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Exploring DAD and ADD Methods for Dealing with Urban Heat Island Effect

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Abstract: The Urban Heat Island (UHI) effect in the context of climate change and temperature fluctuations is an increasing challenge for contemporary cities. Numerous activities focus on mitigation and adaptation to the UHI effect using both appropriately selected design strategies and technological solutions. However, not all of these technologies support the postulates of ecological and low-carbon cities. Their design, implementation, and operation process sometimes causes conflicts or misunderstandings among designers, industry engineers, and residents. The aim of the research was to examine the relationship between UHI effect mitigation, adaptation, and energy efficiency strategies. A further goal was to build a matrix of synergistic elements and conflicts for respective actors and stakeholders, and an analysis of the elitist DAD (Decide-Announce-Defend) method and participatory ADD (Announce-Discuss-Decide) or EDD (Engage-Deliberate-Decide) in dealing with the UHI effect. The literature review and case study analysis methods were applied. In the study, the strategies of five chosen European capitals (Berlin, London, Paris, Vienna, and Warsaw) experiencing a UHI problem were analyzed. As result, a matrix of the most common goal differences of respective stakeholders in dealing with the UHI effect was developed. One of the main conclusions is the necessity of undergoing synergic collaboration between actors that are not cooperating yet, combined with risk analysis and appropriate education at different levels for a successful and socially equal mitigation and adaptation to the UHI effect.

Keywords: ADD (Announce-Discuss-Decide); DAD (Decide-Announce-Defend); EDD (Engage-Deliberate-Decide); Urban Heat Island; strategy; energy; urban planning; sustainable development

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1. Introduction

The Urban Heat Island (UHI) effect is a phenomenon manifested by higher near-surface air temperatures in urban areas and is associated with an anthropic overheating problem [1]. The increase in temperatures in urban areas in comparison to surrounding rural areas is mainly caused by changes in the surface energy balance, and radiative and thermal properties over the urban land surface [2].

The problem of the UHI effect has been noticed at the global politics level and it has been shown that energy aspects play a significant role and are related especially to the issues of buildings use and their structure. In the urban context, the UHI effect is directly related to the built environment (building density and either building volumes or greenery) as well as the location and relationships between buildings.

The UHI effect significantly increases the cooling load in the summer [3,4] and therefore raises energy consumption in buildings [1,5,6]. The extreme heat events are very severe and, especially in the summer, can overload the energy system and lead to power outages—brownouts, or blackouts [7]. The most vulnerable to the power outages are dense urban structures in hot and tropical climates, however, the problem also occurs in the temperate climate zone. To avoid interruptions in the electricity supply, energy engineers recommend establishing special utilities dedicated to solve the energy supply problems [8,9].

Currently, one of the major problems in terms of interdisciplinary UHI effect mitigation and adaptation strategies is the lack of coordinated planning approaches, and the main cause of this may be insufficient collaboration of different stakeholders at respective design stages.

The major problems and difficulties are associated with end-users and result mostly from the lack of knowledge and the low motivation for changes. Sometimes the users' difficulties are also associated with social inequities or vulnerabilities. The experts group expresses more specific knowledge, and their potential problems result mostly from differences in the way of understanding the topic according to the professional discipline they represent. Unfortunately, common solutions for the group of users and experts often do not overlap. Users mostly choose available and well-known solutions. However, these solutions are not always recommended by a group of experts. Therefore, there is a need to research possible tools that would reconcile all these groups, eliminate the problems, and suggest the most efficient solutions—i.e., based on smart governance tools.

A large and growing body of literature has investigated the aspects of ultimate measures for UHI prevention [7,10,11]. More recent attention has also focused on the community engagement methods [10,12,13], such as proper communication between different stakeholders and users [12,14], along with the challenges of social vulnerabilities and inequities [15]. On the societal level, the UHI effect affects all of the population; however, the most challenging vulnerability may be residents experiencing energy poverty who may have reduced capacity to adapt to climate change at the household scale [15].

Still missing are the universal interdisciplinary tools and methods for dealing with the UHI effect and energy aspects that include the collaboration of the respective stakeholders and users at different design stages.

The DAD (decide-announce-defend), ADD (announce-discuss-decide), and EDD (engage-deliberate-decide) risk management and communication methods are working strategies for complex problems in the energy field [16–18]. This paper presents original considerations of applying the top-down DAD and more participatory, bottom-up ADD and EDD methods as potential solutions for solving complex energy and UHI effect challenges. The DAD, and ADD and EDD methods deriving from energy discipline were analyzed and verified with reference to five European capitals' strategies.

The application of a method from another discipline that could also be potentially supported with IoT technology is considered to represent a smart governance approach [19] and may allow addressing innovative solutions to the major UHI problem. However, it may also require a change in the approach of individual stakeholders along with a practitioners' workshop modification and respecting a wider range of interdisciplinary factors and methods than it was used to before.

Aims

The aim of this article was to examine the relationship between the major UHI effect and energy efficiency countermeasures to verify the potential conflicts between the stakeholders involved in the process. Based on these, a matrix of synergistic elements and conflicts for respective actors and stakeholders in dealing with the UHI effect was developed.

A further goal was to analyze the elitist DAD (Decide-Announce-Defend) and participatory ADD (Announce-Discuss-Decide) and EDD (Engage-Deliberate-Decide) smart governance risk communication and management methods traditionally deriving from energy discipline.

The next purpose was to verify the DAD, ADD and EDD methods on selected five European capital cities strategies concerning the UHI effect. As the UHI effect occurs mostly in densely urbanized areas such as large cities, the subjects of this research were western and central European capitals with a minimum size of 1.7 million inhabitants, population density of at least 3300 people per square kilometer, and the location in a temperate climate zone. Especially location in a temperate climate zone was crucial for a better comparison of the cities and their strategies, as most of the strategies are strictly climate and population bound [20]. More cities from the European Northern Hemisphere may meet these criteria. To make the analyzed cases comparable, it was decided to limit to five selected European capitals. These capitals are characterized not only by similar climatic and territorial conditions, but also by a similar planning procedure and urban processes culture. The five European capitals chosen for analysis were Berlin, London, Paris, Vienna, and Warsaw. The UHI effect in selected cities causes impacts of, i.a., higher daytime temperatures, reduced nighttime cooling, and higher air-pollution levels [21–25] that may, as a result, lead to heat-related deaths and illnesses [8]. Major attention in the analysis process was paid to the interdisciplinary approach, and citizen involvement, along with the assessment of the similarity of applied strategies to either DAD, or ADD and EDD.

2. Materials and Methods

The UHI Effect-A Challenge for Different Stakeholders

There have been numerous studies to investigate the engagement around UHI countermeasures. Several approaches have been proposed to be achieved mainly through societal engagement, whereas some of them still require complex coordinated planning approaches. There exists a considerable body of literature on what can be achieved through societal engagement [10,12,14,15]. In terms of societal engagement, community engagement methods are a key factor for mitigation and adaptation and raising awareness among the public [10]. Proper communication measures are crucial for encouraging citizens' adaptation and mitigation behaviors and cooling practices (such as air condition use, staying in shade or visiting cool-sharing facilities) and can be combined with energy saving behaviors [12,14]. A further factor for successful societal engagements is greater public awareness, knowledge, and encouragement to address UHI effects [12,13]. Whereas the awareness of the problem is crucial for mitigation strategies [13], adaptation strategies are a more helpful tool for those with lower awareness or concern [12]. For proper social engagement, a crucial aspect is also identifying and addressing those most vulnerable during heat events [14]. This requires the appropriate support of leaders towards social service or community programs [14].

Several aims, however, are not possible to be met without interdisciplinary coordinated planning approaches. For instance, urban design and resulting airflow: types of buildings, materials and morphology, urban greening, water features, green and blue infrastructure, and cities albedo need coordinated planning approaches and the collaboration of different stakeholders [15]. Several studies emphasize also the need for determining the ultimate measures for UHI prevention—heat action plan recommendations that will involve a wide variety of stakeholders, and form the neighborhood scale to city decision makers, funders, and additional communities [10].

Coordinated planning may also be a key for corresponding to the needs of the most vulnerable. The studies suggest that interventions such as emergency preparedness plans or heat health warning systems may not be reaching the most vulnerable and may remain often inaccessible financially, physically, or culturally [14]. In light of these reasons, the more inclusive coordinated approach is recommended that, along with the expertise and evidenced-based data, will help to understand personal, interpersonal, and community resources influencing the vulnerable during heat events [14].

As the prior studies showed [10,26], the process of UHI mitigation and adaptation concerns a wide group of stakeholders, such as policymakers, the users, and the practitioners—an experts' group including architects, urban planners, energy engineers, and other specialists. All of these actors have their own needs, expectations, and knowledge. Due to different factors, not all of them are involved in the UHI mitigation and adaptation process at the same level. The involvement of respective actors depends largely on their awareness, willingness to participate, and, first of all, the adopted policy and risk management method.

Numerous research evidenced the use of urban greening, aspects of albedo and emissivity [3,6,7,27], or modification of urban designs [11,27,28] as useful solutions for UHI effect mitigation. These exemplary activities require the interdisciplinary cooperation of many actors at various levels of planning and implementation. Despite this fact, the incorporation of new strategies into urban policy still depends mostly on policy-makers awareness [26].

A severe challenge for the stakeholders is also the fact that the growing problem of the UHI effect requires often unhesitating, multi-faceted actions and interventions met under the time pressure. Due to time restrictions, rapid reactions to the problem are required where either all the actors involved must make several compromises and not always meet their individual goals, or some of the stakeholders are excluded from the decision-making process. Due to time restrictions and the severity of the problems, the approach to the decision-making process is therefore mostly top-down. As it may be difficult to implement a rapid strategy and engage society at the same time, there is an emerging tendency among cities of planning in advance and preparing how to involve the users and other stakeholders into a more inclusive process of UHI effect mitigation and adaptation.

3. Results

3.1. Contradictory Aims of Different Expert Groups in Terms of UHI Prevention and Providing Highest Possible Building Energy Efficiency

The interdisciplinary strategies undertaken by all stakeholders are of a great meaning due to the complexity of the UHI effect.

Despite the commitment of individual actors and the willingness to make their own contribution, some significant conflicts of interest between the various groups may appear during the decision-making process. They result from the specificity of the work of individual groups and their individual goals, and are synthetically presented in Table 1.

Determination of the main goals and the most common problems of individual groups of stakeholders at the beginning of the process of UHI effect strategies creation may facilitate cooperation and dialogue along with the creation of possibly beneficial solutions for various parties.

The main aim of energy engineers is to provide reliable, failure-free energy systems-to achieve it not so much attention is laid on planning issues and UHI effect. The understanding of "climate action" by energy engineers is focused mainly on the application of renewable energy sources and distributed energy systems.

One of the goals of planners and architects is to minimize total building energy consumption and avoid building and urban overheating by a proper solution (i.e., passive cooling strategies at the micro (building) scale, mezzo (neighborhood) scale, and macro (city) scale). Increasing awareness on energy aspects means that planners are obligated by national and international regulations to integrate in their design workshop exergy-based energy efficient solutions, such as passive design, net-zero energy buildings, plus energy buildings and renewable energy sources. However, energy efficient design may stay in contrast to some UHI strategies, such as district cooling [29]. This shapes a further potential conflict between energy engineers and planners.

The users should be focused on minimizing energy consuming patterns and the usage of individual air conditioners and use instead of organized passive building solutions.

The examples recalled show only a certain part of the problem but are a sign of increasing problems arising from different needs. Conflicting groups result from the same point of view and different professional knowledge. From these examples, it can be seen that there is a need for synergistic planning. To visualize these conflicts and collect synergies and conflicts, a matrix was developed (Table 1).

Table 1. Matrix of most common problems and adopted solutions by the stakeholders in terms of UHI effect mitigation and adaptation.

Involved Stakeholders	Involved Stakeholders					Problem	Common Solution Used by the Group to Solve the Problem	CONFLICTING SOLUTION: Explanation of Contradiction	Reference
	Users, Residents	Urban Planners a & Architects	Energy Engineers	Policymakers					
Users, residents		+	+		1	Little awareness or education on UHI effect mitigation and adaptation associated with user behavior	Individual air conditioning system	Urban overheating caused by individual air conditioning installations	[12,13]
			+		2	Little motivation for energy-saving behavior or approach	The usage of numerous non-energy saving electric appliances (especially in hot summer days)	Energy brownouts and blackouts (especially in hot summer days)	[12]
		+			3	High cooling demand of non-retrofitted buildings-high prices of building energy retrofits, discouraging from renovation	No action: lack of building energy retrofits	Non energy-efficient buildings requiring high cooling (and heating) demand	[30]
Urban planners and architects			+	+	4	Restrictive legal regulations on climate-sensitive and energy-saving planning	Application of restrictive energy efficient solutions to buildings and urban layouts	Expensive design solutions, Difficulties with district cooling	[29]
Energy engineers		+			5	The occurrence of energy brownouts and blackouts	Application of District Cooling solution	District Cooling functions best at high urban densities and for non-energy-efficient buildings	[7,9]
Policymakers	+	+	+		6	Little expertise on technical or inclusive solutions and adoptions for UHI effect mitigation and adaptation Lack of understanding the "real needs and problems" of the users and the complex expertise methodologies of the experts' group	Either focusing only on experts' point of view or allowing for spectacular solutions well approved by the users (but not by the experts/ but having minor significance and not solving the real problem from the technical point of view)	Excluding either the society from decision making process	[29]

Note: Shadowed elements marked with a plus (+) indicate the existence of a conflict between respective stakeholders.

3.2. Matrix of Contradictory Aims and Problems Differences of Respective Stakeholders in Terms of UHI Prevention and Providing Highest Possible Building Energy Efficiency

The matrix was made based on literature review results and presents the most common goals of respective stakeholders involved in energy efficiency and UHI effect countermeasures application. The matrix considers the problems between individual actors and the solutions they take, often leading to conflicts. The last column lists the conflicts that occur between the respective groups with a brief explanation of the conflicting solution.

Many problems presented in the matrix arise from lack of communication at each design phase—from the very beginning until the end. A further problem shapes the lack of qualification and little motivation. On the professional background, serious problems shape mainly the differences in design and work practice and the overload of regulations.

In UHI effect mitigation and adaptation strategies, a crucial aspect is creating decision-making and communication between experts and the lay public. [18] Due to the potential conflicts and misunderstandings among different stakeholders, and to provide a fair inclusive urban policy and decision-making process, currently, the recommended approach is represented by inclusive participatory actions. Therefore, there is a great need to seek for a common dialogue tool and a strategy for the method of operation between respective stakeholders.

3.3. Risk Communication and Management: The DAD, ADD and EDD Methods

In the context of increasing energy problems (also in terms of the UHI effect), it is worth considering implementing the working tools known and successfully used by other specialists in their regular professional practice.

Currently, several approaches concerning the decision-making process in the public sector can be distinguished—from traditional top-down to a more inclusive bottom-up approach. In terms of energy context and discussing the issues with the public [18,31,32], worth mentioning are the DAD (decide-announce-defend) [16,17,33], and ADD (announce-discuss-decide) [18] or EDD (engage-deliberate-decide) [17] methods.

These methods, due to their universality, could be successfully applied in other disciplines and processes related to risk communication and risk management [34], such as UHI effect mitigation and adaptation strategies.

A brief graphical comparison of top-down DAD and bottom up ADD and EDD methods is presented in Figure 1.

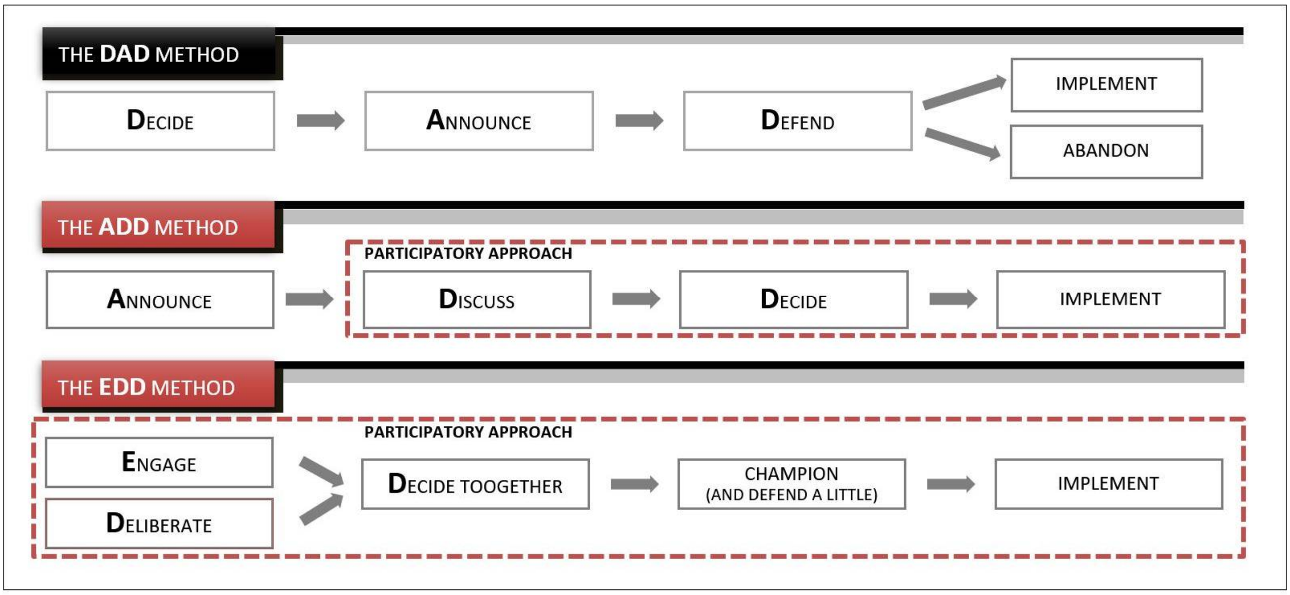

Figure 1. The juxtaposition of DAD, ADD, and EDD methods. Authors' elaboration based on [16,18].

The ADD and EDD strategies can be relevant to climate risk reduction strategies as they are traditionally applied for complex energy problems engaging a wide variety of different stakeholders representing contradictory aims. In energy problems [31], the application of ADD or EDD methods leads to engaging a wider range of different actors that enables deliberating together and leads to smoother, widely supported, and more quickly implemented solutions.

The elitist model of the DAD method is a commonly adopted top-down method based solely on best expert knowledge and practice, at the same time ignoring the meaning of (end-)user experiences and collaboration [16,17], but at the end explaining the experts data and decisions to the public. The unquestionable benefits of the DAD method are the use of expertise and fewer people involved, meaning a shorter decision-making process. In emergency situations, the usage of this method may prove most relevant, when the speed of reaction is of a biggest importance.

However, the DAD method is not recommended to the contexts where a wider group of factors is influencing the situation and the successful implementation may involve numerous actors [16]. The biggest disadvantage of this method is the probability of failure in the case of the lack of acceptance in the final implementation phase from the users' side. Users' resistance in the final phase may occur to be time consuming and the defense of the experts' solutions may end up in abandoning the carefully developed experts' solutions.

The alternative approach, engaging with users' concerns and needs, at the same time inviting them in to the participation at an early stage, is the EDD [16] or ADD [18] method. Both ADD and EDD methods have a lot in common with the participatory approach broadly adopted in urban planning. These inclusive decision-making methods are recommended by Sustainable Development Commission and the Environment Agency (as part of its Building Trust with Communities) [16].

Both in the ADD and EDD approach, the dialogue with the public is of a great importance along with involving the public into the decision-making process. In EDD, instead of blocking users' objections, such as in the DAD approach, they can be discussed in public and solved in an understandable and commonly acceptable way.

The ADD and EDD solutions have also disadvantages specific to the participatory approach. First of all, they can be difficult to implement in a restricted timeframe. Environmental extreme weather conditions associated with UHI effect can occur unexpectedly and in such situations the time for reaction is very limited. Moreover, integrating too many actors in the decision-making process may end up with no clear solution for the problem. In the planning and solution-finding process, the correlations between the individual actors involved in the process can be very complex, and therefore the outcome of the design decisions made can be unpredictable [35].

The DAD and ADD methods differ primarily in their approaches towards decision making-top-down and bottom-up, and the aspect of including society in decision-making process.

Nowadays, participatory models have proven their worth and currently they are the main substitute for the elitist, top-down DAD planning and decision-making process. However, still, in traditional approaches to problems, very often a top-down solution is the main choice that excludes the participation of the public but provides a relatively quick and expert-based solution.

In the study conducted for this article's sake, after analyzing contemporary applied urban practices aimed at preventing the UHI effect, noticeable was a clear dominance of the non-participatory DAD method (Berlin, London, Paris)—despite the fact that DAD is no longer accepted by a variety of interest groups or parts of the general public.

The understanding of smartness in terms of DAD, and EDD and EDD is associated with basic smart objectives—being Specific, Measurable, Attainable, Relevant, and Time-Bound. In the context of emerging smart governance solutions [19,36,37], the promising solution may be the application of smart collaboration tools and strategies based on them. In the future, the ADD and EDD methods, thanks to the support of smart technology-enabled solutions, could better reach a wider stakeholder group and facilitate the joint efforts towards UHI effect mitigation and adaptation.

3.4. The Selected Capitals' Approaches and Strategies for UHI Effect Mitigation and Adaptation

In the last decades, Europe experienced an increased number of extreme heat waves that affected not only southern Europe, but also its central and western parts. So far, extreme heat waves in western and central Europe have not been a frequent phenomenon. Recent studies [38,39] indicate that Europe experienced, and is going to continue to encounter, an increased probability for heatwaves despite the fact that global mean temperature projections do not differ significantly.

For the sake of this study, five European capital cities were qualitatively chosen for the analyses based on the criteria described in detail in the Methods section. The strategies of the selected capitals focus on an interdisciplinary approach and citizen involvement. A case study approach combined with a critical qualitative literature review was used to allow complex analyses within this research. The case study analysis included a critical qualitative literature review of the official capitals' documents concerning UHI strategies under the criteria determined in Table 2.

The UHI effect strategies of the selected five European capital cities were analyzed in terms of interdisciplinary approach, level of stakeholder collaboration, and the method of citizen involvement. Then, the strategy type was assessed for similarity to DAD, or ADD and EDD strategies. The analyses were conducted according to the official documents provided by cities describing their UHI effect urban strategies (Table 2).

Table 2. The main elements of citizen involvement, interdisciplinary approach of five capital cities based on their official UHI effect strategies.

City	Documents and Strategies Analyzed	Interdisciplinary Approach	Citizen Involvement	Collaboration at All Planning Levels (Policymakers, Citizens, Experts)	Method of Citizen Involvement			Similarity of Adopted Model to: DAD/ADD/EDD
					Workshops	Education	Pilot Projects	
Berlin	"Ökosystemleistungen In der Stadt" [Ecosystem services in the city] [40] "Stadtentwicklungsplan Klima" [Urban development plan climate] [41]	+	+	+		+	+	Similarity to DAD -Education and participation (EDD) for "smaller small-scale climate adaptation measures"
London	"Severe Weather and Natural Hazards Response Framework" [42,43], "Reducing urban heat risk. A study on urban heat risk mapping and visualization". [44]	+	+	+		+		Similarity to DAD-citizen engagement only when engagement and communication with local residents is required -providing triggers "individual agency and partnership action"
Paris	"Paris 2050, Climate Air, Energieé" "Paris climate action plan towards a carbon neutral city and 100% renewable energies" "Paris-Adaptation Strategy: Towards a More Resilient City" [45]	+	+			+		Similarity to DAD -citizen engagement
Vienna	"Urban Heat Island Strategy, City of Vienna" [24]	+	+		+	+	+	Similarity to ADD/EDD New plans achieved through participation
Warsaw	"The climate change adaptation strategy for the city of Warsaw by 2030 with the prospects until 2050" [ADAPTCITY project] [46]	+	+		+	+	+	Similarity to ADD/EDD-education, consultation and participation of citizens

Notes: The official cities documents were analyzed under the aforementioned UHI effect criteria. The analyzed document were most recent available versions (no older than 6 years for the moment of this study). Shadowed elements marked with a plus (+) indicate the existence of respective solutions.

The analyzed documents indicate that in the context of current UHI city strategies in London, Berlin, and Paris, the activities are mainly focused on professional actions (not including energy engineers) in the top-down approach similar to the DAD method. This approach is supported by single participatory activities. The role of citizens is reduced to small-scale participation: "small-scale climate adaptation measures" (Berlin) [41], or limited to the situations "only when engagement and communication with local residents is required" (London). The strategy of London also incorporates "providing triggers for individual agency and partnership action". It should also be emphasized that the participation activities of individual cities were evaluated only in terms of UHI mitigation and adaptation strategies. The above-mentioned cities successfully implement participatory activities in other fields of planning, which is not the subject of this article.

Compared with other analyzed cities, Vienna is the most oriented towards participatory activities, and has already successfully implemented a participatory approach in the decision making and planning process of UHI effect mitigation and adaptation. Vienna's approach is similar to ADD or EDD models and creating incentives for private individuals can become a good role model for other cities in terms of participatory approach.

Warsaw also promotes an inclusive approach in line with the ADD or EDD assumptions. As a part of the Warsaw ADAPT City project, a series of workshops, consultations, and participation actions were organized that led to an increase in citizens knowledge and awareness in terms of climate-bound occurrences [46]. Also, in Vienna there are already examples of implementing such an approach—considering better citizen inclusion in UHI effect strategy development [24]. UHI-related basic activities in the city of Warsaw focus mainly on the level of awareness-raising of individual actors as the basis for all activities.

Energy issues were addressed in each of the UHI effect strategies and most often amounted to the issue of improving the energy efficiency of buildings and reducing heat demand along with promoting sustainable mobility (public transport, cycling, and walking). Despite the clear connotation of energy demand and UHI effect, the strategies did not pay special attention to the expert group of energy engineers. In the analyzed documents, all cities emphasize only the general importance of an interdisciplinary approach and the involvement of various actors.

All the analyzed cities emphasize in official documents the role of participation and inclusion of society. They also provide studies on the UHI effect on generally accessible websites, what proves the commitment and willingness to educate the public. All the cities indicated also at least one form of participatory approach as one of the solutions to the UHI problem at the urban level.

4. Discussion

The study confirmed the occurrence of conflicts and contradictory aims of different stakeholders involved in the implementation of UHI effect and energy efficiency strategies. However, it is hardly possible to state unanimously which party to prioritize, as the intensity and severity of the conflicts may be site-specific.

DAD (Decide-Announce-Defend), and ADD (Announce-Discuss-Decide) and EDD (Engage-Deliberate-Decide) strategies are working solutions in the energy sector. The DAD approach is mostly top-down, whereas ADD and EDD are more inclusive and participation oriented. The major difference between ADD and EDD is the moment of participation introduction—either at the very first stage (EDD) or during the discussion stage (ADD). Both of these strategies may be laborious, but in turn assure successful problem solutions (that may also require severe compromises from different stakeholders). The DAD approach promises quicker problem solutions based solely on experts' knowledge but may result in abandonment when lacking in public acceptance. The analyzed DAD, ADD, and EDD risk communication and management methods derive traditionally from energy discipline, and thanks to their special characteristics can be considered as smart governance tools and may find a potential application for dealing with interdisciplinary UHI effect and energy problems. In the future, the promising perspective may be a combination of ADD and EDD strategies with smart IoT technologies to better address a variety of stakeholders, trigger more effective communication, and raise the common awareness of the UHI effect and energy efficiency challenges.

This study analyzes only some strategic documents and is the first step to the research on risk communication and management methods in terms of energy and the UHI effect. As the next step for the future research, it will also be important to analyze the public perception of the effectiveness of the strategies implemented by the cities. It could be useful to conduct bottom-up research analyzing, for instance, local press. Then it will be possible to gain in-depth understanding and social evaluation of the discussed issues from the end-users' perspective.

The UHI effect strategies of all the analyzed European capitals contain at least the elements of inclusiveness, citizen involvement, and interdisciplinary approach. They differ in applying either the ADD, EDD, or DAD strategies, and the respective stakeholders at different implementation phases. Currently, most of them (London, Berlin, Paris) are still focused more on an approach similar to DAD. The strategies of Vienna and Warsaw declare a more bottom-up approach close to ADD and EDD methods. There is a need of further verification of the strategies for updates concerning citizen involvement, as inclusiveness is a postulate declared by all analyzed capitals.

As there are no universal solutions, the UHI strategies require site-specific solutions. However, the conclusions from the conducted analyses of strategies, with some limitations, can serve as a guideline for other cities. Although it is impossible to transfer the solutions directly because of unique characteristics, needs, and values, the process could be applicable to other locations and can be supported by a thorough application of ADD or EDD milestones.

5. Conclusions

Nowadays, the importance of energy problems increases also in the context of the UHI effect. Therefore, it is worth considering the implementation of tools known and used by energy specialists to solve the interdisciplinary UHI problems. The DAD (Decide-Announce-Defend), ADD (Announce-Discuss-Decide), and EDD (Engage-Deliberate-Decide) approaches are traditionally associated with energy conflicts and provide a theoretical possibility of adopting them into UHI effect countermeasures. Their basic characteristics enable their consideration as a smart tool—meeting the objectives of being Specific, Measurable, Attainable, Relevant, and Time-Bound.

Crucial information is also the fact that the action against UHI effect should also be oriented on energy aspects, such as decreasing energy demand by building energy retrofits, optimizations in urban layout, and raising user awareness on responsible electricity use. In the context of the ongoing dynamic technological development, there is a possibility that participatory methods of ADD and EDD will be supported by smart governance and smart energy solutions for a better technology-enabled collaboration between citizens, experts, and local governments, and a more effective contribution to the UHI effect strategies.

Methods involving the community and various actors are well known in the design practice of urban planners; however, attention should be paid also to the necessary dialogue with other experts, including energy specialists, that should ideally be applied from the early-stage design phase (Figure 2).

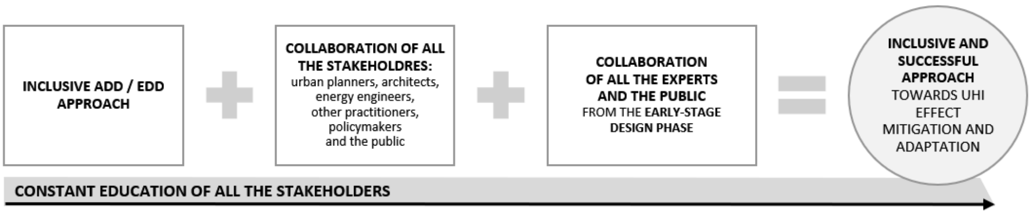

Figure 2. The main milestones of inclusive and successful approach towards UHI effect mitigation and adaptation strategies.

The conflicts between the stakeholders can pose a challenge to the successful implementation of solutions; however, if all stakeholders are engaged in a dialogue in advance, some ambiguities can be minimized at the beginning of the strategic process—such as determination of a common strategy and appliances used.

There is a great need for collaboration and proper communication of policymakers, energy engineers, and planners, joined with the participation of residents from the initial design phase. The practice of energy engineers shows that the top-down solutions, in accordance with the DAD principle, may meet with the final rejection and the destruction of the effort put into the developed strategy. However, even with an early interdisciplinary collaboration, the trade-offs between individual stakeholders may prove necessary as the respective priorities may be mutually exclusive—as shown in Table 1. Hence, it is important to educate and constantly improve the competences of all the stakeholders regarding UHI effects, strategies, and solutions.

Persuading people to accept or take a change may be challenging, especially in terms of environmental actions. Therefore, it is crucial to respect an inclusive participatory ADD or EDD approach rather than forcing a top-down, expert-based only solution and risking generating resistance.

The developed matrix of contradictory aims and problem differences of respective stakeholders in terms of UHI prevention showed several potential conflicts, such as the contradictory stakeholders' aims, appliances, and methods used. The research showed that the users generate the most problems in terms of UHI effect countermeasures acceptance.

Earlier studies showed that there is a need for raising awareness among the public because the awareness of the problem is crucial for mitigation and adaptation strategies. Therefore, also proper communication measures are crucial for encouraging the stakeholders' involvement. Out of these reasons, the authors decided to explore thoroughly the decision-making process. It was shown that a more participatory-oriented approach is represented by the ADD or EDD methods.

This study fills the existing gap in the literature as it shows different stakeholders' visions and conflicting dimensions of the UHI effect countermeasures. As a result, the novel ADD and EDD methods for solving complex problems associated with UHI effect and energy efficiency were proposed. The wider the variety of different citizen involvement methods is, the smoother and more successful the impact and collaboration with the users and other stakeholders may become. Hence, it is crucial not only to inform, but also to educate and pilot the implemented solutions. It can hardly be achieved by the only means of formal documents; therefore, effective user behavior changes and involvement methods may prove necessary to achieve a real change.

This application of a method from another discipline that could also be potentially supported with IoT technology is considered to represent a smart governance approach [19] and may allow for addressing innovative solutions to the major UHI problem. However, it may also require a change in the approach of individual stakeholders along with a practitioners' workshop modification and respecting a wider range of interdisciplinary factors and methods than it was used to before.

It will be important that future research investigates the impacts of ADD and EDD methods in Warsaw and Vienna, and measures how much influence they had on user behavior. Future studies should also aim to replicate results in a larger research sample—including a larger number of analyzed cites and verifying their strategies with a longer time perspective. This approach could be the next step to fully evaluate the usefulness of ADD and EDD methods in UHI effect and energy efficiency countermeasures. Another promising direction for the future research could also be supporting the DAD, ADD, and EDD strategies with smart technologies such as IoT to trigger better inclusion and dialogue between all the stakeholders and users.

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