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Evaluation of Economic Valuation of Air Quality Improvement: A Systematic Review

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Abstract

Air quality improvement (AQI) can reduce health costs and improve socio-economic and human well-being. AQI is one of the regulating ecosystem services that maintain air pollution and improve environmental quality. The study aimed to identify and analyze studies on the economic valuation of AQI and its application in cities worldwide. This study identified 97 documents across three phases that addressed economic or monetary valuation, using a list of keywords in accordance with the PRISMA 2020 statement. The result shows that among 18 methods, the contingent valuation method is used the most. Spatially, China is the dominant contributor, and most studies are done in cities in the global South. This study will further guide planners, policymakers, and potential users of these methods. It will also help identify the gap between studies conducted in the global north and south cities. Additionally, improving urban settlements, making them safe for residents, and inclusive and sustainable management are the 11th goals of the Sustainable Development Goals.

Keywords: *Air Quality Improvement; Contingent Valuation Method; Economic Valuation; Ecosystem Service; Global Cities; Regulating Ecosystem Service*

1. Introduction

In 2022, the world's population is 7.924 billion and will reach around 8.5 billion by 2030 (United Nations, 2022). This increasing population triggers more demands for basic needs and economic growth, enhancing air pollution (Malla et al., 2011). Air pollution is one of a major global problem that negatively impacts the environment and human health. It contributes to life-threatening diseases such as chronic obstructive pulmonary disease, lung cancer, acute lower respiratory illness, non-fatal diseases, lung disorders, and acute asthma (Lelieveld et al., 2015; Giannadaki et al., 2017; Nowak et al., 2018). Moreover, Johnson et al. (2021) found that $PM_{2.5}$ and PM_{10} pollution concentrations are highest in less developing countries, higher in developing countries, and the most minor in developed countries. Air pollution-related mitigation costs can be one approach to assess the the burden of the economic costs of Air Quality Improvement (AQI) in the country and the cost of enhancing human health (Giannadaki et al., 2017). This burden is higher in cities with larger populations and diverse economic activities, which generate higher emissions. The emergence of global consciousness and initiatives to protect the environment virtually divided the world into global South and North countries where financial and technological transfer remains the central theme of global environmental politics (Jaiswal, 2015). Low-income or vulnerable communities have been adversely affected by air pollution. For example, due to health damages, air pollution impacts their income and employment (Clougherty & Kubzankdy, 2009; Forastiere et al., 2007). Air pollution also increases sickness and reduces working productivity. Thus, labor supply and the country's economy are shortened (Ostro, 1983; Hansen & Selte, 2000; Hanna & Oliva, 2011). Likewise, air pollution harms stock returns by altering human mood (Li & Peng, 2016; Demir & Ersan, 2016). Moreover, exposure to air pollution is associated with crime, homicide, and aggressive and offending behavior (Nevin, 2000; Stretesky & Lynch, 2001). The studies also found a strong negative relationship between air pollution and happiness, which has been seen worldwide (Ambrey et al., 2014; Barrington-Leigh & Behzadnejad, 2017). However, this problem can be reduced by delivering its corresponding Ecosystem Service (ES), such as AQI or Air Quality Regulation (AQR). Ecosystem Service is "the benefits people obtain from the properties and processes of ecosystems" (de Groot et al., 2002). Regulating Ecosystem Services (RES) is crucial for mitigating negative impacts and providing regulatory services such as environmental protection and human safety (Mengist et al., 2020). AQI is one of the regulating ecosystem services that can mitigate and improve environmental quality (TEEB, 2011; Gómez-Baggethun & Barton, 2013). The study of AQI is very significant for increasing people's happiness and improving working productivity and efficiency. Estimating air contaminants, comprehending their health impacts, and anticipating air quality are essential to safeguarding public health from dangerous air pollutants (Mathew et al., 2024). Along with public health benefits, improving air quality also

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yields social, economic, and environmental benefits (Wang et al., 2024). Remarkably, the economic valuation of ecosystem services can help decision-makers assess ES holistically by integrating them into environmental management. It can explain the effects of artificial policies on the quality of life and ecological structures (Farber et al., 2006). Moreover, there are few global studies on the economic value of regulating ecosystem services. For example, Balasubramanian (2019) estimated the value of regulating ecosystem services at 29.08 US$ trillion based on various economic valuation methods. Mengist et al. (2020) argued that the value of regulating ecosystem services should be integrated into environmental management policies, rules, and regulations. Moreover, the value of air quality regulations/improvements can improve environmental quality and sustainable development goals at the local level (Koudouri et al., 2023). Therefore, it is crucial to investigate the studies on AQI using an economic valuation approach and its application in cities across the rich and poor countries of the globe.

The literature has identified different types of ecosystem services, such as air filtration or gas regulation, microclimate regulation, noise reduction, etc. (MA, 2003; TEEB, 2011; Gómez-Baggethun & Barton, 2013). AQR and environmental improvement of the can be understood through valuation approaches (TEEB, 2011; MA, 2005; Haines-Young & Potschin, 2018). Though studies of ES valuation have been conducted since the 1960s, they have increased tremendously since the 1990s (de Groot et al.,2002). The concept of value was first introduced by Ehrlich & Ehrlich in 1992 to evaluate biodiversity (Torres et al., 2021). The valuation of ES has increased tremendously worldwide after the monumental work 'The Value of the World's Ecosystem Services and Natural Capital' by Costanza et al.,1997. ES valuation can be classified mainly into three types: ecological value, economic value, and socio-cultural value dimensions based on axiology, ontology, and epistemology aspects (Groot et al., 2002; Gómez-Baggethun & Barton, 2013). Moreover, there are many studies on different methods of ES valuation, which focus on ecological values (Bagstad et al., 2013; Neugarten et al., 2018; Rötzer et al., 2020; Agudelo et al., 2020; Meraj et al., 2022; Zaman-Ul-haq et al., 2022; Yu et al., 2023; Liu et al., 2023), and socio-cultural values (Neugarten et al., 2018; Scholte et al., 2015; Castro et al., 2011). Furthermore, economic valuation of environmental amenities (Adamowicz, 1991), ecosystem management (Farber et al., 2006), mangrove ecosystem services (Vo Quoc et al., 2012), and land degradation and restoration (Turner et al., 2016) has already been done. Zhao et al. (2022) showed that air pollution has increased in the global South due to increased fossil fuel use.

After extensive studies, the following research gaps have been identified: Firstly, the valuation methods for ecosystem services have been widely studied to understand ecological and socio-cultural values. However, economic valuation needs to be studied to understand the monetary significance of ecosystem services, such as regulating ecosystem services. Secondly, studies focusing on the economic valuation of regulating ecosystem services, such as AQI, are not summarized in review work, which needs to be assessed. Thirdly, the financial division of world countries, such as those in the Global South and North countries, needs more attention to examine the application patterns of the economic value of air quality improvement (EVAQI) and to determine the scope of further studies. Air pollution is a global phenomenon than a local one. However, globally, most deaths occur in low-nd middle-income countries (World Health Organization, 2021). Considering these, it is essential to identify studies on the EVAQI, particularly in cities in the global north and south.

Therefore, the main objectives of this study are (1) to identify and analyze methodological approaches of existing studies on the EVAQI and (2) their application in the global south and north cities. The study has been organized into two sections. The first includes the methodological approaches to the EVAQI, which incorporates the study's approaches, identified methods, variables used, and temporal analysis. The second part discusses their geographical application, including their application in the global south and north cities, and the spatial scale of studies. The study will be a significant addition to the field of research, i.e., ecosystem services. It will further guide planners, policymakers, and potential users of these methods. It will also help identify the gap between the studies executed in the global north and south cities. Additionally, improving urban settlements, making them safe for residents, and inclusive and sustainable management are the 11th goals of the Sustainable Development Goals, where air pollution-free urban centers are one of the main missions of SDGs (United Nations, 2015).

2. Materials and Methods

Search strategy: In the present study, an extensive literature survey was conducted from January 1992, the year of the first publication on the value of the ecosystem (Torres et al., 2021), to December 2022. The process of data collection, search strategy, screening, and analysis is based on the guidelines of the Preferred Reporting Items for Systematic reviews and Meta Analyses or PRISMA 2020 statement for systematic review (Page et al., 2021). The checklist for the abstract and for the whole study has also been included (Appendix Tables 1 and 2). The search was conducted across digital repositories, including Google Scholar, Web of Science, Scopus, and ScienceDirect. It includes peer-reviewed articles, review papers, conference papers, reports, dissertations/theses, and grey literature in English. Particular keywords are used for data search on digital repositories (Table 1).

Literature selection, inclusion, and exclusion criteria: Based on these keywords, the literature review was conducted in three phases (Figure 1). At the primary stage, 17000, 2952, 5780, and 5935 results were retrieved from Google Scholar, Web of Science, Scopus, and ScienceDirect, respectively; thus, 31667 studies were identified. However, 29122 duplicate documents have been removed after using the first set of keywords. In the second phase, a new set of keywords was used to further refine the results. This search string returned 2152, 134, 195, and 109 results in Google Scholar, Web of Science, Scopus, and ScienceDirect, respectively.

Table 1. List of keywords used for document search

Search Order	Keywords	Yielded Results	Total
First-order search string	a. "Ecosystem services" AND "Economic valuation" OR "Monetary valuation"	17000	31667
	b. (Economic Valuation OR Monetary Valuation) AND Ecosystem services	2952	
	c. {Economic valuation} AND {Ecosystem service} & {Monetary valuation} AND {Ecosystem service}	5780	
	d. ("Economic valuation OR Monetary valuation") AND Ecosystem service	5935	
Second-order search string	a. "Economic valuation" OR "Monetary valuation" AND "Air quality regulation", "Economic valuation" OR "Monetary valuation" AND "Air quality Improvement" & "Economic valuation" OR "Monetary valuation" AND "Air quality purification"	2152	2590
	b. (Economic valuation OR Monetary valuation) AND Air quality regulation, (Economic valuation OR Monetary valuation) AND Air quality Improvement and (Economic valuation OR Monetary valuation) AND Air quality purification	134	
	c. {Economic valuation} AND {Air quality regulation}, {Economic valuation} AND {Air quality improvement} and {Economic valuation} AND {Air quality purification}	195	
	d. ("Air quality regulation" OR "air quality improvement" OR "air quality purification") AND economic valuation OR monetary valuation with keywords (Air quality regulation OR air quality improvement AND economic valuation OR monetary valuation)	109	
Third order search string	The following must be used explicitly in title and abstract: 1. keyword either economic valuation or monetary valuation 2. One keyword among air quality regulation, air quality improvement and air quality purification	274	
Final selection	97 documents included for systematic review out of 274		

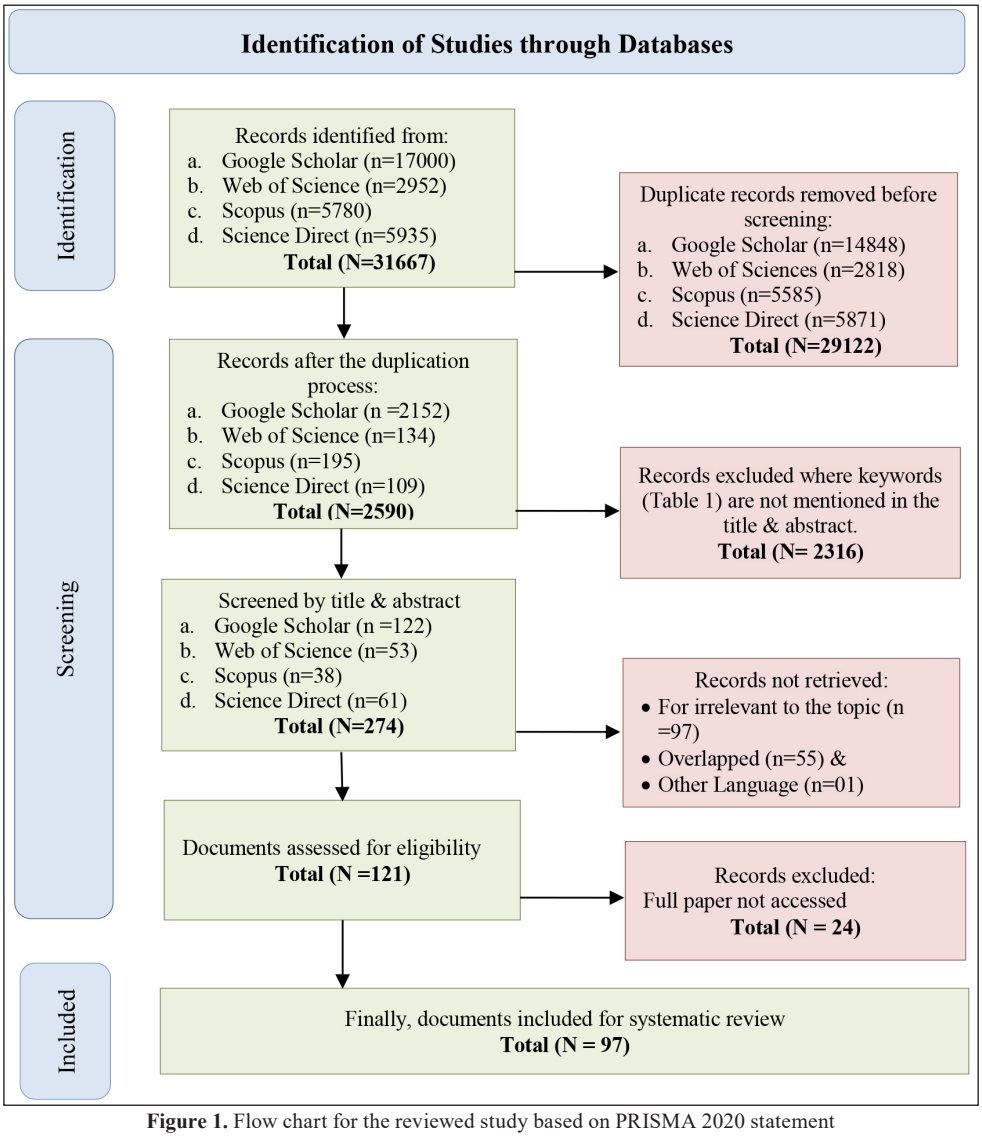

Figure 1. Flow chart for the reviewed study based on PRISMA 2020 statement

Consist of keywords searched in databases i.e. a. Google Scholar b. Web of Science c. Scopus d. Science Direct Of 2590 documents, 2316 records without selected keywords in the title and abstract were excluded. Then, 122, 53, 38, and 61 documents were refined at the third search string based on two criteria, i.e., (i) any documents that incorporate either economic valuation or monetary valuation and (ii) one keyword among 'air quality regulation,' 'air quality improvement' and 'air quality purification' must be used explicitly in title and abstract. Out of 274 searched documents, 153 have been excluded due to overlap across the databases, irrelevance, use of another language, or inaccessibility. Finally, in the last phase, 121 documents were refined manually to get more relevant, specific, and accurate results. After excluding 24 inaccessible documents, 97 documents were included in this study. These consist of review papers (n=03), dissertations/theses (n=05), working papers (n=02), a conference paper (n=01), and research articles (n=86).

3. Results

3.1 Methodological Approaches

Selected 97 pieces of literature have been further analyzed based on the methodological background. Thus, the study's approaches, identified methods, variables used, and temporal analysis have been executed.

Valuation Approaches and Methods: Four main approaches and eighteen valuation methods have been identified. The approaches are the Revealed-preference approach (RPA), the Stated-preference approach (SPA), the Cost-based approach (CBA), and the Subjective well-being approach (SWA) (Table 2).

Table 2. Identified methods used for economic valuation of air quality improvement

Method	About the Methods	Approach
Hedonic Price Method (HPM)	It is a method in which the valuation of goods is determined based on external characteristics of the premises or environment (Pagiola et al., 2004; Turner et al., 2010).	Revealed-preference approach (RPA)
Dose-Response method /Dose-Response Function (DRM)	It is based on the effects of changes in particular elements or pollutants on economic activity or a consumer's utility. For example, levels of air pollution affect the growth of various plant species differentially (Turner et al., 2010).	
Cost of Illness Method (CIM)	It is also known as the burden of disease, defined as the impact of diseases on human health and their effect on individuals, regions, or countries (Jo, 2014).	
Compensating Surplus Value (CSV)	CSV is a method in which people are willing to pay to reduce the number of air pollution days (Liu et al., 2022).	Stated-preference approach (SPA)
Contingent Valuation Method (CVM)	People are directly asked about their WTP or are compensated for a change in ecological services (e.g., WTP for cleaner air) (Pagiola et al., 2004; Turner et al., 2010).	
choice modeling/choice experiment (CEM)	People are asked to choose or rank based on service scenarios or ecological conditions(Pagiola et al., 2004; Turner et al., 2010).	
Theory of Planned Behavior Method (TPB)	It is based on behavior, attitudes, and subjective norms to predict behavioral intention, which helps individuals pay for improvements (Fu et al., 2018).	
Median Externality Value (MEV)	It is a method for each pollutant based on the pollutants' price applied in the USA. (i-Tree, 2021)	Cost-based approach (CBA)
Replacement Cost Method (RCM)	The loss of a natural system service is evaluated by the cost of replacing it with a man-made system (Turner et al., 2010).	
Shadow Project Price (SPP)	Shadow project price is the allotment of cost on something without services or goods (Xie et al., 2019).	
Cost of Emission Control (CEC)	It is determined by the government's prevention cost to control air pollution (Jim & Chen, 2008).	
Avoided Cost Method/ Damage cost (ACM)	The method considers the costs people incur to avoid damage from the loss of ecosystem services or from air quality regulations (Farber et al., 2006). (Example- cost for clean water reduces costly incidents of diarrhea)	
Cost saving method	In this method, the cost applied for treating pollutants in a region or country is considered for valuation (Xi, 2009).	
Demand Function Approach (DFA)	The demand function method is based on market demand for goods, which affects the value of the benefits of those goods (Okuyama, 2018).	
Value Transfer Method (VTM)	In this method, the economic valuation of ecosystem services is based on previously estimated values (Turner et al., 2010).	Stated-preference & Revealed-preference approach
Value of Statistical Life (VSL)	The VSL is defined as the amount an individual is willing to pay to reduce mortality risk (Hammitt, 2000).	
BenMap Program (BMP)	BenMap (Environmental Benefits Mapping and Analysis) is a computer program that estimates the economic value of air pollution-related costs using air quality and demographic data, along with concentration-response relationships (US EPA, 2016).	
Life Satisfaction Method (LSM)	This method is based on the experience of utility and emphasizes the subjective opinions of the individual(Frey et al., 2009).	The subjective well-being approach (SWA)

Source: Prepared by the researchers

Among these identified methods, the contingent valuation method (CVM) accounted for the largest share, i.e., 45.91 percent of the total. However, the choice modeling/ choice experiment (CEM), median externality value (MEV), Avoided cost method/ Damage cost (ACM), and the value transfer method (VTM) are used at 9.18 %, 8.16%, 5.10 %, and 5.10%, respectively. Moreover, the hedonic price method (HPM), dose-response method/dose-response function (DRM), value of statistical life (VSL), BenMap program (BMP), and life satisfaction methods (LSM) are used at 3.06 percent each. Methods like the replacement cost method (RCM), cost of emission control (CEC), and cost-saving method (CSM) are used at only 2.04 percent each. Besides, some methods, such as the cost of illness method (CIM), compensating surplus value (CSV), theory of planned behavior (TPB), shadow project price (SPP), and demand function approach (DFA), are used only once.

Variables used for valuation: Many variables were used in the selected studies (Appendix Table 3). They can be summarized into five broad dimensions, i.e., Air quality (directly), Environmental, Infrastructure, Human, and Technology (Appendix Table 4). The study reveals that the majority of studies select variables for valuation under the air quality dimension (54.29 percent), followed by Human (21.90 percent), environmental (13.33 percent), infrastructure (8.57 percent), and technology (1.90 percent). Moreover, the decade-wise use of valuation variables in the selected documents reveals that the variable 'clean air/improved air' has been widely used throughout the decades (Figure 2). Apart from that, the variable human health is widely used in the literature.

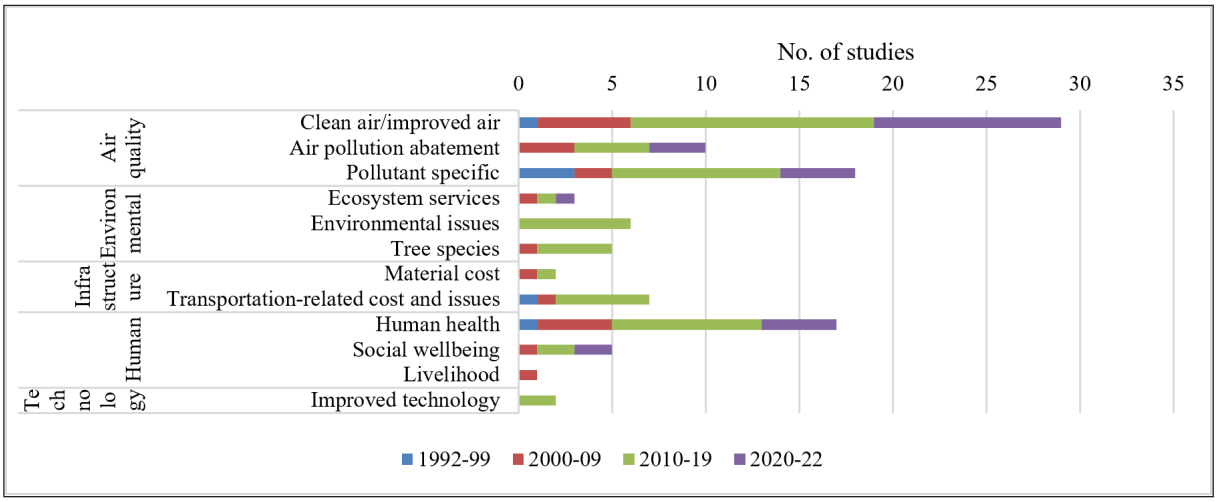

Figure 2. Decade-wise use of variables used for valuation in the selected documents

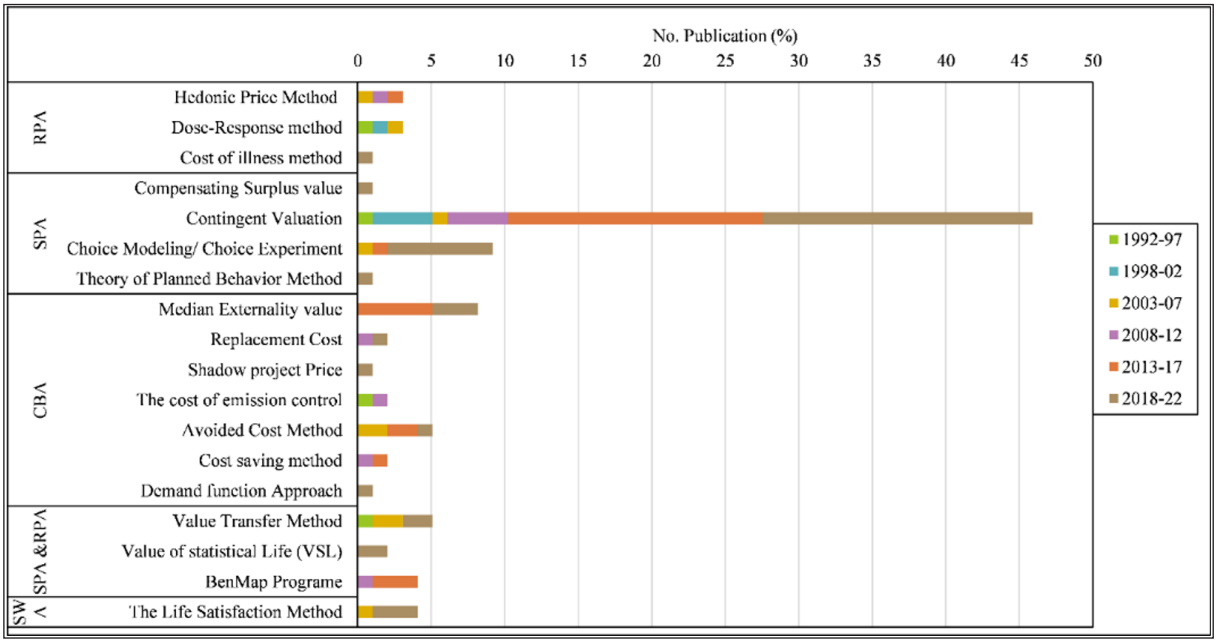

Figure 3. Identified methods used from 1992 to 2022

Publication year-wise methods: Publication year-wise use of the identified methods has been presented with a five-year gap (i.e., for periods 1992-97, 1998-2002, 2003-07, 2008-12, 2013-17, and 2018-22) and is interesting (Figure 3). Among these methods, CVM is the most consistently used in all the periods. CIM, CSV, TPB, VSL, and LSM are relatively recent methods. After the first use of CEC in 1994, it was used once during 2008-12.

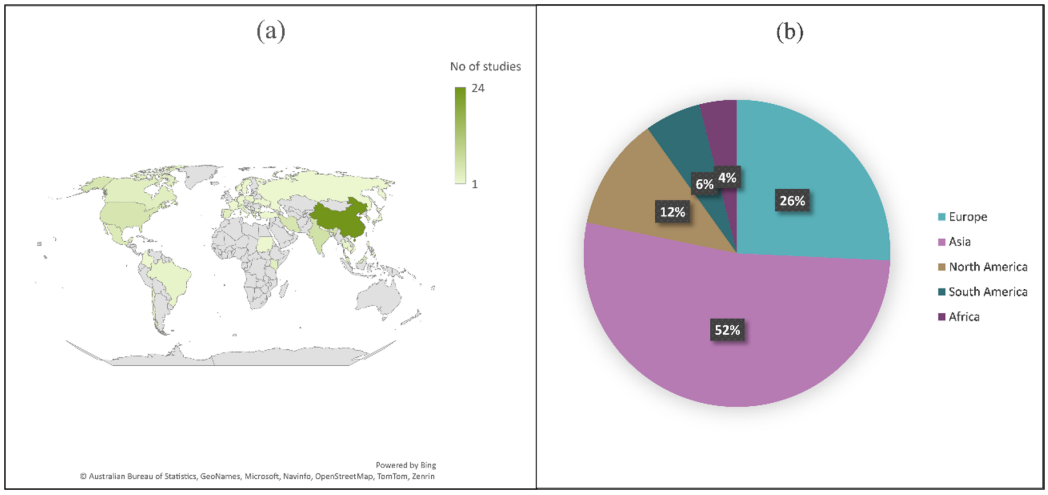

Figure 4. Worldwide spatial distribution of reviewed studies (a) Country-wise (b) Continent wise

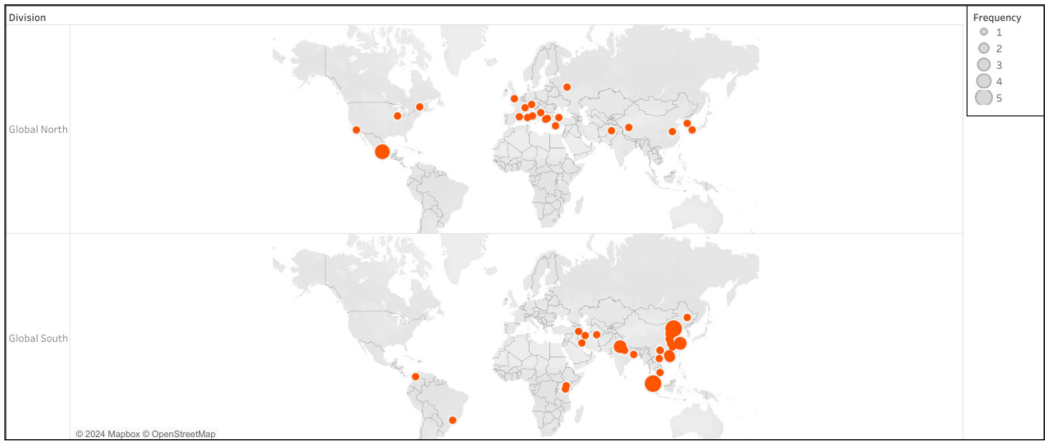

Figure 5. Publication in world megacities

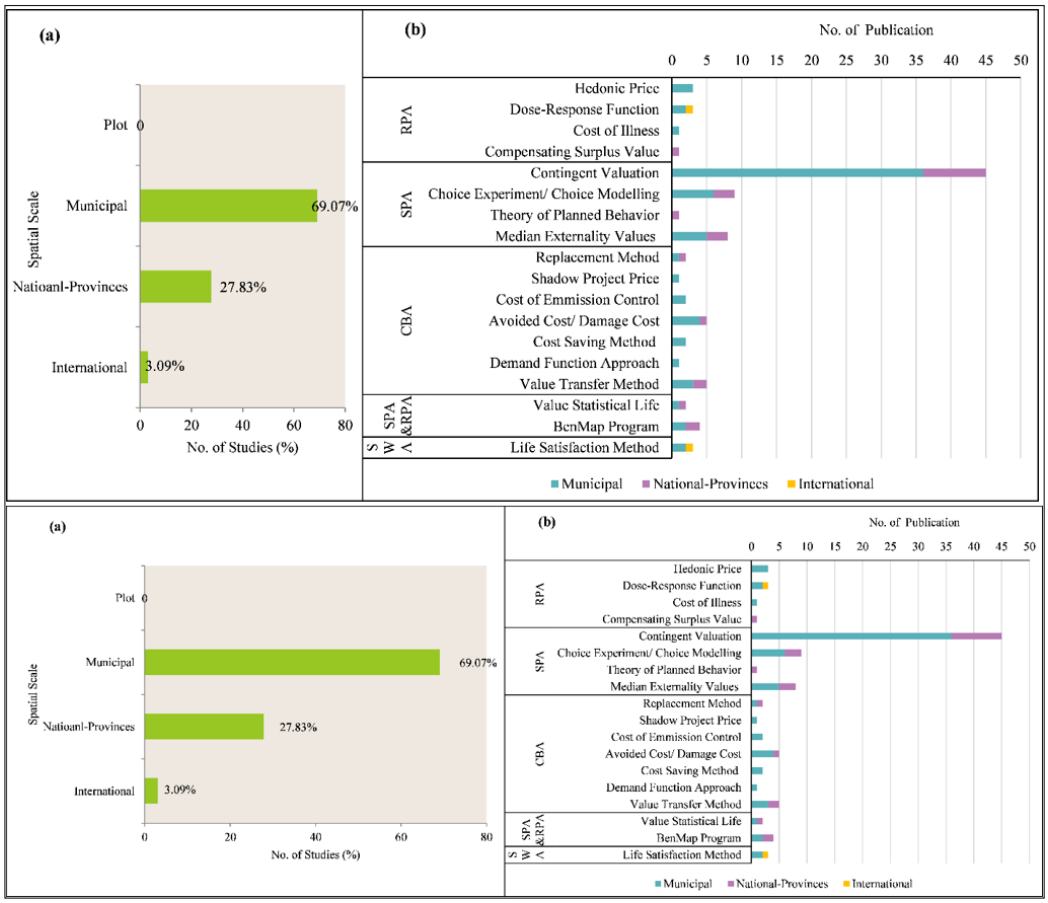

Figure 6. Reviewed studies at (a) Percentage of studies based on spatial scale (b) Method-wise spatial scale

3.2 Geographical application of the methods

Identified methods are used worldwide for EVAQI. Countries in Asia and Europe contribute more than those in North America, South America, and Africa (Figure 4). Asia is the leading continent (with 52.48 percent), and along with Europe (25.74 percent), it accounts for more than 75 percent (Appendix Table 5). Furthermore, China is the leading country in terms of the number of studies on EVAQI.

Publication in global cities: To understand the publication in cities across the globe, the city-level study has been segregated from the non-city-level study (Appendix Table 3). The city-level studies were further classified into global North and South cities to examine publication patterns from a global economic division perspective (Figure 5). Publications in the global south cities have been found to be higher than in the global north cities. Although the number of publications is higher in the southern world, it is repeatedly studied in a few cities. Most of them were carried out in Beijing City and Klang Valley (05 each), followed by Delhi and Shanghai (03 each), and Hong Kong and Guangzhou (02 each). There are 30 more cities that were studied once. On the other hand, studies in the global north mainly were carried out in different cities, 20 cities were studied once. Only Mexico City was studied 4 times.

Spatial scale: Four types of spatial scales have been considered for the analysis based on their size (Figure 6a and 6b). These are (i) plot (< 1 sq. km), (ii) municipal (1-10,000 sq. km), (iii) national provinces (10,000-1,000,000 sq. km), and (iv) international or global (>1,000,000) based on both ecological and institutional dimensions (Groot et al., 2010; Hein et al., 2006). At the municipal level, both urban and non-urban areas are included as physical dimensions to demarcate boundaries (Appendix Table 3). The non-urban regions are delineated at a municipal level based on the studies of Kumar & Rao (2001), Masahina et al. (2012), Srisawasdi et al. (2021), and Ribeiro et al. (2022). The results show that most studies are conducted at the municipal (69.07 percent) level, followed by provincial (27.83 percent) and international/global (3.09 percent) levels. Interestingly, no study was executed at the plot level (Figure 6a). Likewise, the CVM method has been applied extensively at the municipal level, with only a few studies conducted at the national level (Figure 6b).

4. Discussion

The study tries to identify and analyze the methods used for EVAQI through a systematic review of the selected literature. The methods identified for EVAQI have been categorized based on different approaches to the study.

4.1 Methods based on Revealed-Preference Approach

HPM, DRM, and CIM consider the actual behavior of consumers i.e. RPA. It estimates the expenditures made on ES-related market goods (Hawkins, 2003). This approach entails valuing recreation, environmental impacts on residential property, and human health (Bateman et al., 2011). Using the HPM, Komarova (2009) evaluated the value of air quality levels based on house prices and showed that house prices decrease with increasing levels of air pollutants. Although it is based on actual rather than hypothetical prices, this method has ignored other local factors such as, crime levels, noise levels, and transportation factors that might influence the considered prices. Bhat et al. (2022) considered treatment and hospital admission costs and estimated the value of human health and productivity influenced by air pollution. However, the value of mortality estimates is limited to people affected by air pollution-related diseases, not to other morbid or non-morbid conditions. Practically, air pollution affects both groups of residents.

4.2 Methods based on the Stated-Preference Approach

SPA is based on a hypothetical market in which respondents are asked hypothetical questions about whether they are willing to pay for ES that are not tradable in the market. This approach has been used to estimate the valuation of water quality, species conservation, flood prevention, air quality, and recreation (Turner et al., 2010; Bateman et al., 2011). Here, CSV, CVM, CEM, and TPB methods are based on the respondent's behavior lying on a hypothetical market of AQI, which is the SPA-based approach.

Compensating surplus can be defined in terms of any other good an individual is willing to substitute for it being valued (Freeman, 2003). Liu et al. (2022) used the CSV in national provinces in China to examine a relationship between air pollution and satisfaction, but it could not predict a cause-and-effect relationship between them. Moreover, CVM became the most popular method to assess the value of non-market goods and services following the landmark support from the National Oceanic and Atmospheric Administration (Arrow et al., 1993). In this method, data collection is easy and straightforward, withrespondents asked to pay or accept compensation based on their maximum willingness to improve air pollution, and it is widely used across disciplines such as ecology, economics, environmental science, and other social sciences. The use of the technique is increasing rapidly in developing countries (Alam, 2005). However, there are three limitations of the method. These are (i) hypothetical biases (which overestimate the value), (ii) there are significant differences between WTP and willingness to accept, and (iii) persistent disparities appear in surveys (Hausman, 2012). Besides, it creates inconsistency in sample size (Iqbal, 2020). Sarabdeen et al. (2019) found that the mean WTP in CVM is higher than that in CEM, though the statistical difference is almost the same. Thus, the CEM method can overcome the weakness of CVM, as identified during the survey, i.e., data collection inefficiency. In this method, residents rank different attribute alternatives of ES based on environmental conditions. The TPB method emphasizes characteristics of psychological behavior that influence people's intention to pay for something. Here, this method considers five factors, i.e., behavior, attitude, subjective norms, perceived behavior control, and behavior intention. It indicates that subjective norms and behavioral attitudes substantially influence people's WTP. However, there are some uncertainties of real value, such as whether the resident's intention is reflected in their income level.

4.3 Methods based on the cost-based approach

CBA is one of the most comprehensive economic valuation methods, which places monetary value on both costs and benefits. This approach has been widely used to estimate the economic value of the world's ecosystem services (Costanza et al.,1997; Wegner & Pascual, 2011). Here, MEV, RCM, SPP, CEC, ACM, CSM, and DFA consider the monetary value of both cost and benefit.

The reviewed paper by Rabl et al. (2007) identified the methods of CBA and proposed incorporating the life quality index into monetary valuation, as it might overcome the uncertainties in the economic valuation of mortality. Notably, MEV is applied during i-Tree model application in these studies. It also does not involve people in the decision-making process for valuation using secondary data (i-tree 2021), which is the method's main drawback. The technique emphasizes the costs of man-made items rather than the AQR service. However, these man-made items can hardly maintain air quality in large outdoor environments, even after significant investment. For example, the tallest air purification tower is installed in Chandigarh, which has a 1 km radius of capacity to purify the air ("Country's Tallest Air Purification Tower to Be Inaugurated Today," 2021). Whereas SPP is used to assess ES values of urban parks in AQI in Wuhan City, China, the denitrification treatment cost for vehicles is considered the value of air pollutant removal (Xie et al., 2019). Here, people without a vehicle are not included in the EVAQI process. Moreover, the ACM estimates the value of the ecosystem based on the costs required to avoid damage from the loss of a service. It has two perspectives: it estimates potential property damage due to service loss and calculates the cost of protecting property from potential injuries. This avoidance expenditure would be an estimated value of the service. It can be a helpful method for estimating property damage due to environmental factors, but it might yield uncertain results if multiple services are provided (Economic Valuation: Damage Avoided, Replacement, and Substitute Cost Methods, n.d.). Then, the CSM is used at the municipal level in China (Xi, 2009) and Cambodia (Kibria et al., 2017), where governments determine the cost of pollutant treatment. DFA is used at the municipal level in Japan based on market-related demand data for goods (such as facemasks and air purifiers), which are used as a defense to estimate AQI values (Okuyama, 2018).

4.4 Methods based on both Stated-preference and Revealed-preference approachs

Interestingly, methods like VTM, VSL, and BMP are derived from both SPA and RPA, in which the actual behavior of consumers is assessed based on a hypothetical market. The VTM is a critical method usually used where primary data are unavailable (Baró et al., 2014). Thus, the process may not always provide actual information on the study area. In the case of VSL, the method estimates the value of the risk fatality based on an individual's preferences, which can be elicited from SPA and RPA. The monetary value of mortality risk mainly depends on the level of wealth (i.e., income) and age. Thus, it may vary individually based on their circumstances. However, this technique helps assess the risk of death (Hammitt, 2000; Andersson, 2020). Based on the Geographical Information System, BMP calculates the economic value of changed health due to air pollution (US EPA, 2016). Here, four studies that used the BenMap program have been identified. Among them, two studies were carried out in the USA; one is at the municipal level (covering ten cities such as Atlanta, Baltimore, Boston, Chicago, Los Angeles, Minneapolis, New York, Philadelphia, San Francisco & Syracuse) and another study is at national-provinces level (Nowak et al.,2013; Nowak et al.,2014). The remaining two studies are taken at the municipal level in China (Ding et al.,2016) and South Korea (Chae & Park, 2011). These studies include the CIM, the cost of health care, WTP, and the cost of decreasing productivity of individuals. However, Ding et al. (2016) suggested that value emission control, transportation, industrial pollutant control, etc., should be considered for long-term AQI.

4.5 Methods based on the subjective well-being approach

Moreover, the SWA is based on the individual's pleasure in life that comes from the individual's experiences or situations related to services or goods. Based on that experience, individuals would be willing to pay for those services (Frey et al., 2009). Thus, the LSM is considered a type of SWA. LSM is based on the individual's judgment about their own welfare and the judgmental aspect of people, which can reveal their self-assessment of a good life. This approach depends on goods or services, income level, and subjective well-being factors (Frey et al., 2009). With higher income and greater life satisfaction, people are more willing to pay for reducing air pollution. Thus, there is a decreasing trend in air pollution with increasing income levels. Moreover, the technique evaluated the value of air quality reduction based on the individual's experience utility rather than preference utility. However, the output of WTP using this technique is very similar to HPM (as it is based on experienced utility) (Mendoza et al., 2019). Moreover, it is found that one of the review papers is conducted at the international level (Kougea & Koundouri, 2011), and the other two are at the provincial level in Canada (Rabl et al., 2007) and China (Jim & Chen, 2008).

The selected variables used to value the AQI can be categorized as either direct or indirect valuations. The variables related to Air Quality and Environment primarily contribute to the direct valuation of AQI and are thoroughly covered in the EVAQI framework. In contrast, the variables categorized under the Infrastructure, Human, and Technology dimensions are utilized for indirect valuation of the AQI. Human health is a particularly significant variable that is frequently employed in EVAQI assessments. Research into the health impacts of atmospheric pollution has shown a strong correlation between pollutant concentrations and conditions such as respiratory disorders, cardiovascular diseases, and lung cancer mortality (Cesaroni et al., 2013; Silveira et al., 2016; Srisawasdi et al., 2021; Chattopadhyay, 2021). As a result, studies assessing EVAQI through a human healthare becoming increasingly popular.

David J Nowak first introduced the economic valuation of air pollution using the CEC method in the USA in the report on Chicago's urban forest ecosystem (McPherson et al., 1994). After this, publications on EVAQI increased

worldwide almost every year. Air quality concerns are a global issue rather than a local one, which may be the reason for the lack of plot-level studies. On the other hand, air quality concerns are primarily associated with urban areas, where air pollution is prevalent due to increasing population concentration, transportation, and industrialization in and around cities. Thus, the maximum studies are found at the municipal level.

The EVAQI was initiated in a developed country, and studies were conducted in various cities across the global north. In contrast, developing cities face significant challenges, including high population density, increased transportation demand, and greater pollution. Many of these cities are in or near the tropics, where pollution processes more quickly than at higher latitudes (Parrish et al., 2016). Consequently, cities in the Global South are often more advanced in their application to EVAQI than those in the Global North. The research indicates that China is the leading contributor to EVAQI efforts in Asia and worldwide, with studies conducted at municipal, national, and provincial levels. Following Asia, many studies have also been conducted in various cities across Europe. Notable Global South cities involved in these studies include Beijing, Klang Valley, Mexico City, Delhi, Shanghai, Hong Kong, and Guangzhou. Zhang et al. (2019) identify air pollution as a significant concern in China. Addressing this issue has become a top priority, requiring substantial efforts in policy design, social investment, and technological innovation (Liu et al., 2023). China has more economic benefits from air quality improvement studies The reasons are: 1) a large number of population has been affected due to poor air pollution, 2) China is willing to invest more in the better air quality as well as balancing economic growth and ecological conservation, 3) an effective policy intervention at the local, regional and national level, 4) Clean air access and achieving SDGs 5) reduce more health expenditure in the present and future. Consequently, China has incorporated environmental valuation methods into its policy decisions. The country initiated the Payment for Ecosystem Services (PES) program in 1999 to promote the sustainable management of ecosystem services (Zhang et al., 2000). Through the PES scheme, China has improved its ecological situation with increased forest cover (Liu et al., 2008) while also generating higher incomes for rural communities (Song et al., 2014). Additionally, two programs were launched: the Conversion of Cropland to Forest Land (also known as the Grain for Green program) in 1999 and the Ecological Welfare Forest Program (a forest resource management initiative) in 2001 (Wang et al., 2020). Furthermore, studies on the valuation of ecosystem services in India are growing, focusing primarily on forest ecosystem services and wetlands (Chora et al., 2022). Thus, economic policy initiatives with local people's participation will be effective in mitigating air pollution.

5. Conclusion and Implications

An in-depth review of the selected research articles, government reports, and theses on the EVAQI service as an ES provides significant outcomes. Among evaluation methods, the most common is CBA. It is followed by SPA, where CVM is the dominant method. The method considers an individual's contribution to the monetary valuation of air quality. This study also revealed that CEM is more effective than CVM for economic valuation of AQI, as CEM can overcome data-collection inefficiencies during the survey. However, COI and BNM techniques showed that government policies related to transportation, industry, and other factors that affect air quality should be included in the methods along with the cost of health care and resources for long-term AQI. EVAQI has been widely used to assess human health. Thus, integrating the costs of health effects and policies into processes will provide more inclusive outputs to environmental decision-makers. Besides, the WTP is the most frequently used term in the selected literature. WTP is much more effective when the subjective and behavioral approach is used in the TPB and LSM. The Damage cost method and the life of statistical life are better methods for valuing damages and the risk of property or resources due to air pollution, which are not traded in the market. Moreover, no study has been conducted at the plot level, whereas most studies are conducted at the municipal level. It may be to consider the space required for monitoring AQI, as well as urban challenges in managing air quality. Interestingly, studies have been found only at the continental level in Europe, and this pattern has arisen due to the concentration of most urbanized countries there. However, most studies are conducted in global South cities rather than global North cities. The studies are primarily concentrated in a few cities in countries of the global south, given their state. Finally, except for China, most studies in developing countries are replications of developed countries. The emergence of ES valuation in the developed world is a significant reason behind this trend. China has applied a new method for evaluating AQI, such as the TPB. The study will be helpful to potential users of EVAQI for assessment and further research, especially in global North and South cities.

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