

CAN CITIES BE NET-POSITIVE? A SYSTEMATIC LITERATURE REVIEW

**Jyväskylä University
School of Business and Economics**

Master's Thesis

2024

**Author: Ihabe El Kehal
Subject: Corporate Environmental Management
Supervisor: Bhavesh Sarna**



**JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ**

ABSTRACT

Author Ihabe El Kehal	
Title Can Cities be Net-Positive? A Systematic Literature Review	
Subject Corporate Environmental Management	Type of work Master's Thesis
Date 12.04.2024	Number of pages 61
<p>Abstract</p> <p>Cities depict the evolution of human civilization, manifesting both triumphs and tribulations, and playing a crucial role in shaping the trajectory of our future. Is this future going to be a socially and ecologically just one? Or is it going to be a harbinger for an unjust dystopian nightmare? On the backdrop of these philosophical speculations, rose a question that intrigues the need for an answer: "<i>Can Cities be Net-Positive?</i>". In a bid to find answers, the paper takes an inductive interpretative qualitative path, bolstered by the Gioia Method. A total of 57 articles were analysed, and a Gioia data structure was constructed. The findings suggest that cities can be net-positive, and there are existing concepts that may support achieving this goal. Some of these concepts are regenerative design, biomimicry, biodiversity-inclusive design, and biophilic urbanism. The paper also draws attention to the established theory of Positive Development (PD) as a valid path to achieve net-positive outcomes. An example of an emerging net-positive urban form was highlighted which is the Positive Energy District (PED). However, a radical change in paradigms is necessary to achieve this seemingly unrealistic goal. This paper claims that human-nature integration could be the bottom-line for this new radical paradigm shift. It also highlights the social and ecological duality meaning that urban actions should always consider these two vectors. And that moving from 'doing less bad' to 'doing more good' is not enough, instead, our actions should draw absolute 'net-positive' outcomes. The paper concludes with exploring some of the research implications, highlighting its limitations, and suggesting future directions for further inquiry.</p>	
<p>Keywords net-positive city, positive development, human-nature integration, gioia method</p>	
<p>Place of storage Jyväskylä University Library</p>	

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LIST OF ABBREVIATIONS

BID	-	Biodiversity Inclusive Design
GI	-	Green Infrastructure
LR	-	Literature Review
PD	-	Positive Development
PED	-	Positive Energy District
RL	-	Relevance Level

1 INTRODUCTION

1.1 Background

Cities are where human beings overlap with nature, and most often if not always, suppress the ecosystem and harm the biodiversity. A city, beyond being a conglomerate of people living in structures and interconnected by infrastructure, can be portrayed differently depending on one's perspective and their school of thought. For a social scientist, a city can be seen as people and thus preserving their wellbeing. For a politician, a city can be seen as a group of voters, and thus catering for their needs and demands. For an entrepreneur, a city can be seen as a market, and thus catching opportunities and increasing profitability. For an environmentalist, a city can be seen as an ecosystem, thus aiming to maintain its biodiversity. Overall, we can portray a city as a living creature and no matter our background, there is an inherent need in making sure it remains healthy and thriving. I have been brainstorming the subject of my thesis for months, various ideas crossed my mind and they all related to sustainability in cities.

Due to my background in Civil Engineering, in which I have a previous master's degree, complemented by my current studies in Corporate Environmental Management, I thought bridging the two worlds would be the way forward. Right before finishing my internship at the UN Global Compact Network Finland, the Executive Director, Marja Innanen, gifted me a book which I have been reading. The book is titled '*Net Positive: How courageous companies thrive by giving more than they take*', by Paul Polman and Andrew Winston. So, I asked myself, if companies as a living entity can do it, why can't a city as well? After a long time of brainstorming, mainly through philosophical monologues, the final thesis subject would become "*Can Cities be Net-Positive?*". If cities are where humans spend most of their lifetime, and if the entire civilization tissue is built on top of nature, then it is only fair to go beyond questioning whether or not we can stop harming the natural ecosystem, and start asking whether or not

we can serve it better and give back more than we take. And thus I decided to embark on this journey, to find answers to one question that seems very valid and logical to say the least.

On this occasion, and before I resume my introduction to this paper, I would like to give special thanks and acknowledgement to my mother and my sisters who have always been there for me. I extend my gratitude to my Supervisor and Teacher Bhavesh Sarna, who have been of great assistance for me throughout this thesis. I am also particularly thankful to Senior Lecturer Stefan Baumeister who have guided me and advised me during my time as a master's degree student. My sincere appreciation is also extended to all the teachers of the Corporate Environmental Management programme and the staff of the Jyväskylä University School of Business and Economics.

1.2 Research Motivation

I am certain I may not be the first to ask this question, but how often has it really been asked? And more importantly, has there been genuine interest in answering this question? To my surprise, I have discovered that research may not have covered this question enough, at least according to my very limited knowledge, nor have it been genuinely asked as a main theme of an article in of itself. The term "net-positive", when it relates to cities or their membranes (people, structure, infrastructure), brings up very poor results on various databases. My thesis supervisor, Bhavesh Sarna, during our first meeting, expressed his interest in the research question, and we agreed that this is going to be a systematic qualitative literature review in the aim of answering the latter question. This research question means a lot to me, because it bridges between the two of my degrees; civil engineering and corporate environmental management. One of the areas which I have always had a particular interest in during my previous education was infrastructure. Particularly urban infrastructure and planning. And since cities are ever-evolving creatures, we may never be able to achieve full knowledge and mastery of the city, especially in the area of sustainability. This was the main motivation for me to start this thesis.

The importance of this subject is paramount. A city is but a mini country, and some countries, the likes of Singapore and Monaco and the Vatican, are cities after all, labeled as "city-states" or "microstates". If we can reach the point of answering whether a city can be net-positive or not, beyond just being net-zero or sustainable, we could inadvertently prove that humanity can indeed live in a net-positive planet. A conglomerate of cities makes up a country, and a conglomerate of countries makes up a continent, and the conglomerate of continents makes up Earth, an egg-shaped planet so perfectly placed in the ever-expanding cosmos, and which we all cherish and love.

1.3 Research Purpose

The main purpose behind this research is to seek an answer to the question: “*can cities be net-positive?*”. This literature review will revolve around this one and only research question. The results may be positive, and they may be negative. And frankly, before I went deep into my research, I was not confident I would find particular answers since an initial search yielded limited relevant results, and many were not directly applicable to the query and/or lacked the needed depth on this specific topic. I am still not sure what this seemingly uncharted territory hides in between its bushes, so let us both embark on this journey to possibly unravel new knowledge, ‘hopefully’. Before indulging in the process of exploration and investigation of the research question, it will be wise to criticize the question itself. What do I mean by “city”, and what do I mean by “net-positive”. This will be articulated in the next sub-section of theory.

1.4 Situating & Defining Net-Positive City

Cities have existed for several millenia, and they have always marked the marvel of human civilization. How many times have you seen documentaries narrating the life of a past people, and often we would base our knowledge on their civilization through the mystical structures of their buildings and within their enchanted alleys. Some of these civilisations fell and perished, some of them survived and are still standing. But what they all have in common, is providing us with a footprint of what humanity once accomplished. Today, with all the advancement in the building sector and technology, and the exponential boom in population growth since the industrial revolution, cities occupy but a mere three per cent of earth’s total landmass (Bai et al., 2016). Although this might appear as if it is a positive aspect, or as if there is so much room for urban expansion and sprawl, it is quite the opposite. Despite this seemingly small percentage, cities are consuming about 75 per cent of global energy, with the building sector alone consuming 30 per cent of energy and emitting 40 per cent of total GHG emissions (Bai et al., 2016; Berardi, 2013). In the EU for example, cities account for 30 per cent of CO₂ emissions, 30 per cent of water consumption, over 50 per cent of extracted materials, and about 30 per cent of all waste production (Marvuglia et al., 2020). The percentage of the population living in cities has been growing, and is expected to continue on this trajectory. From 30 per cent in 1950 to around 55 per cent today, humans are expected to populate cities by 60 per cent by the year 2030 and over 66 per cent by the year 2050 (Blau et al., 2018; Marvuglia et al., 2020; Peponi & Morgado, 2020).

My research question has two important terms in it, ‘city’ and ‘net-positive’, so it would be important to examine these two. While there is no consensus upon a scientific definition of what a city is (Porfiryev & Bobylev, 2018), let alone a net-positive city, let us try and generate one based on vocabulary and theory from

previous knowledge as well as justify it intellectually. Using Merriam-Webster as an authoritative dictionary source, we can try to define the words 'city' and 'net-positive'. A city (noun) is defined as "an inhabited place of greater size, population, or importance than a town or village". This is the literal English translation, and it typically translates into what the lay people understand or call a city. In our case, and as per my unbounded definition of what a city can be as per its form or size: a city can be as small as it can get (e.g., a residential building), and as big as it can get (e.g., a megacity). As for the term 'net-positive', it does not appear on the Merriam-Webster dictionary whatsoever, and since it is a composite of two words, let us define them separately. 'Net' as an adverb is defined as "free from all charges or deductions" such as losses, and 'positive' as an adjective can be defined as "having a good effect" or favorable effect. That is, by composing the terms, we could define it as "having an overall favorable impact or effect that exceeds any losses or deductions." My definition suggests that net-positive cities generate more positive outcomes than negative ones, meaning all losses are outweighed by positive impacts. Meaning in absolute terms, these cities emit absolute gains across the triple bottom line: society, environment, and economy.

A city, in order for it to be net-positive, it would require that buildings are net-positive, the interconnections between these buildings (e.g., infrastructure) are net-positive, and the social vector (e.g., wellbeing) is net-positive. The perception that some of us may have when we hear the term 'net-positive' is the correlation with the energy sector. This is simply not true. Net-positivity extends beyond just the energy sector and includes every aspect and dimension. In fact, net-positivity is beyond just a question of achieving surplus or absolute gains, it involves value-adding within sustainability in general (Mang & Reed, 2015). Net-positivity is also not only limited to quantifiable objects or resources, on the contrary, it is to be questioned if a net-positive development is only limited to quantitative analysis only (Pearl & Oliver, 2015). For example, if certain elements in urban development such as happiness, health and safety, and wellbeing, cannot be quantified, they should not be left out of the net-positive discourse. In this paper, I will not be delving into how to achieve a net-positive city, as this would require an entire different research design from people far more competent than myself and across various fields of knowledge. I will merely stick to whether net-positivity as a concept can be achievable for a city or not.

1.5 Research Boundaries

When I embarked on this research journey, I decided to study my 'net-positive city' from a generic theoretical sense. That is, not to take a particular form of city, or a real example for a real city, and treat my research question from a global perspective. As I have explained above, what I mean by city could be any form, and any size. There is no time frame of when the articles were published and no geographic boundary on where they were published. Therefore, I suppose there

are no research boundaries forcibly set by myself except for the ones emanating from the limitations of the research design and selection of articles itself and from my own interpretative analysis which is fallible and can be falsified. The research design and data collection will be thoroughly explained in the Data & Methods section. There, I will be explaining how I conducted the literature review, how and why I used the Gioia Method to induce and interpret data in order to answer this one research question: “*Can Cities be Net-Positive?*”. I do not claim the results of this paper are objectively true, but quite the opposite, the inductive interpretative analysis I will be conducting is subjective, and therefore the results themselves will be subjective. Albeit I will be arguing and making assumptions emanating from my understanding and my interpretation of what literature has to offer. The literature included will be thoroughly explained in the second section of Data & Methods, along with the limitations and constraints I set out or experienced while doing this literature review, which may impact the comprehensiveness of it. I claim that this paper may contribute positively to the discourse of sustainable cities, as I will aim to investigate whether cities can become net-positive in absolute terms and across the board (i.e., energy, biodiversity, well-being, etc.). The audience and stakeholders of this literature review can be fellow students, researchers in the science of cities and/or sustainable development, or urban planners and policymakers. This paper may bring together different approaches already existing in the body of knowledge on sustainable urban development, although in a very narrow and limited sense due to the small size of literature analyzed and the various limitations of the literature review. However, I envision that this paper can be expanded upon, and I will explain how this may be done in the future in the Discussion & Conclusion section.

1.6 Thesis Structure

The structure of the paper is going to be the following: A first chapter of ‘Introduction’ where I have delved into the relevance of the research question and why it is important, a second chapter of ‘Data & Methods’ where I will articulate how I searched and selected articles for my literature review, a third chapter for ‘Findings’ where I will present the knowledge I was able to gather from this review, and finally a fourth chapter for ‘Discussion & Conclusion’ where I will attempt to answer the research question and expand on it by pinpointing the missing areas of knowledge for future research.

2 DATA & METHODS

In this section, I will be providing a comprehensive overview of how I conducted my research and what the rationale behind my choices was. This is important for the reader to be able to judge the credibility and reliability of this paper through understanding the limitations and the constraints of the research design, collection and analysis of data, and major factors that have to be taken into account. Through this section I understand that research ethics is important and should be upheld, and I will be transparent to the best of my knowledge and ability.

2.1 Introduction to Literature Review

This paper conducts a literature review to answer a general question. Literature reviews have been known to play a significant role in providing an overall comprehensive overview of knowledge that has been compiled within a specific subject or field, and sometimes within a specific timeframe. LR aims to bring together theories and results explored by professionals before and tries to organize them within a broader context in order to find research gaps and suggest future directions for it. To achieve the goal of my LR research, I believe I should follow scientific logical reasoning. Mantere and Ketokivi (2013) have thoroughly explained the three kinds of logical reasoning: deductive, inductive, and abductive. The first one moves from the general to prove the particular using rules and available explanations to deduce observations. The second one moves from the particular to the general linking the observations and explanations to induce general rules for the studied phenomenon. The third one starts from the rule and uses the observation(s) to find an explanation to the phenomenon (Mantere & Ketokivi, 2013). For my particular research, I will be following the second one, which the inductive logical reasoning. The reason is because I will be compiling a pool of scattered information related to the sustainability of cities, some of this information verges towards answering my research question while

other information may not. That is, I will be linking different observations from different sectors (built environment, energy, water, transportation, etc.) to induce whether or not cities can be net-positive. Albeit logically this may not be reasonable, however, I have found several journal articles who have approached the matter from a generic perspective which will tremendously support answering the research question, and later I will explain how I classified the relevance of these articles.

Since I am doing a literature review, it is only fair to explore and learn more about review research as a distinct and significantly growing class of scientific inquiry. For that, my research supervisor has recommended an interesting paper, *Review Research as Scientific Inquiry* by Kunisch et al. (2023). The authors explained review research as a “class of research inquiries that uses prior research as data sources to develop knowledge contributions for academia, practice and policy”. This paper has provided me with significant guidance on how to conduct my literature review research. It has also proven that review research is a credible and legitimate scientific endeavor that has to be taken more into consideration (Kunisch et al., 2023). Review research is more than just a compilation and analysis of previous knowledge, it is also a birther of new knowledge through systematic brainstorming and questioning of studied phenomena. Kunisch et al. (2023) have proven that review articles have been a really important part of various subfields in recent years, especially in subfields related to our field of Business and Management (accounting, marketing, strategy, supply chain, etc.), but also more importantly in Corporate Social Responsibility. Their popularity is ever-growing, the percentage of published review articles have grown from only three percent (3%) in the 2000s to over thirteen percent (13%) in the 2020s. With the cheer knowledge that has been compiled over the years since the booming of modern scientific inquiry, I believe so much knowledge may have never been tapped into. Now more than ever, producing more review research is needed to touch upon undiscovered ideas and patterns of knowledge. Which now makes producing high-quality literature reviews even more demanding, which has been proven to not be as simple as it may sound (Kunisch et al., 2023). On the contrary, Kunisch et al. (2023) have found through journal articles (Breslin & Bailey, 2020; Rojon et al., 2021) that it is a demanding scientific endeavor that requires “multiple scientific skills and competences”.

2.2 Logical Reasoning of this LR

The logical reasoning behind this research review (also labeled as ‘review purpose’) should be highlighted. Beyond just trying to answer whether cities can be net-positive or not, if ever, I have to lay down a rigorous way on how to answer it scientifically. Here, Kunisch et al. (2023) have highlighted “eight major purposes for review research” which they were able to synthesis through their research. They called these eight logical pathways as ‘purposes of review research’, thus why I mentioned that they are also labeled as such. Since we

understand now that review research articles can serve several purposes, each research question can be approached from a different angle and would thus generate different knowledge. It all depends on the major purpose behind the LR. It is always best to follow one purpose at a time, that way the review will be logical, compact, and more in tone with the reader's flow of information. After doing a deep analysis of the eight different purposes, I have decided to follow the *Interpreting Purpose*. Kunisch et al. (2023) define interpreting in review research as "the critique and synthesis of independent studies covering a phenomenon of interest by means of reviewers creating and associating their own subjective and intersubjective meanings as they interact with the literature." According to Gond et al., (2020) (as cited in Kunisch et al., 2023), interpreting is characterized by a 're-presentation' of the literature, whereby it is possible to reconstruct new meanings based on various literature, "by intervening, adding or potentially transforming the literature." They also add that interpreting "may help generate more comprehensible and generalizable theory" (Gond et al., 2020, as cited in Kunisch et al., 2023). This is very applicable to this research design since I am trying to accumulate new generalizable knowledge (by answering the research question) based on previous research. Interpreting has a duality, whereby this paper attempts to understand the phenomena as seen by the primary authors, and what this paper interprets in relation to the studied phenomena (Kunisch et al., 2023). The interpreting purpose helps the interpreter (myself) "find higher-order theoretical constructs", through synthesizing findings from individual studies into new interpretations while preserving the theoretical sovereignties of those prior studies (Kunisch et al., 2023). This means that this paper will use previous (the particular) studies to answer whether cities can be net-positive or not (the general). Shall I give more reasons why this purpose pathway is perfect for this paper? Well, the latter idea that was explained seamlessly aligns with inductive logical reasoning this paper is based on!

2.3 Method of this LR: Gioia Method

I have made it the case that my research is inductive-interpretative-qualitative, and now I will explain why it follows the Gioia grounded theory method, also known as the Gioia Method (GM). First, let us recap. It is inductive because it follows the inductive logical reasoning. It is interpretative because the purpose of my literature review is to interpret a general theoretical construct based on particular scattered knowledge. It is qualitative because it involves synthesizing and analyzing qualitative data, in this case, in the form of text from scholarly journal articles. As a consequence, all the previous elements have made it the case that, I argue, the best qualitative method this paper can follow is the Gioia Method. But why follow a grounded theory method in qualitative review? Well, scholars have often critiqued and criticized qualitative research for "lacking scholarly rigor", albeit the method has so much untapped potential for discovering new areas of knowledge (D. A. Gioia et al., 2013). In order to reach

the rigor of top scholarly journals, Gioia has come up with a systematic approach to qualitative and interpretative research (valid in this paper's case), with more than thirty years of constantly refining the theory. Although Gioia has pointed out that in no way does he claim his method is the best, and that he invited researchers to innovate and expand on it, it remains one of the most compact in qualitative research (D. A. Gioia et al., 2013). His method stands on the following premise: 1st order, 2nd order, and aggregated dimensions. The 1st order can be understood as the practical realm, it includes all the qualitative knowledge gathered from the sources, which can be informants in an interview, etc. The 2nd order can be understood as the theoretical realm, which is where the researcher or the interpreter does their magic. The idea here is that, the researcher starts from an analysis using informant-centric terms or codes in the 1st order, then they move to using researcher-centric themes in the 2nd order. Then from the 2nd order, the researcher can conceptualize "aggregate dimensions", which are going to be the theoretical baselines to potentially answering the research question (D. A. Gioia et al., 2013). In a nutshell, the researcher moves in a linear inductive interpretative path from 1st order concepts to 2nd order themes to aggregate dimensions. It should be noted that Gioia first intended this method to aggregate knowledge based on analyzing 'informant testaments', e.g., through interviews in a controlled environment in the context of organizational management. In the case of this paper, this is not possible since it is based on reviewing literature, so the resources are not primary but secondary in the form of text from journal articles. I would assume that this should not be a problem, in fact, it could possibly yield new knowledge. The reason behind this is that, while informant-centric 1st order is primary source material, the respondents remain anonymous. In this paper, since it is a text-centric 1st order, and although it is secondary source material, it is possible to openly disclose the authors of the 1st order concepts giving the paper the scholarly rigor it deserves.

Despite critics saying that qualitative research lacks the scientific objectivity similar to that of the traditional scientific method, for which quantitative research excels at, they often neglect the fact that this is the strength of the qualitative method in of itself. The reason behind this is that qualitative research has wider range of interpretation and abduction capabilities, and a larger spectrum of unfolding new knowledge and perspectives. Gioia explained this in a simple way: "Advances in knowledge that are too strongly rooted in what we already know delimit what we can know" (D. A. Gioia et al., 2013). I would personally explain this as if though quantitative research resembles the 'fly mask', also known as the 'blinkers' or 'blinders' that we put over the horse's eyes to delimit his vision range and make them focus on the task at hand. This in no way means that I am negatively criticizing quantitative methods, the latter have been proven to follow the 'safe' and 'measurable' way of doing science and providing objective results. What I am trying to saying is that qualitative research, if done correctly, can open new horizons of research that could have not been achieved otherwise through other methods. The use of qualitative research has been widely praised in works such as Glaser and Strauss (1967) and Strauss and Corbin (1990) (as cited in

Langley and Abdallah, 2011). The latter studies were also pivotal in Gioia's development of his method. Articles which have successfully followed this method include Gioia & Chittipeddi (1991), Corley & Gioia (2004), Gioia et al. (2010) (as cited in Langley and Abdallah, 2011). There are several qualitative methods which different scholars tried to articulate through the past decades, but mainly two have been able to assert their presence, at least in the North American management journals: 'Eisenhardt Method' and 'Gioia Method' (Langley & Abdallah, 2011). The first one is not applicable for my research, but the second one is highly compatible. The Gioia Method captures previous knowledge and models new one through interpretive assumptions. The data it bases its analysis upon has been so far through real-time interviews or observations, but for my case it is going to be applied on literature. It begins with informant first-order and progresses into researcher second-order themes to finally aggregate overarching dimensions which are going to be my answers to the research question. For more insight on the Gioia Method, see (D. Gioia, 2021; D. A. Gioia et al., 2013; Magnani & Gioia, 2023).

2.4 Data Collection

For the data collection, I will be gathering secondary data from published sources. No primary data was collected as I have not conducted any surveys or experiments. I based my research on well-known and mainstream databases, the Scopus and Web of Science databases. The search parameters for both databases will be shown in Table 1. However, in order to achieve the research set shown in Table 1, I undertook several steps to test the waters and see what – at least at that time – I had assumed to be the most efficient way to search for articles. The first search I have done was on JYKDOK, the University of Jyväskylä's online library, on the 25th of January 2024. The search terms were: "cities" and "net-positive" + peer-reviewed + full text + subjects: "sustainability" and "sustainable development" and yielded 133 total results, out of which I detected only 22 that were relevant to my research through reading the titles and abstracts. The same search was done on Scopus, Web of Science, and ProQuest Central. Results ranged from 40 to 55 at best between the 29th of January and the 7th of February 2024. Therefore, I noticed that the pool of results was already super limited. This was the first major limitation to my search for data, as the pool of articles was highly constrained. In order to expand my set of results, I added the search term 'net-zero'. The idea was that 'net-zero' would be on the same level of terminology as 'net-positive', although different in a sense, and then count on the term 'cities' to give us inter-related articles. This assumption was true, although I will later discover through reading the articles that there are other terms such as 'regenerative design' that would be fitting more this terminology of 'net-positive'. This was the first seemingly "crack" in the research design, however, I will later explain how it resulted in the benefit of the overall bigger picture. Albeit I would recommend – for future research – experimenting with the above terms, as well

as others which will be exhibited in the results section, this may yield new pools of results. All of this will be thoroughly explained later in the Future Directions sub-section.

Table 1: Search parameters for the Scopus and Web of Science databases

Scopus	
Search terms	“net positive” OR “net zero” + refine search: “cities” AND ““sustainable development” OR “urban development””
Subject area limited to	Energy, Social Sciences, Business Management & Accounting, Decision Sciences
Document type limited to	Article, Review, Book Chapter
684 total results found as of 09.02.2024	
Web of Science	
Search terms	Similar to Scopus
Subject area limited to	Environmental sciences, green sustainable science technology, construction building technology, environmental engineering, water resources, civil engineering, management, urban studies, regional urban planning, transportation, political science, transportation science technology, sociology, social sciences, interdisciplinary, demography.
Document type limited to	Article, Review, Book Chapter
647 results found as of 21.02.2024	

It is worth mentioning that the search on both databases was not mutually similar. The reason behind this was the use of ‘limiting subject areas’. Putting this limitation was important because the results were giving staggering numbers of 3000+ articles in each database. And due to differences in what constitutes a subject area according to each database, I can only assume that there could be a slight inaccuracy in the pool of results. Table 1 shows the subject areas I limited the search to, in both databases. Most articles selected from Scopus appear on WoS as well, with few that appear in one and not the other. The number of articles that were analyzed were 684 on Scopus and 647 on Web of Science. A total of 131 preliminary articles were selected and archived on Zotero which I used as my annotation tool. My sampling strategy was the typical old-school one: reading titles and abstracts. The preliminary selected articles were screened through reading the titles of the 684 + 647 articles and their abstracts to see which relate to our research topic. When in doubt, I skimmed through the introduction and/or the conclusion. In the second phase of screening, I read the introduction of each of those articles, which allowed me to further narrow down the number of articles to 57 for this literature review. Table 2 exhibits the selection criteria (inclusion + exclusion).

Table 2: Inclusion and exclusion criteria of our articles

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> + Search terms in table 1 + Subject area limits in table 1 + Document type limits in table 1 + Peer-reviewed + Full text + English language only + No limitation on publication dates + Articles that mention net-zero and not net-positive but delve into net-positivity using another term (e.g., regenerative design) 	<ul style="list-style-type: none"> - Anything outside of the search result parameters in the inclusion criteria - Articles deemed purely technical (e.g., comparison between two types of energy sources for a district) - Articles mentioning net-positive or net-zero outside the context of cities

I selected the final pool of results through three steps: a specific search criteria with the search terms mentioned in Table 1, then the reading of titles and abstracts, and finally skimming through the introduction and conclusion. Most of the final articles selected were in both databases, apart from 24 that were in either one of the two. The articles selected that literally mention the word “net-positive” are 26. The rest do not mention net-positive but do mention ‘net-zero’, and they will later give complementary knowledge to sustainability in future cities. About half of the articles treat the matter from a general perspective, a handful of them are literature reviews (a total of 8 articles, plus 5 which were literature reviews mixed with other methods). Others also approach the matter from the term “Regenerative Design”, which we have only discovered after reading the articles. The latter term came to be one of the most mainstream terms related to my research question. Thus, one of the recommendations I will be highlighting in the Discussion & Conclusion section for future research is to conduct a literature review specifically dedicated to this term in its relationship with cities. All results selected were journal articles by chance, not by design. About 30% of articles from the 57 approach the matter from a technical standpoint, one for water management, a minority for transportation, and the majority for energy and the built environment. The rest of the articles, from the 131 that were set apart, either only mention ‘net-positive’ or ‘net-zero’ or both outside of the context of cities and the built environment or are purely just technical, within a narrow field whether in energy or transportation or food security. These articles have been later set apart. It is worth mentioning that the search on both databases is not accurately similar, as the two do not offer the same selection of categories. Using categories is important because it cuts down many articles. Each of the databases has given a staggering result of 3000+ articles, so we limited the search to specific categories that were mentioned in Table 1.

2.5 Classifying Articles

Coding the articles while reading them is important to ease and hasten the process of aggregating the data and interpreting the results. Here, I decided to use an Excel sheet to aggregate data and classify the articles. Articles were numbered from 1 to 57, and for each article there were columns for the following information: type, title, authors, year, journal/source, description, key words, methodology, main findings, relevance to research question, quotes/citations from the article, other notes. I proceeded to full-text reading the articles, but sometimes I would skip some sections I deemed irrelevant to my research question (e.g., technical matters related to energy calculations, engineering design, etc.). It is worth mentioning that in order to speed up the process of aggregating data and classifying it, AI was used to summarize the description of the article, the methodology used, and the main findings. Instead of rewriting or copy-pasting those information into the appropriate columns from Zotero to Excel, I have found that it would halve my effort to ask AI to organize them into columns which I later would copy and paste into Excel. After reading the text, the Abstract, Methods section, and the Results section, they were given to AI and it was asked to summarize the abstract for the description column, summarize the methods for the methodology column, and summarize the results for the main findings column of the Excel file. Every output was verified to achieve accuracy. I have used both OpenAI's ChatGPT and Google's Gemini to draw a comparison and figure out which is program is more accurate. ChatGPT was constantly accurate giving high fidelity results, while Gemini would sometimes try to interpret my commands. I used ChatGPT and asked it to stick to the inputs given word-for-word and not interpret the content. The command prompt was tested several times and improved until I achieved the most accurate output. The command prompt was the following: *< I will give you the abstract, methods, and results of an article. Based on it, I want you to fill in the following data spreadsheet in the form of Excel columns: Description, Methodology, Main findings (including gaps in research). The length should be 3-4 sentences max. Summarize without reformulating or interpreting the data. The abstract: xxx. The methods: xxx. The results: xxx. >*. The quotes/citations column was used to register the sentences or paragraphs which are relevant to my research question and which will help categorize the data in the results. The notes column was used for my own observations and comments, which I deemed would help later in interpreting the results. The Excel sheet came up to be the following size: 404 lines x 14 columns. Reading through this massive Excel sheet would be time consuming and would scatter all the information everywhere. So, in order to facilitate interpretation, I added a new column which is the *Relevance Level*. The relevance levels were also colour coded as shown below (see Table 3).

Table 3: Color-coded relevance levels of our pool of articles

Colour	Relevance to the research question	Description
	Very High	Develops knowledge and concepts that directly help answering the research question
	High	Bolsters knowledge accumulated from the prior level with examples, case studies, other
	Intermediate	Delves into sustainable urbanism without directly addressing the research question

The Table 3 above shows the relevance levels for articles. I conceived this method to help me classify the articles within them, seen the sheer number of scattered ideas and knowledge which was genuinely hard to make sense of. The dark green color is coded for the articles that founded the overall picture of where the inductive interpretation is going, and thus given the 'Very High' level of relevance. Through reading these articles, they have shown to be the most converging towards helping me find the answers I am looking for. Then there is the light green, and it is coded for articles that support the concepts emanating from the prior level through e.g., case studies or practice. These articles were given the 'High' relevance level. And finally for the 'Intermediate' level, these contain all the articles that genuinely helped me paint the bigger picture of where sustainable urbanism is, albeit their content was deemed different from the answers I was looking for. A fourth level with 'Low' relevance level was later removed after the screening process, and it included the articles that were not eligible as per the specific research question. All three levels were important for the overall inductive interpretative exercise on this paper. The full list of articles analysed for the literature review can be found in the Appendix attached below.

2.6 Preliminary Analysis of Included Studies

In the first sub-section, I will be providing a brief overview of the studies included in my review. This will include the diagram of the flow of article selection, the number of studies per year, the authors with the most studies within the selected pool of results, the number of articles per journal, and finally the number of articles with each relevance level. It is also worth noting that all the final selected records happened to be journal articles. You can find the list of all included articles in the Appendix attached at the end of this paper.

First, Figure 1 shows the diagram of the flow of article selection. As explained in the Data & Methods section, the initial search using the terms ‘city’ and ‘net-positive’ only did not fruit any significant results that may allow to genuinely investigate our research question. It could have been possible if all the

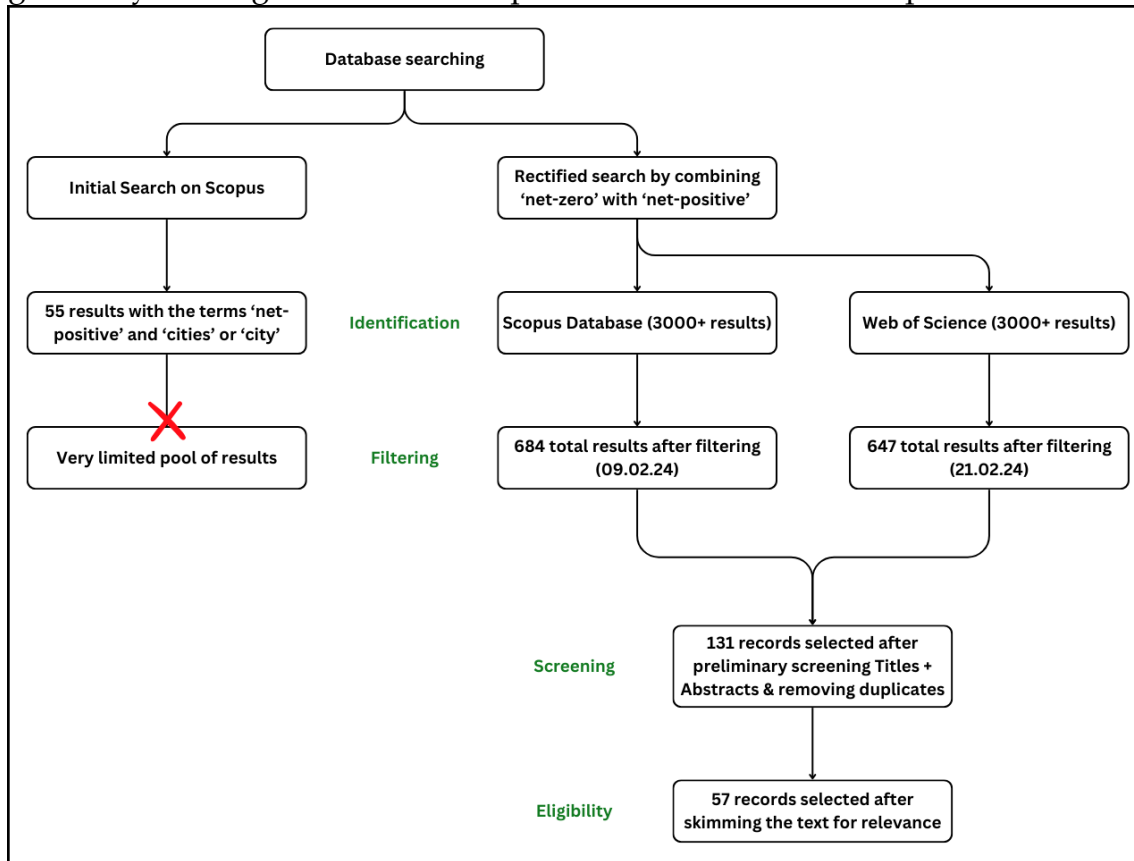


Figure 1: Flow Diagram of the process of article selection

55 results were eligible as per the research question, but roughly a third of them were not. This is why ‘net-zero’ was added to rectify the search and widen our pool of results. It was also useful to add ‘net-zero’ because at that time, I still had no knowledge of whether net-positive cities were discussed in academia so by logic if net-zero cities exist then through an interpretative inductive analysis, I thought it would be possible to extrapolate some reasons that make net-positive cities stand a chance. As expected, the new refined search gave a massive result number, which was filtered and then screened, and then selected the records which proved eligible for my research, which are 57.

Next, for the number of studies per year, Figure 2 shows a spike in studies in recent years. With the exception of 2015 which had 6 studies, and 2024 where only 1 was recorded since the search for these articles took place in February early 2024, the trend shows a significant spike upwards with a whopping 18 articles in 2022 and 15 articles in 2023. Of course, the pool of results which is 57 would not give a very accurate representation of how the terms ‘city’ and ‘net-positive’ have

been trending, especially since adding the term 'net-zero' would influence the results, but overall, there is a clear increase in the number of studies.

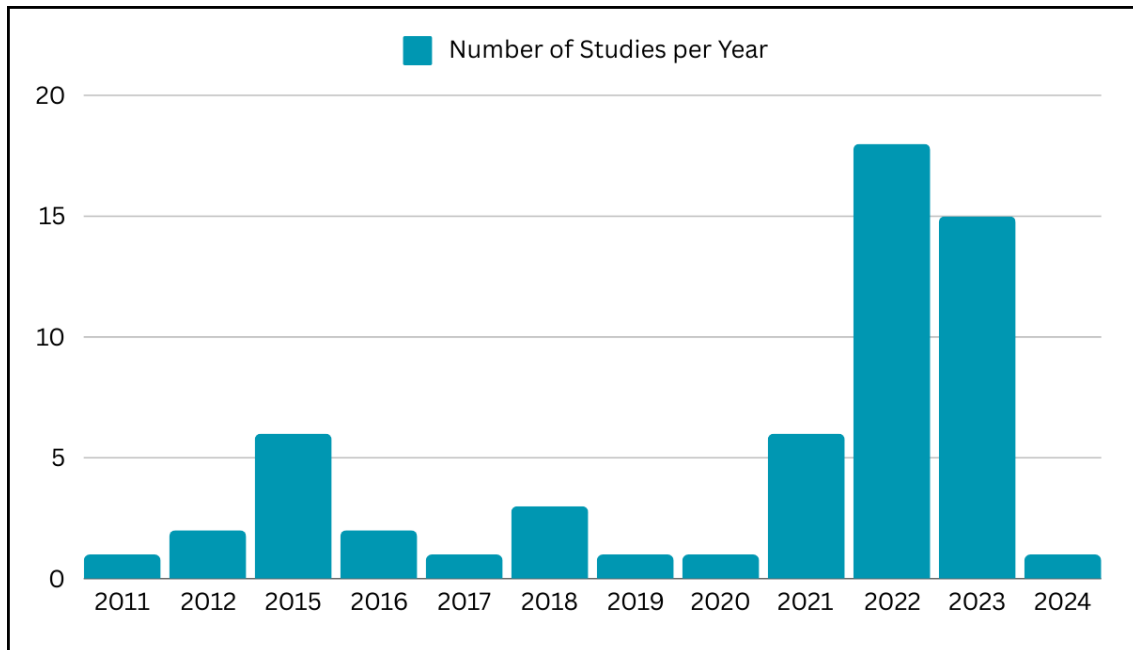


Figure 2: Bar chart of the number of studies per year

As for the first authors with the most studies done, Birkeland dominates by far with 6 articles from the total number of 57. Then comes Camrass, Blanco, Koutra, and Ulpiani with 2 articles each, and the next 43 first authors have 1 article each. This shows the immense diversity in the people behind the works.

The total number of first authors is 48, meaning that roughly 84% of articles were published by different first authors.

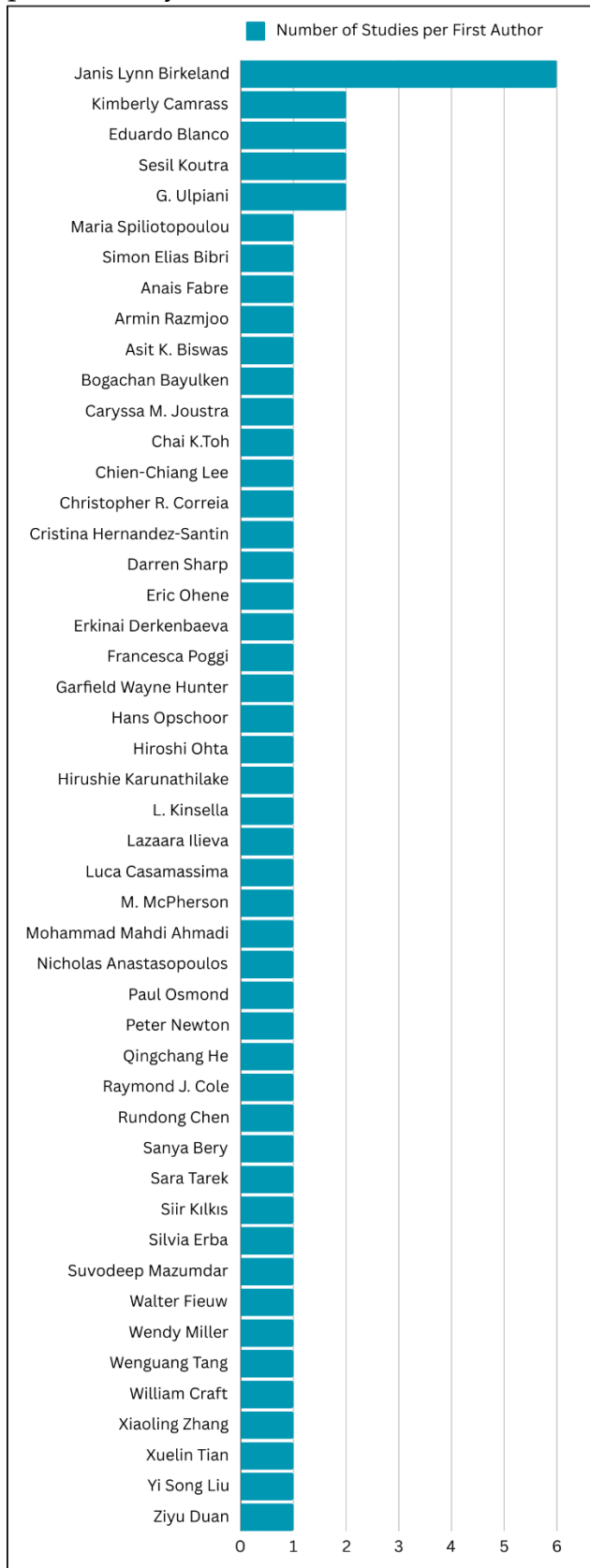


Figure 3: Number of studies per first author

Now for the number of articles per journal, the journal of 'Sustainability' comes on top with a staggering number of 9 articles. The second position goes to the journal of 'Sustainable Cities and Society' with 5 total articles. Third comes 'Renewable and Sustainable Energy Reviews' and 'Urban Science' with 4 articles each. Fourth comes 'Building Research & Information' with 3 articles. The next four journals have 2 articles each while the rest have 1 each. The total number of journals is 34, which shows rather a diversity in the sources of the articles selected.

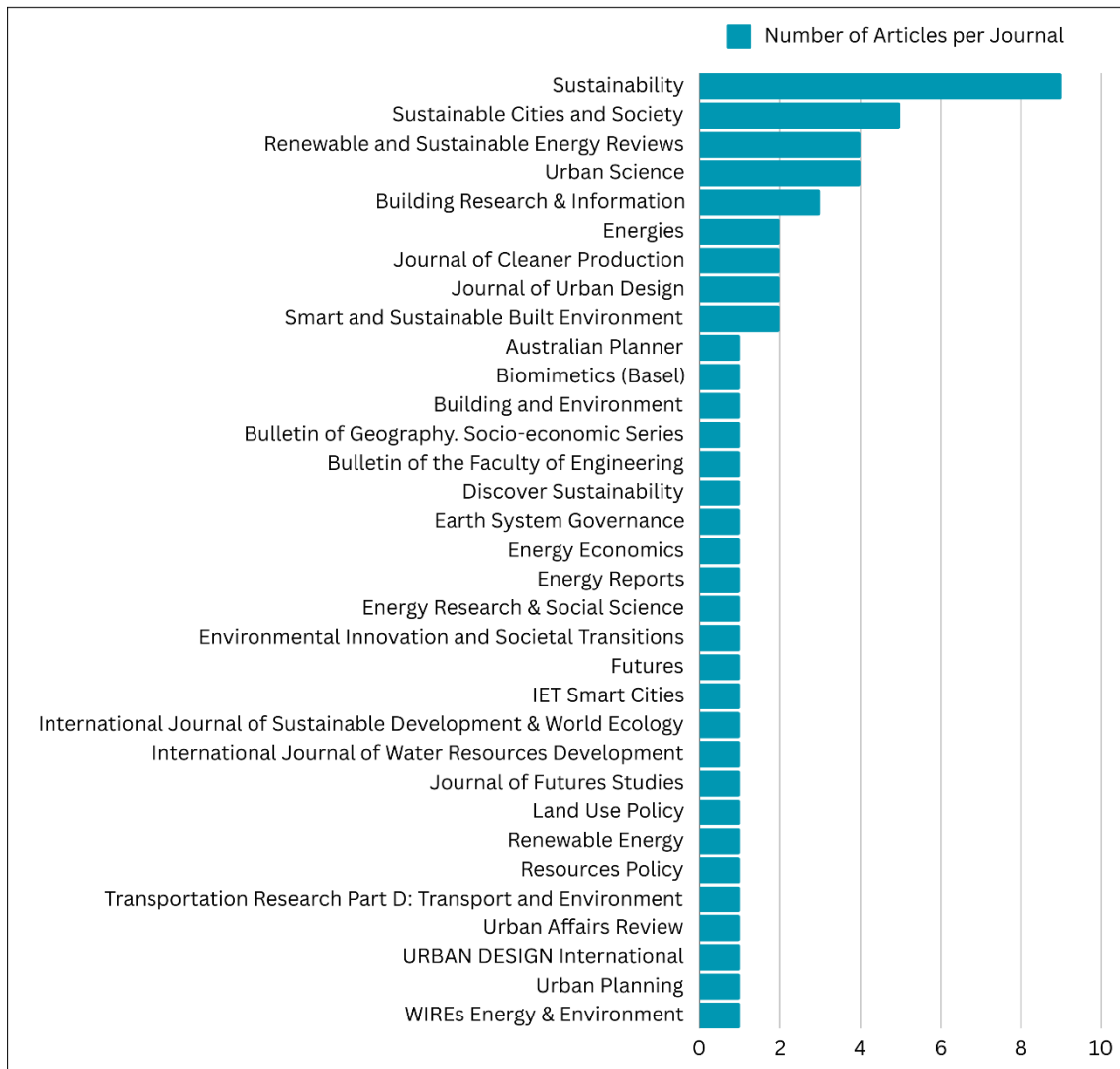


Figure 4: Number of articles per journal

Finally, since I have categorized the articles in what I have called 'relevance level', it is only fair to show the numbers of each category. Relevance levels were explained above in the Data & Methods section. For the 'Very High Relevance' category, there are 20 articles. For the 'High Relevance' category there are 15

articles. And finally for the 'Intermediate Relevance' category, there are 23 articles.

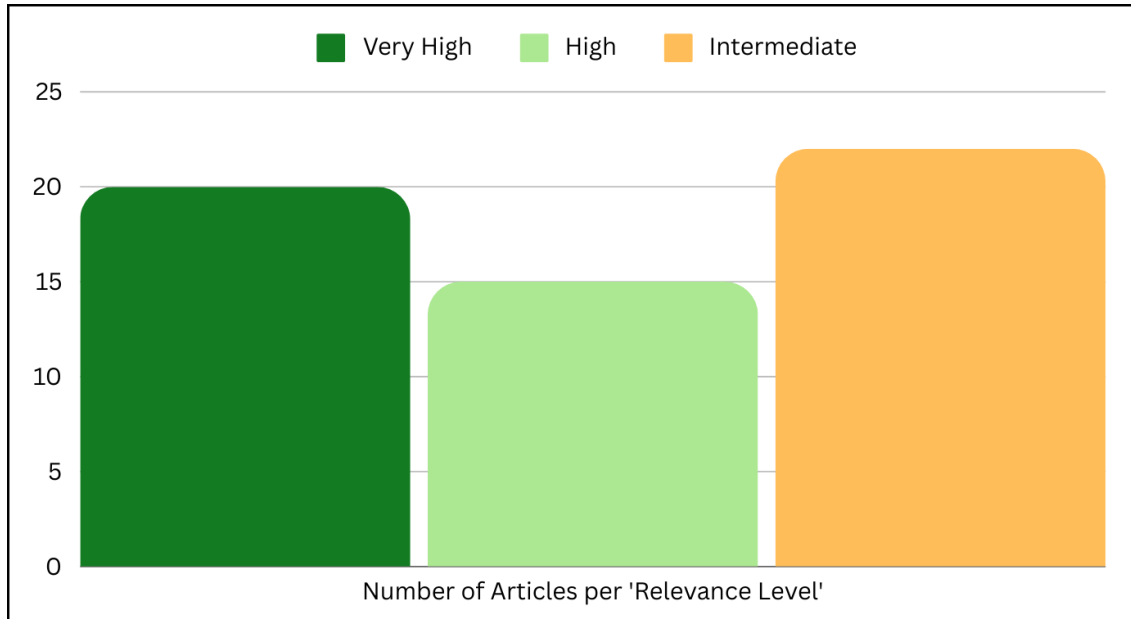


Figure 5: Number of articles per 'relevance level'

In the next subsection, I will explain how I constructed the Gioia data structure and then exhibit it. This data structure will constitute the logical interpretative inductive reasoning behind the answers to the research question, which resulted in three bubbles as aggregated dimensions. The data emanating from this structure will be thoroughly explained in the Results section.

2.7 Constructing the Gioia Data Structure

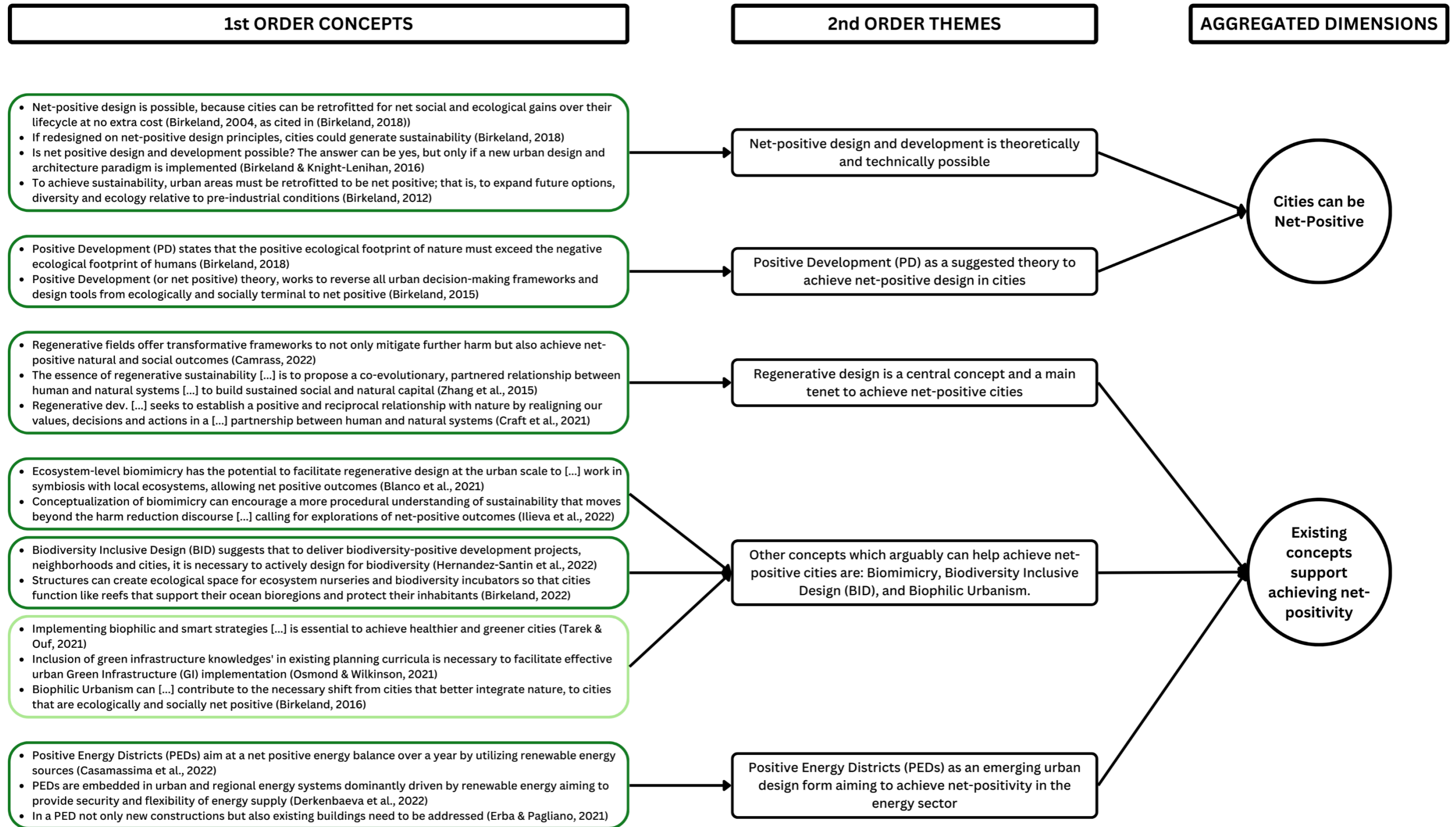
As I have explained in the sub-section 2.3 of the Gioia Method, there are three dimensions or layers of data: 1st order concepts, 2nd order themes, and 3rd order aggregated dimensions. The idea here is that data evolves from 1st order to 3rd order, in an inductive interpretative way, from dozens of general concepts to few bubbles of particular knowledge. The 1st order is purely and unequivocally taken from the 'informants', which in our case is literature, without any interpretation of their concepts or knowledge, i.e. keeping them intact. Then the 2nd order is where the interpretation of the researcher comes in. Here, it was more like a puzzle game where I had to analyse all the knowledge emanating from the 1st order, bring together the several concepts, detect where they overlap and/or support each other, and interpret 2nd order themes that build up towards answering the research question. Finally, 2nd order themes are then compiled and converged towards the 3rd order that is aggregated dimensions. The aggregated dimensions will then represent the result of an interpretative inductive analysis, which

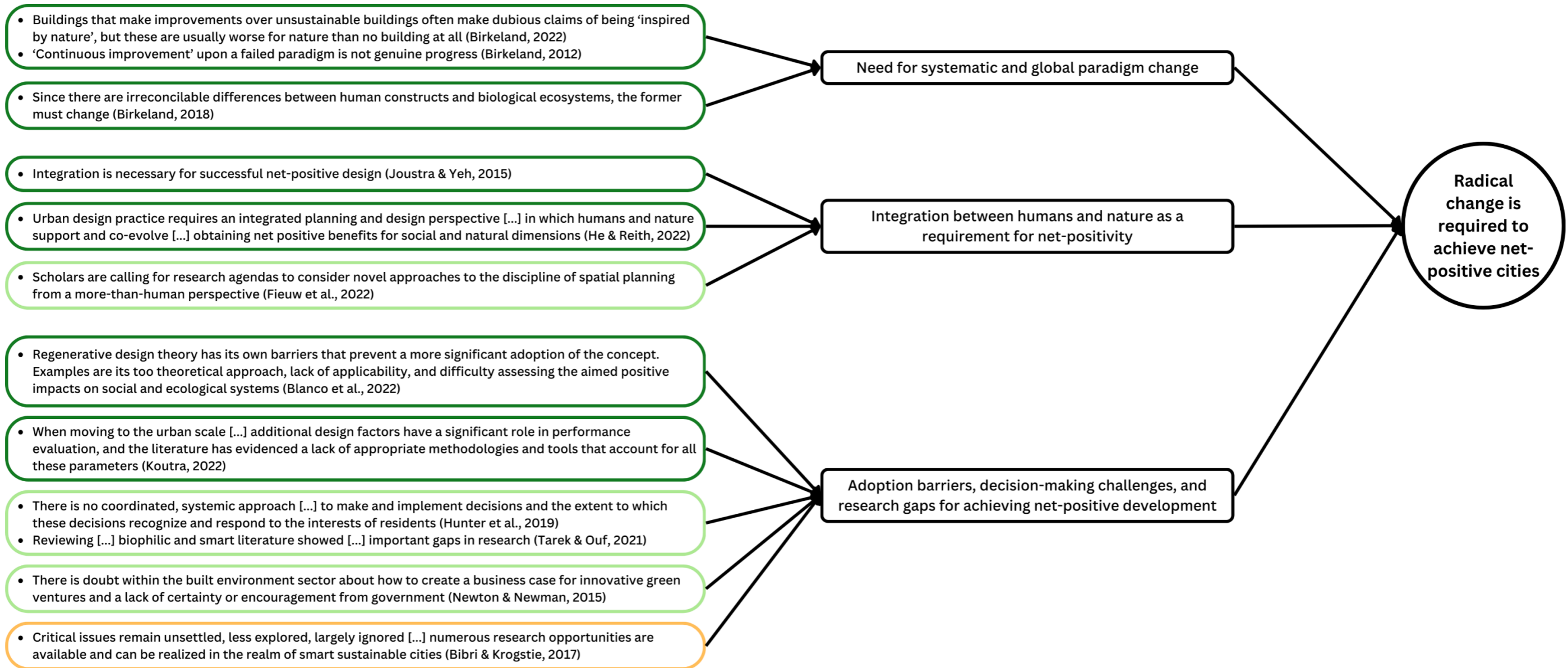
started from literature concepts and ended up with qualitative theoretical assumptions.

To get back to the 'relevance levels', they have proven very useful in the process of constructing the Gioia data structure. To simplify how useful they were in a practical real life scenario, imagine building the ground slab of your house. First, you meticulously layer and connect the steel reinforcements (metal rods), then you pour your concrete mixture, and after it solidifies you can then pave it with your favorite floor tiles. Without the first step, the second nor the third would be possible. And without the second step, the third would not be possible. The slab without steel reinforcements would be crushed, and the hardened concrete without the floor tiles on top would not be comfortable for the everyday life. Now, the 'Very High' RL represents the steel reinforcements in our example, the 'High' RL represents the concrete, and the 'Intermediate' RL represents the floor tiles. In other words, the main frame of knowledge emanated from the first level, and was reinforced by the second and then the third levels. From a personal assessment, this conceived table have been vert useful in the process of construction, and it befitted the Gioia method in a sense that it has given a little more control over what would "assumably" constitute core data in order to narrow it down to the most useful and converge to the aggregated dimensions. It has given me somewhat a control setting almost similar to that of an interview environment, in a sense that you as a reacher can guide, to some degree, the informant and take from them the knowledge that will benefit your research. It is worth mentioning that the color codes of the relevance levels will be shown on the Gioia data structure in the Results section.

The next sub-section below will exhibit the Gioia data structure.

2.8 Gioia Data Structure





3 RESULTS

3.1 Findings

In this sub-section, I will be dissecting the Gioia data structure above. The Data Structure presents the overarching 1st order concepts that resulted from the pool of articles that were analyzed, and specifically limited to the concepts answering the research question of this paper. As explained before, intersecting concepts are joint within the same rectangle, and are supported by other concepts in the rectangles below them. The overlapping concepts guided me (as an interpreter) to construct the 2nd order themes through a hefty reading of the articles at hand. The colors in the first order concepts indicate the level of relevance (see table 3) which is an idea I came up with to enhance the classification of the concepts and group the ideas that intertwine and support answering the research question: Can Cities be Net-Positive? The following sub-subsections will expose the overarching aggregate dimensions based off of 2nd order themes within the nested sub-subsections, which are in turn based off of analyzing and interpreting the 1st order concepts the interpretative inductive analysis allowed me to uncover. The exhibition of the findings will closely follow how the Gioia Data Structure is presented above. The sub-subsections 3.1.1, 3.1.2, and 3.1.3 are key aggregate dimensions that emerged from my review, and each of them serve as a focal point for discussing the relevant findings. The sub-section 3.1.4 on the other hand explores other niche themes that did not figure on the data structure.

3.1.1 Net-Positive Design and Development

3.1.1.1 Achieving Net-Positive: Is it Possible?

Well apparently, net-positive design and development is theoretically and technically possible. Big words? Yes, and no. In my exploration of what academia has achieved so far, I found myself immersed in the many works of Birkeland, who appears to me to have gone above and beyond the known boundaries of what can be sustainable and what can't be, at least within the area of sustainable

cities and to the extent of the limited knowledge I gathered throughout my research. As I immersed myself in her vision, I often found that she proves net-positive design is possible, 'BUT' certain change is required. Now, there are many reasons she exhibits why it is possible, and what needs to be changed to achieve that. The main argument is that cities can be retrofitted for absolute socio-ecological gains over the span of their lifecycle, for no added costs as it has been proven that eco-retrofitting has paid for the construction work in energy 'savings' alone (Bell et al., 2008; as cited in J. Birkeland, 2012). You see, retrofitting here does not entail what most will think it does, e.g. enhance the power grid, retrofit the façade of the buildings, implement smart technologies, etc. Rather, what she means by retrofitting is making use of space and architectural elements for both an 'ecological base' and a 'public estate base' (J. Birkeland, 2018).

This goes beyond just integrating nature into our concrete jungles, to actually creating new socio-ecological landscapes. Let us say that for a city that is decently integrating nature in a Nordic country, the likes of Espoo or Lahti or Jyväskylä, it would most likely be that the horizontal spaces are already at full capacity (parks, forests, etc.). What Birkeland is pointing at is the ability to use vertical structures, such as buildings! These can increase the capacity for the natural and social vectors to go beyond compensating for negative impacts (which we have yet to fully achieve) to actually *over*-compensating for them (which is the prime premise of 'net-positive' development). This is not rocket science, it is fairly simple, doable, and most importantly comes at no extra cost. The two vectors are intertwined. The ecological or natural one, represents according to Birkeland "the means of survival", and these include e.g., the ecological carrying capacity, biodiversity, ecosystem services, etc. (J. Birkeland, 2018). The social one represents the "access to the means of survival", and these include e.g., social support systems, essential services, environmental justice, etc. (J. Birkeland, 2018). So yes, cities can be net-positive but only if the integral processes of design, development, implementation, and assessment, are redesigned to fit net-positive standards and benchmarks supporting the two vectors explained above (J. Birkeland & Knight-Lenihan, 2016). All this amalgamation of Birkeland's knowledge buildup on how cities can be net-positive would result in the formation of the Positive Development (PD) Theory.

3.1.1.2 Positive Development (PD): Towards Net-Positivity

As I immersed myself in Birkeland's vision, I understood that our concepts of sustainable development in cities should be completely uprooted and switched into vital concepts that live up to the real doctrine of sustainability. It is better to start over on proper foundation rather than try to "fix" the issues as they rise. Birkeland suggests Positive Development (PD) as a process to achieve net-positive design in cities. "Positive Development states that the positive ecological footprint of nature must exceed the negative ecological footprint of humans." (J. Birkeland, 2018). The problem with most urban forms which we have had or anticipated, is the intrinsic system boundaries they come with, either intentionally (by design) or by inherent traditional thinking (J. Birkeland, 2012).

Birkeland argues that these “sustainable” urban forms only amount to ‘best practices’ after all, which is far from enough. This very short-sighted closed thinking makes it impossible to achieve true sustainability. Thus, an open-systems thinking is the solution. This open-systems thinking is the Positive Development (J. Birkeland, 2012).

PD spans the entirety of stakeholder sectors (decision-making, design, etc.) and works to reverse the processes from socio-ecologically ‘terminal’ to ‘net-positive’ (J. L. Birkeland, 2015). One of the major things PD proposes is the “design for eco-services”, which promises social benefits emitting from nature and in turn benefiting nature in of itself (J. Birkeland, 2018). But what is the meaning of ‘design’ here, and what are ‘eco-services’? Design according to Birkeland (2012) is “creating synergies, syntheses, and symbiosis across different dimensions: the cultural, social, psychological, economic, biophysical, climatic, and so on”. So ‘design’ here means an open-systems thinking whereby we create new connections and new values instead of setting up predefined parameters and limiting our scope of sustainable urbanism. As for ‘eco-services’, Daily and Ellison (2002) explain them as “the natural systems, elements and forces that constitute the life support system and its myriad environmental benefits” (e.g., clean air, energy, water, soil, and pollination) (Daily & Ellison, 2002; as cited in Birkeland, 2012). There is a whole spectrum of eco-services out there, ‘green scaffolding’ for example, which adds an extra thermal skin to buildings, support fuel production through algae, enhance carbon sequestration, etc. This method for example comes at no cost, and can be easily integrated into building structures and above roadways, with little to no added materials or energy (J. Birkeland, 2018). With every theory or process, there are elements that hinder its adoption or application. Some of the handicaps Birkeland presented were: Design-blindness in mainstream ethics, ecology, and design; Inadequacy of eco-efficiency tools in ecological design; Legacy of reductionist science in urban ecology, etc. (J. Birkeland, 2012).

3.1.2 Emerging Concepts and Approaches

Although the term ‘net-positive city’ is virtually almost absent from academia with the exception of few scholars like Birkeland – at least from a literal sense –, I would argue that it could be interpreted as an umbrella term for all the theories, approaches, and terms, which the science of sustainable cities have thus achieved so far. I would reinforce my argument by using Birkeland’s hefty research on the subject of sustainable cities, which is her recently proposed paradigm of Positive Development which this paper has explained in the previous nested sub-subsection. PD overall inbulks terms such as nature-positive, regenerative design, eco-positive development, etc. If you take a closer look at Birkeland’s works, you will see many approaches and terms she had discussed over the years, all tied up to what has eventually resulted in Positive Development. As for other works, several terms and approaches have been explored throughout the years, from different perspectives and schools of thought, but they all eventually intersect with what this paper claims as net-positive development.

There are other concepts that intertwine with ‘net-positive development’ which I have discovered with my literature review. One of these terms, and the most used, was ‘regenerative design’. There have been multiple studies that explored this concept such as: the need to rethink and redesign the human-nature relationships through regenerative sustainability (Zhang et al., 2015), how regenerative design integrates principles of ecosystem-level biomimicry and theories of ecosystem services (Blanco et al., 2021), how regenerative approaches in the built environment provide transformative potential for cities (Camrass, 2022), among others. In this sub-subsection, I will be explaining what these concepts are, at least the major ones I was able to uncover. There are many, for example, some approaches to urban sustainability came from the notion of biomimicry and its various interpretations vis-à-vis achieving sustainability (Ilieva et al., 2022). Or the emergence of the biodiversity issue where a design approach called Biodiversity Inclusive Design (BID) was argued for to be formalized (Hernandez-Santin et al., 2022). Or the concept of biodiversity offsetting and its application in urban management (J. Birkeland & Knight-Lenihan, 2016). Or the several studies that delve into the Positive-Energy Districts (PEDs) as a valid urban form to achieve net-positive energy in urban areas (Casamassima et al., 2022; Derkenbaeva et al., 2022; Erba & Pagliano, 2021). In the following nested sub-subsections, I will exhibit regenerative design as a central concept, followed by other intertwined concepts which are biomimicry, biodiversity, biophilic urbanism, and how these concepts can support cities in achieving net-positivity.

3.1.2.1 Central Concept: Regenerative Design

Regenerative design is a central concept and a main tenet to achieve net-positive cities. I only came to know about this concept during my work on this thesis paper. To be frank, the last time I heard about ‘regenerative’ -*something*- was during my previous studies in Civil Engineering, and I recall writing a small paper about ‘regenerative concrete’, also known as ‘self-healing concrete’. As the name suggests, this concrete can effectively heal its own cracks in a simple way through incorporating microbiological elements to concrete. Now I came to realize that regenerative design has far more applications than I knew. This is not science-fiction, it’s simple engineering where humans incorporate technology with living nature, in a sort of symbiosis merger. To understand what the term ‘regenerative’ entails, take it as a simple process of recreating or revitalizing any type of energy or matter in a natural way (He & Reith, 2022). It can also refer to the process of shifting urban development from its current linear systems to a new cyclical unbound system (He & Reith, 2022) where humans and nature go into perpetual symbiosis and co-evolve (Camrass, 2022; Zhang et al., 2015) into an eco-system of absolute net-positive gains both for society and the environment (Camrass, 2022). He & Reith (2022) call achieving this eco-system the “rebirth of life itself”, and Zhang et al. (2015) call it “building a sustained social and natural capital in ultimate co-benefit”.

You may have already noticed that regenerative design is very reminiscent of the Positive Development process, that is because regenerative design

supports PD. This concept as well as the framework of PD also share similarities with many other theories and processes which we will see (some of them, the major ones) below, and their premise revolves around an “eco-centric worldview and an awareness of the acceleration of anthropogenic pressures on the Earth” (Camrass, 2022). The second most important thing you as a reader may have also noticed, is a recurring major theme, which is the *human-nature* relationship. Positive Development theory, the concept of regenerative design, as well the other concepts I will be exposing below, all share the same bottom-line; an approach where humanity and nature co-integrate and co-evolve together. Craft et al. (2021) has explained this as the human establishment of a relationship with nature through reshaping our values and decisions and actions to achieve harmony together (Craft et al., 2021). This will later become more evident as I will explain why this human-nature relationship matters and why it is at the core of our ambition to achieve net-positive cities. The problem is, so far, most of us do not contemplate what net-positive cities could entail, all due to the short-sighted vision of “immediate results” (Camrass, 2022) and this issue will be discussed in the sub-subsection of barriers and challenges.

3.1.2.2 Other Interlinked Concepts: Biomimicry, Biodiversity-Inclusive Design, Biophilic Urbanism

Biomimicry is a well-known concept that can help achieve regenerative design within the urban environment, and can play a massive role especially in the design phase (Blanco et al., 2021). This concept arguably excels at the symbiosis of nature and human processes, and when applied to the urban scale, it can easily allow for integrating urban structure with the local natural ecosystem (Blanco et al., 2021). This in fact leads to similar results of that of regenerative design: net-positive gains of both the social vector and the natural vector. Blanco et al. (2021) have extensively explained what ecosystem-level biomimicry is, and how it is used to understand patterns and functions of the local ecosystem to apply its metrics to urban space at the design phase. The same argument of co-evolution and integration between nature and humans are present in this concept, like the previous one and the ones coming next, and it is also compatible with PD’s ‘beyond harm reduction’ rule. Though biomimicry presents itself as a solid concept supporting the achievement of net-positive design and development, there are still many issues and limitations that overshadow it. For instance, Ilieva et al. (2022) have questioned the claim that biomimicry always leads to sustainable results. Some of the gaps needed to be filled within research when it comes to biomimetics is the need for more practical experiments as well as deeper theorization on their applicability to the urban sustainable development and how far can it enhance human-nature relations, including more research on how to give agency to nature (Ilieva et al., 2022).

Biodiversity is the next element of matter in line. Birkeland & Knight-Lenihan (2016) argue what they called “net biodiversity gains” to be possible in case frameworks on how to assess that are based on net-positive planning and design. The reason behind their paper was to study biodiversity offset schemes

and analyse their limitations and opportunities, and they found out that they do not fully compensate yet for the entirety of the impacts caused by urban development. Here, Hernandez-Santin et al. (2022) formalised the Biodiversity Inclusive Design (BID) concept which aims to, as the title suggests, incorporate biodiversity in the equation of urban design in order to achieve “biodiversity-positive” development. Not only did they intensively map out the entire BID process and the variety of applicable methods for the practice, they also identified nine design principles, twenty-eight factors of ‘best-practice’, and most importantly three core dimensions of BID. To my surprise, these three dimensions actually answer for some of the main tenets of net-positive design that have come before (Hernandez-Santin et al., 2022). The first dimension is to “design for functional ecology”, which supports the idea of symbiosis between human technology and nature (e.g., the example I have given of regenerative concrete, and Birkeland’s example of green scaffolding). The second dimension is the “non-human users of place as clients”, which supports the Ilieva et al. (2022)’s call for more research on giving agency to nature. And finally, the third dimension “nurturing people-nature relationships”, which if you recall, I have pointed out that this is the main recurring theme among all the body of knowledge I was able to analyse for this paper. This is a very advanced paper, Hernandez-Santin et al. (2022) have analysed fifteen different framework designs related to biodiversity, and I would recommend you checking those frameworks in page 9 if you are interested in how BID compares to those frameworks. The human-nature relationship also appears to apply here, as Birkeland (2022) argued that buildings and different structures can act as ‘reefs’ through creating “ecological spaces” and “ecosystem nurseries” (J. Birkeland, 2022).

Biophilic Urbanism is the fourth in line and it refers to an urban planning and design approach that integrates nature into cities in a way that fosters ecological and social benefits (J. L. Birkeland, 2016). The main purpose of it according to Birkeland (2016) is to shift cities from merely integrating nature to cities that are both socially and ecologically net-positive, which is the duality we are looking for to achieve a net-positive city. Several authors have already studied the possible integration of biophilic approaches to the urban design process (Camrass, 2022). Biophilia can also be applied together with smart strategies (e.g., AI, IoT, etc.) to achieve “urban resilience and healthier and greener cities” (Tarek & Ouf, 2021). Biophilic Urbanism is very tied to the concept of Green Infrastructure (GI), which relies on integrating green space into densifying cities (Osmond & Wilkinson, 2021). However, there are still many limitations to achieve biophilic urbanism and green infrastructure, such as integrating biophilic indicators with smart city indicators (Tarek & Ouf, 2021), securing financial resources and addressing political complexities inherent with the needed change (Osmond & Wilkinson, 2021), and the need for interdisciplinary collaboration and stakeholder engagement etc. (Osmond & Wilkinson, 2021).

3.1.2.3 Example of Emerging Urban Design Forms: PEDs

Throughout the literature I have read, there have been a dozen urban forms which I have come across. Just when you think you have read it all, a new urban form sprawls in between the lines and they all have different names, sometimes odd and weird names. Since the pool of articles this paper have gone through is minimal and compact due to the term limitations, I would not be surprised to learn that there are at least forty of fifty different urban forms out there being discussed in Academia. Maybe one of the reasons for this would be the inherent need for researchers to name things from their perspective since many urban forms are similar of the day. I find myself guilty of this too for the term 'net-positive cities', albeit thankfully there is a hefty amount of evidence this could be taken as an umbrella term for many other types of cities, or so I claim. But within the literature I was able to read, Positive Energy Districts came out as the main emerging sustainable urban form that claims to achieve net-positivity at least in the energy sector.

PEDs are a novel concept, and their premise is to achieve net-positive energy balances per year through the use of renewables as an energy source (Casamassima et al., 2022). Although they clearly focus on the energy sector, they claim to distinguish themselves from other urban forms through their holistic approach in which they integrate social and inclusivity concerns (Casamassima et al., 2022). And that is crucial for what I consider a net-positive city albeit they do not claim to be net-positive on the social vector as far as my limited knowledge goes. It is worth mentioning that PEDs do not yet have a unified definition (Koutra, 2022).

PEDs were classified as Very High on the relevance scale which I have shown in table 3, which is why they made it to Gioia data structure. Otherwise, there are other urban forms that were either Intermediate or Low relevance, mainly the Net-Zero Energy Buildings or Communities or Networks (NZEBS, NZECs, NZENs). These urban forms have similar aims as the PEDs, they only differ in such a way that their bottom line is to achieve net-zero energy balance (Casamassima et al., 2022), which is not enough for a net-positive city. What makes PEDs also relevant is the fact that they are already here and under development. The EU through its Strategic Energy Technology Plan has put the target to erect one hundred PEDs by the year 2025, as part of the union's path towards climate neutrality (Derkenbaeva et al., 2022). PEDs can be easily integrated as they do not require much embedding into the urban systems, especially if the city has already established the necessary infrastructure for renewable energy (Derkenbaeva et al., 2022). Renovations are still necessary for both new and existing buildings though. Albeit, the main issue I have with PEDs, and by extension the other urban forms that are inferior in their goal-orientation, is the idea that their premise is to create urban platforms that do 'less bad' or at most 'more good'. That is the problem Birkeland has with the way sustainable urban development has been growing, and she has been warning about the idea of merely evolving from 'doing less bad' to 'doing more good', proving that it

can only go so far without fixing inherent issues of our cities, if not making things worse on the long run. This is why radical change is needed!

3.1.3 Radical Paradigm Change is Required to Achieve Net-Positive Cities

“Continuous improvement upon a failed paradigm is not genuine progress”, wrote Birkeland (2012). This is what I have just pointed to in the previous paragraph, fixing issues as they come when the foundation is shallow, will lead to catastrophic failure. This is applicable in real life across all sectors and industries. Let us take the building industry for example, coming from myself as a Civil Engineering graduate. Before a building is erected, so much goes into studying the soil and designing the right foundations for the structure, sometimes the entire soil is extracted and replaced with a better quality one. Otherwise, there is no escape from completely demolishing the building and starting over. The same thing goes to laying down roads, as several layers are carpeted underneath before laying down bitumen (also known as asphalt), sometimes as many as six or seven different layers. Bridges are obviously the same thing, towers, dams, you name it. This very peculiar care is forced upon the building sector and related industries because failure could either cost them a juggernaut mountain of finances that could amount to hundreds of millions of euros which could lead to bankruptcy, or even worse, it could cost hundreds of human lives. Now, one could argue that this should also be applicable for the environment. That is only fair, since we are now discussing nature and other species as clients and stakeholders – why not even shareholders if we achieve a high integration of nature into our lives – so making them part of the safety and integrity due diligence when erecting and expanding our cities is a necessity and a bare minimum. However and to this day, reducing negative externalities is still often seen as a positive gain and a win (J. Birkeland, 2012). If we continue down this path, we are bound to fail.

So far, human constructs and natural ecosystems are irreconcilable, and since we cannot change nature, we as humans must adapt and change for it (J. Birkeland, 2018). But how can we change? Through a systematic, disruptive, and radical change in worldviews and actions (J. Birkeland, 2018). The way we plan, design, develop, and make decisions, needs to be based on ethics and aligned with eco-positive principles (J. Birkeland, 2018). This is why Birkeland (2012) sees the current age of “green development” as a fake development, and that we are far better off without these green buildings than with them since they collectively aim to “do less harm” than “do more net-positive good”. I would personally align this with where the current philanthropic era of sustainability is at the moment, as many industries think they are doing good by being slightly better than what the codes and regulations permit. This may be subjectively good compared to the overall action of their competitors or their sector in general, but it is still objectively bad or at best not enough for the planet. Birkeland (2012) also brings up the new schools of thought regarding sustainable urbanism, as she sees that their premise of shifting from 'doing less bad' to 'doing more good' would still be not enough. Twelve years later, we see that she was right, most SDG indicators

are far from achievable for the 2030 agenda, and we may not achieve them by then, this is why for example, the Secretary General of the UN launched the Forward Faster last year to accelerate the actions of the private sector in a bid to achieve the bare minimum of 2030's agenda.

“Buildings that make improvements over unsustainable buildings often make dubious claims of being ‘inspired by nature’, but these are usually worse for nature than no building at all” (J. Birkeland, 2022). The contemporary sustainable buildings often fall short of achieving net-positive outcomes, merely offsetting the damage they cause without truly benefiting nature (J. Birkeland, 2022). The entire doctrine of urban sustainable development must change, and instead of ‘doing less bad and more good’ or offsetting damage, we need to start building nature and social-life support systems in a way that co-benefits humans and nature alike (J. Birkeland, 2012, 2022). If we are going to live together and share one planet and one destiny together, then us humans and nature should integrate and co-evolve. And that is the paradigm we are so much in need of!

3.1.3.1 New Paradigm: Human-Nature Integration

Humans have always sought after control. Our inherent greed of power and control has been largely celebrated for a very long time as we seize control over nature and over ourselves. "One of the central narratives of the modern world is to control nature and our external surroundings for the benefit of humankind." (Zhang et al., 2015). This so-called “indomitable human spirit” has made us achieve in two centuries what our ancestors did not for several millennia. The capitalist will see this as an absolute win, but they forget that our desires are quite literally blackholes and we can never fill our hedonistic nature with more technological progress. This is not a good thing. Why? Because we are actively wreaking havoc on the eco-systems around us. Instead of integrating with nature and co-evolving together, we seize more and more control over it. And with every action there are chains of reaction, and climate change is just one of them. And if there is anything major that all the journal articles have agreed on, and me and you were able to detect, it is the need for systematic human-nature integration!

Human-nature relationships have been emphasized across almost the studies we have run through together. These relationships are cornerstones in regenerative design, biomimetics, biodiversity, and biophilia. It now undoubtedly true that urban practice, whether in its planning phase, design phase, development phases or decision-making phase, should have a perspective in which it integrates human and natural systems to co-evolve with each other and achieve net-positive gains on the both the social and natural levels (He & Reith, 2022). The authors also add that, since regenerative design is interdisciplinary in nature, it is only fair that research should be integrative also. Although it was only applicable in the area of water cycle management, Joustra & Yeh (2015) have made a good point about the concept of integration. Integration is necessary for successful net-positive design (Joustra & Yeh, 2015). This paradigm of *human-nature integration* which I argue should be the basis for

all research of net-positive cities, has also been called 'more-than-human approach'. Fieuw et al. (2022) pointed out that scholars are actively calling for novel perspectives on why and how it is important for planners and designers to view cities as more-than-human. They have recognized the urgency of "transformative reform" and that the 'business-as-usual' of cities is not the right path, they also called for identifying gaps in planning practices regarding the rights of other species in the local eco-system of cities (similar to the calls for agency to nature) (Fieuw et al., 2022). Not only that, but Fieuw et al. (2022) have also endorsed what I claimed to be the most correct and advanced vision for cities yet, which is Birkeland's call for a radical net-positive design and development approach, supported by her vision of Positive Development.

3.1.3.2 Barriers and Challenges

By now it must be evident that the paradigm of human-nature integration is a primary basis to achieve net-positive cities. It is the basis of regenerative design, biomimetic-inspired design, biodiversity-protective design, and biophilic urbanism. These were the main frameworks or concepts evident to support our goal of a net-positive city as per the study in this paper. So, is this paradigm of human-nature integration already well rooted in academia? Is it well explored and understood? Let alone expanded upon its applications to design and development? Frankly, I do not have the answer as the literature analysed in this qualitative review does not cover the intricacies of human-nature integration in of itself, but it stresses upon its crucial importance. This should be an area of future research, and I would argue, the most important area as per the results I was able to obtain for my study.

However, within regenerative design and other concepts, many relevant barriers and challenges that overshadow net-positing design and by extension the human-nature integration were raised by almost all journal articles. Positive Development, which I would argue is the most advanced framework so far for achieving net-positive cities, Birkeland (2012) has stressed on the need to overcome design-blindness in ecology and environmental ethics. And when it comes to urban eco-positive retrofitting which is the path towards net-positive design according to Birkeland, she (Birkeland (2015)) pointed out that there is more need for empirical studies that prove its effectiveness and outline its feasibility. And for regenerative design, the latter lacks the mechanisms which building occupants can use to achieve the co-evolution between them and their local eco-system, since they are a primary stakeholder in this relationship (Camrass, 2022). Regenerative design is also still deemed very vague and theoretical which diminishes its adoption, making it difficult to apply in real world scenarios (Blanco et al., 2021). There is also need for more pathways and tools to assess regenerative design's effectiveness and performance on both social and natural vectors (Zhang et al., 2015). Tarek & Ouf (2021) have pointed out the need for more research on biophilic urbanism. Still within green infrastructure, creating a business case for green ventures and the continuous lack of governmental support still overshadows the advancement of greener cities

(Newton & Newman, 2015). Biomimicry is also in its early stages, as Ilieva et al. (2022) call for more experimentation and practice on biomimetics. Apart from theoretical or technical barriers, some of the other issues are decision-making and collaboration. For example, there should be more of what is called city-city network, where cities collaborate and learn from each other, sharing is caring after all (Hunter et al., 2019). Top-down decision-making is another issue, change will never come to fruit if those in power do not act according to the interests of the people (Hunter et al., 2019). Talking about the people, I would personally also argue that there should be more bottom-up pressure from residents in order to drive change. Awareness and commitment from the top as well as the bottom should be on the rise, and both private and public sectors (Newton & Newman, 2015). In their interdisciplinary literature review on smart sustainable cities of the future, Bibri & Krogstie (2017) highlighted that many elements remain unsettled and less explored if not theoretically underdeveloped, although within the framework of “smart sustainable cities”, I would argue many of those issues are applicable to other perspectives as well. They also highlighted the sheer number of research opportunities available to explore in connection to smart sustainable cities and I would argue this also applies to biomimetics and biophilic urbanism since some of their application require smart strategies (Bibri & Krogstie, 2017).

With all these concepts, frameworks, and theories, it gets easy to get lost in the jungle of sustainable urbanism, and I, myself have felt this writing this paper. There is a need to unify the concepts and filter what is needed to achieve our goal of net-positive cities. I would argue that the concept of *Net-Positive Cities* supported by the lifelong works of Birkeland and her recent theory of *Positive Development* can be the umbrella of all the scattered concepts and themes. “An enhancement of the studies to unify the concepts and assess the feasibility of their implementation is a primary concern”, wrote Koutra (2022), although in a different context but the idea remains the same. Zhang et al. (2015) also emphasize the need to reconstruct our understanding of the notion of human-nature relationships and champion regenerative design and development. He & Reith (2022) also stressed the need to integrate our practices with nature in order to co-evolve with each other and thus net-positively capitalize on social and natural benefits. Finally, Birkeland and across many of her works, she emphasized that the current “sustainable design” practices in the urban sector are not really that sustainable – if not worse overall – and more should be done. Birkeland (2022) proposed a ‘paradigm shift’ towards “nature-positive” development, and I claim based on the qualitative study and the exhibition of all the findings, that the main paradigm to achieve the Positive Development which is the way towards net-positive cities, it would be to radically shift our focus to human-nature integration.

3.1.4 Other Literature Themes

In this sub-subsection, I will delve into some of the knowledge that did not directly make it to the construction of the Gioia data structure and thus was not present in the sub-sections above. Most of the themes and aspects discussed here

will be from the 'Intermediate' relevance level. These articles were crucial in the sense that they filled up the gaps of knowledge I had while interacting with the data, and formed a base of knowledge which I did not have before especially in relation to where net-zero has achieved so far. It is also important to note that, from my personal fallible judgment, most of the studies may be regarded as 'best practice', and according to Birkeland as mentioned before, best practice does not make it past radical change and remains within the incremental 'doing less bad and more good' philosophy of things.

Beginning with the 'smart sustainable cities', which was the most brought up type of cities in this layer of articles. Smart sustainable cities, just like most other types of cities or urban forms, are still underdeveloped. Bibri & Krogstie (2017) highlighted that there so many issues remain "unsettled and less explored" if not largely ignored, and that there are many research opportunities available for the sustainable urban forms. They also add that research in this field is in its early stages, which may explain the lack I found in literature (Bibri & Krogstie, 2017). But what is a 'smart sustainable city'? Bibri & Krogstie (2017) point that the term is not heavily discussed in of itself, but they defined it as a "city that is supported by a pervasive presence and massive use of advanced ICT". Bibri & Krogstie (2017) have also defined a sustainable city, in the context of their particular paper, as "an urban environment designed with the primary aim of contributing to improved environmental quality and protection and social equity and well-being over the long run". If I were to give me own opinion on this, I would say that this definition may not reconcile with the radical need that Birkeland claims to be necessary, and that it may not be radical enough in a sense that "contributing to improved" is not equal to "absolute net-positive gains". Bibri & Krogstie (2017) have done a significant effort in reviewing different types of smarter cities such as ubiquitous cities e.g. (Batty et al., 2012; Lee et al., 2008; Shin, 2009), ambient cities e.g. (Böhlen & Frei, 2009; Crang & Graham, 2007), sentient cities e.g. (Shepard, 2011; Thrift, 2014); and cities as an Internet of everything e.g. (Kyriazis et al., 2014). It should be highlighted that smart does not mean sustainable, there are smart cities that are not sustainable. However, smart can always be integrated with different city models, such as the biophilic smart city where Tarek & Ouf (2021) discussed the role of nature and technology in enhancing urban resilience. As for the sustainable smart cities, the two most important ones are the compact-city and eco-city, being the most prevalent up to the time of Bibri & Krogstie (2017)'s study. There is also the neotraditional development or new urbanism form, as well as the urban containment one (Bibri & Krogstie, 2017). Razmjoo et al. (2021) have also investigated the roles that green buildings and electric vehicles play in enhancing smart cities. They also highlighted some of the barriers and solutions to their adoption, especially when it comes to policy, technology, and stakeholder engagement. Some of the studies worth investigating for compact cities and eco-cities, as cited by Bibri & Krogstie (2017), would be (Jabareen, 2006; Jenks et al. 1996a,b; Joss, 2010, 2011; Joss, Cowley, & Tomozeiu, 2013; Neuman, 2005; Register, 2002).

How far are we with net-zero cities? Well, maybe still far from achieving them. Duan & Kim (2023) have given a literature review on the progress in research on net-zero cities. They highlighted the importance of net-zero buildings, energy systems, as well as policy support for achieving Net-Zero Carbon Cities (also labelled as NZCCs). However, there is still so much need to develop assessment models. Koutra et al. (2018) have confirmed this before, which is the challenging aspect of developing accurate tools. For example, in their study they have pointed to an assessment tool which is supposed to extend from assessing a building to an entire district. Talking about districts, or precincts, Sharp et al. (2024) have highlighted four different frames (perspectives) to argue the idea that there is not one way to achieve net-zero, and that visions can differ and we need to integrate them together to achieve a holistic transition. This helped me with developing the idea that main concepts I brought up in my review must be integrated so that they can cover and enhance one another. Moreover, it seems that urban planning paradigms also need some developing (Duan & Kim, 2023). And here I would probably point out towards the main paradigm of my paper which is the human-nature integration, I believe it could be studied and integrated with the NZCCs. Policy remains a barrier according to most studies, no matter the urban form or model. Similar barriers have been seen in the main concepts and themes I discussed previously above. Perhaps only Ohene et al. (2023) have disagreed, pointing out that economy and legislation are actually drivers for change, while financial and knowledge barriers are hindering it, and this is actually within the implementation of Net-Zero Carbon Buildings (NZSBs). Interdisciplinary collaboration is already happening, but it should increase (Duan & Kim, 2023). The achievement of net-zero might be very unlikely, at least in the current atmosphere. Ohta & Barrett (2023) did a study on green transformation in Japan, uncovering how complex the situation is especially with vested interested and the interplaying waves of politics, economy, and institutions. All of this shapes Japan's actions, but I would probably guess that similar happens to many countries within the developed world. I believe that most countries, just like Japan as per this study, have not really reconciled between economic growth and environmental sustainability (Ohta & Barrett, 2023). Hundreds of cities have shown ambition towards achieving net-zero emissions, but so much needs to be done in terms of collecting data, standardizing methods, capacity building, collaboration, community-level engagement, government-level actions, etc. (Ohene et al., 2023; Ulpiani et al., 2023, 2023).

In a study done on the types of factors that affect a city's ambition towards implementing climate actions, Bery & Haddad (2023) have found that population size, partisan orientation, per capita income, as well as other factors, "do not considerably influence the ambition level of cities, at least for US cities. They highlighted that the most influential factors are the existence of a team dedicated to environmental or energy policy and a university within the city borders. This is why collaboration is important, especially within a city-university setting (Bery & Haddad, 2023).

Transport was also a main theme among this layer of articles, especially electric vehicles. Tian et al. (2023) argued for achieving net-zero emission targets in Canada through the electrification of buses in cities. Still in Canada, transition systems within transportation, but also buildings and electricity were modelled (McPherson et al., 2023). Electric taxi fleets were also brought up as a pathway towards decarbonization (Kinsella et al., 2023). Similar studies were conducted in Australia (Fabre et al., 2023).

3.2 Synthesis and Integration of Findings

Cities are complex by nature, and they require several intertwined systems socially, ecologically, and technologically (Bai et al., 2016). This makes the science of cities intrinsically dependent on research to enhance and develop urban design approaches. However, these approaches have proved, so far, to be futile in delivering what humanity requires to sustain its livelihood on the planet. Universal wellbeing is nowhere to be achieved, nor is the environmental justice, and the depletion rates of nature are ever-growing (J. Birkeland, 2018). The way cities are being governed is a problem in of itself, since this governance is increasingly segregating sectors and departments from each other, and fragmenting the institutional structure which then leads to less coordination (Bai et al., 2016). What is needed now more than ever, is for the urban systems to go beyond just limiting their negative effects on nature, to actually reach net-positive gains across the board (Zari, 2012). Birkeland has been consistent in her philosophy and approach throughout her research across several years, resilience and eco-restoration are not enough, and contemporary policies and incentive schemes are futile if not negative on the long term. She argues that achieving net-positive design is the basis to achieving sustainability in the urban context (J. Birkeland, 2012, 2018). She also highlights that the current so-called sustainable practices in urban development often fail to achieve real sustainability, and proposed the theory of Positive Development (PD) as a possible method to achieve net-positivity in its absolute terms (J. Birkeland, 2022).

The Gioia data structure has helped build up the narrative and inductively and interpretatively construct the answer to the research question. The data structure has three levels to it: the first order based on relevant knowledge gathered from the source material that is journal articles, the second order based on the researcher's amalgamation of the data and interpretation of the knowledge through a hefty reading and analysis of the text, and the third level representing the aggregated dimensions of knowledge which are in this paper's case the answers to the original research question. These orders were neatly presented in the Gioia Data Structure in sub-section 3.2, and then explained and expanded upon in sub-section 3.3. This inductive interpretative analysis have helped answer my research question, which is yes, cities can be net-positive. Other knowledge outcomes that came with this research was figuring out that there are concepts that can help achieve net-positive cities. None of these concepts are

perfect, nor do they have a clear path towards net-positivity, but, they nonetheless all have a common goal of a sustainable urban development. And what is the peak of sustainable urbanism, other than achieving net-positivity across the board? Birkeland, through her decades of research, presented to us the Positive Development framework, which emphasizes open-systems thinking and the integration of ecological and social dimensions to achieve net-positive outcomes. The critical insight from her work is that cities can indeed achieve net-positive status, but not by incremental improvements, rather through radical shifts in how urban areas are designed, developed, and managed. As for regenerative development, it was the most outlined concept, and has been invoked the most by many researchers including Birkeland. If I were to redesign the research process, or maybe a new one, I would make the term “regenerative” paired with “cities” the core of the literature review. Then there were the other concepts: Biomimicry, biodiversity-inclusive design (BID), and biophilic urbanism. Biomimicry encourages the emulation of nature and its various processes in urban design, fostering environments that operate in harmony with the urban setting. BID on the other hand integrates biodiversity into urban planning, ensuring that urban development enhances the well-being of the local ecosystems. Finally, biophilic urbanism focuses on integrating natural elements into cities to promote human well-being and ecological resilience alike.

Now, while all these concepts and frameworks differ in how they approach achieving sustainable urbanism, the paper was able to detect overarching patterns on which they meet and intertwine. I would say that, and perhaps this has been already discussed in academia, these concepts can support each other as they may fill up the disadvantages of one another. This might be a research idea for the future to do a comparative analysis between them and list their advantages and disadvantages, that way we can assess their interpolation in research and practice. The main pattern that was redundant across all of them was the human-nature integration, which as I assumed before, should be the bottom-line paradigm for our next radical shift in sustainable urbanism, if we ever make one. Otherwise, and including human-nature integration, the following may be the most important overarching patterns and trends that the paper have uncovered:

a) *Human-Nature Integration*

Perhaps the most consistent trend across the board was the necessity of fostering human-nature relationships. This trend was noticed especially in Birkeland’s Positive Development (PD), but also in regenerative design, biomimicry, and biophilic urbanism. This constant emphasis on this theme, makes it – as the paper assumes – the new ‘paradigm’ for achieving net-positive cities. No matter the path taken, it is significantly clear that the bottom-line of any approach should be the focus on building a symbiotic relationship between humans and their local ecosystems, if not global as well.

b) *Ecological and Social Duality*

Related to the previous one, is the duality of the new age of sustainable urban design and development. This is the dual focus on ecological and social vectors, meaning that every action should take these two into account, not one only, not

one over the other, but both. I would assume that, by fully integrating human and nature factors into design, development, and decision-making, the duality of ecological and social vectors will be preserved. And what this duality means in practical terms, is that cities must not only sustain natural systems but also enhance social structures.

c) *Shifting from 'Less Bad, More Good' to 'Net-Positive'*

Swiping the dust under the carpet will not take us further, in fact, it may just be extremely detrimental to the future of our cities and by extension our Earth. Birkeland has continuously criticized the current era of urban “sustainable” practices, and argued that they are not sustainable whatsoever. She supported her narrative with her advocacy for Positive Development, which requires more research and a critical open-systems thinking that is unbound by inherent business-as-usual practices (J. Birkeland, 2012). In other words, incremental changes will not take us further, but radical and total change will. As a radical myself, I support this idea. Although cities have shifted from doing less bad to doing more good, this quasi-decent development is nowhere near what objective sustainability requires. Therefore, a *net-positive* future city will not only create regenerative self-sustaining urban ecosystems, but should also reverse negative impacts along the way just like Birkeland intended with the adoption of Positive Development (J. L. Birkeland, 2015).

The synthesis of findings shows that achieving net-positivity is not only feasible but necessary for cities. This would require that we first implement a radical paradigm shift towards integrating human and nature relationships in a healthy symbiosis that co-benefits the two. The human-nature integration will be the foundation on top of which we build our future net-positive city. Then through several well-established concepts that support sustainable urbanism, such as regenerative design, biodiversity-inclusive development, biomimicry, and biophilic urbanism, we can build pillars that support the implementation of our new vision. Only then, or so I would interpretatively assume, can we reach the level of Positive Development on top of which we can build our new societies. PD underscores the necessity of switching from conventional practices that merely reduce harm, to new practices that ever-create social and ecological benefits. If you remember the concept of unearthing the construction area and reintroducing new earths to it which I have given as an example before, in the case of a low quality soil that does not support our foundations, this might be reminiscent of it. Figure 6 below is a personal trial to portray this vision or model. This is at least how I would explain it in simple terms. It is now wise to extract the entire old earths (past and presents paradigms of sustainable urbanism) and replace them with new earths (the new paradigm of human-nature integration). On top of this new soil we can build our pillars of sustainability practices, and on top of them lays the support of the new city with an open-systems thinking and with a clear vision to future where no party, whether human or non-human, is left behind. Achieving this would require overcoming barriers and challenges, and there were some highlighted in the Findings sub-section. However, these were in no means an exhaustive list of barriers, not even close. They were merely some that were present in the researched literature, and even those may not give

the general picture of what makes a barrier and a challenge to achieving net-positive cities. The reason is because they are study-related, and each paper is

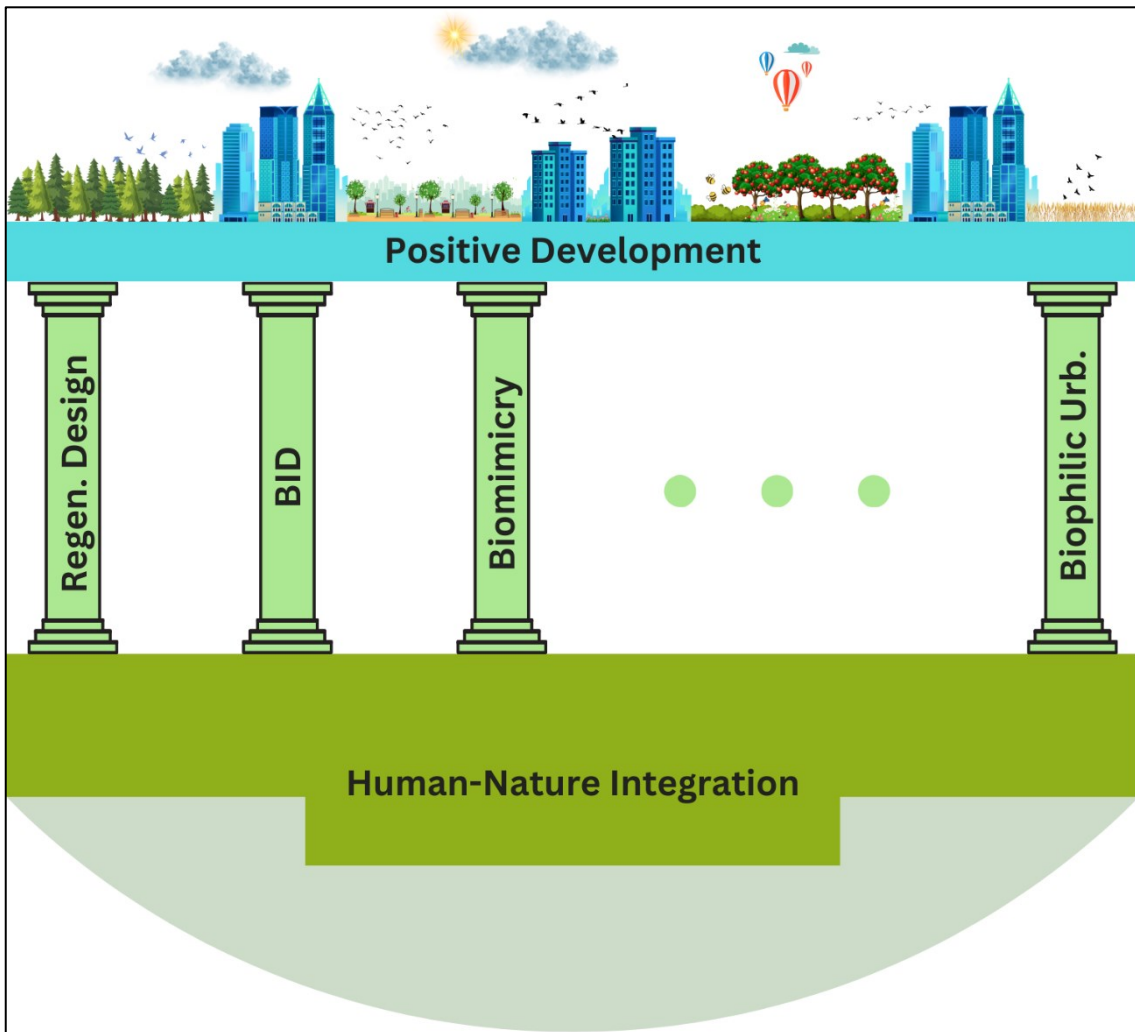


Figure 6: Vision of a Net-Positive City

different from the other, either in the sense of research design, research area, or both. Therefore, further research may be required to understand the full scale of challenges that hinder the achievement of net-positive cities. The reason why they were highlighted in the study in the first place is to show that there is a need for a paradigm shift, that human-nature integration may be the needed paradigm, and that there are barriers and challenges hindering it. Detecting and then overcoming these challenges would require a concerted effort in research, interdisciplinary collaboration, as well as policy support.

In the next and final section, I will conclude with the research results and some of their implications, the limitations of this paper, some of the future directions I would suggest, and finally a sealing conclusion.

4 DISCUSSION & CONCLUSION

In this master's thesis I delved into a singular central research question: "*can cities be net-positive?*". As exposed in the previous section, and based on an inductive interpretative analysis using the Gioia Method, I suggested that cities can be net-positive and that there are concepts and theories that support this suggestion, however, radical change is required to achieve this "seemingly utopic" net-positive city. In the upcoming sub-sections below, I will wrap up the research results and some of its implications I assume it has. Then, I will examine some of the research design limitations. And finally before giving a conclusion to this paper, I explore some of the research gaps and then provide my personal assessment of what I believe may be some of the plausible future directions mainly for research but for other sectors as well.

4.1 Research Results and Implications

This paper which is based on a systematic qualitative literature review and bolstered by the Gioia grounded theory to give it more scientific rigor, has come to present the findings initiated by a simple yet complex question: Can Cities Be Net-Positive? The answers have come in three main bubbles:

- 1- Yes, cities can be theoretically and technically net-positive.
- 2- There are already existing concepts and theories that promote the achievement of a net-positive city.
- 3- However, radical change is required to achieve net-positive cities, and it begins by implementing a new paradigm that is human-nature integration.

Cities can be net-positive, and the research demonstrated that there are means for cities to provide more ecological and social benefits at no extra cost (J. Birkeland, 2018; J. Birkeland & Knight-Lenihan, 2016). In other words, cities can be designed and managed in ways that they generate more absolute environmental and social benefits than the resources they consume (Zari, 2012).

The paper may not have delved into a fraction of strategies that can help achieve that, let alone the exhaustive list of all what state-of-art and state-of-knowledge have achieved and has the potential to achieve. The paper's entire goal was to answer whether cities can be net-positive, and now I assume we have the answer, and so did many great scholars before, especially the visionary Birkeland through her lifelong research and her framework of *Positive Development* (J. Birkeland, 2015, 2018, 2022). Albeit, while trying to answer the research question, the paper came across several concepts that were already established and that support the goal of net-positive cities, and they are primarily *regenerative design* (Camrass, 2022; Craft et al., 2021; Zhang et al., 2015) but also *biomimicry* (Blanco et al., 2021; Ilieva et al., 2022), *biodiversity-inclusive design* (J. Birkeland, 2022; Hernandez-Santin et al., 2022), and *biophilic urbanism* (J. L. Birkeland, 2016; Osmond & Wilkinson, 2021; Tarek & Ouf, 2021). All these concepts emphasize the importance of designing cities that work in harmony with natural systems, while also building resilience and sustainable well-being for the people of the city. This is where the necessity of a new radical paradigm shift came to surface (J. Birkeland, 2012, 2018, 2022), and this paradigm would be the *human-nature relationship* (Fieuw et al., 2022; He & Reith, 2022). Several trends and patterns were detected that support this new paradigm, and they are the intrinsic focus of all the concepts discussed before on the said human-nature integration, which can be explained as the symbiosis of humans with their local eco-system (J. Birkeland, 2012; Camrass, 2022; Zhang et al., 2015), then there is the duality of ecological and social development, meaning that any action should take into account both of them by giving agency to the non-humans (Fieuw et al., 2022; Ilieva et al., 2022), and finally the necessity to move from the mentality of doing 'Less Bad, More Good' to doing absolute 'Net-Positive' (J. Birkeland, 2012). This radical paradigm shift to foster human-nature relationships requires re-thinking urban design, development, and decision-making, and Birkeland (2012) called for shifting from a closed to an open-systems design thinking. Humans and their natural environment can co-exist and co-evolve (enhance each other) in a closed loop, and this requires an open-systems thinking that integrates the human and non-human, living and non-living, practically what Fieuw et al. (2022) called a more-than-human approach. Our cities can transition from being resource-intensive to contributing positively to nature and society. However, the bids of achieving net-positive cities stays tied up to our efforts in research, technology, policymaking, and many other barriers (Bibri & Krogstie, 2017; Blanco et al., 2021; Koutra, 2022; Newton & Newman, 2015). However, I remain optimistic, especially with one of the emerging and perhaps the most advanced urban forms "yet" that claim to achieve net-positivity to are the Positive Energy Districts (PEDs), which aim at a net-positive energy balance through renewables but also take into account to some degree the social and ecological outcomes (Casamassima et al., 2022; Derkenbaeva et al., 2022; Erba & Pagliano, 2021).

There are some theoretical and practical implications that come along with this paper, or so I would assume. More so theoretical than practical, since within the academia, it still requires hefty amounts of research to support it (Bibri &

Krogstie, 2017; Tarek & Ouf, 2021). The findings that this paper underscored in the previous section along with the synthesis, imply the necessity of a new theoretical framework in urban sustainability that goes well-beyond our traditional understanding and practice of sustainable development. Here, the paper especially underlines Birkeland's Positive Development (J. Birkeland, 2022), along with other concepts that intertwine and support each other; regenerative design, biodiversity, biomimicry, and biophilic urbanism. This paper claims that Positive Development with its focus on net-positive outcomes and the paradigm of human-nature integration may offer the most advanced theoretical foundation for future research, based on the hefty research done by Birkeland. Birkeland's PD framework is challenging current practices and paradigms, and calls for a radical rethinking of what urban sustainability is, and how cities should be designed, developed, and managed (J. Birkeland, 2012, 2015, 2016, 2018, 2022; J. Birkeland & Knight-Lenihan, 2016;). This paper has also identified three key overarching patterns: human-nature integration which the paper assumes should be the bottom-line paradigm for the new radical shift towards net-positive cities, the ecological and social duality whereby any development should be focusing on both natural and human factors, and finally shifting from 'less bad, more good' to the new age of 'absolute net-positivity'. The most important theoretical implication though is the answer to the original research question, which is yes, cities can be net-positive, but a new radical paradigm of human-nature integration should surface, and several barriers and challenges related to research, practice, and policy, should be overcome.

As for the practical implications, this paper may present for practitioners a good basis for a case study and maybe even inspire a practical application for an urban district, a precinct, a neighbourhood, or as small as a residential building. This paper does not claim in any way to have given the full picture of the state-of-the-art or best-practice for practical applications in today's atmosphere, but, it does present theories and strategies for achieving net-positive cities. As explained in the introduction on what we meant by a city, it could be prototyped to be as small as a residential building, and then scaled up from there. This paper's practical implications revolve around encouraging practitioners to implement regenerative design principles, adopting biomimicry, protecting and preserving biodiversity through nature-inclusive design practices, and promoting biophilic designs in urban development. If not advancing the achievement of net-positive cities, these practices can at least significantly improve sustainability in urban areas and lead to more resilience and equity in cities. If I may go further, I would assume that the paper may have some policy implications as well. Policymakers hold the most power, and they can either advance the transition towards net-positive cities or render it futile. In that sense, I suppose policies should support the adoption of regenerative practices, give incentives for eco-positive retrofitting, based on Birkeland's definition of eco-positive retrofitting (J. L. Birkeland, 2016), and promote interdisciplinary research and cross-collaboration between cities (city-city networks and knowledge sharing). The policy frameworks on top of which policymakers base

their decision-making could also ensure that both public and private sectors are aligned in their efforts to achieve net-positive outcomes.

4.2 Research Limitations

For the research design limitations and constraints, the Gioia Method has given me the ability to classify data and analyse it in a slightly more rigorous way. In a sense, it took away a little of the “burden of proof” that is usually problematic with qualitative methods, although not totally whatsoever. Yes, the GM does help with giving more rigor, especially since I was able to cite the 1st order concepts, which is not possible in the ‘informant-researcher’ environment. That is because the researcher must protect the identity of the informant, and in my case, this was not necessary because the data I featured and analysed did not come from interviews but from existing literature. Although this might be an advantage to the way I used the Gioia Method, which is different from the way Gioia intended for it to be used, but the disadvantage that remains is that I only relied on secondary source material. Gioia has developed this method first for primary source material, through inducting interviews, however, he himself has invited researchers to innovate on his approach and not follow it to the point (D. A. Gioia et al., 2013). From my own perspective and my own humble fallible judgment, I would suggest that the Gioia Method has worked well for me, and it was especially applicable for this qualitative study since it was both inductive and interpretative. The point and the strength behind qualitative research unlike quantitative research, is its ability to birth new ideas and illuminate new perspectives. I do not assume that this paper has birthed new ideas or new perspectives since I do not possess enough knowledge to know what constitutes a new knowledge in the field of sustainable urbanism and what does not. However, I do hope that this paper gives a very good case for further research in the field and more specifically on how to achieve net-positive cities.

Another thing that is worth mentioning is related to search terms. Roughly half-way through my work on this paper, I wished I could have known the term ‘regenerative design’ seen the cheer use of it in the papers that were relevant to my research. So, I thought it could have given me a wider pool of results. However, by the end of my work on this paper, I was grateful I did not know the term beforehand, because otherwise I would have probably not known the shallow use of the term ‘net-positive’ in sustainable urbanism, and the reason why I embarked on this journey for my master’s thesis was the genuine question of “if companies can achieve net-positivity, can cities do that as well?”. This immediately reminded of Gioia basically saying that not knowing enough is a blessing, because our minds will be open to all possibilities, and that knowing a little enough might hinder the possibilities of discovering new knowledge. “There is value in semi-ignorance or enforced ignorance of the literature [...], because knowing the literature intimately too early puts blinders on and leads to prior hypothesis bias (confirmation bias)” (D. A. Gioia et al., 2013). As for the

term 'net-zero', you as a reader may find it questionable, and that is justifiable. The term itself may not have been used to construct the data structure to answer the research question, and that is by uncontrolled outcome and not by design. However, it did bolster the knowledge related to synthesizing and interpreting the results, and it also drew a good picture of where research has been so far in terms of net-zero. The reason behind the choice of adding that term, is the problem that I had with the very limited pool of results in the databases when using the term 'net-positive' paired with 'cities' only. Therefore, I added the term 'net-zero' to widen the pool of results. That was valid at that point, and it made sense, because if I am not finding enough articles for net-positive cities, then what about net-zero cities, do they exist? Could they exist? It was a sort of "forced" setback, nonetheless, it proved useful in the overall picture. The bid was to find a clue as to whether net-zero cities are possible and whether there is a way to extend their narrative to net-positive cities. Now, obviously by the end of the study, it should be fair to assume that cities can be net-zero although I am not certain whether we have achieved that goal or not.

As for the table of "relevance level" I used, it was a personally conceived idea to help me classify and filter the articles by how likely they are to offer me the answer I am looking for. This was after the articles were read, and there was a very scattered amount of data that was quite hard to navigate. That is when I thought that I needed to set boundaries on the data and stick to my very specific research question. The relevance level was defined in accordance to how relevant each article is to my particular research question. From a personal assessment, this method did help me plenty, and it did prove very useful to the construction of the Gioia data structure. I would say this classification may be biased, since there is the element of interpretation which may vary from one person to another depending on many factors such as one's knowledge background and how they interpret data. Again, that is the beauty and the ugly of qualitative research.

4.3 Future Directions

By the end of my work on this master's thesis, I have gotten more interested and invested than I were before embarking on this journey, and I have even more questions now than I had before. What I would say about future directions is the need for more literature reviews. There is so much knowledge out there in academia about virtually every concept or theme brought up in this qualitative paper. From a personal assessment, there is so much untapped potential for qualitative research, and for literature reviews especially, at least within the area of sustainable urbanism. Within each of the following paragraphs, there is a research area I suggest could potentially lay down the path for future directions.

Can the term "net-positive city" be an umbrella term for all the others, or is there already an objective one? In this paper I have claimed that "net-positive city" can be an umbrella term for the several dozen terms in academia, and I based my claim and assumption on the definition I have given of what a net-

positive city could be. However, this remains subjective. I believe unifying and integrating the various concepts under a cohesive framework that clearly outlines the steps towards net-positive cities might be important at some point. But on the other hand, it could also create a negative effect on creativity by setting up boundaries, which is something qualitative research does not appreciate. I would suggest that a literature review is done to map out all the terminology that relates to sustainable cities, which is scattered in academia. I would not be surprised if there were at least thirty or forty different terminologies.

Next, and assuming that the paper has got the answer right, that cities can be net-positive, how objectively true is that? I do not have the answer. But that is the point of qualitative research, leaving doubts and point blanks ignites the need for further research and discussion. Just to reiterate, this is a qualitative inductive interpretative paper, so knowledge emanating from it can be biased as per the researcher's interpretative analysis and can differ from one person to another, but that is what Gioia meant when he developed his method in a bid to strengthen qualitative research's ability to birth new knowledge and new perspectives in more rigor (D. A. Gioia et al., 2013). This paper does not claim to give the formula for achieving net-positive cities. Although through interpretative analysis, I assume to have argued a good case for how to achieve net-positive cities, and that is through radically adopting human-nature integration and applying the framework of Birkeland's Positive Development, whom herself have had a lifelong scholarship on sustainable urbanism. That is to say, although net-positive cities may be possible, in no way does the paper or the author claim the way towards implementation is clear, as this may require further research.

Now let us assume that cities can be net-positive. Then, what about the concepts and frameworks mentioned in this paper? How can they support achieving net-positive outcomes? I would assume that the correlation between the four different concepts in between each other (regenerative design, biomimicry, biodiversity-inclusive design, biophilic urbanism) and with the framework of Positive Development would constitute a research paper, maybe even four different papers or more. It would be wise to investigate how they can support or enhance each other. This would also mean the need to study the applications of each of them, as well as their advantages and disadvantages and maybe which urban settings they would work best for. Assuming that this area of research was not explored before, because there could be so much work already done on this which I am not aware of. This could be a work of a lifetime, that is why these concepts remain mentioned just "there", a by-product of the analysis of this paper.

Among the concepts mentioned before, I believe the most potential for literature reviews goes for Regenerative Design. There are many possible subjects such as its practical applications (e.g., in buildings, infrastructure, etc), how far has theory and practice gone into the subject, how it might support Positive Development, how it intertwines with other concepts such as biomimicry, etc. If I were to choose a new subject for a research paper, I would make the term

“regenerative” paired with “city” the core of my literature review. Of course, I would suggest that the same thing applies to the other concepts (biodiversity-inclusive design, biomimicry, biophilic urbanism). These concepts can be very theoretical and sometimes vague and require clearer mechanisms for implementation.

And still within the concepts is Biodiversity-inclusive design. Biodiversity is one of the trending subjects in academia right now, and the University of Jyväskylä, I would assume, is one of the leaders at least in Finland. Research could investigate how biodiversity can help achieve net-positive outcomes in the urban sector. The CEM programme at JSBE will be conducting a doctoral programme on the subject of ‘Biodiversity footprint of the Finnish traffic system’.

Central to the results emanating from this paper is the *human-nature paradigm* which may require its own literature review, to understand how it has been approached so far. Most of the concepts that helped me answer the research question of this paper had the human-nature relationship as an important vector to achieving net-positive outcomes (J. Birkeland, 2022; J. L. Birkeland, 2015, 2016; Ilieva et al., 2022; Zhang et al., 2015). And with my fallible interpretative analysis, I claimed that this could be the bottom-line paradigm and foundation for a radical shift towards net-positive cities. I think this paradigm might be the most important by-product of this paper. I have not done my due diligence to see how far it has been articulated and rooted in academia, so I think it is worth being researched especially since it constitutes a major factor in Positive Development.

Related to the previous point, are the barriers and challenges hindering the achievement of a full-scale integration between humans and their natural environment, which is what I claim to be the bottom-line paradigm for a shift towards net-positive cities. As explained before, this paradigm requires the symbiosis between humans and non-humans, but what are really these barriers and how can they be solved? In the Findings sub-section, those barriers and challenges were not an exhaustive list nor were they specific to the human-nature integration paradigm in of itself, but through the interpretative sense of things, they appear as if they are. Those barriers and challenges were the ones that overarched from various papers limited to the literature at hand. Moreover, they strictly depend on each different study, their own research design, their boundaries and limitations, etc. They also depend on the subject matter, some were for regenerative design, some for biomimicry, etc. So, those barriers and challenges were a by-product from those specific analysed papers. There is a need for future research on the exact barriers of human-nature integration, of its research, of its practice, and of policymaking. This may also go back to the question of biomimicry and biophilic urbanism, what are the barriers to their adoption (e.g., technical barriers, knowledge barriers, etc.) and how can they help achieve human-nature integration.

While all of the above is theory, I would assume that there is a possibility for practical case studies in Finland. Especially for the Finnish cities that are advanced in sustainability, such as Espoo, it would make a good case to investigate how concepts such as biomimicry are being applied, if ever, or how

they can be applied. Various professionals from stakeholder and/or shareholder sectors can be interviewed, and new knowledge can be generated through the use of the Gioia Method or similar. Other research possibilities could involve conducting empirical studies or developing practical tools to assess and implement net-positive-related practices, such as, for example, validating the effectiveness of practices related to eco-positive retrofitting.

I should also note that there is a possibility to upgrade the Gioia data structure that emanated from this paper with future interviews. Now I am not particularly sure on how this can be conducted and with whom. But if done with accuracy, this could either fortify or nullify some of the 2nd order concepts in the data structure, which in turn can influence the aggregated dimensions.

I also believe there is room for interdisciplinary collaboration, although this would take so much effort and resources. For example, it can be possible to foster community involvement through participatory workshops either for the general public, within governmental sectors, or simply for students across various disciplines (sociology, engineering, urban planning, etc.). An easy way would be the use of case studies for workshops such as Hackathons. Students from various disciplines can then brainstorm and co-create new ideas for net-positive city concepts.

Finally, policy advancement remains one of the most important elements to drive and implement change. Just like how design, development, and decision-making should be unchained through open-systems thinking, policymaking can also be dynamic and adaptive to changes and opportunities in sustainable urbanism. I think it would also be wise to promote policies that support radical changes, particularly policies that could enhance or hinder the paradigm of human-nature integration. For policies that render achieving net-positive outcomes handicapped, it would be wise to reform them. Policy should also reflect the long-term visions of cities, swiping the dust under the carpet with “quick fixes” may have a few economic benefits for the short-term, but definitely not for the long-term. Maybe incentives could be another element of discussion, whether they are for the public sector, research organizations, think-tanks, private sector, etc. These incentives can come in many forms such as grants or subsidies or tax breaks. This could drive more innovation and most importantly collaboration in the quest towards net-positive cities.

To conclude, I would say that the objective truth of net-positive cities could remain an issue of dispute, and many will see it as an absolute utopia. Although as per my research findings I can assume that cities can be net-positive, but did I investigate all the perspectives? I did not. I can see myself overthinking about this question a lot, maybe years after submitting this paper. Maybe by then research would have advanced more on the subject of sustainable urbanism, but so far from what I have witnessed, “net-positive city” is not common in Academia. Yes, there are other terms that have been deeply studied already, but I still deem that “net-positive” could be an umbrella term for what could be an ‘objectively sustainable city’ based on the perfect objective meaning of

sustainability. Therefore, I would invite you to overthink, like I did, and extrapolate new meanings and knowledge.

4.4 Conclusion

Through a systematic qualitative inductive interpretative literature review, paired with the Gioia Method grounded theory, and in a bid to answer a seemingly simple but rather complex and important question, this paper claims to have reached an answer. Can Cities Be Net-Positive? This was the question that ignited it all. As it appears, cities can be net-positive and there are several concepts and frameworks that support this goal, however, radical change is necessary. If I were to judge how my interpretative findings align with existing theories, I would say that Birkeland had the most influence on this paper.

This journey which began with one question, did not just end with a theoretical plausible answer, it opened up new doors with many other questions. The Gioia Method has allowed me to identify several critical themes, each with so much potential for future research. The idea of a net-positive city should NOT be far-fetched, it should be a goal we all strive towards. I enjoyed working on this subject and it was a rollercoaster of incredibly informative knowledge. The short timeframe of my research left little room for extensive exploration, leading to personal concerns about the fruitfulness of this paper. Thus, my strategy was to adopt a focused approach as perhaps noticed on my work. However, what I appreciate the most is that, I believe, the paper has presented various insights for future research, and it has the potential to be developed further and the data structure can be enhanced either with more explorative literature reviews or practical interviews with some of the identified shareholders in this paper.

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APPENDICES

APPENDIX: List of Articles Analyzed in this LR

RL	Authors	Year	Title
	Darren Sharp, Rob Raven, Megan Farrelly	2024	Pluralising place frames in urban transition management: Net-zero transitions at pre-cinct scale
	Sanya Bery and Mary Alice Haddad	2023	Walking the Talk: Why Cities Adopt Ambitious Climate Action Plans
	Nicholas Anastasopoulos, Penelope Iliaskou, Mariela Nestora	2023	The MOVING GROUND Project: A Nature-Positive Case Study
	G. Ulpiani, N. Vetters, G. Melica, P. Bertoldi	2023	Towards the first cohort of climate-neutral cities: Expected impact, current gaps, and next steps to take to establish evidence-based zero-emission urban futures
	G. Ulpiani, N. Vetters, C. Maduta	2023	Towards (net) zero emissions in the stationary energy sector: A city perspective
	Anais Fabre, Michael Howes, Tom Deweerdt	2023	Best practice in urban transport decarbonisation: a case study of three initiatives in Brisbane
	Ziyu Duan, Seiyong Kim	2023	Progress in Research on Net-Zero-Carbon Cities: A Literature Review and Knowledge Framework
	Chien-Chiang Lee, Fuhao Wang, Yu-Fang Chang	2023	Towards net-zero emissions: Can green bond policy promote green innovation and green space?
	Rundong Chen, Pengpeng Xu, Haona Yao, Yangquan Ding	2023	How will China achieve net-zero? A policy text analysis of Chinese decarbonization policies
	Xuelin Tian, E. Owen D. Waygood, Chunjiang An, Zhikun Chen, He Peng	2023	Achieving urban net-zero targets through regionalized electric bus penetration and energy transition
	Wenguang Tang, Liuqing Mai, Meifeng Li	2023	Green innovation and resource efficiency to meet net-zero emission
	Hiroshi Ohta, Brendan F.D. Barrett	2023	Politics of climate change and energy policy in Japan: Is green transformation likely?
	Eric Ohene, Albert P.C. Chan, Amos Darko, Gabriel Nani	2023	Navigating toward net zero by 2050: Drivers, barriers, and strategies for net zero carbon buildings in an emerging market
	M. McPherson, E. Rhodes, L. Stanislaw, R. Arjmand,	2023	Modeling the transition to a zero emission energy system: A cross-sectoral review of

	M. Saffari, R. Xu, C. Hoicka, M. Esfahlani		building, transportation, and electricity system models in Canada
	Suvodeep Mazumdar, Dhavalkumar Thakker, Jenny Hayes, Nelio Matos, Paul Bate	2023	Towards achieving net zero by 2050 in the UK – Stakeholder perspectives in integrated urban planning
	L. Kinsella, A. Stefaniec, A. Foley, B. Caulfield	2023	Pathways to decarbonising the transport sector: The impacts of electrifying taxi fleets
	Kimberly Camrass	2022	Urban regenerative thinking and practice: a systematic literature review
	Luca Casamassima, Luigi Bottecchia, Axel Bruck, Lukas Kranzl, Reinhard Haas	2022	Economic, social, and environmental aspects of Positive Energy Districts – A review
	Lazaara Ilieva, Isabella Ursano, Lamiita Traista, Birgitte Hoffmann, Hanaa Dahy	2022	Biomimicry as a Sustainable Design Methodology – Introducing the ‘Biomimicry for Sustainability’ Framework
	Cristina Hernandez-Santín, Marco Amati, Sarah Bekessy, Cheryl Desha	2022	A Review of Existing Ecological Design Frameworks Enabling Biodiversity Inclusive Design
	Qingchang He, Andras Reith	2022	(Re)Defining Restorative and Regenerative Urban Design and Their Relation to UNSDGs – A Systematic Review
	Janis Lynn Birkeland	2022	Nature Positive: Interrogating Sustainable Design Frameworks for Their Potential to Deliver Eco-Positive Outcomes
	Kimberly Camrass	2022	Regenerative Futures: Eight Principles for Thinking and Practice
	Eduardo Blanco, Kalina Raskin, Philippe Clergeau	2022	Towards regenerative neighbourhoods: An international survey on urban strategies promoting the production of ecosystem services
	Sesil Koutra	2022	From ‘Zero’ to ‘Positive’ Energy Concepts and from Buildings to Districts – A Portfolio of 51 European Success Stories
	Erkinai Derkenbaeva, Solmaria Halleck Vega, Gert Jan Hofstede, Eveline van Leeuwen	2022	Positive energy districts: Mainstreaming energy transition in urban areas
	Asit K. Biswas & Cecilia Tortajada	2022	Net positive and its application to water management
	Chai K. Toh	2022	Tokyo's city sustainability: Strategy and plans for net zero emissions by 2050

	Mohammad Mahdi Ahmadi, Alireza Keyhani, Marc A. Rosen, Su Shiung Lam, Junting Pan f, Meisam Tabatabaei, Mortaza Aghbashlo	2022	Towards sustainable net-zero districts using the extended exergy accounting concept
	Walter Fieuw, Marcus Foth, Glenda Amayo Caldwell	2022	Towards a More-than-Human Approach to Smart and Sustainable Urban Development: Designing for Multispecies Justice
	Yi Song Liu, Tan Yigitcankar, Mirko Guaralda, Kenan Degirmenci, Aaron Liu, Michael Kane	2022	Leveraging the Opportunities of Wind for Cities through Urban Planning and Design: A PRISMA Review
	Christopher R. Correia, Mark Roseland	2022	Addressing Negative Externalities of Urban Development: Toward a More Sustainable Approach
	Maria Spiliotopoulou, Mark Roseland	2022	Sustainability planning, implementation, and assessment in cities: how can productivity enhance these processes?
	Siir Kilkis	2022	Urban emissions and land use efficiency scenarios towards effective climate mitigation in urban systems
	Eduardo Blanco, Maibritt Pedersen Zari, Kalina Raskin, Philippe Clergeau	2021	Urban Ecosystem-Level Biomimicry and Regenerative Design: Linking Ecosystem Functioning and Urban Built Environments
	Sara Tarek, Ahmed Salah El-Din Ouf	2021	Biophilic smart cities: the role of nature and technology in enhancing urban resilience
	William Craft, Lan Ding, Deo Prasad	2021	Developing a Decision-Making Framework for Regenerative Precinct Development
	Paul Osmond, Sara Wilkinson	2021	City Planning and Green Infrastructure: Embedding Ecology into Urban Decision-Making
	Silvia Erba, Lorenzo Pagliano	2021	Combining Sufficiency, Efficiency and Flexibility to Achieve Positive Energy Districts Targets
	Armin Razmjoo, Meysam Majidi Nezhad, Lisa Gakenia Kaigutha, Mousa Marzband, Seyedali Mirjalili, Mehdi Pazhoohesh, Saim Memon, Mehdi A. Ehyaei, Giuseppe Piras	2021	Investigating Smart City Development Based on Green Buildings, Electrical Vehicles and Feasible Indicators
	Francesca Poggi, Ana Firmino, Miguel Amado	2020	Shaping energy transition at municipal scale: A net-zero energy scenario-based approach

	Garfield Wayne Hunter, Gideon Sagoe, Daniele Vettorato, Ding Jiayu	2019	Sustainability of Low Carbon City Initiatives in China: A Comprehensive Literature Review
	Janis Lynn Birkeland	2018	Challenging policy barriers in sustainable urban design
	Hirushie Karunathilake, Kasun Hewage, Rehan Sadiq	2018	Opportunities and challenges in energy demand reduction for Canadian residential sector: A review
	Sesil Koutra, Vincent Becue, Mohamed-Anis Gallas, Christos S. Ioakimidis	2018	Towards the development of a net-zero energy district evaluation approach: A review of sustainable approaches and assessment tools
	Simon Elias Bibri, John Krogstie	2017	Smart sustainable cities of the future: An extensive interdisciplinary literature review
	Janis Lynn Birkeland & Stephen Knight-Lenihan	2016	Biodiversity offsetting and net positive design
	Janis Lynn Birkeland, Jay Yang, Cheryl Desha	2016	Net positive biophilic urbanism
	Bogachan Bayulken, Donald Huisingh	2015	A literature review of historical trends and emerging theoretical approaches for developing sustainable cities (part 1)
	Xiaoling Zhang, Martin Skitmore, Martin De Jong, Donald Huisingh, Matthew Gray	2015	Regenerative sustainability for the built environment e from vision to reality: an introductory chapter
	Raymond J. Cole & Laura Fedoruk	2015	Shifting from net-zero to net-positive energy buildings
	Janis Lynn Birkeland	2015	Prospects for nature in proposals for urban growth
	Caryssa M. Joustra, Daniel H.Yeh	2015	Framework for net-zero and net-positive building water cycle management
	Peter Newton, Peter Newman	2015	Critical Connections: The Role of the Built Environment Sector in Delivering Green Cities and a Green Economy
	Wendy Miller, Laurie Buys	2012	Positive-energy homes: Impacts on, and implications for, ecologically sustainable urban design
	Janis Lynn Birkeland	2012	Design Blindness in Sustainable Development: From Closed to Open Systems Design Thinking
	Hans Opschoor	2011	Local sustainable development and carbon neutrality in cities in developing and emerging countries