primary objective of this paper is to address the research gap of CAPs, which predominantly address highly populated areas while overlooking the Midwest. To ensure comprehensive coverage, a CAP from each state will be selected for evaluation to ensure every state in the Midwest is accounted for. The Kansas City Metropolitan Area includes both Kansas and Missouri, so St. Louis, Missouri will also be added to the data to better represent that area of the Midwest. North Dakota does not currently have any CAPs. To reflect the study this thesis replicates, a CAP from the most urban city of every state is selected. To ensure an accurate representation of the Midwest, I selected CAPs based on states rather than population size. I then selected plans based on how recently they were published and if they were an appropriate distance away from other selected cities to justify their analysis. Figure 2 shows a map of the Midwestern CAPs.

To assess the effectiveness of this approach, every city CAP that exists in the Midwest was researched and mapped out on Google Maps, as illustrated in Figure 2. The Environmental Resilience Institute of Indiana University provides a list of planning documents that "incorporate resilience, sustainability, adaptation, and/or greenhouse gas reduction goals and initiatives" (Midwestern Plans). This resource was used to find most of the CAPs present on the map. However, this list does not include the states of Nebraska, North Dakota, South Dakota, or Kansas. CAPs for these states were found through individual Google searches of the state and the five most populous cities within that state.

After each CAP is scored and graded, common themes are located by analyzing similarities and differences of where specifically they are lacking and succeeding from the quantitative scores they were given. This study is also particularly focused on comparing CAPs from states that have a state CAP with those from states that do not, to see if there is a difference in the quality.

Figure 2: Map of Midwestern Climate Action Plans (Google Maps)

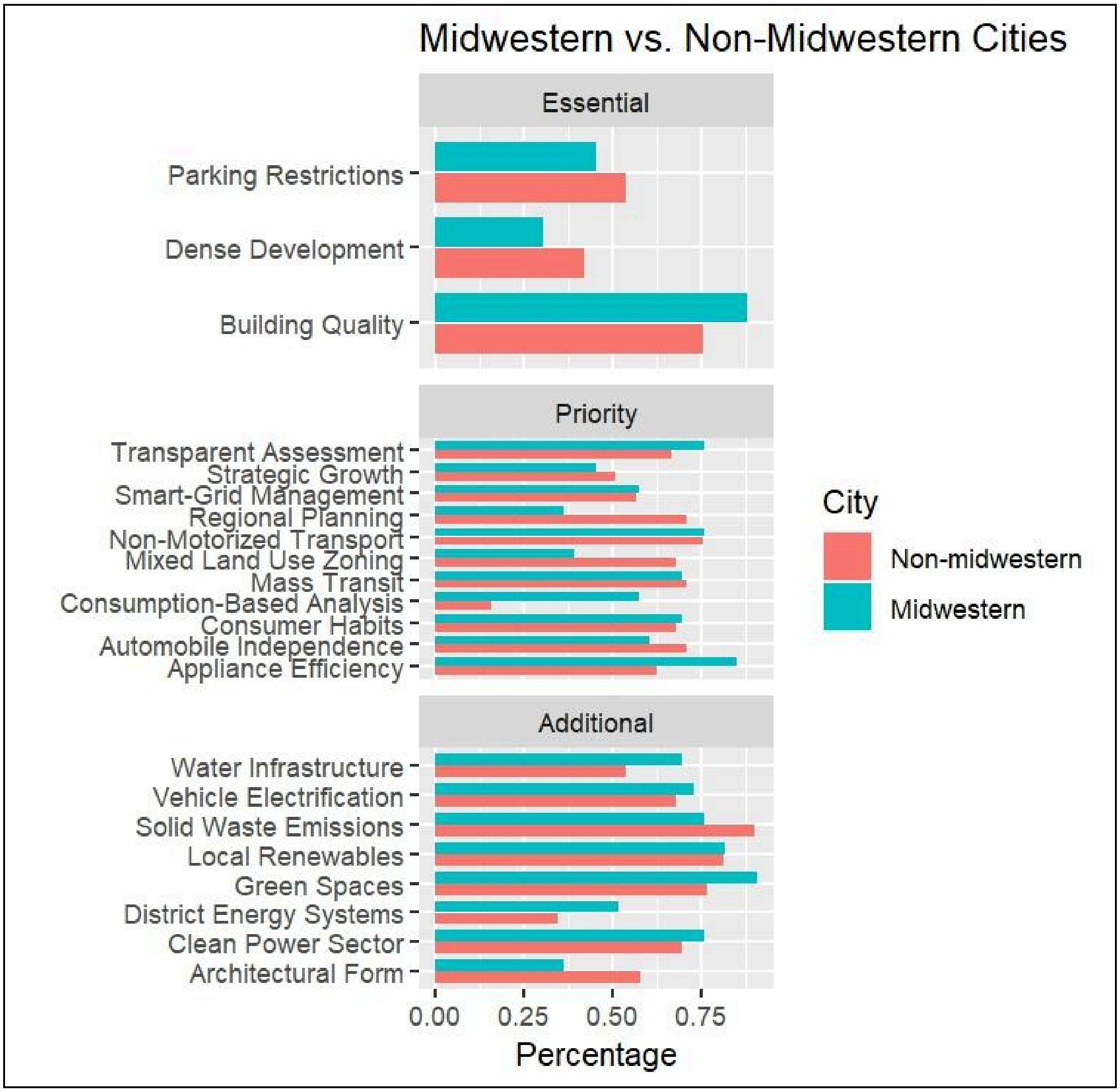


Data Analysis

The data from the graded CAPs (Appendix B) was processed and analyzed using the programming language R, commonly used for visualizing data and computing statistics. I worked with the UNL Statistical Cross-disciplinary Collaboration and Consulting Lab (SC3L). Using R, we generated bar graphs of Midwestern City Scores (figure 3), Non-Midwestern City Scores (figure 4), and a scatter plot for energy consumption (figure 5). In Spring 2024 I enrolled in a statistics course that covers R, which allows me to better understand and interpret the code developed and statistical analysis from the consulting lab. Using the notes from the consulting lab, I was able to generate the rest of the scatter plots (figures 6, 7, & 8).

Results

Figure 3



These bar graphs include the averaged scores of the different policy types for Midwestern and Non-Midwestern cities, separated by weight.

E is used to label essential policies, P is used to label priority policies, and A is used to label additional policies.

Midwestern cities score better than non-Midwestern cities in eight policy categories: building quality (E), transparent assessment (P), consumption based analysis (P), appliance efficiency (P), water infrastructure (A), green spaces (A), district energy (A), and clean power sector (A).

Midwestern cities score about the same as non-Midwestern cities in seven policy categories: strategic growth (P), smart grid management (P), mass transit (P), non-motorized transport (P), consumer habits (P), vehicle electrification (A), and local renewables (A).

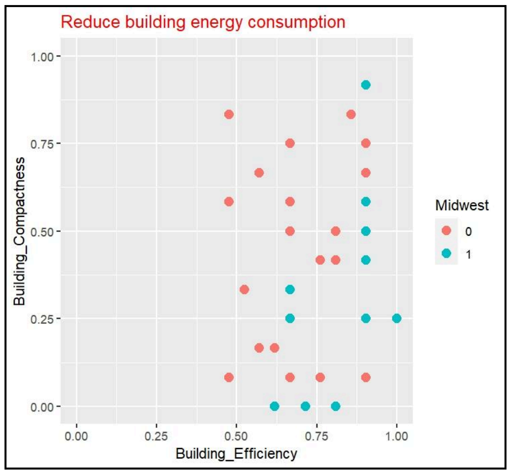
Midwestern cities score worse than non-Midwestern cities in seven policy categories: parking restrictions (E), dense development (E), regional planning (P), mixed use land zoning (P), automobile independence (P), solid waste emissions (A), and architectural form (A).

The average score of Midwestern cities was 61.27%, and the average score of Non-Midwestern cities was 62.43%. This is a 0.16% difference.

Scatter Plots

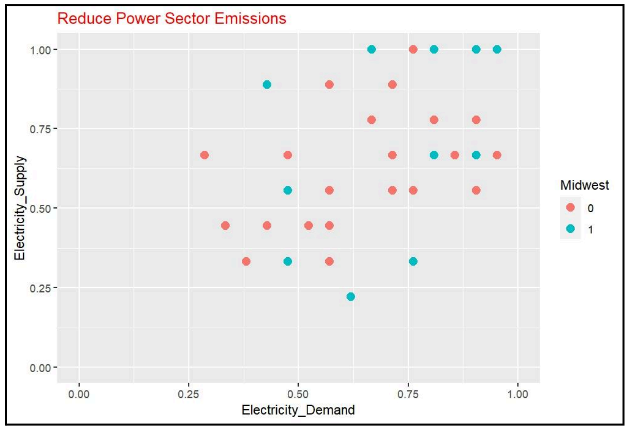
Each point on the scatter plots is representative of a city's score, with Midwestern cities coded as blue dots and Non-Midwestern cities coded as red dots. When a yes/no variable is transformed into 0 and 1 for coding purposes, 0 means "no" and 1 means "yes". In this case, 0 means Non-Midwest and 1 means Midwest. Each axis incorporates multiple policy types which are similar to each other to generate a separate score for the subjects of each scatter plot. The different weights of each policy type are taken into account in the R code (Appendix A) used to generate them, since policies in different categories are weighted differently. The farther up and right a dot is, the more comprehensive the CAP is for that particular subject and vice versa. If a point lands far towards the top left or bottom right, then that indicates a policy imbalance which would need to be addressed in order to effectively solve each issue these scatter plots represent. There are no outliers in any of the plots.

Figure 4



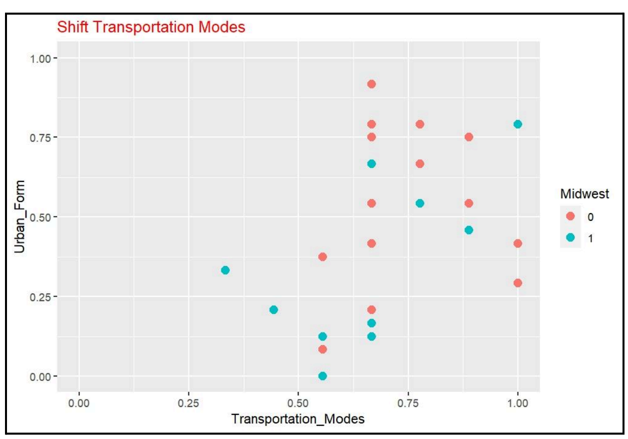
The x-axis, Building_Efficiency, encompasses the variables of building quality, appliance efficiency, and consumer habits. The y-axis, Building_Compactness, encompasses the variables of dense development and architectural form. This scatter plot shows the most imbalance of all, which means that cities particularly struggle with the building compactness needed to support building efficiency. A higher proportion of Midwestern cities are towards the bottom and/or the right of this scatter plot, meaning they do not have the building compactness policies to adequately contribute to their energy consumption goals. A higher proportion of Non-Midwestern cities are towards the top and/or right of this scatter plot, meaning they have on average more comprehensive building energy consumption policies.

Figure 5



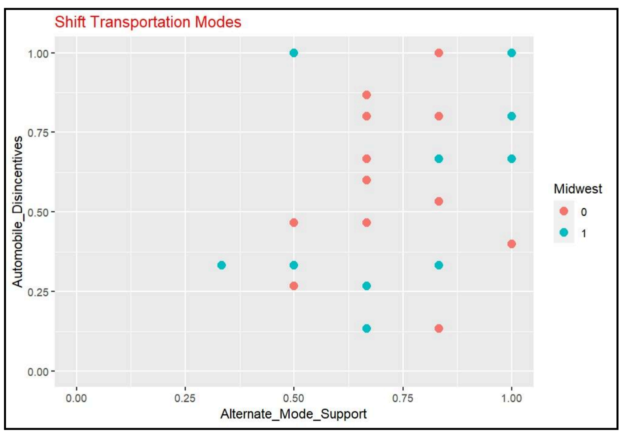
The x-axis, Electricity_Demand, encompasses the variables of smart-grid management, vehicle electrification, appliance efficiency, and consumer habits. The y-axis, Electricity_Supply, encompasses the variables of clean power sector, local renewables, and district energy systems. The spread of Midwestern cities and Non-Midwestern cities is even, and there are few points that lean to the top left, bottom left, and bottom right corners. This means that on average, CAPs are relatively balanced when it comes to reducing power sector emissions. Both are evenly spread between Midwestern and Non-Midwestern cities as well.

Figure 6



The x-axis, Transportation_Modes, encompasses the variables of automobile independence, mass transit, and non-motorized transport. The y-axis, Urban_Form, encompasses the variables of dense development, parking restrictions, and mixed use land zoning. A higher proportion of Midwestern cities lean towards the bottom of the scatter plot, which means they are more likely to prioritize alternative modes of transportation that aren't fully supported by their urban infrastructure. A higher proportion of Non-Midwestern cities lean towards the top of the scatter plot, which points to efforts for alternative transportation modes to cars being more adequately supported by urban form.

Figure 7



The x-axis, Alternate_Mode_Support, encompasses the variables of mass transit and non-motorized transport. The y-axis, Automobile_Disincentives, encompasses the variables of parking restrictions and automobile independence. There is little difference in the spread of Midwestern cities and Non-Midwestern cities. Most data points as a whole lean towards the right half of the graph, meaning that they have more success in policies aimed at alternate modes of support.

Cities With CAPs vs Cities Without

Of the 34 cities graded in the data set, 21 were from states that had state CAPs and 13 were from states that did not. Since both Maryland and Virginia, the states bordering Washington DC, have state CAPs, Washington DC was counted as one of the cities with a stateCAP. Overall, cities from states with state-level CAPs scored 64.48%. Cities from states that do not have state-level CAPs scored a %56. 38. This is an 8.1% decrease in overall score. Of the 21 cities that were from states with CAPs, 15 of them (66.67%) were published after their states' CAP, 2 (9.52%) were published in the same year, and 4 (23.81%) were published before.

Quality Assurance

To ensure that the R code and subsequent visual aids were done correctly, I enlisted the Stats Consulting Lab. The Stats Consulting Lab is a free service for UNL students, faculty, and staff which employs advanced PhD statistics graduate students to work one-on-one with clients to “design experiments, conduct power analyses, summarize data, and conduct statistical analyses” (). By using the expertise of the consultant James Clothier, I am able to assure that the bar graphs and scatter plots were generated in the same way and with the same accuracy as the study this paper is replicating.

To verify that my analysis of these visual aids was done correctly, I visited the Center for Academic Success and Transition (CAST). CAST is a free service for UNL students with academic coaching and tutoring. I visited Devansh, a statistics tutor, to make edits to my analysis.

While I graded each CAP, I examined the grades and plans from the study this paper is replicating to match my grading standards to those of the authors of that study. I also re-graded all Midwestern CAPs present in the study to further reduce variability of grading standards in that area, since the Midwest is a focus of this paper.

Discussion

Figure 3 shows that there is roughly the same amount of Midwestern policies that score better, the same, or worse than Non-Midwestern policies. However, half of them that score better are in the additional category, which is not weighted heavily. Three are in the priority category, which is weighted moderately. As for the seven policies the Midwest scores worse on, two of these are in the essential category, which is weighted the most, and three are in the priority category. This means that the Midwest CAPs excel in areas that are less impactful than others for reducing GHG emissions. Climate action plans across all areas of the US have on, average, the same comprehensiveness, but the Midwest places more emphasis on policies that will provide less emissions reductions than other policies. This may be because oftentimes the policies that are easiest and least costly to implement do not contribute to significant emissions reductions. For example, updating appliance efficiency and water infrastructure may be easier than redoing the city's zoning requirements and building inwards, which would be more effective at reducing emissions. Despite this, there was only a 0.16% difference in average scores between Midwestern cities and the rest of the US. This is surprising given that the Midwest excels in policies that are not as impactful. Figures 4-7 show the high variability between plan quality no matter their location, which may be a reason why the difference ended up being so minimal. I also theorize that since climate action policy has taken longer to diffuse to the Midwest, these plans are more recent and therefore based on more current data and policy recommendations.

Notable Scores

The most stark difference in scores in the bar graphs is in consumption based analysis, where the Midwest scores on average 46% higher. The Midwest also excels in appliance efficiency, where they score on average 31% higher. The Midwest also scores on average 43% worse on regional planning, 27% worse on mixed land use zoning, and 20% worse on architectural form.

The policy types the Midwest scores worse in and the scatter plots show the subject Midwestern cities struggle with on average more than Non-Midwestern cities is density. Figures 4 and 6 show that the unwillingness of Midwestern cities to prioritize density in their climate action plans is harming their GHG reduction goals and sets them behind the rest of the US. More specifically, their building compactness and urban form needs work. This means that the policies which were used to evaluate building compactness and urban form (architectural form, dense development, parking restrictions, and mixed use land zoning), which are more specific measures of density, should be emphasized in future iterations of their climate action plans and new plans in the Midwest.

This supports findings that show the Midwest has a concerning amount of urban sprawl when compared to the rest of the US, which makes emphasis on density even more important. This finding also relates to the Midwest’s green space score from figure 3. This is the Midwest's highest score, and performs on average better than the rest of the US, but directly counteracts efforts towards density because of the space needed for green spaces to exist (Deetjen et al., 2018). The density scores also support previous research from Fulton et al. (2001) that concluded the Midwest consumes land at a rate unproportional to their population growth. The effects of urban sprawl on automobile emissions can be counteracted by efforts to improve policies related to urban form as seen in Figure 6. While on average the Midwest does not score much worse than the rest of the US on the subject of transportation, transportation policy is unsupported by urban form policy. The policies in the rubric related to transportation (automobile independence, mass transit, and non-motorized transport) are more effective when combined with effective urban form policies because other forms of transportation need to be similarly efficient and convenient in order to compete with automobiles. If they remain the most efficient and convenient form of transportation because of how sprawled a city is, then those policies will not have as significant of an effect on emissions reduction as intended.

Cities With State CAPs vs Cities Without

Cities that are from states with CAPs performed on average 8.1% better than states without, which supports ideas of policy diffusion. I theorize that cities from states with CAPs referenced the policies provided from the state for implementation into their own plans. This theory is further supported by the fact that two thirds of the graded plans from states with CAPs were published after their states' CAP. Having a guide that was already specific to the area the city resides in likely made them stronger, supporting the importance of having location specific literature to reference when making policy. All of the city CAPs from states with previously published state CAPs bordered the coast or the great lakes, except for Cedar Rapids, Iowa. This is in line with the findings of Soni et al. (2022), cities that face a greater variety of environmental threats, which are coastal cities, are more likely to develop CAPs.

Limitations

The largest limitation to the quality of the results is grading standards. While I did evaluate what quality of plan achieved what score from the Deetjan et. al. (2018) study, there is no way to truly know how all of the plans compared without re-grading all of them myself. This would have made the grading standard more consistent among my data. If I had looked at all of the city's CAPs again, it is likely I would have found plans that were updated since they were analyzed by this study in 2018. Re-grading all of the updated plans would have made my results more current.

Conclusion

The analysis performed by this paper replicated a previous study done by Deetjen et al. (2018) which grades climate action plans (CAPS) from 29 US cities. I applied the rubric developed for this study to CAPs in the Midwest to fill a gap in the literature that evaluates CAPs in mostly highly populated areas to find where Midwestern plans are lacking based on quantitative analysis of their scores. Focus on population leads most of the existing literature to neglect the Midwest since it is less populated than the rest of the US. This is important because policy relevant to the environment needs to be highly customized to the area it is employed in. Cities in the Midwest cannot follow many of the policy recommendations provided in the literature because it is mostly relevant to other areas of the US. Policy also spreads from city to city through policy diffusion, meaning if CAPs in the Midwest have relevant literature to reference when determining priorities and best practices, those have potential to spread throughout the Midwest (Gilardi & Wasserfallen, 2019).

The Deetjen et al. (2018) study was chosen to replicate so that the findings of this paper would be easily comparable with the findings of the rest of the US. This study was also chosen because of the variety of policy types covered and emphasis on density, which the Midwest struggles with, in the rubric. Lastly, as the original data set was expanded with the addition of more Midwestern cities, I was able to compare the scores of plans within states that have a state CAP and cities that were not in states that have CAPs. This aspect was included to find if the presence of a state CAP was enough relevant policy for cities to reference to have a strong CAP.

Quantitative analysis finds that Midwestern CAPs excel over the rest of the US in areas that are less impactful than others for reducing GHG emissions. There was a 0.16% difference in average Midwestern and Non-Midwestern scores. Cities that are from states with CAPs performed on average 8.1% better than states without.

Midwestern CAPs may have scored better only in policies that are less impactful because the rubric weighted policies that supported density in the most impactful category, which is an aspect the Midwest already struggles with. However, the difference in policy quality of less impactful policies between the Midwest and Non-Midwest was so great that the difference in average scores between Midwestern cities and the rest of the US was marginal. The fact that cities from states with state CAPS scored slightly better on average could mean that cities from states with CAPs were able to reference the policies provided from the state for implementation into their own plans, or practice policy diffusion.

For Future Study

From these scores, future analysis can link policy recommendations relevant to the Midwest that would improve the plans developed there. However, future analysis may also benefit from more specific areas of focus and/or adjusting the rubric to better accommodate studying the Midwest.

To be more specific, future study could focus on rural towns over urban cities to better open analysis to the important agricultural aspects of mitigating climate change that were ignored during this study but heavily relevant to the Midwest. This would involve changing the CAPs selected and the method of selection to those from rural areas. 'Rural' does not have a specific definition and is instead classified as any area that does not meet the criteria to be classified as urban. This means any city that contains under 50,000 people in its borders and does not contain any 'urban clusters' is rural. Urban clusters are areas that have "2,000 housing units or at least 5,000 persons" and "425 housing units per square mile" (*Urban Area Criteria for the 2020 Census-Final Criteria*, 2022b). As these areas are more spread out, they are also more likely to contain farmland, since only one house is typically present on hundreds of acres of land. This is important because the emissions released from farming are deserving of the same attention given to issues such as density, transportation, and energy efficiency in this study. This would also have to be addressed in the rubric.

The rubric developed for the Deetjen et al. study should be adjusted to better reflect the unique needs of the Midwest. This modification could ensure that the scoring rubric can provide feedback for aspects of life in rural communities that are not relevant in highly urban cities, which have been the focus of most of the literature. First, a section focusing on sustainable agriculture should be added. Subjects such as no-till farming and drip irrigation specifically for rural areas are important to address. For the continued study of urban areas, urban agriculture needs to be added. Most areas that will create a CAP are urban and non-agricultural. This is still true for many less populous towns in the Midwest. However, since previous work finds that

CAPs get most of their ideas from the towns around them through policy diffusion, adding agriculture to the rubric will support rural areas when they decide to build their own CAP (Gilardi & Wasserfallen, 2019). As they become more widely used and agricultural areas acknowledge their contribution to climate change, it is important that they have an existing model, so they know where to start. Therefore, it is essential to include these agricultural categories, even if not every CAP that this study addresses pertains to cities with agricultural areas.

Additionally, due to less construction in rural areas, the policy types that relate to expansion and development should be scored at a lower weight. Low-density cities, of which many are found in the Midwest, need more focus on their increased energy consumption and rural power sector emissions than air pollution or traffic as high-density cities need (Lohrey & Creutzig, 2016). This paper assumes that previous research that has mainly focused on the most populous cities of the United States likely ended up prioritizing high-density cities as well, because high-population cities tend to be denser (US Census Bureau). Therefore, low-population cities will have different priorities when it comes to reducing emissions since they function differently.

Water infrastructure policy that aims to reduce water utilities energy consumption and emissions is in the additional category. So the rubric can best fit the needs of the Midwest, it should be moved to the priority category.

Reflection

If I were to start this thesis again knowing what I know now, there are a few things I would do differently. First off, I would make my objective as simple as possible. Many ideas in the 'For Future Study' section were methods I had tried to employ, but abandoned because their added complexity made every other aspect of this thesis more difficult and time consuming, even though they were not beyond the scope of my abilities. Simplifying my objective was helpful because I was able to make my analysis more focused.

Secondly, I would have approached the Stats Consulting Lab sooner. I did not expect the level of customer service they provided, and could have used their guidance during the data collection process. When I did finally make an appointment, it was well worth my time.

Lastly, I would have not worked on the final draft of my introduction, literature review, and methods until I finished my results. Since my objectives and methods changed throughout the writing process, these sections needed continuous updating that left me stuck and overwhelmed at times. Ultimately I decided to completely rewrite the introduction and literature review, and heavily modify the methods after I had completed the results and some of the discussion. This made the process much smoother even though it was risky to abandon so much work I had already done. I learned that I prefer this approach, and in the future I will only do brief introductions and literature reviews until my results are finished

Studying climate action plans expanded my knowledge of sustainability by exposing me to what the best efforts of it looks like in a government context. I already knew that the definition of sustainability is not the same for everyone, but I learned that this is actually good and necessary for the health of our planet, likely because all of the policies I looked at had a different approach to sustainability and emissions reduction. I encountered methods of sustainable development that were effective mostly in the locality they were based in, and other methods that were unexpected or creative that would benefit other areas. We need different definitions of sustainability because different areas have different environmental needs, economies, and abilities. However, one thing all of these definitions still need to have in common that is still relevant to the definition provided by the UNL Sustainability Initiative Team is themes of environmental/social responsibility, consideration of long-term consequences, and economic viability.

I also found there to be an air of criticism around the study of local CAPs, but would like to recognize their importance.

All in all, climate action plans, no matter their scope, are important and necessary to keep the warming of the planet below 1.5C and avoid irreversible effects of climate change. Plans at the city level have a lot of work to do to make their contribution to emissions reduction impactful enough to meet this goal, and thus have been evaluated in previous literature that provides them with policy recommendations and areas for improvement. The Midwest has largely been ignored in this evaluation because this type of policy is more recent and is a less populated region of the US. The Midwest is still important to study because it has different environmental needs and abilities, and cannot borrow policy from other regions with different environmental needs. This paper succeeded in helping to close this gap in the literature, which will hopefully lead to more comprehensive and effective climate action plans in the Midwest.

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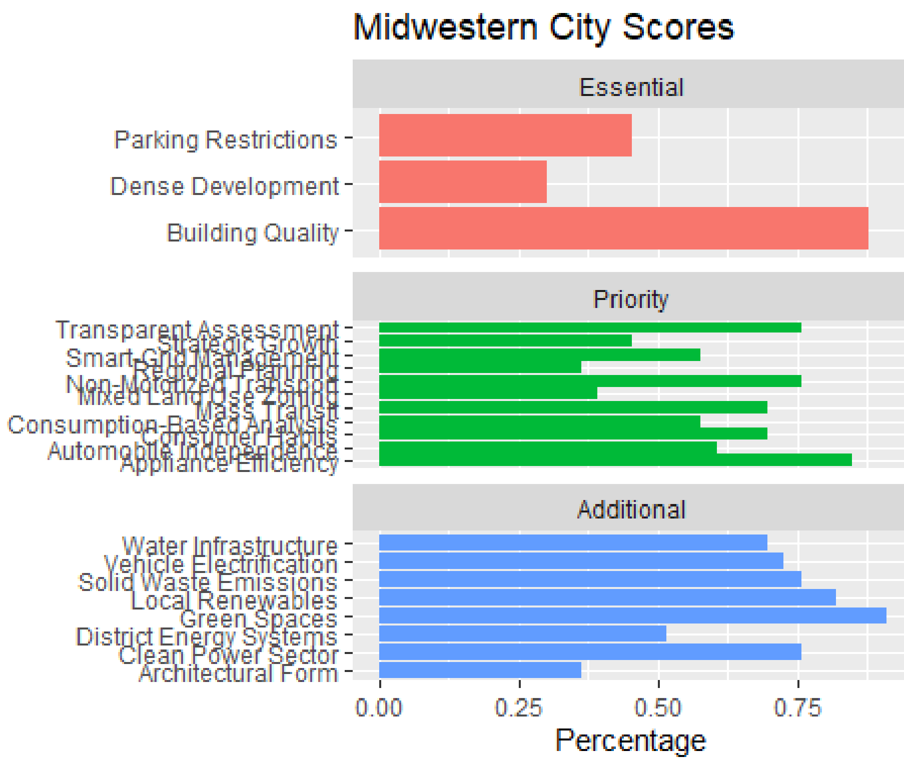
Appendix A

Knit R Code

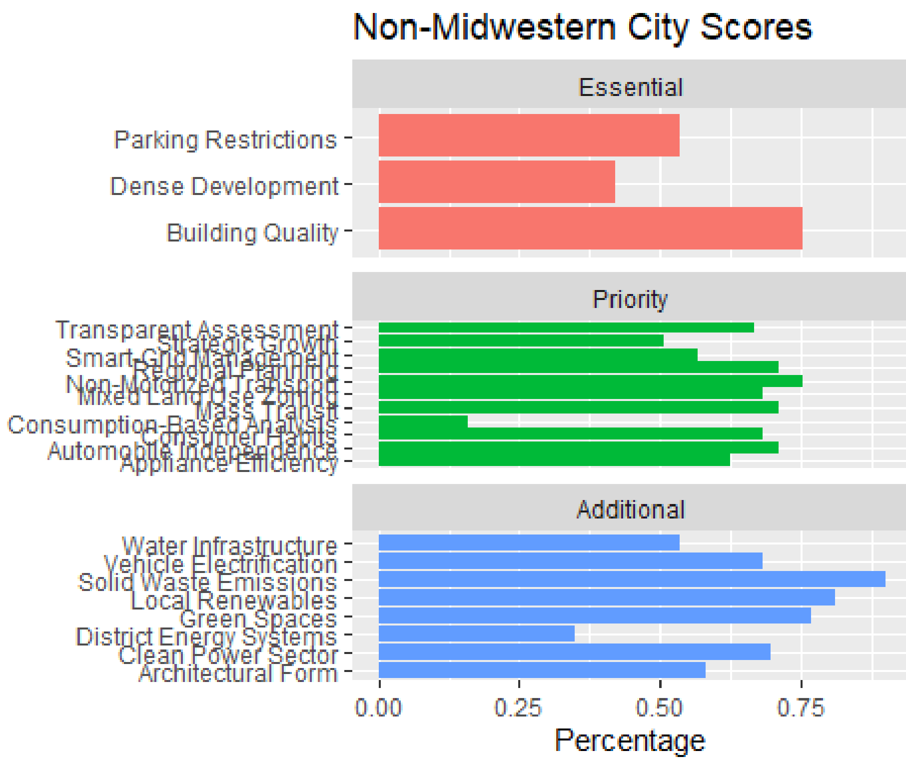
2024-04-10

```
library(ggplot2)

setwd("C:/Users/User/Documents/Thesis")

allScores =
read.csv("C:/Users/User/Documents/Thesis/CombinedSheetScores.csv")

#this function gets the aggregate scores

sum.scores = aggregate(Points ~ Midwest + Policy.Type + Policy,
data = allScores, FUN = sum)

#add the percentage of total points for each

sum.scores$Percentage = NA

#Essential have 9 points per city
#this is creating the percentage values for the scores for the essential
policy.
#First line does the midwest cities and second line does the non midwest
sum.scores[(sum.scores$Policy.Type == "Essential") & (sum.scores$Midwest ==
1),
"Percentage"] = sum.scores[(sum.scores$Midwest == 1) &
(sum.scores$Policy.Type
== "Essential"), "Points"]/(length(unique(allScores[allScores$Midwest == 1,
"City"]))*9)
sum.scores[(sum.scores$Policy.Type == "Essential") & (sum.scores$Midwest ==
0),
"Percentage"] = sum.scores[(sum.scores$Midwest == 0) &
(sum.scores$Policy.Type
== "Essential"), "Points"]/(length(unique(allScores[allScores$Midwest == 0,
"City"]))*9)

#Priority have 6 points per city
#same thing as above but for priority
sum.scores[(sum.scores$Policy.Type == "Priority") & (sum.scores$Midwest ==
1),
"Percentage"] = sum.scores[(sum.scores$Midwest == 1) &
(sum.scores$Policy.Type
== "Priority"), "Points"]/(length(unique(allScores[allScores$Midwest == 1,
"City"]))*6)
```

```
sum.scores[(sum.scores$Policy.Type == "Priority") & (sum.scores$Midwest ==
0),
"Percentage"] = sum.scores[(sum.scores$Midwest == 0) &
(sum.scores$Policy.Type
== "Priority"), "Points"]/(length(unique(allScores[allScores$Midwest == 0,
"City"]))*6)

#Additional have 3 points per city
#same thing as above but for additional
sum.scores[(sum.scores$Policy.Type == "Additional") & (sum.scores$Midwest ==
1),
"Percentage"] = sum.scores[(sum.scores$Midwest == 1) &
(sum.scores$Policy.Type
== "Additional"), "Points"]/(length(unique(allScores[allScores$Midwest == 1,
"City"]))*3)
sum.scores[(sum.scores$Policy.Type == "Additional") & (sum.scores$Midwest ==
0),
"Percentage"] = sum.scores[(sum.scores$Midwest == 0) &
(sum.scores$Policy.Type
== "Additional"), "Points"]/(length(unique(allScores[allScores$Midwest == 0,
"City"]))*3)

#reorganize levels to Essential, priority, and additional
#organizing the levels of the policy type variable so that they
#matched the order in study being replicated
sum.scores$Policy.Type = factor(sum.scores$Policy.Type, levels =
(c("Essential",
"Priority","Additional")))

#horizontal Bar plots this creates a horizontal barplot for midwestern cities
ggplot(data = sum.scores[sum.scores$Midwest == 1,], aes(y = Policy,
x = Percentage, fill = Policy.Type)) + geom_col() +
facet_wrap(vars(Policy.Type), scales = "free_y", ncol = 1)+
guides(fill = "none") + ggtitle("Midwestern City Scores") + ylab("")
```

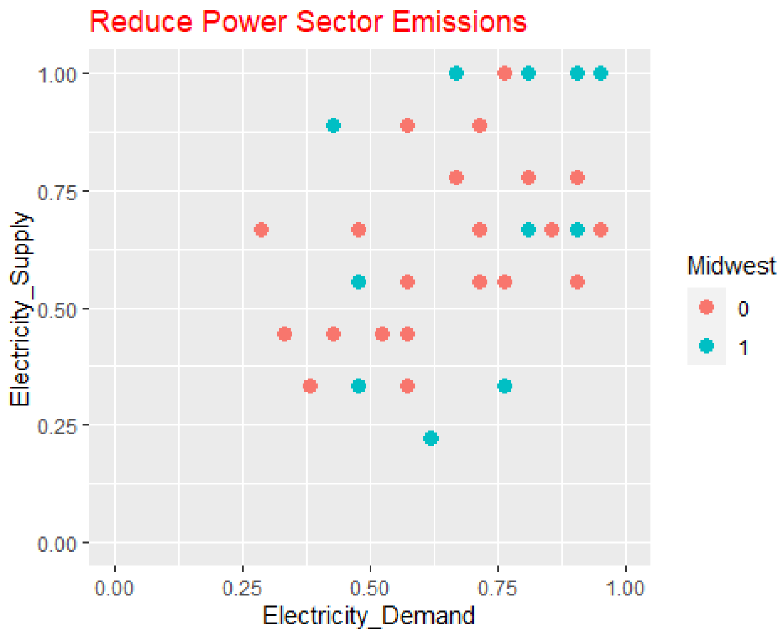



```
#non-midwest
ggplot(data = sum.scores[sum.scores$Midwest == 0,], aes(y = Policy,
x = Percentage, fill = Policy.Type)) + geom_col() +
facet_wrap(vars(Policy.Type), scales = "free_y", ncol = 1) +
guides(fill = "none") + ggtitle("Non-Midwestern City Scores") + ylab("")
```

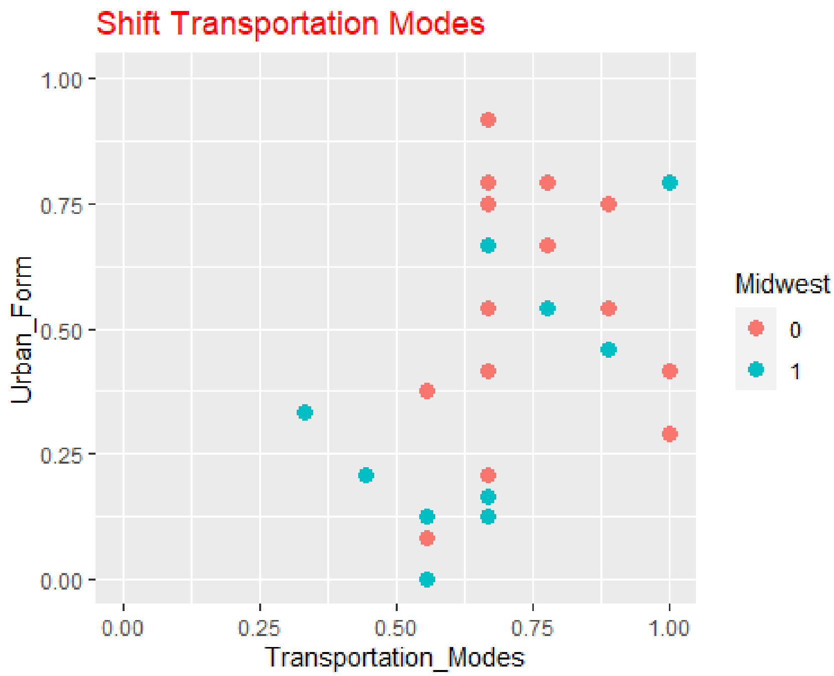



```
#new data frames with partitions based on scatter plots
#separates the data into the groupings that were in the scatterplots
buildingEnergyConsumption = allScores[allScores$Policy %in%
c("Building Quality","Appliance Efficiency", "Consumer Habits",
"Dense Development","Architectural Form"), ]

buildingEfficiency = aggregate(Points ~ City + Midwest,
data = buildingEnergyConsumption[buildingEnergyConsumption$Policy %in%
c("Building Quality","Appliance Efficiency", "Consumer Habits"),],
FUN = function(x) sum(x)/21)

buildingCompactness = aggregate(Points ~ City + Midwest,
data = buildingEnergyConsumption[buildingEnergyConsumption$Policy %in%
c("Dense Development","Architectural Form"),], FUN = function(x) sum(x)/12)

b.en.con = cbind(buildingEfficiency, buildingCompactness$Points)
colnames(b.en.con) = c("City","Midwest", "Building_Efficiency",
"Building_Compactness")
b.en.con$Midwest = factor(b.en.con$Midwest)

#graph for the Reduce Building Energy Consumption
ggplot(data = b.en.con, aes(x = Building_Efficiency,
y = Building_Compactness))+ geom_point(aes(color = Midwest), size = 3) +
xlim(0,1) + ylim(0,1) + ggtitle("Reduce building energy consumption") +
theme(plot.title = element_text(color = "red"))
```

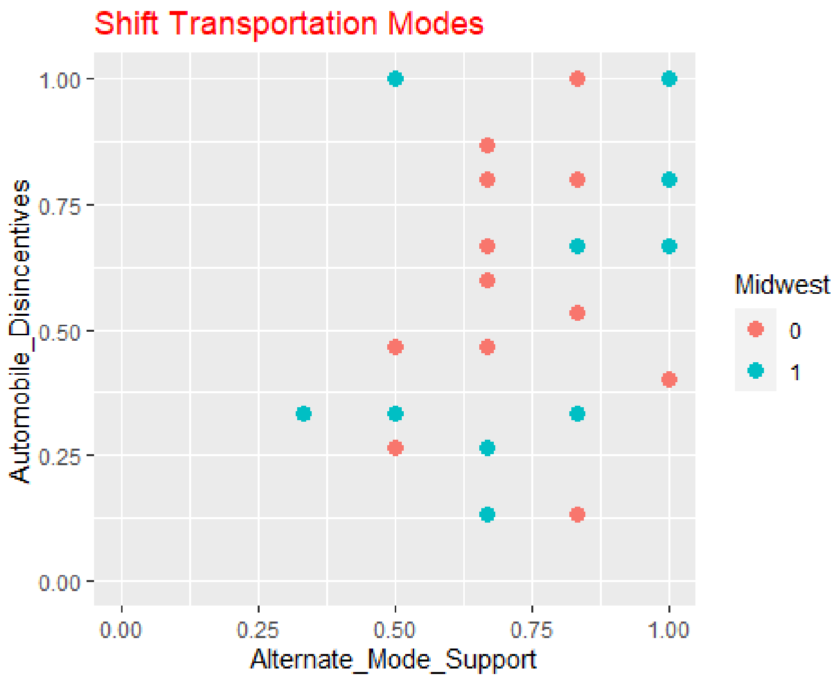

```
#Reduce Power Sector Emissions Scatter Plot
powerSectorEmissions = allScores[allScores$Policy %in%
c("Smart-Grid Management","Appliance Efficiency", "Consumer Habits",
"Vehicle Electrification","Clean Power Sector","Local Renewables",
"District Energy Systems"), ]

electricityDemand = aggregate(Points ~ City + Midwest,
data = powerSectorEmissions[powerSectorEmissions$Policy %in%
c("Smart-Grid Management","Appliance Efficiency", "Consumer Habits",
"Vehicle Electrification"),], FUN = function(x) sum(x)/21)

electricitySupply = aggregate(Points ~ City + Midwest,
data = powerSectorEmissions[powerSectorEmissions$Policy %in%
c("Clean Power Sector","Local Renewables", "District Energy Systems"),],
FUN = function(x) sum(x)/9)

b.en.con = cbind(electricityDemand, electricitySupply$Points)
colnames(b.en.con) = c("City","Midwest", "Electricity_Demand",
"Electricity_Supply")
b.en.con$Midwest = factor(b.en.con$Midwest)

ggplot(data = b.en.con, aes(x = Electricity_Demand, y = Electricity_Supply))
+
geom_point(aes(color = Midwest), size = 3) + xlim(0,1) + ylim(0,1) +
ggtitle("Reduce Power Sector Emissions") +
theme(plot.title = element_text(color = "red"))
```



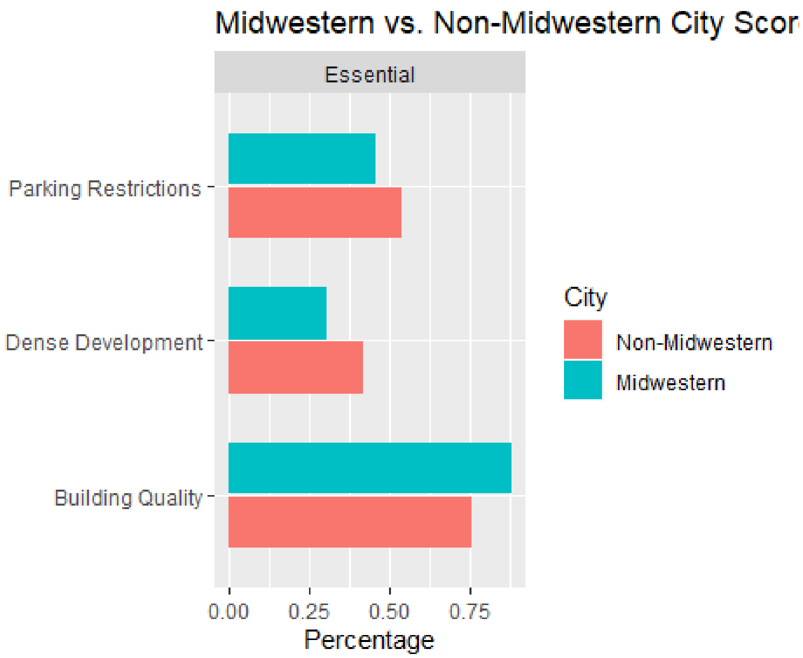

```
#Shift Transportation Modes Scatter Plot
transportationModes = allScores[allScores$Policy %in%
c("Automobile Independence","Mass Transit", "Non-Motorized Transport",
"Dense Development","Parking Restrictions","Mixed Land Use Zoning"), ]

TransportationModes = aggregate(Points ~ City + Midwest,
data = transportationModes[transportationModes$Policy %in%
c("Automobile Independence","Mass Transit", "Non-Motorized Transport"),],
FUN = function(x) sum(x)/18)

urbanForm = aggregate(Points ~ City + Midwest,
data = transportationModes[transportationModes$Policy %in%
c("Dense Development","Parking Restrictions", "Mixed Land Use Zoning"),],
FUN = function(x) sum(x)/24)

b.en.con = cbind(TransportationModes, urbanForm$Points)
colnames(b.en.con) = c("City","Midwest", "Transportation_Modes",
"Urban_Form")
b.en.con$Midwest = factor(b.en.con$Midwest)

#graph for the Shift Transportation Modes
ggplot(data = b.en.con, aes(x = Transportation_Modes, y = Urban_Form)) +
geom_point(aes(color = Midwest), size = 3) + xlim(0,1) + ylim(0,1) +
ggtitle("Shift Transportation Modes") +
theme(plot.title = element_text(color = "red"))
```



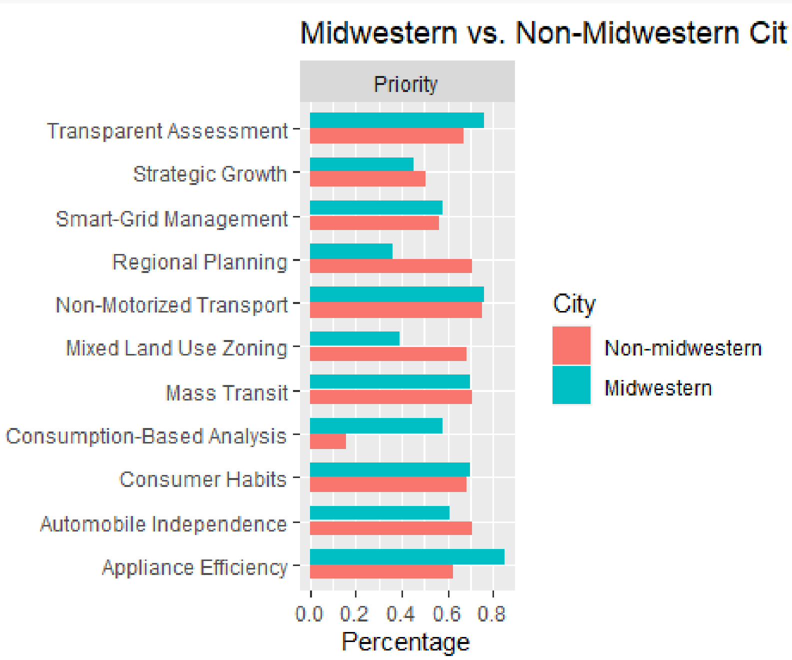

```
#2nd Shift Transportation Modes Scatter Plot
transportation.Modes = allScores[allScores$Policy %in%
c("Automobile Independence","Mass Transit",
"Non-Motorized Transport","Parking Restrictions"), ]

alternateModeSupport = aggregate(Points ~ City + Midwest,
data = transportation.Modes[transportation.Modes$Policy %in%
c("Mass Transit", "Non-Motorized Transport"),], FUN = function(x) sum(x)/12)

automobileDisincentives = aggregate(Points ~ City + Midwest,
data = transportation.Modes[transportation.Modes$Policy %in%
c("Automobile Independence","Parking Restrictions"),],
FUN = function(x) sum(x)/15)

b.en.con = cbind(alternateModeSupport, automobileDisincentives$Points)
colnames(b.en.con) = c("City","Midwest", "Alternate_Mode_Support",
"Automobile_Disincentives")
b.en.con$Midwest = factor(b.en.con$Midwest)

#graph for the Shift Transportation Modes
ggplot(data = b.en.con, aes(x = Alternate_Mode_Support,
y = Automobile_Disincentives)) + geom_point(aes(color = Midwest), size = 3)+
xlim(0,1) + ylim(0,1) + ggtitle("Shift Transportation Modes") +
theme(plot.title = element_text(color = "red"))
```



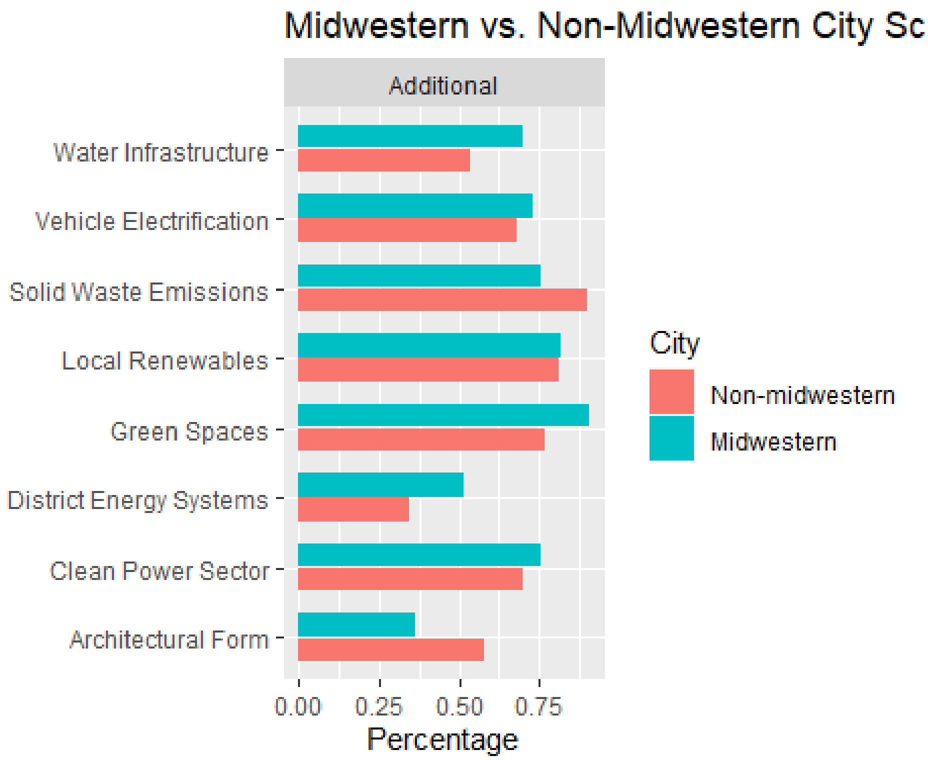

```
#### Stacked Bar Plots ####

#For the Midwestern data, the 'fill=' argument is changed to Midwest
#(which is in the data set), a factor was created and labels were changed
#associated with that factor 0 = Non, 1 = Mid, this is for the legends
purposes.

#To stack, y = policy in the aesthetic, so each position on the y axis
#corresponds to a policy. The 'fill=' arguments communicates that I will have
#two bars at each location based on whether it is the value associated with
#Midwestern or not

#BUT, by default, these bars are stacked behind each other when using
#geom_col(). So, if you look at geom_col(), I have added the position
argument,
#and by using position=position_dodge2(), the bars will now 'dodge' each
other
#and set side by side.

ggplot(data = sum.scores[sum.scores$Policy.Type == "Essential",],
aes(y = Policy,x = Percentage, fill = factor(Midwest,
labels = c("Non-Midwestern","Midwestern")))) +
geom_col(width = 0.7,position = position_dodge2(padding = 0.05)) +
facet_wrap(vars(Policy.Type), scales = "free_y", ncol = 1)+
guides(fill = guide_legend("City"))+
ggtitle("Midwestern vs. Non-Midwestern City Scores") + ylab("")
```



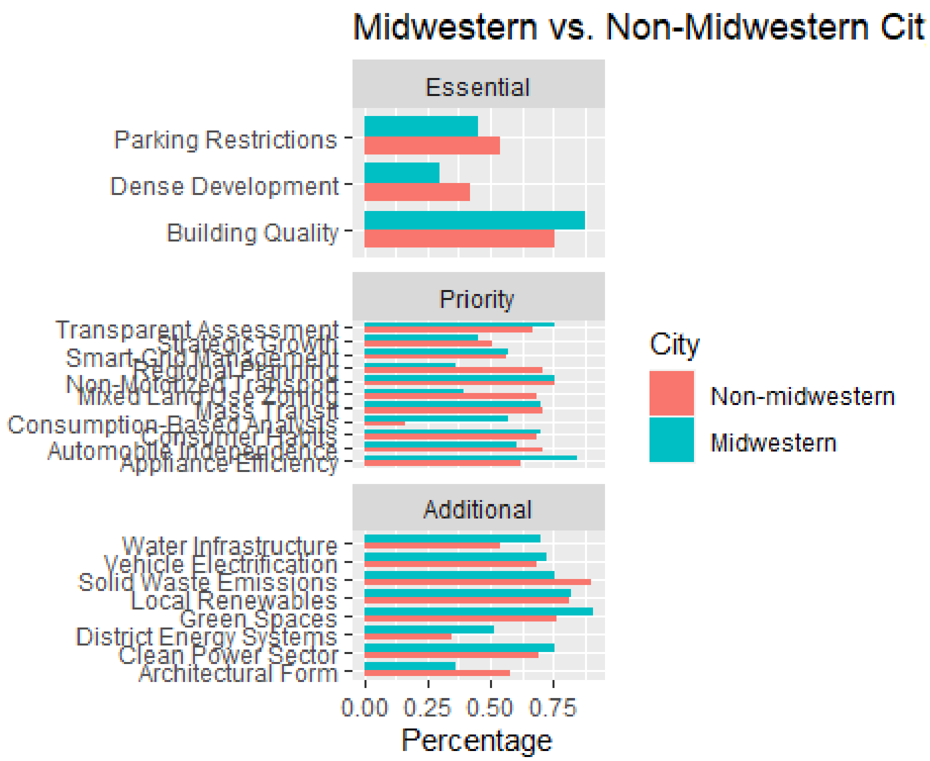

```
ggplot(data = sum.scores[sum.scores$Policy.Type == "Priority",],
aes(y = Policy,x = Percentage, fill = factor(Midwest,
labels = c("Non-midwestern","Midwestern")))) +
geom_col(width = 0.7,position = position_dodge2(padding = 0.05)) +
facet_wrap(vars(Policy.Type), scales = "free_y", ncol = 1)+
guides(fill = guide_legend("City"))+
ggtitle("Midwestern vs. Non-Midwestern City Scores") + ylab("")
```



```r
ggplot(data = sum.scores[sum.scores$Policy.Type == "Additional",],
aes(y = Policy,x = Percentage, fill = factor(Midwest,
labels = c("Non-midwestern","Midwestern")))) +
geom_col(width = 0.7,position = position_dodge2(padding = 0.05)) +
facet_wrap(vars(Policy.Type), scales = "free_y", ncol = 1)+
guides(fill = guide_legend("City"))+
ggtitle("Midwestern vs. Non-Midwestern City Scores") + ylab("")
```




```r
#a plot with all of it together
ggplot(data = sum.scores, aes(y = Policy,x = Percentage,
fill = factor(Midwest, labels = c("Non-midwestern","Midwestern")))) +
geom_col(width = 0.8,position = position_dodge2(padding = 0.01)) +
facet_wrap(vars(Policy.Type), scales = "free_y", ncol = 1)+
guides(fill = guide_legend("City"))+
ggtitle("Midwestern vs. Non-Midwestern City Scores") + ylab("")
```


Midwestern vs. Non-Midwestern Cit
Essential
Parking Restrictions
Dense Development
Building Quality
Priority
Transparent Assessment
Strategic Growth
Smart Grid Management
Regional Planning
Non-Motorized Transport
Mixed Land Use Zoning
Mass Transit
Consumption-Based Analysis
Consumer Habits
Automobile Independence
Appliance Efficiency
Additional
Water Infrastructure
Vehicle Electrification
Solid Waste Emissions
Local Renewables
Green Spaces
District Energy Systems
Clean Power Sector
Architectural Form
0.00 0.25 0.50 0.75
Percentage
City
Non-midwestern
Midwestern

Appendix B

Data

		Minneapolis, MN	Kansas City Met	Chicago, IL	Detroit, MI	Lincoln, NE	Cedar Rapids, IA	Indianapolis, IN	Columbus, OH	Milwaukee, WI	Spearfish, SD	St. Louis, MS	total	% of possible
Essential Policies														
Building Quality		9	9	9	9	9	6	9	6	9	3	9	87	0.9666666667
Parking Restrictions		9	6	6	0	3	3	3	0	9	0	6	45	0.5
Dense Development		3	3	3	0	0	3	0	3	6	0	9	30	0.3333333333
Priority Policies														
Mass Transit		2	6	6	4	2	0	4	6	6	4	6	46	0.7666666667
Automobile Independence		6	4	4	4	2	2	2	2	6	2	6	40	0.6666666667
Non-Motorized Transport		4	4	6	4	4	4	6	2	6	4	6	50	0.8333333333
Mixed Land Use Zoning		4	4	2	4	2	2	0	0	4	0	4	26	0.4333333333
Regional Planning		2	2	4	0	6	0	0	0	4	6	0	24	0.4
Stratgic Growth		4	6	0	2	4	0	0	2	6	6	0	30	0.5
Transparent Assessment		4	6	6	4	4	6	4	6	6	0	4	50	0.8333333333
Consumption-Based Analysis		4	4	4	2	2	4	4	6	6	0	2	38	0.6333333333
Consumer Habits		6	4	4	6	4	2	2	4	4	6	4	46	0.7666666667
Appliance Efficiency		6	6	6	4	2	6	6	4	6	4	6	56	0.9333333333
Smart-Grid Management		6	6	6	2	0	0	4	6	4	0	4	38	0.6333333333
Additional Policies														
Green Spaces		3	3	3	2	3	3	3	3	2	3	2	30	1
Architectural Form		0	3	2	3	0	1	0	0	1	0	2	12	0.4
District Energy Systems		3	3	0	0	3	0	3	0	3	0	2	17	0.5666666667
Vehicle Electrification		2	3	3	1	3	2	2	2	3	0	3	24	0.8
Clean Power Sector		3	3	3	1	3	2	3	1	3	1	2	25	0.8333333333
Local Renewables		3	3	3	1	2	3	3	2	3	2	2	27	0.9
Water Infrastructure		2	2	3	1	2	2	2	2	2	2	3	23	0.7666666667
Solid Waste Emissions		3	3	3	3	2	2	2	1	2	2	2	25	0.8333333333
% of Possible		75	79	74	49	53	45	53	50	86	38	72		61.27
														61.43
state plan?		Y	N	Y	Y	N	Y	N	N	Y	N	N		

	Non-Midwest			state plan publish date		Midwest		state plan publish date					
2015	san diego	Y	65	CA- 2009		2008	Chicago	IL-2007					
2016	tampa	Y	50	FL-Oct 2008		2013	Minneapolis	MN- 2015					
2015	denver	Y	66	CO- 2015		2017	Detroit	MI-March 2009					
2016	Charlotte	Y	38	NC- 2008		2021	Cedar Rapids	IO- Dec 2008					
	San Antonio	N	62			2023	Milwaukee	WI- 2008				13 no state plan	733
2015	portland	Y	79	OR-March 2010								21 yes state plar	1354
2015	pittsburg	Y	68	PA- 2018									
2017	las vegas	Y	49	NV-dec 2020					if city CAP was published after state CAP =			14/21	
	Austin	N	78						same year			2/21	
	Nashville	N	51						before			5/21	
2010, 2018	NY	Y	67	NY-nov 2010									
2016	LA	Y	77	2009									
	Dallas	N	52										
	Houston	N	50						Non-Midwestern Scores:				
2016	Washington DC	Y	65	VA-2008					Mixed Land Use Zoning		92/132	0.696	27% difference
2011, 2016	Philadelphia	Y	62	2018					Regional Planning		98/132	0.7424	34% difference
2011	Miami	Y	67	Oct 2008					Consumption-Based Analysis		22/132	0.16666	46% difference
	Atlanta	N	50						Appliance Efficiency		82/132	0.6212	31% difference
2011	Boston	Y	65	Nov 2010									
2004	San Fransisco	Y	73	2009									
	Pheonix	N	45										
2016	Riverside	Y	69	2009									
2013	Seattle	Y	65	April 2012									