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Developing Policy Scenarios for Sustainable Urban Growth Management: A Delphi Approach

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Abstract: In many parts of the world, a rapid urbanization process is taking place at an unprecedented scale, and its drastic impacts on societies and the environment are evident. To combat the externalities of such rapid, and to a degree uncontrolled, development, many cities around the globe introduced various urban growth management policies. However, policy making—to provide sustainable outcomes, while generating growth opportunities—has been a daunting task for urban administrators. To ease the task, scenario-based planning methods are introduced to produce alternative visions for managing urban growth in sustainable ways by incorporating various socio-environmental issues. However, even though modelling urban growth and associated impacts based on these scenarios have emerged to strengthen and quantify the future of urban policies and related planning actions, this process has a number of glitches. Major issues include the uncertainties associated with the selection of suitable methods to generate scenarios, identify indicators to be used to assess scenarios, evaluate scenarios to prioritize for policy formulation, and assess the impacts of policy scenarios. This paper aims to address the challenge of developing suitable policy scenarios for sustainable urban growth. As for the methodological approach, the study undertakes a thorough review of the literature and current practices, and conducts a two-round Delphi survey—involving experts from public, private and academic sectors specialized in the fields of urban planning, environmental planning, social planning, transportation modelling, and economic development. The expert driven policy scenarios are validated in a local context by comparing findings against the policy options as proposed in the South East Queensland Regional Plan 2017 (Australia). The findings offer valuable guidelines for planners, modellers, and policy makers in adopting suitable methods, indicators, and policy priorities, and thus, easing the daunting task of generating sustainable policy solutions.

Keywords: sustainable urban development; urban growth management; policy scenarios; scenario-based planning; sustainability indicators; Delphi method; regional plan; South East Queensland; Australia

1. Introduction

This study focuses on addressing the research question of: How can alternative policy scenarios for sustainable urban growth be developed? Urban areas are the most functional centres on the planet earth [1,2]. Due to their functional diversity, sustainable management of urban growth is a major challenge for urban planners and administrators. The complexity of urban ecology, social aspirations, and economic concerns have never provided a perfect solution that may lead to a sustainable urban growth policy [3]. Additionally, major environmental challenges such as climate change, resource depletion and deterioration of biodiversity have made this desire more difficult to achieve [4,5]. Technological advancement has also contributed to increased environmental problems. For example,

air pollution is considered to be one of the major second-order consequences of combustion engine motor vehicles [6], although these undesirable effects were not originally intended by the technological advancement of the early 1900s [7]. As a response, sustainability science has emerged to deal with these intricate issues of urban growth through an analysis of complex interactions of diverse systems and providing ideas for sustainable societies accompanying technological advances [8–10]. Sustainable urban development is a contemporary paradigm to address the abovementioned challenges to provide a way to achieve a desirable urban future. It is deliberated as improving the quality of life in urban areas, including socio-ecological, institutional and economic components without draining the natural resources [11].

Traditionally, master plans, land use allocation, and functional zoning were used as the main tools for urban growth management [12]. Functional zones were used to prescribe land use characteristics and economic functions of an area, while master plans were employed to locate the future functional zone [3]. With the technological advancement, planners have adopted highly innovative and modern methods to envisage urban growth plans and assess their effectiveness. Particularly with the use of computers, modelling algorithms and big data processing have enabled urban planners to utilize such methods effectively and efficiently to address future problems. However, questions still remain about their reliability against uncertainties particularly when an analysis is focused on the sustainability of urban growth. Urbanization process can produce both negative and positive outcomes in a socio-environmental context. Urban growth management approaches to manage the urbanization process may generate unexpected or unwanted and uncontrolled results, when approaches failed to find a right balance between negative and positive effects of urbanization [13]. To identify sustainable urban growth management solutions, it is of critical importance that planners and urban growth managers are able to forecast and mitigate conflicts as well as prepare the cities for potential shocks.

Recently, scenario-based planning approaches have gained importance to deal with uncertainties associated with economic, social, and environmental outcomes of urban growth. Researchers have combined scenario-based planning approaches with urban growth models to simulate alternative urban growth scenarios and to assess their impacts [14–18]. In contrast to the traditional planning approaches, scenario-based planning is not merely a prediction; rather it is an imaginative explanation of possible future images that might unfold by analysing past, present and future challenges [19,20]. Therefore, the scenario-based planning method is a remarkable progress towards the notion of sustainable urban growth, as scenarios assist policy makers to select strategies via exploring alternative futures, warn people about uncertainties, and help all parties in developing a sound vision [19,21]. However, even though modelling urban growth and associated impacts based on these scenarios have emerged to strengthen and quantify the future of urban policies and related planning actions, this process has a number of glitches. Major issues include the uncertainties associated with the selection of suitable methods to scenario generation, identify indicators to be used to assess scenarios, evaluate scenarios to prioritize for policy formulation, and assess the impacts of policy scenarios. Previous works of the authors have contributed to solving the first two issues—scenario generation and indicator selection process [18,22,23]. This paper aims to address the challenge of developing suitable policy scenarios to steer sustainable urban growth. The findings of this research form critical evidence base of what constitutes a sustainable urban growth management policy. The policies identified in this study are not specific to any geographical location. Furthermore, the policies identified in this study cover all three aspects of sustainability—i.e., social, economic and environment—and provide a broad area of application. Therefore, researchers, planners, and policy makers can use the findings of this study to evaluate the potential outcomes of alternative urban growth policies to select the most suitable scenario for sustainable growth in different parts of the world. However, this research urges to validate the suitability of the identified policy scenarios when applied in a particular context.

From an operational perspective, it is critical to proactively develop policies that would enable growth management in a sustainable way rather than following a reactive approach [16]. A reactive approach relies on historical data and trend analysis to generate growth management policies without

taking into account uncertainties and potential technological disruption [9,24]. Existing research studies have also taken the policy measures as given and focused more on analysing their sustainability outcomes rather than focusing on how to develop policy scenarios that would generate a sustainable urban development [10,25–30]. This research is an attempt to address this research gap, and aims to apply a systematic method for the generation of sustainable growth management policies, and their validity in a local context namely, South East Queensland (Australia). Section 2 of the paper provides a detailed review of the literature with an intention to identify a range of policy options that have been used to manage urban growth in a sustainable manner. Section 3 outlines the methodological approach employed to assess the suitability of policy scenarios for sustainable urban growth management. Section 4 presents the evaluation results of the policy scenarios. Section 5 discusses the results in operational terms, and concludes the paper by highlighting the key findings.

2. Literature Review

2.1. Sustainable Urban Development and Growth Management

Natural resources have been significantly compromised and degraded due to rapid urbanization—i.e., increasing urban population, urban sprawl, and extending transportation networks and industrialization. Therefore, the concept of sustainable urban development has been a prime concern of policymaking and government to aware and mitigates the impacts of climate change due to fast paced and irreversible urbanization [31,32]. Urban growth management has been defined in many ways, but essentially it involves government's actions to guide the location, quality, and timing of development [33]. Urban growth management policies are frameworks or tools to manage urban growth in a way to restrain its implication to natural areas and the environment [34]. These policies can be regulatory or incentive oriented to manage urban development by using diverse strategies [35]. Land use zoning is a key method used for urban growth management [36]. Different urban growth management plans have been practiced by local governments to guide land use allocations at different scales, such as city, region and state levels [37]. However, growing concern about the socio-environmental cost of urban growth in the 1960s and 1970s indicates a surge in anxiety about the impacts of urbanization and importance of managing growth [35]. Such concerns are closely linked to quality of life, environmental conservation, efficient urban form, urban revitalization, transportation choices, and affordable housing [38]. Urban growth management policies that can lead to the development of environmentally, economically, and sociality sustainable urban areas are key topic of urban planners, policymakers, and scholars.

To overcome the weakness of traditional planning practices, alternative urban growth management approaches are proposed [18]. These alternative approaches include: dispersed city (continual low density suburban development) [39,40]; compact city (increased population density within a central group of suburbs) [41]; fringe city (further growth predominantly on the fringe of the city); corridor city (growth along linear transportation corridors originating from the central business district) [42]; city cluster development (regional city cluster that consists of cities of different sizes instead of one large city) [43]; and transit-oriented development (integrated amenities and neighbourhood development within a walkable distance from public transport) [44]. Hence, various policy instruments are available for policy makers and planners to manage the future urban growth. However, sustainable urban growth policies require an in-depth understanding of the impacts of current urban growth policies to prepare for and mitigate unexpected outcomes. Additionally, urban growth management policies, to achieve sustainable development, require a holistic approach to involve all stakeholders from relevant areas in the decision process, such as transportation, land-use, environmental, and economic developments [45].

2.2. Indicators of Sustainable Urban Growth

Sustainable urban development concept was adopted by planners as an ideology or a development philosophy as early as 1970s [13]. Since its formulation, the approaches for achieving sustainable urban development aimed to incorporate environmental issues along with socioeconomic challenges in growth management policies. To understand about the state of, or changes to, urban areas for achieving sustainable urban development different sets of indicators, a number of frameworks and assessment tools have been employed [11,46]. These urban sustainability assessment frameworks and indicators were developed to better inform urban management policy formulation and decision-making processes. Today, a wide range of indicators for monitoring sustainable urban development is in use across the world, which varies according to their specific goal in different geographic locations [47–49]. Dur et al. [50,51] described an indicator as a parameter, or a value derived from parameters, which points to, provides information about, describes the state of a phenomenon/environment/area. An additional term composite indicator by definition refers to an aggregate metric derived from a set of indicators. Composite indicators are based on a complex concept used to define a set of multidimensional indicators by using mathematical and statistical tools.

During the last decade, researchers used various indicators and indices to analyse sustainable urban growth. These indices included indicators such as: land use indicators [52]; transportation indicators [25,53]; land-use and transport integration indicators [50]; environmental indicators [54,55]; and socioeconomic indicators [55–57]. Sustainability assessment indicators were employed as a tool for analysing the urban growth impacts on environment and as policy formulating instrument to identify way for achieving sustainable urban development [58]. Furthermore, sustainability assessment indicators are increasingly being used as a key instrument to monitor the human-environment interaction in the world. It provides valuable information to assess the performance of existing economic, social and environmental policies [59]. In general, sustainability indicators and indices are employed for four main purposes: (a) providing information about the current state of a phenomenon; (b) supporting policy making; (c) monitoring the efficiency and impacts (or outcomes) of policies; and (d) increasing awareness by providing information on environmental externalities of urban development [60].

2.3. Scenario-Based Planning for Sustainable Urban Growth

The term "sustainability" has been integrated in a number of ways with the term "urban" since early 1990s [10]. Few of the examples are "sustainable cities" [30], "sustainable urbanization" [61], "urban sustainability" [62], "sustainable urban planning" [63], "sustainable urban form" [5], and "sustainable urban development" [64,65]. Usually, these terms are interchangeably used in the literature [10]. However, there are some important differences. For example, the term "sustainable city" can be defined as a self-sufficient city that utilize the resources produced within the city independently [66]. The term sustainable urban development refers to the mechanism to achieve urban sustainability—i.e., urban sustainability is the desired development outcome [67]. Thus far, the terms "sustainable urban development" and "sustainable urban growth" are both used as synonyms to each other, as both terms refer to the same process. As described by Dizdaroglu and Yigitcanlar [68], sustainability is a manifesto for destructive human activities. The concept of sustainability of urban areas has led to the self-contradictory term sustainable urban development. Sustainability refers to maintaining the existence of the ecosystem and its services, while also providing for human needs, whereas, in contrast, urban development refers to any activity that improves the quality of life by depleting natural resources and devastating natural areas [68,69]. Therefore, the sustainable urban development concept is presumed as a solution to minimize the environmental externalities caused by widespread urbanization on the ecosystem [69].

Scholars define sustainable urban growth as a process of integrated development of all subsystems (i.e., economic, environmental, and social) of urban areas without compromising the wellbeing of communities while reducing the pressure on natural resources [70,71]. However, sustainable urban

growth requires active involvement of all stakeholders affecting (or being affected by) urban growth including policy planners. Thus, the ultimate aim of sustainable urban growth management is to find a balance between environmental, economic, and social aspects of urban areas to minimize negative impacts of fast paced urbanization on natural system. To achieve this aim, a holistic approach is required—as discussed in Section 2.1. While there is substantial agreement about the theoretical definition of sustainable urban growth, a major challenge is the conversion of the theory into a planning policy or standard of urban growth management practices [26].

Institutions, urban planners and governments adopted various frameworks and assessment tools to promote sustainable urban growth [46]. Sustainability indicators, composite indices and integrated assessment models like multi-criteria analysis (MCA) are few examples of the tools used to promote sustainable development [72]. Recently, scenario-based planning has gained considerable importance as it facilitates the policy makers to foresee and mitigate the conflicts among urban growth subsystems—i.e., environmental, economic, and social. In addition, scenario-based planning let policy makers and governments to prepare for the uncertain future and prevent them for the undesirable surprising outcomes of their urban planning policies [21,73–78]. Perveen et al. [18] elaborated that scenario-based planning methods are the key instruments for urban planning because planning policies are often undertaken for longer time spans—e.g., 10, 20, 50 years—and based on present day assumptions of future conditions, and therefore, involve a great deal of uncertainty to reach the policy goals. The conventional urban planning model—e.g., zoning of different land uses—employs trend projection as an approach for future development, and therefore, lacks the ability to take into account uncertainties associated with urban development. Among many challenges to achieve sustainable urban growth, addressing the prospect socio-environmental issues required participatory and community based planning. Consequently, researchers have used scenario-based planning methods to produce alternative visions for managing urban growth in sustainable way by incorporating the socio-environmental issues.

Scenario-based planning practices highlight that it is impossible to predict one future that would be the reality because it is unknowable and human adoptions play a significant role in developing the future. For these reasons, futurists do not practice a single scenario, but foresee several alternative scenarios. Nonetheless, there are no set criteria for an ideal number of scenarios. Pillkahn [79] explained that the number of scenarios can range between two to 10 according to the definition, aim and scope of a project. Mostly, scenario-based planning practices rely on three to five scenarios to model the impacts of urban growth [4,29,80–82]. Schwarz [83] indicated that a large number of scenarios have a tendency to blur the differences between scenarios, and lose their meaningful distinctions as decision tools. On the contrary, fewer scenarios are not proficient to apprehend the complexity and uncertainty associated with future urban growth. Therefore, multiple scenarios are essential to understand the information outlooks about uncertain and challenging transformation of futures.

2.4. Methods of Scenario-Building

Different techniques have been used to develop urban growth scenarios as shown in Table 1 [16,84–86]. Urban growth scenarios generated through assumptions are generally based on historical values and trends. An expert, or a group of experts, assuming a scenario can have personal influence on the facts due to particular knowledge area, which can mislead the outcomes of the scenario. More specifically, the past trend analysis method relies on temporal availability of data and involves great efforts, time and investment due to dependency on past data. Other methods to generate urban growth scenarios involved stakeholder consultation through working group meetings, workshops and seminars. This method is helpful for both scenario generation and consensus building because the selected stakeholders are knowledgeable on local context. However, such a method suffers from external validity of the generated scenarios because of the narrow locally based perception of stakeholders about sustainability issues. As a result, the outcome cannot be generalized given that every context is different and the method is tailored to fit for unique situation [87,88]. In addition,

the method requires face-to-face interaction among the stakeholder groups which can result in overly optimistic opinions with the possibility that the voice of minority groups could suppressed by influential actors. Likewise, these practices require reasonable finance, time and effort to involve a desired number of experts in the scenario generation process.

Delphi technique is defined as a systematic method for the solicitation and aggregation of informed judgments from a group of experts on a particular subject [89]. It enables structured communication among group of individuals allowing them, as a whole, to deal with a complex problem in an effective way [90]. More specifically, urban growth management involves an engagement of diverse actors and Delphi technique lends itself suitable for such engagement. It enables the collaboration of a diverse group of experts through an iterative survey process as opposed to face-to-face meetings. Susskind, McKearnan and Thomas-Larmer [88] emphasized that consensus building exercise needs to be initiated by a facilitator or a group of facilitators in a position to bring the key stakeholders together. In a Delphi process, a facilitator or coordination team designs a questionnaire that is then sent to a group of selected experts. Thus, it facilitates involvement of geographically dispersed experts in the process and brings external validity of the scenarios. Furthermore, Delphi technique ensures the anonymity of experts, and therefore warrants that the results are not biased due to dominance of a single group/individual. Participants in Delphi methods feel more comfortable in sharing their opinions on uncertain issues in an anonymous form, which leads to a higher response rate compared to other group communication methods, such as seminars, workshops, and working/focus groups. Besides, the notion of what constitutes a sustainable urban growth management policy has been a subject of extensive debate, which cannot be identified by a precise analysis technique. The underlying objective of Delphi technique is to establish a consensus among a number of experts. As opposed to relying on the judgment of one expert, the group consensus is more credible approach due to aggregated weights and scores of different perspectives of experts [91]. With the advancement of computer-based communication technologies, Delphi technique offers significant potential for enhancing consensus building. Obvious advantages include time savings and increased convenience [92]. Despite the benefits, Delphi technique is criticized for its purely expert driven approach often overlooking actors, who own a problem in a particular context [4].

In summary, none of the scenario generation methods can qualify all the criteria that need to be met—i.e., resource efficient, unbiased, externally valid, and context sensitive. However, it is noted that [93], keeping all other factors constant, if a quick and low budget synthesis is required and simple expert consultation is employed, this is likely to be less reliable than using expert elicitation using the Delphi method.

Table 1. Methods used to generate urban growth scenarios.

Methods Used	Scenario Numbers	Strengths	Weaknesses	References
Based on assumption	2, 3	Simplicity	Personal influence on facts due particular knowledge area	[24,94,95]
Past trend analysis	3	No calibration required	Temporal data dependency	[16]
Proposed by a group of experts (expert opinion)	3	Effective storytelling to make the consequences of different alternatives policies	Overly optimistic predictions (bias)	[17]
Stakeholder consultation	3	Effective storytelling to make the consequences of different alternatives policies	Require time investment to involve trained personals	[85]
Informed qualitative ranking through expert opinions	3	Informed decision making	Pure accuracy in pinpointing areas of future growth	[96]

Table 1. *Cont.*

Methods Used	Scenario Numbers	Strengths	Weaknesses	References
Collaboration with the planning department (expert opinion)	2	Successfully implemented in practice	Personal's Influence on facts due to particular knowledge area	[86]
Delphi technique	3	Iterative process, involvement of multidisciplinary stakeholders, anonymity (no bias) or influence of an expert on the outcomes	Need time and efforts to involve desire number of experts	[97,98]

2.5. Types of Scenario Planning

Scenario- based planning is the testing and application of different scenarios to come up with a plan. It is a powerful way to deal with uncertainties of the future associated with urban growth, and has been a common practice in recent years with technological advancements [99]. Researchers used scenario typology to define various scenarios in different areas of application [100]. Scenario typology is a classification of scenario practices on the basis of purpose, process of development and issues for the different types of scenario methods. However, there does not exist a standard typology of scenario planning and researchers often classified their types according to the objective of a given application. Ducot and Lubben [101] identified three types of application: (a) exploratory or anticipatory (i.e., given the causes, what the effects are, or given the effects, what the causes could have been); (b) trend or peripheral (not hypothetical—rely on estimation of scenario probabilities); and (c) descriptive or normative (an ordered set of possible occurrence, irrespective of their desirability or undesirability). Table 2 outlines these application types in different studies. The exploratory-descriptive type has been most commonly applied in urban planning [101]. Bishop et al. [102], in contrast, has outlined a typology of scenario planning approaches with eight classes: judgment, baseline/expected, elaboration of fixed scenarios, event sequences, back-casting, dimensions of uncertainty, cross-impact analysis, and modelling based scenarios. These classes have again been divided into 23 sub-classes. Van Notten [100] has developed a series of typologies for three different themes of planning and includes: (a) formulation of project goal: exploration vs. decision support; (b) process design: intuitive vs. formal; and (c) scenario content: complex vs. simple. The first theme deals with project goal, scenario's objectives and requirement and can be divided into two—i.e., explorations and decision support systems. Exploration scenarios contain awareness raising, the stimulations of creative thinking, and gaining insight; on the other hand, decision support scenarios suggest concrete strategic options. The second theme is a process design which is associated with the degree of quantitative and qualitative data used, or the choice for stakeholder workshops, expert interviews, or desk research. It has two dimensions—the intuitive approach, and the formal approach. The intuitive approach is qualitative scenario development and considers scenarios as an art. Accordingly, the development of stories and storylines are important. On the other hand, the latter is quantitative scenario development and uses quantified knowledge and computer simulation. The third theme is scenario content. It addresses the nature of variables and dynamics in a scenario, and how they interconnect. Complex scenarios deal with an intricate web of causally related, interwoven, and elaborately arranged variables and dynamics, while simple scenarios may be limited to the extrapolation of trends. Sometimes the latter can deliver a stronger message than the former.

In summary, the numerous definitions of scenarios types are of necessarily vague and cannot cover all of the characteristics involved in scenario practices. Literature also reveals that there is no ideal typology, which is generally acceptable as better or no. Given the nature of this study, it is, therefore, important to generate exploratory-descriptive scenarios to answer the research question posed in the Introduction section—i.e., how can alternative policy scenarios for sustainable urban growth be developed?

Table 2. Type of planning scenarios.

Name of Planning Scenarios	Type of Scenario	Citation
A contiguous new town development	Exploratory or descriptive	Jun and Hur [103]
A scenario with new towns (baseline) One with no new towns (no-new-town scenario)	Exploratory or descriptive	Jun [104]
Employment decentralization scenarios	Trend or peripheral	Burke et al. [105]
Scenario-A ("nothing changed/trend" scenario) Scenario-B (TOD regional plan) Scenario-C (discouraging car use)	Exploratory or descriptive	Feudo [94]
Industrial decentralization	Trend or peripheral	Aysan, Demir, Altan and Dokmeci [24]
Historical growth scenario (HU) Regional and urban planning scenario (RUP) Ecologically sustainable scenario (ES)	Trend or peripheral	Hua, Tang, Cui and Yin [16]
Scenario 1: Business as usual (S1) Crisis (S2) Innovation and sustainability (S3)	Exploratory or descriptive	Plata-Rocha, G¢mez-Delgado and Bosque-Sendra [17]
Business-as-usual (BAU) Low carbon scenario (LCS)	Based on assumptions	Mittal, Dai and Shukla [95]
Baseline development, Rapid development Green land protection	Exploratory or descriptive	Tian and Qiao [85]

3. Materials and Methods

This research applied Delphi as a preferred method for the validation and evaluation of policy scenarios. The procedure applied in this research is outlined in the following subsections.

3.1. Delphi Survey Questionnaire Development

In total, 19 policy scenarios under three groups (environmental, economic, and balanced) were selected from the literature based on their relevance to sustainable urban growth management. The selected policies were transformed into a web-based questionnaire using an online survey tool (Key Survey). The questionnaire consisted of a question for each of the selected 19 policy scenarios under three groups (environmental, economic, and balanced) as listed in Table 3.

The questionnaire was designed in a way so that relevant experts can provide an importance rating for each of the policy scenarios on a 5-point Likert scale (1, least important to 5, most important). The Likert scale method was applied for importance rating based on the literature [89,98,106]. Experts were also given option to suggest additional policy scenarios they feel are important but not included in the original questionnaire. The questionnaire was pilot-tested by three local experts for clarity and consistency, and then updated as per their advice. Necessary ethical clearance was obtained from a relevant Human Research Ethics Committee prior to conducting the Delphi survey.

Table 3. List of policy scenarios identified from the literature for expert evaluation.

Scenario A: Environment Focused Scenario	
(1)	Reducing greenhouse gas emission by 5–15% below emission levels as of now in the next 30 years
(2)	Reducing natural resource consumption (planning to promote neighbourhood accessibility to reduce the automobile usage)
(3)	Conserving green areas, agriculture land, natural landscapes, wild life areas, heritage places and archaeological sites
(4)	Avoid high risk development in flood zones
(5)	Development away from the coast due to increased intensity of storm tides
(6)	No development in the bushfire prone areas
(7)	Preservation of habitat loss and environmentally sensitive areas (coastal, estuarine, riverine and hinterland)
Scenario B: Economy Focused Scenario	
(8)	Monocentric development, increased accessibility and reduction of commuting time and cost in future
(9)	Development on peripheral regions (dispersed urban growth)
(10)	Fast paced development to accommodate demand for housing, infrastructure and services such as health, education, electricity, water and other utilities
(11)	Development of areas for agriculture industry
(12)	Development of new commercial and employment centres to accommodate increasing population
(13)	Development of socio-economically vulnerable areas
Scenario C: Balanced Scenario (Balanced Environmental and Economic Gains)	
(14)	Development in rural areas to reduce the gap between urban wealth and rural poverty (substantial reduction in rural–urban migration due to economic incentives)
(15)	Afforestation specially near industrialized areas and increase in agricultural productivity to decrease greenhouse gas effects
(16)	Sustainable scale of economic activity within the ecological life-support system
(17)	Less energy-intensive and efficient public transport systems with low fares to demote private car usage—this substantially decreases the use of natural resources and emission of greenhouse gas
(18)	Selection of priorities listed above in "Scenario A: Environment focused scenario", which support the self-contained economic activities
(19)	Selection of priorities listed above in "Scenario B: Economy focused scenario", which support environmental improvements

3.2. Identification of Experts for the Delphi Study

Identification of relevant experts is a critical task in a Delphi survey to grab the broad cross-sectoral perspective on the importance of urban growth policies. Previous studies have explicitly emphasized integrating a diverse set of viewpoints in scenario development to prevent misleading consensus among a like-minded group of experts [107]. Similarly, the reliability of survey results relies on their knowledge and experience. Involving experts with different cognitive and functional backgrounds in evaluating strategic issues could be a way to increase ambivalence in perceptions about strategic issues. Therefore, an expert identification approach was developed with the following three pronged criteria:

- Relevant experience and expertise measured in terms of their years of experience;
- Geographical diversity for external validity of the selected policies; and
- Sectoral diversity given that the policies cover a wide range of sectors.

A thorough review of professional profiles was undertaken to prepare a list of over 100 experts from the following academic and professional disciplines:

- Urban planning;
- Transportation;
- Economic development;

- Environment; and
- Social development.

The prevalent groups of panellists (24.1% each) were academics and urban planning practitioners, followed by transportation planners (20.7%) and environmental scientists (13.8%). A lower representation of economists (10.3%) and social planners (6.9%) was probably due to their understanding that the topic is not directly linked to their area of expertise. Spatially, the panellists were based in Australia (31%), Asia (24.1%), Europe (20.7%), USA (10.3%), and Africa (13.8%). From a geographically dispersed and multidisciplinary expert's panel, the outcome of Delphi survey was improved due to fair collection of information and opinions from all regions of the world. Significantly, a higher rate of expert's participation from different spatial regions with diverse expertise and knowledge provided a valuable input and critical insight in the policy selection process.

3.3. The Delphi Method

Delphi survey was executed in two rounds. In the first round, focus was given to the experts' consensus on the importance and validity of the selected 19 policy scenarios under three groups; whereas, the second round was conducted to seek further opinion on their importance rating and then ultimately to reach a consensus. Feedback on the rating scores from the first round was provided to the experts for evaluation in Round 2.

3.3.1. Delphi Round 1

Experts were invited through emails for participation in the survey during October to December 2016. Reminders were sent to the invited experts to accomplish the survey process twice. Initial participation agreement was 35%; however, finally, 29 experts submitted their complete response within time. Table 4 presents a comparison of sample size in previous studies using a similar Delphi survey approach.

Table 4. Sample sizes used in Delphi surveys.

References	Field of Study	Round 1 Sample Size	Round 2 Sample Size
Hemphill, McGreal and Berry [92]	Sustainable urban growth	19	19
Spickermann, Grienitz and von der Gracht [107]	Urban planning	57	39
Hayati et al. [108]	Land use and transportation	9	9
Cavalli-Sforza and Ortolano [97]	Land use and transportation	17	12
Manoliadis et al. [109]	Urban sustainability	20	20
Cavalli-Sforza and Ortolano [97]	Land use and transportation	30	30
Kaufmann [98]	Land use scenarios	18	10

Four summary statistics were derived based on the importance rating of the policy scenarios from Round 1 of the survey: median score, standard deviation (SD), interquartile range (IQR), and expected probability of occurrence (EP). Median score was calculated to measure the central tendency of the given ratings. The level of dispersion on rating was derived through SD and IQR in order to analyse the collective judgments of respondents for each policy [110,111]. IQR is the absolute value of the difference between the 75th and 25th percentiles and with smaller values indicating higher degrees of agreement. A higher IQR score indicates a wide variance of opinion in positioning the ranked items [112]. Likewise, a higher level of SD is associated with weaker agreement because of the high distribution of scores around the mean. Conversely, a smaller SD demonstrates a stronger agreement because responses will be clustered more closely around the mean [113]. An IQR value of 1 or less and the standard deviation below 1.0 were considered as low dispersion level in the ratings based on the literature [106,113,114]. Additionally, for analysing the feedback on Likert-type scale data, the use of

median is highly recommended in the literature for Delphi studies [29,97,106,111]. The median score and EP were used to provide feedback on the level of consensus to the experts in Round 2. EP was calculated to represent the frequency of responses on the scale of 0–100%—i.e., if 60% of experts rated a policy as highly important, the calculated EP is 60% [115]. An EP of at least 50% on a scale 0–100% is used as a standard measure for consensus level [89,111].

3.3.2. Delphi Round 2

Before executing second round of Delphi survey, the outcome of first round was analysed to identify the policies that already reached consensus, and the policies that did not. A summary statistics table showing the consensus level measured by median score and EP of occurrence from Round 1 was provided with each policy scenarios in the second round. A 50% cut-off point was set for the consensus level based on the literature [111]. For example, if 50% experts rated a policy as highly important, that policy was assumed to reach a consensus. Therefore, the questionnaire in the second round contained only those policies that had not reached a consensus. Experts were asked to provide their opinion on the statistical summary provided by asking the following question: "to what extent do you agree or disagree with the scores" based on a 5-point Likert scale (1, strongly agree to 5, strongly disagree). An email was sent to the 29 experts, who participated in Round 1 of the survey, requesting to participate in Round 2 in February 2017. A reminder email was sent in March 2017. All 29 experts completed the questionnaire in Round 2 by March 2017, yielding a 100% response rate. The responses were analysed to identify consensus level in Round 2. Overall, it was felt that a third round of the survey would not add to the understanding provided by the first two rounds and thus the survey was concluded.

Although the responses were collected on a 5-point Likert scale in Round 2, these were recoded into 3-point scale in order to create more meaningful categories based on the literature. The agree and strongly agree categories were combined to obtain the percentage of agreement and the disagree and strongly disagree categories were combined to obtain the percentage of disagreement [116,117]. The neutral category was retained as neutral. A combination of criteria was used for consensus measurement in the Round 2. Consensus levels were denoted if the respondents were in agreement for certain level as shown below and the score fell either in the agree or disagree range instead of neutral (on a 3 point Likert scale) [89]:

- 50% agreement: less important;
- 60% agreement: moderately important;
- 70% agreement: important; and
- 80% agreement: highly important.

The need for the categorization for the policies were felt due to the diverse opinion for generating urban growth scenarios overall and converging towards optimal opinion specifically to identify the highly suitable policy scenarios for sustainable urban growth management.

3.4. Validation of the Generated Policy Scenarios

As indicated earlier, the generation of policy scenarios for sustainable urban growth management through Delphi survey has certain advantages (e.g., external validity). However, an externally valid scenario does not necessarily mean that this is valid in a local context where contextual norms and preferences of local stakeholder might outweigh the experts' knowledge. As a result, it was required to test the applicability of the expert driven policy scenarios in local contexts. In this research, the South East Queensland (SEQ) Region in Australia was selected to test the validity of the identified policy scenarios. In particular, the growth management policies as proposed in the SEQ Regional Plan 2017 (Shaping SEQ) were compared against the policy scenarios as identified by the experts. This comparison enables the research to identify whether the expert driven policy scenarios are a reality or rhetoric. The SEQ Regional Plan 2017 was chosen for three reasons: (a) This the most recent plan published in

2017 which means that the plan was developed in parallel with the development of policy scenarios for this research, and, therefore, the issues are contemporary in nature. (b) Similar to this research, the SEQ Regional Plan has a regional focus rather than the city or local level. (c) The SEQ Regional Plan has provided a greater emphasis to manage urban growth in a sustainable way over the next 25 years. In particular, the plan focuses on responding to the region's projected growth, and the opportunities and challenges associated with global megatrends. With this plan Queensland Government sets the direction for sustainability, global competitiveness, and high-quality living by identifying a long-term sustainable pattern of development. This issue is further discussed in Section 4.4.

4. Results

4.1. Consensus in Round 1

The experts rated 19 policy scenarios under three groups—i.e., environmental, economic, and balanced scenarios. Table 5 provides a summary of consensus level of the 19 policy scenarios evaluated in this study. According to the consensus criteria used, Table 5 shows that no policy has gained consensus in the first round of survey. However, out of 19 policies, there were nine policies scored more than 40% of EP including two policies with 48.3% of EP score of being highly important, thus, only less than two per cent away from consensus level as listed below:

- Monocentric development, increased accessibility and reduction of commuting time and cost in future; and
- Less energy-intensive and efficient public transport systems with low fares to demote private car usage—this substantially decreases the use of natural resources and emission of greenhouse gas.

The results of the first round of the survey validate the usefulness of iterative Delphi technique in scenario planning for urban growth management. The diverse nature of experts' opinion and expectations from future urban growth make it difficult to get an effective and optimal opinion. Successive round of information, hence, reaches every panel member, so that the opinions can be retracted, altered with the provided feedback.

As requested in the questionnaire, experts have suggested some policy strategies to include. The suggested strategies were examined for inclusion in this research. However, we found that the essence of many of these suggested policies were already included in Round 1. In addition, some of the suggestions were not directly linked to urban growth management but broadly related to regional level analysis. Hence, these suggestions did not provide any new insight to the objective of this study and were not included in the second round of the Delphi survey.

Table 5. Round 1 rating results of importance of policies for sustainable urban growth.

Focus	Scenario	Med	IQR	SD	EP
Environment Focused Scenario	Reducing greenhouse gas emission by 5–15% below emission levels as of now in the next 30 years	4	1.5	0.9	31
	Reducing natural resource consumption (planning to promote neighbourhood accessibility to reduce the automobile usage)	4	2	1.1	38
	Conserving green areas, agriculture land, natural landscapes, wild life areas, heritage places and archaeological sites	4	2	1	31
	Avoid high risk development in flood zones	4	1	0.8	45
	Development away from the coast due to increased intensity of storm tides	3	1	1.1	41
	No development in the bushfire prone areas	3	1	1.1	28
	Preservation of environmentally sensitive areas (coastal, estuarine, riverine and hinterland)	4	1	0.7	45

Table 5. *Cont.*

Focus	Scenario	Med	IQR	SD	EP
Economy Focused Scenario	Monocentric development, increased accessibility and reduction of commuting time and cost in future	4	1.5	1	48
	Development on peripheral regions (dispersed urban growth)	4	1.5	1.1	34
	Fast paced development to accommodate demand for housing, infrastructure and services such as health, education, electricity, water and other utilities	4	1	0.8	48
	Development of areas for agriculture industry	3	2	1.1	34
	Development of new commercial and employment centres to accommodate increasing population	4	1	1	45
	Development of socio-economically vulnerable areas	4	1.5	1.1	41
Balanced Scenario	Development in rural areas to reduce the gap between urban wealth and rural poverty (substantial reduction in rural–urban migration due to economic incentives)	3	2	1.2	34
	Afforestation specially near industrialized areas and increase in agricultural productivity to decrease greenhouse gas effects	4	1.5	1.2	38
	Sustainable scale of economic activity within the ecological life-support system	4	1.5	1.1	34
	Less energy-intensive and efficient public transport systems with low fares to demote private car usage—this substantially decreases the use of natural resources and emission of greenhouse gases	4	1.5	1	45
	Selection of priorities listed above in "Scenario A: Environment focused scenario", which support the self-contained economic activities	4	1	1	41
	Selection of priorities listed above in "Scenario B: Economy focused scenario", which support environmental improvements	4	2	1.2	28

Note: EP = expected probability of occurrence, SD = standard deviation, IQR = inter quartile range, Med = median.

4.2. Consensus in Round 2

Table 6 illustrates the results from Round 2 of the survey for each policy strategies. Overall, all policy scenarios for sustainable urban growth management have gained consensus among the experts according to the defined criteria. However, out of 19 policies, two of them gained consensus as highly important, seven as important, seven as moderately important, and three as less important.

The policies that reached consensus as highly important among the experts in Round 2 are:

- Avoid high risk development in flood zones; and
- Development of new commercial and employment centres to accommodate increasing population.

Both of the above policies were also reached a reasonable level of agreement in the first round of the survey—i.e., 45% of the experts rated both policies as highly important in first round too. The results from both rounds show that there was strong agreement among the experts on these two policies so that this could be termed as "critical policies for achieving sustainable urban growth". However, a higher level of consensus cut-off point (80% agreement) for highly important policy scenarios results in less number of strategies (10.5%). Furthermore, seven policies (36.8%) gained consensus as "important" are:

- Fast paced development to accommodate demand for housing infrastructure and services such as health, education, electricity, water and other utilities;
- Sustainable scale of economic activity within the ecological life-support system;

- Less energy-intensive and efficient public transport systems with low fares to demote private car usage—this substantially decreases the use of natural resources and emission of greenhouse gas;
- Selection of priorities listed above in "Scenario A: Environment focused scenario", which support the self-contained economic activities reducing greenhouse gas emission by 5–15% below emission levels as of now in the next 30 years;
- Reducing natural resource consumption—planning to promote neighbourhood accessibility to reduce the automobile usage; and
- Preservation of environmentally sensitive areas—coastal estuarine, riverine and hinterland.

An aggregated analysis of consensus level from both rounds is elaborated in the following section to policy scenarios that would lead sustainable urban growth management.

Table 6. Round 2 consensus agreement results of the importance of policies for urban growth.

Focus	Scenario	Disagree	Neutral	Agree	Consensus
Environment Focused Scenario	Reducing greenhouse gas emission by 5–15% below emission levels as of now in the next 30 years	14	7	79	Important
	Reducing natural resource consumption (planning to promote neighbourhood accessibility to reduce the automobile usage)	14	7	79	Important
	Conserving green areas, agriculture land, natural landscapes, wild life areas, heritage places and archaeological sites	7	28	66	Moderately important
	Avoid high risk development in flood zones	0	7	93	Highly important
	Development away from the coast due to increased intensity of storm tides	3	34	62	Moderately important
	No development in the bushfire prone areas	0	32	68	Important
	Preservation of environmentally sensitive areas (coastal estuarine, riverine and hinterland)	3	17	79	Moderately important
Economy Focused Scenario	Monocentric development, increased accessibility and reduction of commuting time and cost in future	7	28	66	Important
	Development on peripheral regions (dispersed urban growth)	17	31	52	Less important
	Fast paced development to accommodate demand for housing infrastructure and services such as health, education, electricity, water and other utilities	7	21	71	Highly important
	Development of areas for agriculture industry	4	41	56	Less important
	Development of new commercial and employment centres to accommodate increasing population	0	14	86	Moderately important
	Development of socio-economically vulnerable areas	24	17	59	Less important
Balanced Scenario	Development in rural areas to reduce the gap between urban wealth and rural poverty (substantial reduction in rural–urban migration due to economic incentives)	14	24	62	Moderately important
	Afforestation especially near industrialized areas and increase in agricultural productivity to decrease greenhouse gas effects	7	25	68	Moderately important
	Sustainable scale of economic activity within the ecological life-support system	4	25	71	Important
	Less energy-intensive and efficient public transport systems with low fares to demote private car usage—this substantially decreases the use of natural resources and emission of greenhouse gas	7	21	72	Important

Table 6. *Cont.*

Focus	Scenario	Disagree	Neutral	Agree	Consensus
	Selection of priorities listed above in "Scenario A: Environment focused scenario" which support the self-contained economic activities	3	24	72	Important
	Selection of priorities listed above in "Scenario B: Economy focused scenario" which support environmental improvements	0	33	67	Moderately important

4.3. Scenario Alternatives

There are 19 key policy scenarios under the three groups are proposed in this study. The scenario generation process has involved identification (through literature review) and verification (through Delphi survey) of the policy scenarios according to their relevance to the sustainable urban growth management. Based on the aggregated results from both rounds of the Delphi survey, following alternative scenarios are outlined.

4.3.1. Scenario A: Environment Focused Scenario

This scenario takes into account various environmental concerns, which need to be incorporated at policy level when planning to manage future urban growth. The environment focused scenario aims to create an urban area that will be more sensitive to the environment. The following policies under environmental focused scenario are identified based on the established consensus of this study.

- Avoid high risk development in flood zones;
- Reducing greenhouse gas emission by 5–15% below emission levels as of now in the next 30 years;
- Reducing natural resource consumption (planning to promote neighbourhood accessibility to reduce the automobile usage); and
- Preservation of environmentally sensitive areas (coastal estuarine, riverine and hinterland).

The identified policies as mentioned above highlight the environmental concerns. Fast paced urbanization in vulnerable areas along the coastal creeks and rivers is causing significant damage to the population and infrastructure due to floods [58,118,119]. Furthermore, urbanization processes always lead to the consumption of natural resources and the result of which is the emission of greenhouse gases [4,70,120]. The policies verified in this study as important, including the reduction of greenhouse gas emission and reduction of natural resource consumption, have been widely discussed in the literature because they have the potential to reduce climate change and to avoid resource depletion by using reusable resources [4,120]. Besides, underpinning to these activities must be to preserve the environmentally sensitive areas from further loss, as well as incorporating ways to address mitigation. The protection of environmentally sensitive areas would help to maintain the biological integrity of the urban areas for achieving sustainable development [121–123].

4.3.2. Scenario B: Economy Focused Scenario

This scenario takes into account various economic concerns, which need to be incorporated at policy level when managing future urban growth. This scenario aims to create an urban area that will be more sensitive to the economic development. Following are the list of policy scenarios that were verified by the experts as "important" and "highly important" to address the economic challenges in order to manage urban growth.

- Development of new commercial and employment centres to accommodate increasing population; and
- Fast paced development to accommodate demand for housing infrastructure and services such as health, education, electricity, water and other utilities.

Economically, urban areas in the world will continue to grow to deliver prosperity for its residents and businesses [124]. Due to increasingly being driven by industrial demand, investment, and population growth, urban region's economy is changing into one of high value professional services and niche manufacturing [3,118,119]. Development of new commercial and employment centre in the growing urban areas away from the city centre will reduce the travel demand from these areas to the core economic areas such as CBD. Furthermore, the stress on the existing facilities of the cities can be minimizing if the need of housing and infrastructure demand fulfilled in efficient way. This will not only reduce the disparity among different urban areas, but also improve the economic growth of the overall region and reducing the maintenance cost of existing facilities due to overutilization [3,7,118,119].

Therefore, the key policies identified in this study will help the economic growth of the urban areas. Interestingly, the policies addressing environmental aspects under economic scenario were rated less important for economic growth of the region as shown below:

- Development on peripheral regions (dispersed urban growth);
- Development of areas for agriculture industry; and
- Development of socio-economically vulnerable areas.

Knowingly, the involvement of experts representing diverse stakeholders of urban growth may lead to conflict of interest on economic growth at the cost environmental impacts.

4.3.3. Scenario C: Balanced Scenario

This scenario provides a balanced approach. It highlights strategies for economic growth while improving the environmental outcomes. Only the following three policies are identified as key policies under the balanced scenario:

- Sustainable scale of economic activity within the ecological life-support system;
- Less energy-intensive and efficient public transport systems with low fares to demote private car usage—this substantially decreases the use of natural resources and emission of greenhouse gas; and
- Selection of priorities listed above in "Scenario A: Environment focused scenario", which support the self-contained economic activities.

The proposed key policies under balanced scenario are revealing a combination of ecological, social, environmental and economic policies, which can help policy makers and urban growth managers to mitigate the "already happened" scars on the environmental and socioeconomic aspects of urban growth. Economic growth at one end promotes urban growth and on the hand, demotes environment system. Moreover, economic growth is not a panacea for environmental problems; indeed, it is not even the main issue. However, to deal with environmental externalities of urban growth, policy makers need to modify the economic policies to meet the environmental challenges. Therefore, such economic policies need to adapt to provide the right incentives for protecting the resilience of ecological systems. This will enable humans to promote urban growth by assuring a sustainable scale of economic activity within ecological life support systems [125–127].

4.4. Comparison of Policy Outcomes with South East Queensland Regional Plan

South East Queensland (SEQ) is the fastest-growing metropolitan region located in the State of Queensland in Australia, and attracting on an average 55,000 immigrants each year [128]. SEQ has been experiencing rapid urban growth over the last few decades. Historically, this region was characterized by isolated, low-density urban developments with spatially uneven distribution of settlements and industries. However, the dispersed urban growth causes loss of biodiversity, natural areas and increased travel distances. Therefore, to sustain the rapid population growth in the SEQ region, recently a strategic plan—i.e., Shaping SEQ: South East Queensland Regional Plan 2017 [129]—has

been developed to manage future urban growth in sustainable way. This plan is the latest edition of a series of strategic development plans of the region that was first put into action in 2005. The findings of this study were compared against the strategies identified in the SEQ Regional Plan to validate the results and gain confidence for further analysis. As presented in Table 7, the policies identified through a Delphi-based stakeholder's consultation are also proposed in the SEQ Regional Plan to promote sustainable urban growth. Although the study in hand was carried out a year before the legitimization of the SEQ Regional Plan (based on non-Delphi based stakeholder consultation), the results are validated as shown in Table 7. The similarities between policies identified in our study and the SEQ Regional Plan indicate that through a Delphi approach policy scenarios for sustainable urban growth management could be developed. However, these policies should be treated as rule of thumb or generic policies, and sensitivity analysis and ground-truthing in their adoption to a locality is a necessity.

Table 7. Comparison of identified urban growth policies with SEQ Regional Plan.

Policies Identified through Delphi Method in the Reported Study	Policies Identified through Stakeholder Consultation in the SEQ Regional Plan 2017 [129]
Avoid high risk development in flood zones;	Use disaster risk management planning, adaptation strategies and avoidance of exposure to high-risk areas to minimize SEQ's vulnerability to climate change impacts.
Reducing greenhouse gas emission by 5–15% below emission levels as of now in the next 30 years.	Reduce greenhouse gas emissions by adopting patterns of urban development that reduce the need and distance to travel and that encourage the use of active and public transport.
Reducing natural resource consumption (planning to promote neighbourhood accessibility to reduce the automobile usage).	Achieve a high-quality urban form that promotes a walkable urban environment within regional activity centres, to encourage interaction and collaboration. Plan for an increased range and mix of complementary activity, including higher residential densities, in and adjoining those centres with direct access to high frequency public transport
Preservation of environmentally sensitive areas (coastal estuarine, riverine and hinterland).	Protect and sustainably manage the region's catchments to ensure the quality and quantity of water in our waterways, aquifers, wetlands, estuaries, Moreton Bay and oceans meets the needs of the environment, industry and community.
Development of new commercial and employment centres to accommodate increasing population.	Plan for and support continued growth in population-serving employment and traditional economic industries.
Fast paced development to accommodate demand for housing infrastructure and services such as health, education, electricity, water and other utilities.	Ensure planning and delivery of land use and infrastructure for new communities, including major development areas, are integrated and sequenced, and deliver complete communities in a timely manner.
Sustainable scale of economic activity within the ecological life-support system.	Protect regional biodiversity values, and the ecological processes that support them, from inappropriate development
Less energy-intensive and efficient public transport systems with low fares to demote private car usage—this substantially decreases the use of natural resources and emission of greenhouse gas.	Extended and reliable high-frequency public transport connections to significantly improve accessibility and create more efficient and functional urban environments
Selection of priorities listed above in "Scenario A: Environment focused scenario", which support the self-contained economic activities.	N/A

5. Findings and Discussion

Urbanization, presently, is unavoidable due to rapid population growth, increased demand of economic gains and social aspiration for quality of life. As a result, in many cases biophysical, strategic agricultural land and other ecologically sensitive areas are at high risk with magnified use of resources and high level of greenhouse gas emissions. Subsequently, these challenges have made the urban planners' job harder, daunting, and of global significance to achieve a balance between environmental quality and socioeconomic growth in urban areas. Research has indicated that effective urban growth management policies have the ability to minimize problems linked with inevitable urban growth—such

as externalities on the environment, congestion, and longer commuting times [130]. The prevailing problems linked with urban development across the world indicates the failure of existing planning practices [19]. A lack of integration between the physical elements and environmental elements makes it difficult to see the functions of urban system in a holistic manner. City planning practices have a tendency towards short-term policy approaches for a speedy solution rather than long term future vision. The limited collaboration of stakeholders and a lack of involvement of public and private sectors is another reason of present day planning failures due to conflict of interests. The future of urban development is not the exclusive interest of the government agencies and the urban planners. Also a successful planning practice require the partnership among agencies, sectors and communities. Therefore, as demonstrated in this study, the visioning of alternative futures of urban growth is critical in order to manage urban growth in a sustainable way – i.e. to mitigate the environmental impacts of urban growth [75].

Developing alternative scenarios for future urban growth requires holistic approaches. Neither a conservative nor a luxurious planning policy can be a sustainable solution in current situation of fast paced urbanization in highly competitive environment. In practice, sustainable urban development is an interactive but at the same time a highly complex concept, which can never be achieved in isolation [5,8–11,26,61–63,65,67,70,71,131]. Urban growth policies with optimistic and balanced environmental, economic and social concerns are proven better choices in the literature. However, polices are not universal truth which can be implemented without pragmatic understanding of the local facts. Thorough consideration is required for identifying urban growth management policies and future outcomes before any plan. In this regard, Delphi technique has been employed for deliberating the identified policies in the form of consensus by sharing the knowledge of experts from diversified fields but having a common interest in sustainable policy making [98,132–135].

5.1. Effectiveness of the Method

The study first identified a range of policy scenarios from the literature, and then used a two-round Delphi survey to assess their suitability as urban growth management policies for sustainable development. Findings of the study highlight the effectiveness of Delphi method for developing alternative urban growth management policies through involving experts from different backgrounds located all over the world. Delphi method's particular strengths over the other methods includes the ability to consult from distance to produce a higher number of response and higher quality of ideas [136]. This study aimed to generate place-less urban growth scenarios, which is why the pooling of expert knowledge from all over the world was deemed to be more useful in identifying sustainable urban growth policies. As discussed in Section 2.4, scenarios are constructed by researchers and experts from diverse backgrounds, often with stakeholders, resulting in the use of a large number of approaches and techniques. These approaches and techniques have been systematized in several ways, depending on the general purpose of the planning exercise [102]. The use of Delphi method to generate urban growth scenario is supported by a vast literature, as shown in Table 2. A critical review of the sustainability scenario design tools was conducted by Kishita et al. [137].

One good example is the study conducted by Kaufmann [98] that used Delphi method to identify a number of urban growth management policies through stakeholder consultation to generate alternative scenarios for the development of Dalmatia (Croatia) for the time frame of 2014–2031. The Delphi method was also employed to assess the impacts of knowledge-based economic development practices on the urban development in the case of Multimedia Super Corridor, Malaysia—in order to develop a more accurate policy mechanism [138]. Likewise, Watkins [139] employed Delphi method to prioritized regional urban growth strategies to generate urban growth scenarios for shaping the future of Northeast Michigan (USA). Furthermore, Bailey et al. [140] demonstrated the usefulness of Delphi method to create a large number of alternative scenarios (seven scenarios) through stakeholder's consultation from different sectors (i.e., political, economy, social, spatial planning, transport, energy and climate change) in the Bristol region (UK). Consistent with the vast majority of the urban growth scenario

literature, the results of this study confirm that the involvement of relevant experts improve the selection of urban growth policies for sustainable development [4].

Delphi technique encourages honest opinion which is free from peer group pressure [141]. However, extensive time commitment is needed to execute the Delphi survey, as used in this study, took more than six months. Furthermore, the involvement of experts from different area of interests was quite effort taking task, as not every "identified suitable expert" was ready to participate. Therefore, the list of experts was revised many times to finally reach a reasonable number of suitable experts willing to participate in this study. It is also recognized that lack of clarity by which consensus may be defined and the resultant differing interpretations required extensive literature review for careful and explicit decision-making for both i.e., consensus and analysis criteria.

5.2. Appropriateness of Scenarios

This study has illustrated the importance of considering the multiple future scenarios as alternative instead of one predicted growth scenario. Three alternative futures are generated in this study under environmental, economic and balanced scenarios that fulfil both criteria for sustainable urban growth policy—i.e., alternative scenario development and stakeholder involvement. The numbers of scenarios are appropriate for urban growth management studies as too less number of scenarios offer no alternative visions Pillkahn [79]. Furthermore, too large numbers of scenarios can blur the future visions, and create difficulty in data collection and analysis [83]. Further analysis of the outcomes of these alternative futures will be done in a prospective study to select the most desirable policy set for sustainable urban growth. The analysis of the outcomes of these alternative scenarios will also help to eliminate the uncertain and unexpected future growth through formulating effective policies [18]. As discussed in previous sections, scenarios are not and should not predict the future outcome rather they draw possible alternatives of the future. Therefore, getting visions of the alternative future is one of the important uses of scenarios [102,142]. Therefore, alternative scenarios identified in this study question conventional views and theories and lead us to explore uncertainties of future urban growth. Consequently, the identified scenarios will help policy makers to consider alternative paths and expected risks for future urban growth.

5.3. Determination of Policies

Out of total 19 policies, 12 are verified as key policies under three groups to manage urban growth in a sustainable way. Verified policy scenarios in this study are holistic and cover all critical aspects of urban growth—economy, environment, and society [45]. However, at large, impression of the results is slightly more inclined to environmental considerations over the economic ones. This is more likely due to the universal nature of understanding of the conserving, preserving and protecting the natural environment [4,125,143–146]. Moreover, human beings have more and more aware of the importance of environment to people's health and overall well-being. As discussed widely in the literature, to archive the sustainable urban growth, a wide range of economic, social and environmental needs must be all satisfied. Therefore, urban areas have to be developed under the policy that will not lead to the depletion of natural resources [147]. The policies identified in this study support this theory for promoting a balanced approach in promoting urban growth while preserving environmentally sensitive areas [143].

Furthermore, the findings of this study both verify the suitability of Delphi technique and expose the shortcomings of the technique. The survey was conducted successfully within a feasible timeframe, using least labour and other resources (cost) applying a technologically advanced survey technique (online tool), covering wide range of expert from across the world [113,114]. However, such diversity results in a lack of consensus among the experts on the importance of policy scenarios. Even though, the policy scenarios are valid internationally. Their relevance and validity in a local context remains an issue which requires further validation of the policy scenarios using stakeholders (including those

who affect a policy decision and who are likely to be affected by a policy decision) drawn from a local context [87,88].

Similar to many other exploratory studies, the study also has limitations, which may have impacts on the findings. For instance, the number and fields of experts participated in the study are major limiting factors. Although 29 professionals from diversified fields of expertise is an acceptable figure, however, increased number with different combination of expertise may change the findings. Moreover, experts might have a bias in their selection of policies due to their backgrounds. Additionally, the method of policy consensus seeking approach is another area with different techniques is reported in the literature may produce different outcomes. The policies identified in this study are from expert's views, which need ground-truthing and further analysis as planned in the successive study. Furthermore, a list of 19 polices provided to experts for consensus might be improved if suggestions were provided according to the objective of this study from the experts in the first round of the survey. In our prospective studies, by focusing on the limitations, a final list of policies for scenario development will be validated through using modelling frameworks for scenario comparison in order to analyse the policy outcomes.

Lastly, the findings from this research reveal that various policies need to be implemented for a sustainable urban development. However, it is not clear which of these policy scenarios would bring the most positive outcomes. Our future research is planned to address this issue as well.

6. Conclusions

This research contributes to the knowledge by selecting and verifying a universal list of policy scenarios for sustainable urban growth management. Initially, 19 policy scenarios were selected from the literature. The suitability of these scenarios was tested through a two-round of Delphi survey involving experts from five sectors (urban planning, transport planning, economic planning, social planning, and environmental planning) from all over the world. The experts rated the importance of the scenarios which were statistically analysed to identify key policy scenarios according to their importance (highly important, important, moderately important, and less important). The findings, therefore, offer valuable guidelines for planners, modellers, and policy makers in adopting suitable policy priorities, and thus ease the daunting task of generating sustainable policy solutions. In this research, the policy scenarios are classified under three themes: environment focused, economy focused, and balanced between environment and economy. This thematic classification would also enable practitioners to select the right set of policy scenarios according to their own priority setting within a local context.

The identified policy scenarios are not meant to predict or forecasts, instead they are to create visions for alternative outcomes. Therefore, the identified policies will be input to the analysis/evaluation (second) part of this research to find out the most suitable policies with least environmental externalities. Academia, business managers and policymakers can use the proposed alternative urban growth scenarios for further analysis as an instrument to gain knowledge of the future. Specifically, the proposed scenarios can assist in the sustainable urban growth management through visioning of possible futures and making people aware of uncertainties in their decisions in any region of the world despite of its geographical locations. The expert's participated in this study were selected from all over the world and thus represented the worldwide view of sustainable urban future. The experts selected carefully in this research for stakeholder's representation and were not anonymous to the facilitator. However, the participants were anonymous to each other, and therefore, the results are free from conflict of interest and dominance bias. The key policies identified belong mainly to environmental concerns of urban development. Policies of "avoiding high risk development in flood zones" and "sustainable scale of economic activity within the ecological life-support system" should be considered as imperative in the process of urban growth management. Additionally, the policy on "less energy-intensive and efficient public transport systems with low fares to demote private car usage" can help substantially decreases the use of natural resources and emission

of greenhouse gas. Similar to these policies, "reducing environmental pollutions", and "urban growth policies for conserving environmentally sensitive areas" should be kept highly important in planning future urban growth policies.

Many of the countries, facing rapidly growing urban population all over the world, are developing strategies to achieve urban sustainability [104]. Cities have great impacts on people's behaviours, lifestyles, and resource consumption patterns. Therefore, a development that is sustainable is crucial not only for increasing the liveability of cities, but also for mitigating the environmental problems. Therefore, the concept of sustainable urban development is broadly linked with urban density, form, design, amenities and infrastructure [144]. This research is based on the idea that we can shape urban development principally by formulating sustainable urban growth policies—even though the terms "sustainability" and "development" are contradicting and for many scholars "sustainable development" is an oxymoron [105,106]. However, still the presented urban management and development approach helps institutions and governments to initiate a thought process for wider and successful implementation of the sustainability agenda, and, consequently, move us one step closer to achieve more sustainable outcomes [145]. Particularly, utilisation of collaborative planning methods [148] along with the presented approach would improve quality, reliability and performance of scenario-based planning in achieving sustainable outcomes.

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