

## Review

# Navigating Uncertainties in the Built Environment: Reevaluating Antifragile Planning in the Anthropocene through a Posthumanist Lens

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**Abstract:** Within the vast landscape of the Built Environment, where challenges of uncertainty abound, this paper ventures into a detailed exploration of antifragile planning. Antifragility, a concept rooted in the capacity of systems to not only withstand but also thrive in the face of volatility, stands as a beacon of resilience amidst the uncertainties of the Anthropocene. The paper offers a systematic examination of antifragile planning, specifically by concentrating on uncertainty as one of its key theoretical tenets and by exploring the implications of these principles within the context of the Anthropocene. After offering a systematic and comprehensive review of the literature, the analysis delves into several important themes in antifragile planning, including the recognition of limited predictive reliability, critiques of conventional responses to shocks such as urban resilience and smart cities, and the strategic elimination of potential fragilizers through a unique planning methodology. Furthermore, the paper discusses three key arguments challenging the efficacy of antifragility: the systemic approach, the classification of responses to perturbations, and the validity of adaptivity and optionality theses. Specifically, the gaps identified in the antifragile planning methodology reveal its shortcomings in addressing the complexity of cities, its failure to recognize the variety of responses to shocks and perturbations, and its neglect of broader urban relationalities, especially in relation to climate-induced uncertainty. Thus, it is asserted that antifragility remains urbocentric. For these reasons, the paper contends that rectifying the gaps detected in antifragility is necessary to address the uncertainty of the Anthropocene. By aligning largely with emerging posthumanist planning strategies, the paper emphasizes the significance of adopting a proactive approach that goes beyond merely suppressing natural events. This approach involves fostering urban intelligence, contextualizing urban materialities within broader planetary dynamics, and embracing exploratory design strategies that prioritize both the ethical and aesthetic dimensions of planning.

**Keywords:** antifragile planning; uncertainty; Anthropocene; posthumanist planning; built environments



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## 1. Introduction

A small, but growing body of literature has gradually started to put the idea of antifragility on the planning agenda. A hallmark of this growing interest in the ideas of antifragility is certainly the work of Nassim Nicholas Taleb [1]. In general, Taleb's theory of antifragility, describes a system's ability to withstand stress and change caused by capital, large-scale, and massive events, that are largely unpredictable; nonetheless, at the core of antifragility is the idea of *thriving* and *improving* in response to various kinds of shocks. The difficulty in predicting and managing rare, consequential events largely arises from system complexity, particularly those that are human-made and characterized by an enormous intricacy of components. As such, *uncertainty* in Taleb's work presents a continuous state of affairs for each system, with the only viable solution being *adaptation*. Namely, rather than focusing on predicting specific events, antifragility emphasizes the importance of being sensitive to the potential harm caused by volatility. Due to the highly unpredictable nature of risks, identifying fragility in a system overpowers predicting rare events that may cause

harm, and thus prioritizes adaptability over conventional approaches to potentiating risk management and forecasting. Accordingly, antifragility has already offered a comprehensive framework for understanding uncertain environments, such as organizations [2,3]. However, its inception into planning theory has also coincided with a growing shift towards imminent *uncertainties* surrounding urban areas and built environments.

Amidst the stark realities exemplified by events like the COVID-19 pandemic, coupled with the enduring challenges posed by climate change, urban environments face an urgent imperative to adapt swiftly to unpredictable changes. This pressing need has spurred a flurry of theoretical discussions, political debates, and innovative concepts, particularly within the framework of the Anthropocene [4,5]. The Anthropocene refers to a new geological epoch where humans have become a dominant physical force, leaving an unprecedented impact on Earth's ecosystems and geology. This shift in our understanding of the human–environment relationship has significant implications. Numerous authors have highlighted the disruption of planetary cycles, ocean acidification, rising sea levels, and the decreased capacity of ecosystems to absorb CO<sub>2</sub> emissions, all of which contribute to a cascade of unpredictable events [6–18]. The concept of the Anthropocene, while still subject to ongoing political negotiations and debates regarding responsibility and future ecopolitical relations, has been widely considered in relation to cities, built environments, and urbanism as a whole [19–21]. This is not surprising, given that radical climatic uncertainty is further intensified by demographic and ecological projections within urban environments. The magnitude and speed of these transformations are overwhelming. It is projected that an additional 2.5 billion people will inhabit urban areas worldwide by 2050, and the rate of urban expansion, both horizontally and vertically, is expected to triple from 0.5% to 1.5% of the total land area by 2030 [22–25].

The endorsement of antifragility within planning theory certainly accompanies many other attempts to not only address a broader issue of *uncertainty* which current ecological crises further enforces, but also rethink the urban habitability anew and, alternatively, situate the planning practice outside the notions of orderly, fixed, and rigid design. A shift in planning methodologies towards more adaptable, introspective, and analytical approaches comes with acknowledging the limitations of predetermined masterplans with fixed outcomes as the epitome of modernist ideology. Instead, embracing an unpredictable, indistinct future that is frequently multifaceted, interrelated, and negotiated, led to a planning philosophy which is inclined towards adaptation, informality, and disorder [26] and is oriented towards “phronetic” institutions that learn from perpetual uncertainty [27]. Nowadays, this philosophy, implying imminent uncertainties and risks which accompany planning and architectural practices in general [28,29], prevails in accounts which adhere to the experimentative ideas of “learning by doing”, downscaling of interventions, and active participatory engagement, among other things. This more or less applies to adaptive urbanism [21,30–33], tactical urbanism [34–36], and inevitably, to variations in urban resilience [37–42]. Although possible professional engagements have to encounter various planning dilemmas and specifically, address the complexities of chronic disasters that are crucial in managing the challenges posed by climate crises [43,44], opting between *mitigation* and *adaptation* measures is a dividing line between these accounts.

In this regard, the methodology of antifragile urbanism inclines towards somewhat radical endorsement of uncertainty, which ultimately follows the formula of improvement through adaptation. This perspective appears to be particularly advantageous when confronted with the challenges presented by the Anthropocene. In contrast to a mere inclination towards mitigation as the exclusive remedy for potential shocks, a strategy commonly associated with the overly stretched concept of resilience, antifragility is often presented in contrast to such an understanding. It counters positions that, at times vacuously, presume the return of the urban form to its previous state. Although the dynamic aspects are recognized as the capacity of a community or system to absorb and recover from shocks and stresses, resilience is essentially seen as an attempt to develop techniques and methods that would maintain adaptivity guided solely by the aim to withstand adverse

events in the future. On the other hand, antifragility, in this regard, comes as a somewhat radical reinterpretation of resilience by accentuating the benefits that can be gained from shocks and disruptions in urban systems. These can be utilized as genuine opportunities for growth, innovation, and improvement, rather than relying solely on engineering capacities to adapt structures or systems in order to absorb and recover from disturbances. Within the framework of antifragility, there appears to be an acknowledgment of a scenario highlighted by some contemporary authors amidst the Anthropocene—the urbicidal nature of climate change that could potentially eradicate all familiar urban forms [45–48]. However, the endorsement of uncertainty does not come without its associated costs. While introducing innovative planning approaches, the translation of antifragile principles into practical strategies for adapting built environments may fall short, especially in tackling climate change challenges. Prioritizing adaptability by identifying urban system “fragilizers” exposes broader theoretical and ontological concerns regarding how cities and built environments are conceptualized within antifragile planning frameworks.

The objective of this paper is to methodically examine antifragile planning, evaluating its implications in the face of uncertainty and contrasting it with posthuman planning principles derived from discussions on the Anthropocene. After presenting the methods and materials employed, the paper thoroughly analyzes antifragility. Besides outlining the fundamental principles (Section 3.1.1), the paper explores several key themes in antifragility: the recognition of limited predictive reliability and critiques of conventional responses to shocks for their failure to endorse subtractive epistemology and evolutionary enhancement. Subsequently, the application of antifragility in planning is thoroughly assessed. The analysis reveals that antifragile planning primarily seeks to eliminate potential fragilizers, offering a distinct critique of smart city concepts and urban resilience. Instead, it proposes an alternative agenda focused on enhancing antifragility and promoting adaptive approaches to building design (Section 3.1.2). In the following sections, the efficacy of antifragile methodology and proposed strategies for coping with uncertainty are counteracted with three key arguments, counterposing the three major meta-analytical moments in antifragility: the assumed complexity of the cities, types of answers, and adaptivity/optionality theses. These arguments challenge the efficacy of the systemic approach in explaining and treating urban dynamics (Section 3.2.1), question the futility of classifying responses to perturbations as fragile, robust, or antifragile, and highlight the importance of a variety of localized types of answers (Section 3.2.2). Ultimately, concerns are raised about the validity of adaptivity and optionality theses, as they not only uncritically endorse evolutionary principles but also presuppose an urbocentric perspective that further fragilizes the broader environment and enhances various risks (Section 3.2.3). Therefore, the uncertainty of the Anthropocene is addressed by aligning it with emerging posthumanist planning strategies. Our study emphasizes the necessity of adopting a proactive approach that transcends the accumulation of errors and the mere suppression of natural events (Section 4.1). This entails fostering the advancement of urban intelligence, situating urban materialities within the broader context of planetary flows and mobilities (Section 4.2), and embracing the exploratory nature inherent in design strategies to prioritize the ethical and aesthetic dimensions of planning (Section 4.3). The conclusion provides a reevaluation of antifragility and underscores the imperative of deliberate engagement with diverse materialities, enabling long-term adaptation to a dynamic and evolving landscape.

## 2. Materials and Methods

A comprehensive review of scholarly literature on antifragility was conducted with the objectives of identifying key publications, delineating core topics and principles, and ultimately, critically evaluating potential limitations of this approach. The methodology employed for data collection and analysis involved a meticulous selection of texts to ensure a comprehensive understanding of antifragility both in general and its application within planning methodology. The analysis itself was carried out iteratively, encompassing *four key stages*, utilizing ScienceDirect and PROQUEST citation databases as primary tools. It

should be noted that while these databases offer broad coverage, the emphasis on English-language publications from these databases may overlook valuable contributions from non-English-speaking regions; however, this does not necessarily constitute a bias. High-quality research is often published in English in prestigious journals, and the selected databases provide an extensive array of publications from the rapidly evolving field of antifragile planning. Furthermore, following the identification, screening, and careful selection of eligible publications, these databases offered a solid foundation for a thorough analysis of this approach.

The first stage of the study aimed to provide a comprehensive overview of publications on antifragility. A total of 1180 results were obtained from the databases using the query strings of “antifragility” OR “antifragile” AND “cities” AND “planning” in combination. Despite the substantial number of publications retrieved, it was observed that the majority of them were not pertinent to the research topic, predominantly covering other academic fields beyond urban planning and urban studies. Therefore, the second stage involved refining the search results through distinct inclusion and exclusion criteria. The first step included narrowing the search to the fields of social and environmental sciences to exclude publications from other disciplines, such as economics, business, or computer sciences. Simultaneously, the search was refined to include only academic journal articles and book chapters, excluding other types of publications. Furthermore, the second stage encompassed the identification of duplicate entries, subsequently excluding them due to overlapping databases. Following this stage, the dataset for antifragile planning was effectively reduced to 653 distinct sources.

In the third stage, a meticulous selection process was undertaken with the aim of choosing only those publications considered relevant to the subject matter from each respective database. To further refine the criteria, the year range was narrowed in stage three to a period of six years, from 2017 to 2023. The rationale behind excluding other publications is justified by the fact that the seminal article on antifragility and cities by Blečić and Cecchini was published in 2017. The papers selected after refining the search criteria, underwent a preliminary screening based on a comprehensive assessment of their titles and abstracts. Additionally, eligibility criteria were introduced, requiring publications to provide insights into antifragility within the realm of planning and architecture. Therefore, at this stage, only publications with keywords including expressions such as “antifragility” or “antifragile,” “city” or “cities,” and “planning” were included. Following this initial screening of abstracts, titles, and keywords, unrelated papers were excluded, resulting in 36 publications being considered suitable for inclusion in the study. Subsequently, in the fourth stage, a thorough examination of the complete texts of the chosen papers was conducted to further determine their eligibility and identify key themes and analytical focus, leading to the selection of 19 key publications. The literature selection process, along with the corresponding search terms used, has been documented in Table 1.

**Table 1.** Key stages and results of queries.

| Stage 1       |                                                              | Stage 2                       | Stage 3                          | Stage 4      |
|---------------|--------------------------------------------------------------|-------------------------------|----------------------------------|--------------|
| Database      | Search Strings                                               | No. of Results—Initial Search | No. after Screening of Abstracts | Final Review |
| ScienceDirect | “antifragility” OR “antifragile” AND “cities” AND “planning” | 184                           | 11                               | 9            |
| PROQUEST      | “antifragility” OR “antifragile” AND “cities” AND “planning” | 996                           | 25                               | 10           |
| Total         |                                                              | 1180                          | 36                               | 19           |

All nineteen selected publications underwent a comprehensive descriptive analysis, facilitated by the MAXQDA tool, in tandem with a rigorous literature review. The primary objective was to discern the frequencies of key terms and conceptual nuances inherent

within the realm of antifragile planning. As delineated in Table 2, it emerged that three overarching themes intricately interweave across these publications, each tethered to a distinct analytical focus addressing specific issues within antifragile planning: *complexity*, *types of answers* and *adaptivity/optionality*. The overarching aim of these analyses was to elucidate the foundational tenets of antifragile planning, thus paving the way for a systematic meta-analysis that could unearth fundamental conceptualizations underlying assumed planning methodology. This analytical approach serves a dual purpose: to generalize the foundational planning principles advocated by proponents of antifragility and subsequently to scrutinize potential limitations inherent in such arguments. This scrutiny involves a comparative assessment against alternative planning methodologies and approaches. The focal point of this endeavor lies in the meticulous examination of how antifragile planners navigate the intricacies of uncertainty and, more critically, an exploration of the ramifications of such postulations within the context of the Anthropocene.

**Table 2.** Comprehensive overview of themes, meta-analytical points, and sources.

| Themes               | Analytical Focus                                                                                                                                                                                                                                                                 | Meta-Analysis          | Sources                |
|----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------------------------|
| Predictions          | <ul style="list-style-type: none"> <li>- inability of gaining predictions</li> <li>- cities comprised of numerous “smaller” components</li> <li>- nonlinear interactions</li> </ul>                                                                                              | complexity             | [49–58]                |
| Fragilizers          | <ul style="list-style-type: none"> <li>- insufficiencies in common planning tools</li> <li>- criticism of urban resilience and smart cities</li> <li>- emphasis of spontaneous evolutionary dynamics</li> <li>- incorporating errors as a basis of urban intelligence</li> </ul> | types of answers       | [49,54–56,59–63]       |
| Planning methodology | <ul style="list-style-type: none"> <li>- adopting solutions that reduce potential undermining of urban systems</li> <li>- focus on optionality and bottom-up learning from errors</li> <li>- envisaging adaptation of buildings with an aim of reducing fragility</li> </ul>     | adaptivity/optionality | [49,52–54,57,58,60–66] |

### 3. Reassessment of Antifragility

#### 3.1. An Outline of Antifragile Principles

Before delving into the intricacies of antifragility within planning frameworks, it is essential to understand its foundational principles and epistemic implications, particularly in relation to other concepts such as stability, resistance, and unpredictability. Antifragility, as elucidated by Taleb, challenges conventional notions of predictability and control, offering a unique perspective on how systems respond to volatility and uncertainty. Unlike resilience, which focuses on bouncing back from disturbances, antifragility suggests that some systems can actually benefit from chaos and disruption. This distinction positions antifragility as a distinct entity, offering a paradigm shift in how we perceive and navigate complex systems.

##### 3.1.1. Antifragility in General

As has already been stressed, one of the basic tenets of antifragile theory encompasses quite an important epistemic moment: limitations imposed on predictions [67]. According to the ontology of antifragility suggested by Taleb [1], each physical object is susceptible to some kind of potential damage from external factors, like instability, uncertainty, or merely the passage of time. Vulnerability is simply inscribed into objects. Still, the specific time and the cause of breaking or harming the object cannot be exactly determined in advance since the systems are characterized by a delicate complexity. Acknowledging the impossibility of making accurate predictions for every possible state of a system can

be unsettling, as it highlights a lack of control over future outcomes and the resulting high levels of uncertainty. However, Taleb does not mourn this. In spite of not explicitly aligning with an emerging criticism towards the Western episteme in the Anthropocene discussions and among postcolonial thinkers, which specifically targets the ossified belief in overarching control over the (natural) world [68,69], Taleb similarly opposes these strict and rigid frameworks. Instead, his suggestion is to embrace such volatility, since it is inscribed into objects. Anticipation of possible scenarios, including any kind of a possible disruption imposed on the object, becomes a prime task [1,67].

In this sense, relying on precise predictions is potentially futile because accurately forecasting outcomes for intricate systems is largely unachievable. This is especially true for social systems, which are doubly complicated. Not only do they possess inherent complexity due to the multitude of nonlinear interactions between their components, but they also involve agents who have the ability to make choices and exercise some degree of free will within certain limits. Natural systems are by no means different. The accuracy of long-term predictions in the case of risks associated with extreme events is even lower. In contrast to striving for precise “hard” predictions, Blečić and Cecchini [70] argue that accepting “soft” predictions is the only viable alternative. Soft predictions do not operate with probability distributions, nor aim to give exact predictions of future events, their occurrence, or dynamics. Instead, soft predictions are designed as analytical tools for discerning the possible reactions of the system to various disturbances, volatility, and even low-probability events. In essence, the goal is to identify the system’s fragility, robustness, resilience, or antifragility, and to understand what makes it exhibit those characteristics.

Thus, antifragility might be understood as a technique for considering a variety of responses to various scenarios of uncertainty. In this sense, it is crucial to sequence out whether objects, organisms, institutions, or systems respond to perturbations, stressors, and volatility by succumbing to *fragility*, *robustness*, or *resilience*, or ultimately, become *antifragile*. This triad imposes capital differences in terms of whether a response leads to a breakdown as it simply cannot withhold the external shock, as is the case in fragility, or, as is the case on the other side of the continuum, to antifragility, defined as gaining benefits from shocks. The answer is in the middle; that is, robustness or resilience, is specific. Whereas robustness imposes a strong resistance to a shock—contrary to fragility—a robustness or resilience simply retrieves the previous state of affairs, without gaining any benefit from perturbations. Certainly, these properties are not absolute: as Taleb [1] underscores, they have to be considered relationally. But, the normative aspect of antifragility, especially in its counteracting to a widely popular concept of resilience, is far reaching when keeping in mind the fact that such a strong accent has been placed on ideas of strengthening and adaptation. When interpreted on two axes—harm/gain and static/dynamic—the differences between the categories in this triad become even more salient. As Blečić and Cecchini [70] emphasize, introducing such dimensions provides better optics for differentiating the intensity of responses. On the one hand, robustness becomes closer to fragility as in these two states a system is internally static; they only differ in how much perturbation they can handle before being harmed. On the other hand, resilience becomes closer to antifragility as, in both cases, the systems are internally active. Once again, the difference is in how they respond to perturbations. Resilient systems can absorb small perturbations without significant changes, while antifragile systems can collect gains from perturbations and become stronger [2,67,71–73].

Accordingly, the ability of a system to simultaneously escape from a breakdown, surpass recursivity to a previous state, and ultimately attain benefits from errors, brings antifragility into close ties with *evolutionary thinking*. Although the resonance of evolutionary thinking in Taleb’s work does not necessarily involve a simple upscaling of this biological paradigm, antifragility is still surely in a neighborhood of evolution. Thus, “[e]volution proceeds by undirected, convex bricolage or tinkering, inherently robust, i.e., with the achievement of potential stochastic gains thanks to continuous, repetitive, small, localized mistakes” [1] (p. 314). Evolution is reflected through a unique *subtractive epistemology*—the re-

removal of what is deemed incorrect. If removing elements results in improvement, it indicates fragility, increased antifragility, or reduced fragility and unsustainability. This aligns with the notion of allowing processes to progress and gradually strengthen through evolutionary tinkering and trial-and-error, since complex systems can be difficult to fully understand and model. Intervening in these systems may lead to unintended negative consequences that create fragility. This does not necessarily mean the interventions are ineffective, but rather that we must be cautious and eliminate factors that cause disruptions and fragilities and jeopardize the system's survival. Each of these three meta-analytical moments—*system complexity*, *types of answers*, and *adaptivity*—will be reflected through key considerations in applying antifragility to the planning and articulation of built environments.

### 3.1.2. Antifragility in Planning

The advantages of such spontaneous dynamics have been increasingly highlighted in recent years, with notable discussions on the general application of antifragility in planning [50–54,59,70], proposals for specific interventions to reduce the fragility of urban systems [55,56,60,61,64,71,73], and other possible policy applications [62,63]. In general, antifragility views cities as adaptive and historically self-organizing systems capable of thriving amidst disorder. Interestingly enough, considering the city as a system involves a “redoubled complexity”—with one element espousing non-linear interactions among the “smaller” components composing it and the other encompassing the relatively autonomous social agents. Such a dual nature inscribed into the very texture of the cities themselves implies a distinct ontological image. Due to complex interactions and feedback loops, cities represent systems that are capable of demonstrating patterns of self-organization and emergent characteristics at higher levels of complexity. In such a highly uncertain setting, social agents are limited in espousing actions, especially because the system evinces unsurmountable variations. Ineffective planning, accordingly, fails to account for epistemic obstacles, since the attainment of exact forecasting models is often untenable; particularly when it comes to social systems that are twice as complex, containing numerous non-linear interactions and agents who are free to choose within certain limits [54,62,63,70].

In order to avoid weakening the city while embracing its spontaneous dynamics, it appears to be necessary to escape from so-called “fragilizers”, which Blečić and Cecchini [70] locate in various planning tools and urban policies from recent times. Among the most common fragilizers are plans and policies based on fragile predictions, stemming from the idea that planning is meant to strongly determine specific spatial and social arrangements, and requiring hard predictions of how the city will evolve and react to planning interventions [55,56,61,62]. However, urban systems are intrinsically unpredictable, and decisions based on hard predictions can be fragile. Similarly, centralization increases the risk of catastrophic failures and jeopardizes the survival of the system, in spite of being justifiable for certain policy goals. Instead, decentralization may lead to local errors that can foster innovation through learning through trials and errors. Pursuing efficiency and the optimization of certain subsystems, services, and processes is only worthwhile if their general purpose is uncontroversial, their relevant performance is measurable on a single criterion, and their outcomes are predictable. However, urban systems are a common platform for the heterogony of aims, making the pursuit of efficiency and optimization a fragilizer, especially if it is focused only on immediate first-order effects. An excess of specialization also makes the system fragile to external perturbations and reduces its capacity to adapt to and evolve with changes in the environment. Examples include one-company towns or places with tourism monocultures. Finally, the extractive political and economic institutions that remove the conditions for political and economic participation, do not provide incentives for investment and innovation, and violate the principles of accountability and publicity. The crumbling of the “cement of society” fragilizes social cohesion, ultimately undermining the social fabric of the system [70].

It is for these reasons that urban resilience faces a certain amount of scrutiny from antifragile scholars, in spite of the two concepts being indeed close and somewhat overlap-

ping [50,51,53,70]. Highlighting the need to safeguard it from becoming a clichéd buzzword that solely attains value in replacing an already shabby concept of sustainability, antifragile planners draw a clear boundary between the “strict” and “extended” meanings attached to urban resilience. As the former largely fails to attain the benefits from disorder and instead remains entrenched into the idea of returning to a previous state of affairs, an extended meaning of resilience as “evolutionary” [38–40] resonates with the antifragile principles of adaptability, transformability, and learning capacity. Rigorous testing and analysis can be applied to ensure that a building or infrastructure can withstand various stressors, such as earthquakes or extreme weather events; however, such an interpretation cannot be reduced to the use of sophisticated knowledge and engineering techniques. Learning capacities in this regard cannot be entirely efficient; for example, no matter how much knowledge can be accumulated on seismic activities, no model could provide certainty and eliminate all potential fragilities. Systemic complexity and the unstable environments in which buildings are situated further fuel a pessimistic stance towards pre-calculated methodologies. Such a perspective on learning from errors or developing sophisticated methods based on machine learning, as some notable examples show [57,58], would not necessarily be embraced by antifragile planners. The reasons for their mistrust in probability-based models, which would lead towards ensuring swift and effective recovery from disturbing events and suspend further risks, are also a matter of creative and flexible decision-making.

Therefore, even the “extended” resilience theory, which acknowledges the nonlinear and ever-changing nature of systems and recognizes the need to intelligently steer toward the unknown and unpredictable [41], lacks another important component of antifragility: *optionality*. Resilience can certainly be an effective and sought-after attribute for urban systems when facing adverse events, such as infrastructure malfunctions, environmental catastrophes, and social upheavals. Pursuing and embracing unexpected opportunities that arise, however, is what allows urban systems to evolve, improve, and expand over extended time frames and enhance their ability to offer optionality; that is, enriching the set of choices for social agents [53].

In their response to Kolars’ [65] harsh rebuttal of the concept, Blečić and Cecchini [70] argued that a “fundamentalist” or illiberal reading of antifragility is misplaced: rather, on the contrary, its relevance is precisely in cultivating creativity, resourcefulness, and cooperative networks at different levels, in order to build the capacity for transformation. Antifragility is, therefore, advanced through anything that encourages local experimentation and innovation, enabling new uses to meet evolving demands and pressures, and learning from trial and error [55,60,62,63,67]. Emphasis being placed on the importance of optionality also intends to reduce asymmetries within urban systems. Unlike fragility-inducing top-down approaches, antifragility thrives on *bottom-up stress* and *disorder*. Indeed, antifragile *tinkering* and *risk-taking* are essential to the process of discovery, innovation, and technological progress, rather than relying solely on existent knowledge and practices [51,52]. Inherent flexibility and adaptability can thus be accessed and harnessed at different points with varying objectives pursued by social agents.

“[E]xperimenting is not just a natural random process but due to actions of individuals who are themselves risk-takers. Conversely, whatever reduces such possibilities, either through prohibitions, regulations, or due to the lack of diversity and of a sufficiently granular plurality of uses and practice on the ground, can be said to fragilise neighbourhoods and cities” [70] (p. 184).

Assuming that spontaneous dynamics should be an imperative, antifragile planning is also set against the quite fashionable conception of a “smart city”. Like many other concepts which have become expansive, encompassing nearly everything, the notion of a smart city also appears to be vague. Besides potential inconsistencies in defining this notion, what is specifically troublesome is the background assumption of “intelligence”. While for the smart city concept an intentional and thoughtful process backbones each design, antifragile planning largely lacks deliberateness and does not necessarily impose an intelligent control over adaptation. Optimization, efficiency and providing “solutions”,

seem to insufficiently address cities as complex systems. Nonetheless, this is something which heavily resonates with ideological formulas of contemporary capitalism. In terms of effectiveness, the concept of the smart city can be seen as a regression to techno-positivism, and can distract from critical thinking. This focus on solutions reflects a broader trend in academia, where universities are encouraged to be more “useful” and to provide technical solutions to contemporary social and political problems. However, this approach risks neglecting critical thinking and goes against incorporating redundancies, duplications, plasticity, exaptations, and other elements of evolution that have helped cities progress over time [50].

An approach to planning, therefore, has to be guided by three principles that aim to articulate, but not suffocate, spontaneous dynamics through which the cities might enhance: the *via negativa*, the *shared vision and coordination through future scenarios*, and the *space of projects* [70]. First, the *via negativa* incorporates a set of negative general rules that establish external restrictions and prohibitions delimiting the space of possible actions, while not directly predetermining outcomes or imposing performative behaviors. The proscriptive nature of *via negativa* planning intends to avoid fragilizers that could undermine the system. Both removing fragilizers and enhancing the adaptive capacities of social agents have to go beyond an abstract rules-following logic and firm, over-controlling policies and incorporate instead a deliberative moment. A shared vision and coordination through future scenarios follow similar tenets. Facilitating deliberation on a shared vision involves empowering a future-oriented political community. As has been said, since hard predictions appear to be unreliable and further fragilize the city, the construction of future scenarios involves creating meaning and shared knowledge for possible futures that participating agents can appropriate and can be mobilized for collective action, in spite of lacking strong predictions. In this regard, simulations and mutually coordinated actions are seen as alternatives [51]. Lastly, the space of projects involves a flexible plane for public and individual actions and projects by combining both the external restrictions and prohibitions that delimit the space of possible actions and the common meaning and shared knowledge of possible futures. The space of projects, therefore, provides a flexible space with stable boundaries and constraints for individual action and public intervention, while offering a drive towards positive objectives that may be heralded by the shared vision. Ultimately, it illustrates the intention of the antifragile planning philosophy to combine top-down with bottom-up approaches, short- and medium-term actions, and possibly reversible, modular, or even ephemeral actions [52,70].

The “progressive research agenda”, proposed by Sartorio et al. [53], further intends to explore the perspectives of attaining urban design interventions, spatial behaviors, and community systems through antifragile planning, and therefore, to enhance the general adaptive capacity of cities [37,66,74]. To achieve this, the authors first suggest conducting culturally contextualized embedded case studies, with the aim of examining the antifragility of the built environment and the capacities of governance and community systems to adapt, but also, to examine the performative capacities of actors in different “arenas”. Further, evaluating whether a given system possesses sufficient qualities to improve after being exposed to stress induces the measurement of the antifragility of the urban environment based on factors such as size, flexible layout, relational position within systems, and multiple-use potential. Nonetheless, contextual and culturally determined elements such as spatial micro-features and behaviors, such as, for example, the socio-economic features of neighborhoods, also accompany spatial and morphological variables. Sartorio et al., also underscore the role of temporality in urban design. While often being overlooked, conceptions of temporality reflect potentially productive capacities of temporary urbanism and adaptation, along with the beneficial deployment of timescales and timeshifts as analytical tools in spatial analysis. Lastly, Sartorio et al. call for expanding multidisciplinary engagements. These would potentially involve an attentive relational and holistic examination of how the socio-economic and cultural variables interact with the materiality of the city in terms of scales, networks, and morphologies [53].

Materiality itself is a particular point of interest for antifragile planners [55,56,60,61,64], specifically due to the varying temporalities and lifespans of the layers from which the buildings are assembled, which require delicate treatment depending on the component itself. To envisage a type of antifragile politics that might be deployed in the articulation of built environments, the process should attentively discern the different components of a building—*site*, *structure*, *skin*, *services*, *space plan*, and *stuff*—which have different rates of change and durability. The *site* is the most permanent aspect of a building, including the land, topography, and neighboring buildings. The site is the foundation upon which the building is constructed, and it can continue to exist even after the building has been demolished. As a load-bearing framework of the building, the *structure* including the foundation, columns, beams, and other structural elements that provide support and stability to the building can also have a long lifespan and, eventually, outlive the building itself. The external envelope or façade, including the walls, roof, windows, and other exterior elements that protect the interior from the elements, present different overlapping layers of *skin*, which can be replaced over time and renewed as a principal barrier between the interior and exterior environment. The services, space plan, and stuff can change at varying rates, from rapidly to slowly. A building’s mechanical, electrical, and plumbing systems, including the heating, cooling, ventilation, lighting, and other systems that provide comfort and functionality to the building’s occupants, present *services* whose lifespans vary depending on the rate of technological change and the degree of maintenance. A *space plan*, however, can change rapidly without altering the actual structure or skin of the building. It includes the placement of walls, doors, and partitions, as well as the size and shape of rooms and corridors. Finally, the *stuff*, which refers to the building’s interior finishes and furnishings and includes everything from furniture and fixtures to artwork and decorations also have a variable durability: from a few hours or days for perishable items to several years for durable goods [50].

By understanding these different layers of a building, planners, and architects can make informed decisions about how to adapt and repurpose existing buildings for new uses [64]. Blečić and Cecchini clearly emphasize that the endurance of buildings and material settings depends on their adaptive capacities; that is, their intelligence and “organicity”, which allow for further and always-renewing improvements over time [50]. Similar principles might be applied to advancements in urban mobilities [55,60] and urban infrastructures [61]. The antifragile character of such assertions goes against emphasizing aesthetic moments or technical innovations in architectural practice along with the potential exaptation of buildings and built environments in a rather organic manner.

“This is true for plenty of the contemporary architecture: no matter how much—dazzled by fashions, by the effervescence of the form, or by the futuristic technology—a building may appear to us extraordinary in all its novelty, its durable success ultimately hinges on its capability to create persistence, to age gracefully” [50] (p. 9).

What remains puzzling here is whether a holistic approach to building design and development, aiming to withstand the test of time, is something that Roggema [73] links with *counterintuitive solutions*: does escaping from applying the already known practices and plans counteract unprecedented and unforeseen disruptions? In other words, to what extent might antifragile planning, with its embracing of spontaneous dynamics, low confidence in forecasting and deliberative politics, be justified as a legitimate answer for the conundrums brought by the Anthropocene?

### 3.2. Interrogating Antifragility

As has been emphasized, antifragile urbanism heavily exploits the ideas that have appeared to resonate more thoroughly in planning theory recently: avoiding a rigid, centralized, and uniform urban forms in favor of decentralized and adaptable ones, along with promoting diversity, redundancy, and modularity in urban systems with better responsive mechanisms to potential disruptions in the face of unexpected events. However, in fostering ideas that could potentially enhance more adaptable placemaking, adjustable to the

diverging demands of both the environment and the social agents, antifragile planning gives a radical, but largely underdeveloped response to the troubles of the ecological era: shape-shifting landscapes, warming, congestion, density etc. As some discussions on the relationship between the Anthropocene, cities, and architecture have already indicated [75,76], rethinking habitability anew in circumstances where rhythms and temporalities escape from being patterned and repetitive, cannot be simply enforced through an advantage-cum-error logic; rather, devising new means of coexistence requires *discerning complex relationalities* in which the cities and buildings are already embedded; specifically, the non-human materialities. In its obsessive focus on reducing vulnerability and seizing knowledge from unforeseen events, antifragile planning fails to account exactly for how the cities and buildings are *constantly being reassembled*. Besides indicating key topics, the previous analysis has revealed several issues at the meta-analytical level regarding antifragile planning. Specifically, the concept of antifragility falls prey to the holistic fallacy by perceiving cities solely as complex yet compact systems. This limited understanding of urban relationality significantly hampers our further comprehension of potential answers and “disruptions”. Consequently, it also disrupts evolutionary metaphysics and its metaphorical application in antifragility, which envisions cities as organism-like entities embedded within a larger environment.

### 3.2.1. Complexity, Nonlinearity and Urban Dynamics

Complexity and nonlinearity are the wrong starting points for explaining the dynamics between cities (wholes) and components (parts). A major drawback of this assumption is in the fact that it mirrors a perennial issue in philosophy related to parts/wholes dualism. In spite of offering almost common-sensical alternatives, where one can either assume that parts assemble wholes, or that wholes dictate the ordering of parts, this thinking has recently been subjected to considerable scrutiny of what is indicated by object-oriented ontology (O-O-O) [77–81]. According to one of the most fruitful representatives of this school, Timothy Morton [79–81], holism in particular fails to account for where the complexity emerges. Antifragility largely fits here. What is commonly assumed in this case, Morton asserts, is that the ontological complexity enlarges with forms and objects of “higher” order—as with antifragility, where vast amounts of components interacting non-linearly prevents us from gaining deeper knowledge. While it might be true that the temporal and spatial attributes of ensembles such as cities or buildings indeed depend on “parts” interacting in a certain manner, the very idea of the system—especially when thought about holistically—neither appears as a compact “whole” nor is it more “complex” than its parts. Specifically, how could one disentangle the vast portions of reality that are concatenated into gigantic formations which object-oriented ontologists call symbioses [78], hyperobjects [79–81], or machines [82]? Therefore, a further problem with this vacuous and underdeveloped idea of the system would be where exactly do wholes/parts end? Explaining the megacities, as Morton wonderfully illustrates, would make this kind of a holistic approach largely unfit for the task.

“For architects and urban planners, megacities are hard to conceptualize: where do they start and stop? Can one even point to them in a straightforward way? And isn’t it strange that entities so obviously gigantic and so colossally influential on their surroundings and economies worldwide should be so hard to point to? The fact that we can’t point to megacities is deeply because we’ve been looking in the wrong place for wholes. We keep wondering when the pieces will add up to something much greater” [80] (p. 12).

Prior inquiries reflect much broader issues of how to accurately assess or weigh the *scale* of urban systems, since their assumed complexity impairs commensurating their size and impact. As Jon [83] notes in *Cities in the Anthropocene*, a critical issue is identifying the “threshold” at which local actions may trigger incalculable and unpredictable outcomes. This threshold marks the point at which the system becomes highly sensitive to small changes in initial conditions, leading to outcomes that are difficult, if not impossible, to

anticipate. This issue is also methodological, as the material functioning of urban systems commonly exceeds given territorial frames. While the onset of the Anthropocene has heightened awareness of the precarity of human existence and the limitations of short-term, leading to human-centric problem-solving approaches that hinder the development of a coexistential relationship with nature, it also raises questions about precisely defining whether the components of urban systems make up “something much greater” and how to understand the emergent properties of these complex systems. One alternative is to adopt a holistic, systematic approach, as Jon does by following DeLanda’s work, which infers that the city as a complex system emerges through a bundle of interactions that begin to comprise “wholeness” through history and evolution. Another alternative would be to adopt a more flexible solution that takes into account the questions of *complexity*, *scale*, *interactions*, and *emergence*.

Although the holistic perspectives have certain value in enforcing coherent governance over wider territories, the wholes/parts dualism must be rethought thoroughly in order to account for the phenomenon of *emergence* without prematurely making inferences about urban complexity. The object-oriented ontology again offers a unique response, specifically by refocusing on entanglements that allow for symbioses between objects. Accordingly, neither *overmining* nor *undermining* can be taken as valid alternatives. As Harman notes, in the former case, the parts have only minor performances; in the latter, objects are explained in terms of their smaller components. Harman’s assertions point to the phenomena of change and emergence “in which new properties appear when smaller objects are joined together into a new one” [78] (p. 30). Complexity is therefore hidden in the parts, rather than in aggregated wholes. Wholes always involve reduction and are thus *less* than the sum of their parts, as Morton [79–81] famously repeats. At first glance, this might be puzzling. However, presupposing that complexity arises from the conjoined but nonlinear spontaneous dynamics of the components is gullible. The very conception of the system implies a normative idea of coherence and even equilibrium, from which otherwise vague conclusions on complexity are derived, along with an odd epistemic pessimism that disregards a plethora of interactions and the effects they have on cities, such as assembling and disassembling, emerging and receding, rescaling and descaling, etc.

### 3.2.2. Urban Relationalities and Answers to Perturbations

Having said this, discerning whether responses to perturbations are fragile, robust, or antifragile is futile. Antifragility fails to account for what has been massively addressed since a relational turn in urban and spatial theory: connections that extend across time and space and enforce formations that exhibit constant changes in composition, character, and extent [82,84–95]. What is particularly at stake in such “flat ontology”, which focuses on intense circulations and lateral movement between the locations, is providing a re-description of cities not as orderly and all-encompassing totalities, but as “oligopticon”: complex webs of circulating networks that flow beneath, above and on the very surface of the cities. Hence, in place of preconceived notions of total, aggregated city, assemblage thinking potentiates on politics of locations that only temporarily condensate the intersecting networks. Hyperconnectivity thus renders separating cities into discrete totalities difficult, as much as placing an excessive emphasis on external shocks dismisses seeing where and how the urban tissues are associated.

Put differently, an assumed categorization of responses to potential disruptions that lead to fragility, resilience, or antifragility restricts a range of possible solutions to urban dynamics. It can be argued that it mainly applies to specific systems or entities that face rare and extreme shocks, whereas the majority of everyday situations and environments do not require or benefit from antifragility. Certainly, malfunctions and disturbances in infrastructures, urban networks, and everyday functioning are frequent and often demand responses of varying scales. However, extensive research from different contexts demonstrates that proactive and preventive approaches are also common, even when the affected populations are considered highly vulnerable and are exposed to various risks.

In this regard, urban materiality is both adaptive and negotiated. In such cases, diverse initiatives result in innovative reconnections of infrastructures and numerous micro-scale adaptations of everyday materialities [95–104]. Furthermore, predominantly informal methods of forging alliances, creating synergies, and establishing hybrid connections offer compensations for the lack of infrastructures, redefine ownership over common goods, and facilitate bottom-up planning practices [82,105–109]. However, although these actions present innovative ways of dealing with uncertainty and disturbances in urban environments, they seldom involve restoring previous states and even less so strengthening after shocks. Instead, the micro-scale of such urban practices highlights the various ways in which urban environments are assembled in response to the specific issues at hand. As Amin and Thrift [86]. (p. 76) emphasize, there is a need to recognize a “fundamentally associative ability of cities to mix and match through a pidgin of subjects and objects moderated by urban form.”

Hybrid and unfolding scenarios within urban dynamics draw attention to how social agents interact with intricate webs of energy, materials, infrastructures, technologies, and other elements [86,90,92,110,111]. From an assemblage perspective, planning strategies that articulate risks and encompass resilience and antifragility often fall short in guiding design approaches. They neglect to fully acknowledge the vital role of objects in shaping urban life and fail to consider their spatial and temporal performances. While materiality is recognized as a significant context that both enables and constrains our actions, as argued by Lieto [112] it does not imply that buildings or infrastructures are simply finite configurations of tangible elements harmoniously combined for functionality. Instead, they embody a *network effect*—an evolving convergence of productive, political, scientific, and technological connections rooted in a shared foundation. Stabilizing objects as networks, as emphasized by actor–network theorists, relies on their material solidity and semiotic consensus. However, controversies, negotiations, and disassembling are also common processes that surround these objects, revealing the amplitude of relationality rather than fragility. Relationality suggests diverse temporalities and interactions between objects that have the potential to foster heterogeneous collaborations, serving as a *via positiva*. The steadfast durability and discreet material substratum encompassing these objects, as argued by some architectural theorists [113], defy linear interpretations and manipulations. The influence and active partnership of objects in shaping their surroundings stem from the qualities they possess within specific contexts. Therefore, if we equate endurance solely with the physical performance of buildings, allowing them “to age graciously” and approach them with a conservative mindset by invoking social cohesion as antifragile planners often do, urban environments become more fragile and lose the agility necessary to comprehend the dynamic interplay in objects–humans relations.

### 3.2.3. Optionality, Adaptive Agility, and Urban Metabolisms

Finally, this also brings theses on adaptivity and optionality, respectively, into question, specifically due to an uncritical reference to evolutionist assumptions and the quite problematic *urbocentrism* inherent in antifragility. The conception of a gradual, adaptive course of urban development in antifragility involves a somewhat radical concession to the quite plain but risky idea of endurance and temporal continuity of cities or buildings as complex organisms. Despite biotic and organic metaphors and analogies having been ubiquitous in planning theory for almost two centuries, as magnificently shown by Amati [114], ideological strands of antifragility regarding evolutionary adaptivity cannot be easily eliminated. This applies not only to the assumed virtues of “creative destruction” [115], firmly incorporated into antifragility, which ultimately means narrowing down urban scenarios solely to acquire knowledge from the somewhat rare, nonlinear, and irreversible effects of “outside” shocks. This occurs after a burdensome process of selection in a rather risky environment. The limits of the evolutionary, adaptive thesis are thus also hidden in the idea that urban environments thrive and prosper as long as they attain the ability to withstand larger perturbations; of course, simultaneously respecting the choices made

and embracing the hyper-liberal phantasmagoria of optionality. In a way, such implicit, urbocentric holism follows the idea of confining the city as a more or less closed system, counterpoised to the external environment through a clear-cut separation of urban space and a self-sustaining biosphere.

Beyond such a view, an extensive body of literature on cities fosters an understanding of the broader metabolic processes in which cities participate [46,116–126]. Specifically, the relevance of imbalances caused by the long geo-history of subjugating non-urban areas to expansive urbanization is noteworthy and extensively studied in the literature on urban metabolisms. By creating their own ecosystems with a massive consumption of energy and other resources, the intricacies of the relationships that emerge and shape through the stretchable corridors of infrastructure promote broader forms of destruction. As infrastructures evolve into the “exoskeleton” of urban metabolisms, situating cities in sprawling networks through which basic life-sustaining elements circulate—such as water, energy, communication, and mobility—they inherently exhibit selectivity in this flow. The selectivity of infrastructures extends beyond mere accessibility; they are inherently impermeable and destructive for many other forms of life. This particularly impacts the “output” side of metabolism, encompassing various forms of urban waste and broader environmental destruction [122,127]. In brief, by eliminating fragilizers, antifragility alienates cities and renders the broader environment more fragile, thereby exacerbating the so-called metabolic rift [16,128–132].

In this context, thinking within the framework of evolutionary adaptation only prolongs an otherwise undesirable situation for cities in the Anthropocene, unexpectedly exacerbating the risks of catastrophic events. Harnessing the potential of redundancies, duplications, plasticity, exaptations, and other evolutionary mechanisms that have purportedly driven the advancement of cities over time becomes particularly problematic. Within the context of incremental and trial-and-error-based development, coexisting with uncertainty translates into extended efforts to solely secure urban forms. However, antifragility in this context predominantly aligns with significantly anthropocentric perspectives. By detaching humans from broader ecological networks, evolutionary adaptation and optionality further reinforce the manipulation of both constructed and natural environments. While adjusting these environments based on accumulated errors from prior urban developments and embracing unforeseen opportunities is important when having in mind potentially destructive events for the cities and buildings, adaptivity primarily represents the progressive securitization of human-made structures. Yet, this approach falls short as a comprehensive solution for the challenges posed by the ecological era, particularly the substantial impact cities have on the environment. Rather than focusing on how to reorganize urban structures and networks in the face of climate change, antifragility emphasizes disturbance and perpetuates divisions arising from extensive interactions between societal and ecological frameworks. By striving to distance progress from uncertainties, antifragility offers little support for *fostering agility* in adapting urban environments to the changes brought by climate change. Instead, it intuitively gravitates toward solutions that exacerbate the existing crisis.

#### 4. Alternative Strategies

Probably the most important question arising from the considerations above is how to bridge the “metabolic rift” and engage in a more feasible project where human-made forms will not remain secluded and counterpoised to the “outside” world. The option is not to “resist or retreat”, as some authors argue [32]. Given the number of uncertainties that have to be encountered—starting from erratic weather patterns all the way down to potential disturbances in supplying infrastructures and materials—architects and planners should not prioritize either the capacities to minimize harm and recover from adversity or potentially cultivate the built environment through encountering uncertain events. In the Anthropocene times, planning should rather pursue a *procreative approach*, which encompasses a tangible reorientation towards exposing and incorporating material dependencies

that heavily partake in urban assemblages. Recent times have seen some considerable shifts towards such a procreative approach, equally by rematerializing planning practices [112,133] and by critically recasting planning in order to encompass more-than-human assemblages in which the cities are embedded [35,75,133–137]. Such innovative approaches profoundly resonate with posthumanist ecopolitics in their ontological and ethical appeals to expand our understanding of relations with more-than-human agencies and, specifically, incorporate what is usually thought of as the “environment”. In this regard, answers to the troublesome character of uncertainty, reconsidering urban materialities as complex transactions occurring on a planetary scale, and ultimately, why exactly enhancing the aesthetic approach and exposing geophysical, technological, and biochemical networks encourage the development of a distinct ecopolitical direction in planning methodology.

#### *4.1. Coping with Uncertainty and Urban Intelligence*

First, coping with uncertainty should be directed towards a proactive approach and the development of urban intelligence, rather than accumulating errors. The Anthropocene undoubtedly presents unprecedented difficulties for planning, given its unpredictable ecological events and developments, potentially jeopardizing the envisioning of urban futures. According to Jon [135], embracing the Anthropocene in planning or actual planning practices has proven challenging due to the overwhelming level of uncertainty, often leading to feelings of paralysis and futility. However, recognizing uncontrollable and unexpected events, such as extreme climate conditions, should not be seen as a dead-end. Instead, it offers an opportunity to reframe the city–nature relationship and move away from traditional anthropocentrism, as argued by Houston et al. [133]. This entails examining the material, ethical, and political aspects of “urban exceptionalism” and aligning urban governance with reciprocal ecological networks. Ultimately, this approach engages planning theory in a dialogue with more-than-human ecologies and embraces a more inclusive and ethical relationship with non-human species.

A nuanced approach to navigating uncertainty should not rely solely on an evolutionary sortition, but rather be informed by a more proactive stance that facilitates the understanding and sensing of relational dynamics through the use of socio-technical tools, scientific networks, and artistic expressions, while fostering material interventions that would resonate among local communities. For example, such a proactive stance involves both shifting decision-making processes towards everyday objects and infrastructures, such as peculiar common goods [26,135]. In the context of the Anthropocene, these interventions would stimulate constructive dialogues with local communities and address their evolving needs, while also being led by expert, scientifically-fed knowledge—especially on climate uncertainties. Unlike the distrust in predictions that is becoming more popular even beyond the scope antifragility due to the assumption that cities are complex interactive systems, emerging posthumanism thus intends to escape from this risky relativism, by abundantly retrieving the rigid findings of climatology, geology, and chemistry and instantiating inquiries into soil, air, or cities in general as the fundamental basis for collective actions and necessary adaptations that can be translated into common, everyday objects. As some authors [138–140] suggest, alongside tracing and mapping assemblages of interactive emergence, utilizing Big Data and the Internet of Things might provide real-time responses to emergency events, along with creative engagements that might recompose existing arrangements and practices. This is highly applicable as a novel means of urban intelligence as well, specifically when pursuing nonanthropocentric design strategies. According to Luusua et al. “[w]hen sensing and AI are embedded into urban materiality, comprising novel smart city systems, the materialities of cities themselves are considerably altered and their agency is expanded, partly in ways that are yet unknown” [140] (p. 302).

#### *4.2. Design Strategies and Planetary Mobilities*

The exploratory nature inherent in these design strategies entails situating urban materialities within larger planetary flows and mobilities. The history of human settlements

has been marked by both the exploitation and actualization of various bio- and geopowers. According to Clark [141], understanding phase transitions between different states of matter and energy in Earth processes can shed light on how dense human settlements are playing a fundamental role in such activities. Precisely by enforcing hybrid biogeomorphic processes [75], cities play a significant role in mobilizing what planetary urbanists refer to as “operational landscapes” [142], and the spatiotemporal dynamics of vast non-urban spaces that are deeply embedded in political-economic relations, land-use patterns, and overall logistics that sustain urban metabolism. It is crucial to recognize the metabolic aspects of urbanization, not only in terms of the existing socioecological crisis, but also as a delicate interplay between planetary forces, flows, materials, engineering, and planning. Brenner and Katsikis [143] argue that an overly narrow focus on urban centers and their intercity relationships can lead to a myopic analysis of the sociomaterial processes that shape urban development. This approach overlooks the complex interplay between urban and non-urban spaces, which are often intertwined in ways that contribute to urban growth and evolution. To fully comprehend the coevolution of cities and non-urban spaces, it is essential to adopt a broader analytical lens that encompasses the manifold sociomaterial processes at play.

Incorporating such material entanglements into planning practice and methodology substantially brings about a reorientation towards a more permeable and porous design, precisely by advocating for the affirmation of worldly connectivity and emergence, as opposed to their outright rejection. Some considerable attempts to articulate these materialities have already been made. Following Amin and Thrift’s [86] notion of the “politics of leverage”, which pertains to minor interventions that can potentially bring about substantial outcomes, Sennet and Sendra [26] propose a spontaneously emerging, yet well-coordinated disorder that enriches the built environment through enhanced associations and connectivity achieved by improving energy-supplying infrastructures. The unveiling of a “hidden city” suggests a synergy of interventions at three levels—namely below, above, and in section—in order to enable adaptations in terms of open forms, porous boundaries, and nonlinear narratives; that is, to facilitate infrastructural connectivity and leave room for incompleteness. Such an idea about porous boundaries that can be reconstructed through practical use also prioritizes a sequential approach to planning where, besides allowing for different practical uses of the built environment, reordering existing materialities adapts to the demands of climate age. By breaking the rigid surfaces of contemporary urbanity and shifting from macro to micro scales, as Dona [134] emphasizes, porosity is implemented through diverse design approaches, such as sponge cities, constructed wetlands, and decentralized canal networks. “Working on the microscale of the city means working with what already exists, not only in terms of buildings but in terms of the already existing network of people connected to those buildings” [134] (p. 198). These strategies have the potential to activate various architectural elements of the city, reconnect urban spaces, and enhance microclimatic conditions.

#### *4.3. Ethical and Aesthetic Effects of Planning*

Instead of suppressing the impacts of natural events, the planning must reorient itself towards ethical and aesthetic effects, by working with divergent materialities in order to adapt to a changing landscape in the long term. A key lesson from the posthumanist agenda is the ethical role of planning, which extends beyond introducing novel construction methods and aims to shape our understanding of the interdependence and interconnectedness of human and non-human agencies, rather than seeing them purely as “fragilizers”. In the Anthropocene era, where nature’s potent feedback can render human intervention futile, Houston et al. [133] suggest that planners should expand political reasoning to include non-human beings, rather than solely focusing on political rights, entitlements, and rewards for humans, without considering non-human entities as independent entities. Jon [135,136] further argues that the interconnectedness between human and non-human entities requires us to consider planning for a “co-becoming” in diverse multi-species

communities. This means recognizing that different agencies influence planning decisions. In the context of urban planning, focusing only on the functionality and persistence of buildings and built environments is not sufficient. Instead, planners must recognize the agency of physical structures like buildings, parks, and streets, particularly as a means of expressing and presenting more-than-human dependencies.

While the daunting issue of environmental deterioration presents an uncanny reminder for recognizing the material fragility, vulnerabilities, and self-insufficiency of urban spaces, posthuman planning, together with some architectural experiments, intends to fulfill such an emancipatory role and emphasize material dependencies through an aesthetic moment. Aestheticizing the contingencies of non-human entities and materials in order to unveil their fragile workings that sustain human life has already been highlighted in architectural discussions [144–147]. Aesthetics in this regard are considered as a tool for encapsulating the performative aspects of materials and elements, but more specifically, for attuning human occupants' perception towards their "productive" output. Bio-digital aesthetics similarly expose the workings of various non-human entities with the help of artificial intelligence. As Pasquero and Polleto [147] emphasize, this approach highlights the beauty and sophistication of the complex interplay between living and non-living matter, resulting in visually captivating and innovative designs. Namely, by integrating digital technologies, one can create striking architectural amalgamations of the organic and inorganic that celebrate the aesthetics of non-human intelligence. Ultimately, this

"[r]eassessing the dark side of urban ecology means opening up to a new aesthetic of nature and, as a consequence, of architecture. This new aesthetic of nature projects the architectural discourse into the realm of micro-organisms such as bacteria and fungi, creatures endowed with exceptional properties that make them capable of turning waste and pollution into nutrients and raw material. These scalar and material domains unveil the missing links to redefine the contemporary urban metabolism" [147] (p. 60).

## 5. Conclusions

Tackling uncertainty will undoubtedly be a significant theme in architectural and planning practices and methodologies. However, the analysis presented in this paper has highlighted specific challenges in applying antifragile tools to articulate various risks, especially those associated with climate change in urban environments. While antifragility appears to be an essential alternative to contemporary planning approaches, recognizing the uncertain and intricate nature of urban environments and fostering creative responses, future developments in antifragility should more thoroughly consider further theorizing cities as complex relational ensembles and acknowledge the inherent limits of planning. The limited applicability of antifragility in the planning and articulation of built environments arises from an overgeneralized conception of cities as systems, hindering the proper elaboration of urban dynamics and relationality. This results in defining adaptation as a simplistic application of evolutionary tinkering and trial-and-error. Such an approach, emphasizing both the ability and flexibility of adaptation, normatively aligns antifragile planning methodology with the *securitization* of urban structures. This alignment occurs without an understanding that the potential imposition of non-fragile cities and buildings may further generate uncertainties.

Therefore, it might be argued that, as a principal limitation, antifragility could introduce unnecessary volatility. The potential benefits gained from shocks are highly unpredictable and uncertain, thus limiting the very application of the antifragility. It is true that predicting can be accurate only to a certain degree and cannot provide a comprehensive understanding of the full scope of uncertainty. However, events such as massive shocks and disruptions in urban systems might be rare and slow, thus they cannot cope with the scope and scale of climate change. While some systems may indeed benefit from disruptions, there is no guarantee that these benefits will outweigh the costs or surpass the benefits of stability and consistency. Instead of focusing on improving and fine-tuning existing

systems, particularly considering that urban metabolisms themselves are at the heart of the current crisis and potential risks, the emphasis shifts towards adapting to and exploiting shocks. However, these trade-offs are not always justified, nor do they seem to be a feasible means for organizing urban structures in the Anthropocene.

For these reasons, the analysis suggests that urban planning should involve multi-faceted considerations and not hinder the somewhat burdensome coping with uncertainty in the Anthropocene. It should be directed towards a proactive and inclusive approach, reframing the city–nature relationship, and as such, incorporating more-than-human ecologies becomes urgent. Antifragility should not be easily downplayed; in fact, the conception of attaining benefits from major disruptions, such as earthquakes or floods, is at the heart of urban continuity and enabling urban well-being. Yet, in the context of the Anthropocene, the major question shifts from adapting to existing conditions for urbocentric survival to enhancing adaptation, considering broader ecological structures and uncertainties arising from their (mal)functioning. Planning should prioritize ethical and aesthetic effects, recognizing the agency of physical structures and embracing the interconnectedness of human and non-human entities. By emphasizing the intricate interconnectedness of materials and the profound significance of non-human intelligence aesthetics, urban planning can play a pivotal role in advancing an urban future characterized by heightened adaptability. It seems that antifragile planning could benefit from the rectifications proposed in this paper.

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