

ECOLOGICAL WISDOM RESEARCH TRENDS IN LANDSCAPE PLANNING: A SYSTEMATIC REVIEW

ABSTRACT

Ecological wisdom has become an emerging field in the context of landscape planning and design practices for achieving sustainability and resilience. Several scholars have published empirical research papers in this field, and some have also conducted reviews to explore its concept and framework. However, since the empirical research varies, no study has made a systematic literature review and thus encountered difficulties in determining the research topic and problem. Moreover, the research approach and data analysis method could differ based on study site characteristics. Therefore, this study aims to identify and analyze the research topic and problem discussed, site characteristics, and methodology of ecological wisdom studies from 2012 to 2021 by conducting systematic literature reviews involving descriptive analysis, and thematic analysis. The analysis of selected primary studies revealed that recent ecological wisdom studies focus on four topics: exploration, in-depth concept, method introduction, and evidence-based study. Most of the problems discussed in primary studies have focused on acquiring and applying ecological wisdom in practice for contemporary planning and design related to landscape sustainability and resiliency. The characteristics of the study sites were grouped into four categories: sites with unique landscape features, historical or preserved sites, sites with environmental problems or limitations, and sites with high biodiversity. The research methodology developed in ecological wisdom studies uses one or a combination of qualitative, quantitative, and/or spatial approaches involving field measurements and spatial modeling. Finally, the contribution, limitation, and opportunities for future improvements.

Keywords: cultural landscape, design, ecological wisdom, planning, qualitative approach.

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INTRODUCTION

Ecological wisdom is a relatively new concept that emerged in 2014 and is still established by many international academic societies and publications. The concept of ecological wisdom influences various landscape planning and design practices as a fundamental framework for achieving sustainability and resilience. In 2016, Springer Nature Press published a book series on ecological wisdom, proposing ecological wisdom as a vital sociological and ecological discourse (Young and Lieberknecht, 2019).

Ecological wisdom is defined as the willingness and ability to integrate ecological knowledge and site familiarity to create a good property design that requires minimal intervention in gaining landscape sustainability over time (Patten, 2016; Wang *et al.*, 2016; Yang and Young, 2019). It consists of evidence-based knowledge—either explicit or implicit—originating from a multidisciplinary background and across generations (Xiang, 2014). Environmental sustainability faces many problems in landscape degradation as an effect of industrialization and urbanization, which also indicates friction between the human desire for prosperity and the ecosystem's integrity. In this issue, ecological wisdom encourages an interdisciplinary approach to enhance sustainable landscape development (Wang *et al.*, 2016b).

Recently, many studies have highlighted ecological wisdom as the main subject of various theories, such as land-sense ecology (County *et al.*, 2020), cultural ecosystems (Chen *et al.*, 2020), environmental change

(Modeen, 2021; Permana *et al.*, 2019; Yuan *et al.*, 2017), sustainability, and resiliency planning (Fu *et al.*, 2016; Liao *et al.*, 2016; Wagner *et al.*, 2016; Wang *et al.*, 2016b; Douglas *et al.*, 2018; Long *et al.*, 2020). Some studies have written review papers on concepts and frameworks (Xiang, 2014; Patten, 2016; Eidinow, 2016; Fu *et al.*, 2016; Liao and Chan, 2016; Wang *et al.*, 2016; Schwann, 2018; Grose *et al.*, 2019; J Forester, 2019; Yang *et al.*, 2019) to provide an understanding of ecological wisdom either from theory or practice. However, literature reviews conducted in this field have not been systematic, but they have identified, analyzed, and interpreted primary studies to answer specific research questions (Kitchenham, 2004; Staples and Niazi, 2007; Wahono, 2015).

The technical research on ecological wisdom varies, which, as mentioned above, creates difficulties in determining the research topic and potential problems to discuss in this field. Moreover, research approaches and data analysis methods could differ based on study site characteristics. Therefore, a comprehensive picture of current research evidence on ecological wisdom is still lacking. In the present study, the systematic literature review aims to identify and analyze the research topics, problems, site characteristics, and methodologies of ecological wisdom research from 2011 to 2021. This paper consists of a review methodology section, a result section providing answers to the research question, and a final section that includes conclusions and recommendations for future work.

METHODS

Review Method

In the present study, a systematic review was conducted according to the systematic literature review (SLR) process (Kitchenham, 2004) and PRISMA guidelines (Shamseer *et al.*, 2015). The systematic literature review identifies, analyses, and interprets primary studies to answer specific research questions (Kitchenham, 2004; Staples and Niazi, 2007; Wahono, 2015). It is using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) which is a 27-item checklist used to improve transparency in systematic reviews (Shamseer *et al.*, 2015). These items cover all aspects of the manuscript, including title, abstract, introduction, methods, results, discussion, and funding. The review stage refers to (Wahono, 2015) who divides the stages into three steps: planning, conducting, and reporting a literature review. The planning step identifies the objectives and requirements for performing SLR and developing a review protocol, which provides guidance for conducting the review and reduces the possibility of research bias. The protocol consists of defining the research question, building a research strategy, directing the study selection process, assessing the quality of primary studies, and conducting the data extraction and synthesis process, and it was evaluated and improved by conducting and reporting reviews. The review framework is shown in Figure 1.

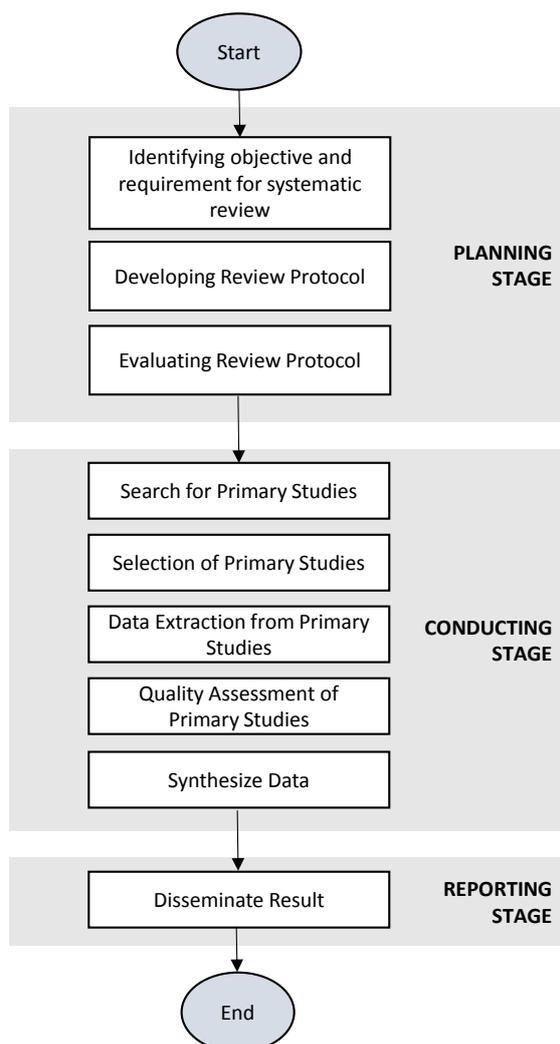


Figure 1. SLR steps according to (Wahono, 2015)

Research Question

The research question defined in this study focuses on a review of specified information in primary studies. The PICOC approach (Boland *et al.*, 2017) was used to develop questions based on five components (population, intervention, control, and outcomes) to organize relevant information. The PICOC structure for the research questions is shown in Table 1.

Table 1. The PICOC structure

PICOC Structure	
Population	Paper in landscape architecture topic
Intervention	Paper about Ecological wisdom, nature-inspired design, eco-design
Comparison	No comparison in this study
Outcomes	Topic and trend, site characteristic, variable used, method and approach applied
Context	Sustainable landscape, resiliency planning, landscape eco-design

Table 2. Research Question of SLR study

Code	Research Question	Objective
RQ1	Which journal is the most significant in the ecological wisdom field?	Identify the most significant journal in ecological wisdom field
RQ2	Which paper was most cited by researchers on ecological wisdom studies?	Identify the most cited paper on ecological wisdom studies
RQ3	What kind of research topics are selected by researchers in the ecological wisdom field?	Identify the research topic in ecological wisdom studies
RQ4	How does the characteristic of study site that selected for ecological wisdom research?	Identify the characteristic of study site that selected in ecological wisdom research
RQ5	What kind of method are applied for exploring ecological wisdom on site	Identify methods are applied to explore ecological wisdom on site.

This study identified research articles in landscape architecture scope in the context of sustainable landscape. Specifically, it identified and analyzed ecological wisdom topics as intervention. The outcome of this study was obtained characteristic of ecological wisdom studies in landscape research topics including topic trends, site characteristics, variable used, and method applied in the research.

The research questions and desired objectives of this study are shown in Table 2. RQ3–RQ5 are the main research questions of the study and will be answered by extracting primary studies and then coding them into theme clusters. While, RQ1 and RQ2 are supporting questions which related to bibliographic information to summarize a particular area of research in the field of ecological wisdom.

Search Strategy

Literature data were collected from four digital libraries: Scopus, Web of Science, Science Direct, and Google scholar as representative academic e-database. A search strategy was developed to identify relevant literature by identifying search terms using PICOC (population and intervention) for relevant titles, abstracts, and keywords. The synonyms and alternative spellings were also identified through Boolean ANDs and ORs. The English research articles were collected in March 2021 from articles published between 2011 and 2021. The document type was required to be a research articles and proceeding paper.

Study Selection

The study selection process adapted from the PRISMA method (Shamseer *et al*, 2015) involved exclusion and inclusion criteria, both of which were used to select primary studies. A positive point value was added to studies that fulfilled the inclusion criteria, while a negative point value was added to studies that met the exclusion criteria. Finally, studies with more positive point values were included as primary studies, while the others were excluded. The inclusion and exclusion criteria were based on the research question and are shown in Table 3.

Table 3. Inclusion and Exclusion Criteria

IC1	Empirical studies about ecological planning/design project	Inclusion Criteria
IC2	Empirical studies about ecological wisdom in the cultural landscape	
IC3	Empirical studies about eco-wisdom in landscape heritage	
IC4	Empirical studies about ecological policy/ideas/strategy	
EC1	Review and concept studies	Exclusion Criteria
EC2	Empirical/concept studies other than sustainable landscape context	
EC3	Article/review paper about indigenous/traditional knowledge/local wisdom	

In general, primary studies were selected in the two stages. First stage, non-relevant documents were excluded based on prerequisite and correspondence to the title and abstract. Next, primary studies were excluded based on the inclusion/exclusion criteria for the full text. The selection process for primary studies is shown in Figure 2. The final stage of study selection resulted in 33 primary studies that were included for further analysis.

Data Extraction

All selected primary studies were listed and extracted to answer the research question by reviewing the full text. For instance, the research questions were grouped into four properties to address the answers (Table 4), and the data were then extracted repeatedly to enhance data accuracy. Furthermore, the extraction result was coded to identify specific terms related to the research question and then grouped into theme clusters.

Study Quality Assessment and Data Synthesis

A quality assessment of the primary studies was needed to guide the interpretation of the synthesis findings and draw a firm conclusion. Therefore, data synthesis was performed to obtain the aggregation of evidence in selected primary studies. The data were synthesized and visualized using the narrative method completed by tables and graphics.

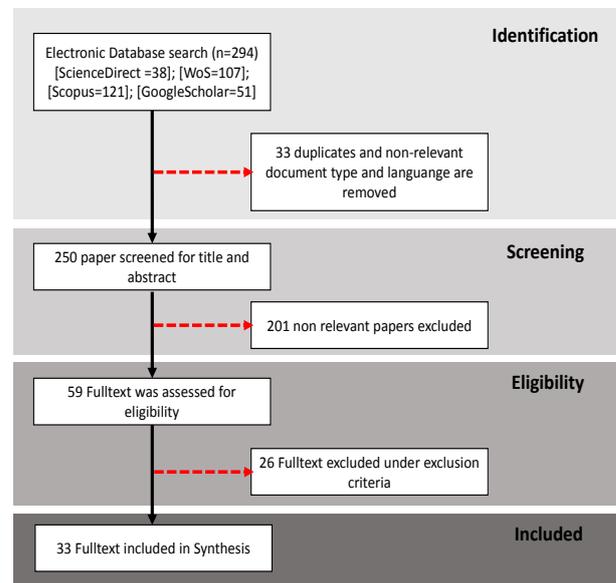


Figure 2. The Study Selection Process

RESULT AND DISCUSSION

Significant Journal Publication and Influential Studies

The distribution of the primary studies over the years is shown in Figure 3. The orange line showed the number of publications over the years, while the orange dotted line showed the linear value of fluctuated line. The study selection process included 33 primary studies in the analysis and revealed that the distribution of ecological wisdom studies related to sustainable landscape development fluctuated from 2015 to 2017, peaked in 2016, and remained stable from 2018 to 2020. While the dotted line shows how the interest in ecological wisdom studies has changed over time.

Although the search was conducted from 2011 to 2021, the selected primary studies were published between 2015 and 2021. Ecological wisdom studies in the context of sustainable landscape development have emerged since 2015 and are still being explored. This also indicates that contemporary and relevant studies were included in the analysis. Moreover, the graphic trend line in Figure 3 shows that ecological wisdom research is still relevant.

Table 5 shows the Scimago Journal Rank (SJR) and Q categories (Q1-Q2) of the most influential journals in the ecological wisdom field. It indicates that studies on ecological wisdom were primarily published in reputable journals regarding the published sources. It should be noted that a study on ecological wisdom is essential to discuss. The best five journal publications were ordered based on the SJR value, which indicates the scientific influence of scholarly journals developed by Scimago from the Scopus Database. It counts the number of citations of the journal, and the higher the SJR value, the greater the journal's prestige.

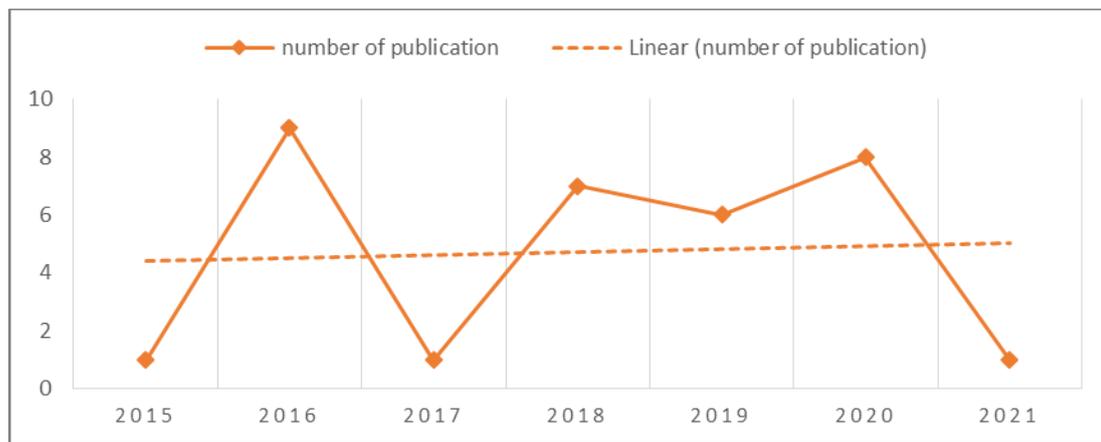


Figure 3. The Study Selection Process

Table 4. Significant Journal Publications by SJR

No.	Journal	SJR	Q Category
1	Journal of Cleaner Production	1.89	Q1 in Environmental Science
2	Landscape and Urban Planning	1.74	Q1 in Ecology
3	The journals of gerontology. Series B, Psychological sciences and social sciences.	1.59	Q1 in Sociology and Political Science
4	HABITAT International	1.54	Q1 in Nature and Landscape Conservation, Urban Studies
5	Urban Ecosystem	0.87	Q1 in Ecology

Table 5. The 10 Most Influential Studies in Ecological Wisdom Research

Title	Cited	Year	Journal
Urban design principles for flood resilience: Learning from the ecological wisdom of living with floods in the Vietnamese Mekong Delta	70	2016	Landscape and Urban Planning
Measuring Wisdom: Existing Approaches, Continuing Challenges, and New Developments	54	2018	The journals of gerontology.
Design with Nature: Ian McHarg's ecological wisdom as actionable and practical knowledge	45	2016	Landscape and Urban Planning
Landscape and Urban Planning: Ecological wisdom as an emerging field of scholarly inquiry in urban planning and design	42	2016	Landscape and Urban Planning
Landscape and Urban Planning: The role of ecological wisdom in managing sustainable interdependent urban and natural ecosystems	37	2016	Landscape and Urban Planning

The most influential studies were also identified by ordered publications based on the number of citations. Table 6 shows the top five journals by citation number. Thirty-three selected primary studies revealed that 27 publications had been cited at least once, and five publications had been cited more than 30 times. Table 5 also indicates that the most influential studies in ecological wisdom research were published in 2016, either discussing concept (Duncan T Patten, 2016; Fu *et al.*, 2016; Robert F Young, 2016; Wang, Palazzo and Carper, 2016b) or learning ecological wisdom from the built landscape (Liao, Le and Nguyen, 2016; Wagner, Merson and Wentz, 2016; Yang and Li, 2016; Zhang *et al.*, 2016).

Topic and Problem in Eco-Wisdom Studies

The analysis of 33 primary studies revealed that ecological wisdom research focuses on four main topics: in-depth concept, exploration, evidence-based study, and method introduction. The distribution of studies by topic is shown in Figure 4. The details of the problems discussed in ecological wisdom studies are as follows.

1. *Deepening the concept and theory of ecological wisdom in the context of landscape and urban planning (in-depth concept)*

This cluster comprised six studies. Two studies reviewed the literature to explore ecological wisdom as the basic framework for landscape and urban planning (Young, 2016a; Wang *et al.*, 2016b). They discussed whether ecological wisdom could promote a new framework and paradigm in urban landscape planning and design in either urban or natural ecosystems. The other studies proposed a new city-planning concept with ecological wisdom as the fundamental paradigm. One study compared the concept of a smart city to a wise city (Young and Lieberknecht 2019). Another sought possibility for the paradise concept to serve a cross-cultural urban discourse (Young, 2016b).

Furthermore, one study discussed how to measure wisdom and its manifestation (Glück, 2018), while the last discussed ecological wisdom related to sustainability and resiliency issues (Patten, 2016). Their synthesized theory clarifies the significance of ecological wisdom in sustainable landscape development.

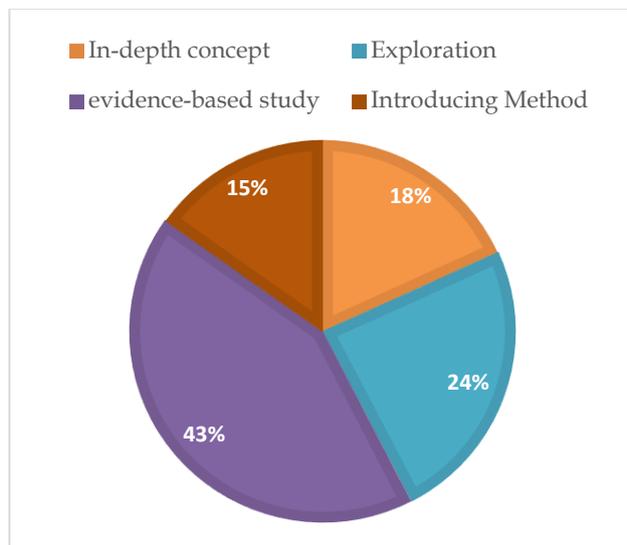


Figure 4. The Distribution of Studies by Topic Cluster

2. *Exploring ecological wisdom of the site case from various theories and perspectives (Exploration)*

An exploratory study of ecological wisdom was conducted based on various theories and perspectives. At least eight primary studies were included in this cluster. Some of the theories used to explore ecological wisdom on-site were land-sense ecology (County *et al.*, 2020), cultural ecosystems (Chen *et al.*, 2020), bioclimatic wisdom (Winarto, Santosa and Ekasiwi, 2015), and spatiotemporal features (Eng, 2019). All these studies have mainly discussed the space of traditional settlements, while other studies have explored ecological wisdom in specific sites to understand people's adaptation to environmental change (Muhdhar *et al.*, 2018; Modeen, 2021).

3. *Learning ecological wisdom from the built landscape to solve landscape problems (evidence-based study)*

Most of the primary studies (14 studies) attempted to learn from the ecological wisdom of the built environment proven over time to solve landscape problems. Some of the landscape issues that have been revealed from an ecological wisdom perspective are flooding adaptation and drainage systems (Liao *et al.*, 2016; Wagner *et al.*, 2016; Zhang *et al.*, 2016; Long *et al.*, 2020), practical solutions for landscape limitations in woodland and urban areas (Yang and Li, 2016; Forester, 2019), and the promotion of landscape sustainability (Yuan *et al.*, 2017; Chu *et al.*, 2018; Zheng *et al.*, 2018; Zhou *et al.*, 2018; Ma *et al.*, 2019; Akbar *et al.*, 2020). All these studies tried to analyze and acquire the ecological wisdom of the site case using various contemporary methods until they gained an understanding of the ecological process that happens on-site as an effect of the ecological wisdom underlying those physical features. Other studies also attempted to search for evidence of people's wisdom in their interactions with natural resources (Casazza, 2020; Saboonchi and Fard, 2020).

4. *Introducing an approach to acquire and apply ecological wisdom in landscape planning and design (method introduction)*

Two studies attempted to develop an approach to acquire ecological wisdom that could thus be applied to present studies. One of them developed a quantitative approach to externalize ecological wisdom to be reusable (Min and Lee

2019a), while the other promoted a qualitative approach to gather ecological wisdom for resiliency planning (Douglas *et al.*, 2018). Three other studies have developed approaches to help landscape planners apply ecological wisdom to actual projects (Fu *et al.*, 2016; Zheng *et al.*, 2018; Radaei *et al.*, 2020).

The Characteristics of the Study Site in Eco-Wisdom Research

Research on ecological wisdom has been conducted at sites, either urban areas or traditional villages. The selected study site usually has one or a combination of the following characteristics: sites with unique landscape features, historical and preserved sites, sites with environmental problems or limitations, and sites with abundant natural resources. The distribution of primary studies by site characteristics is shown in Figure 5, and the description of each character is as follows.

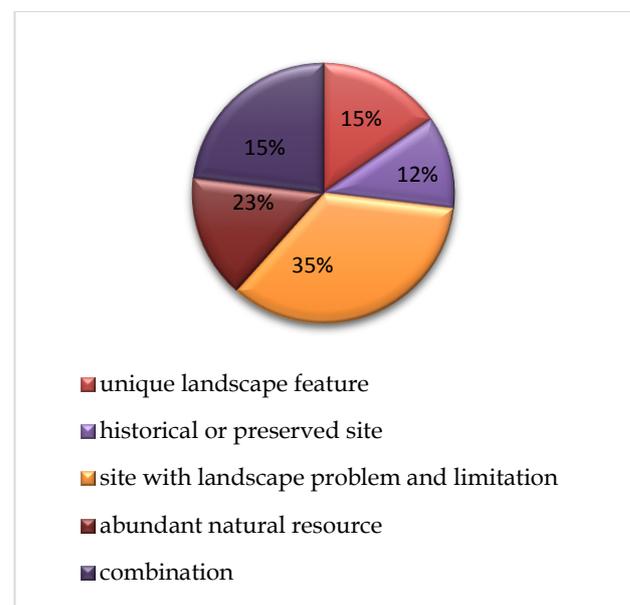


Figure 5. The Distribution of studies by site characteristic

1. *Unique Landscape Feature*

(Yang and Young, 2019) stated that reverence to nature is the primary principle for obtaining ecological wisdom. The way that the community shows respect for their landscape creates sustainability in the living environment. Landscapes with unique spatial features have encouraged communities to adapt to them and generate ecological wisdom; therefore, some primary on-site studies have represented communities' reverence to nature and revealed the interaction of landscape features with people's adaptation (Ma *et al.* 2019; Saboonchi and Fard 2020; Yuan *et al.*, 2017))

2. *Historical or preserved site*

The historical and preserved site represents a time-honored, eco-design product that may contain ecological wisdom. This is an evidence-based study to acquire ecological wisdom from the past for new knowledge. Some studies have been conducted at historical sites, including traditional settlements (Chu *et al.*, 2018; Zheng *et al.*, 2018; Zhou *et al.*, 2018; Chen *et al.*, 2020; County *et al.*, 2020), nomadic settlements (Eng, 2019), agricultural heritage areas (Li *et al.*, 2020), and historical drainage system areas (Zhang *et al.*, 2016).

3. Site with environmental problem or limitation

A site with environmental problems or limitations mainly was chosen as a study area. In this context, ecological wisdom is used to solve the landscape problem to create an ideal site. Some of them are located in urban areas, mainly residential and industrial areas that face environmental challenges (Patten, 2016; Fu *et al.*, 2016; Wagner *et al.*, 2016; Douglas *et al.*, 2018; Casazza, 2020; Long *et al.*, 2020). Other studies have focused on challenging living environments (Radaei *et al.*, 2020) or environmental problems (Forester 2019; Yang and Li 2016). Since most primary publications are evidence-based studies, it might suggest that environmental problems encouraged people to transform their ecological knowledge to gain ecological wisdom.

4. Site with abundant natural resource

The exploration of ecological wisdom in a site with abundant natural resources is mainly related to how people interact with and manage the ecological factor and conserve their natural resources. Most studies have been conducted in traditional villages (Kakoty, 2018; Muhdhar *et al.*, 2018; Permana *et al.*, 2019; Modeen, 2021), while others have been conducted in a historical agricultural system (Li *et al.*, 2020).

The Research Design and Approach in Eco-Wisdom Research

The research design and approach in ecological wisdom studies vary depending on its objective. However, most studies have applied a qualitative approach and combined it with a spatial analysis and modeling approach. In contrast, the quantitative approach is rare. The distribution of the studies by their research design is shown in Figure 6.

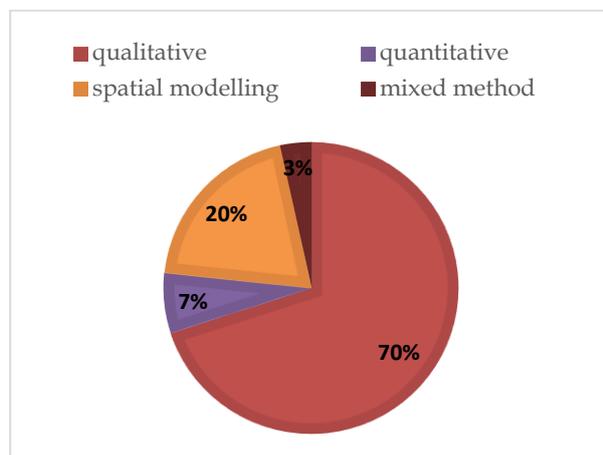


Figure 6. The distribution of studies by research design approach

The qualitative research approach was either literature- or fieldwork-based. A study using literature-based comparison analysis explored urban sustainability related to ecological wisdom (Akbar *et al.*, 2020; Casazza, 2020) and explored the fundamental factors of smart and wise cities (Young and Lieberknecht, 2019). Fieldwork-based studies have mainly applied field observations to data collection methods combined with interviews (Liao *et al.*, 2016; Douglas *et al.*, 2018; Kakoty, 2018; Muhdhar *et al.*, 2018; Meng and He, 2019; Permana *et al.*, 2019; Long *et al.*, 2020; Saboonchi and Fard, 2020; Modeen, 2021) and

literature surveys (Winarto *et al.*, 2015; Zhou *et al.*, 2018; Eng, 2019; Chen *et al.*, 2020; County *et al.*, 2020; Li *et al.*, 2020; Long *et al.*, 2020).

Furthermore, the data analysis that was applied for those fieldwork-based study was ethnographic (Muhdhar, Syamsuri and Indriwati, 2018; Modeen, 2021), SWOT analysis (Douglas *et al.*; Li *et al.*, 2020) and spatial analysis (Liao *et al.*, 2016; Zhou *et al.*, 2018; Chen *et al.*, 2020; County *et al.*, 2020; Long *et al.*, 2020).

Scholars have also developed a spatial modeling approach either to acquire and apply the ecological wisdom of a site case. Some studies have built climate simulations using microclimate software such as ENVI-met urban microclimate software (Ma *et al.*, 2019), point-cloud modelling software (Chu *et al.*, 2018), and VENT wind simulation (Zheng *et al.*, 2018). Another study built a hydrological model through Stella software to explore storm and flooding events and determine annual water balances in the historical drainage system (Zhang *et al.*, 2016). Another study attempted to develop a planning support system software called EWIPSS using Community-Viz (Fu *et al.*, 2016). Furthermore, the thematic map overlay analyses conducted to analyze land-use suitability (Wagner *et al.*, 2016) and morphological characteristics to acquire ecological wisdom embodied in the site (Zheng *et al.*, 2018; Zhou *et al.*, 2018).

A quantitative approach was developed to externalize ecological wisdom from built heritage (Min and Lee, 2019a) and applied ecological wisdom in planning and design (Fu *et al.*, 2016). (Min and Lee 2019a) developed a quantitative method from spatial data to measure the similarity pattern of a site and calculate the matrix correlation between pairs of spatial components and environmental factors, while (Fu *et al.*, 2016) developed EWIPSS software to calculate planning simulation with ecological wisdom as a benchmark. Furthermore, ecological wisdom research was also applied using a mixed method, both qualitative and quantitative, as studied by (Radaei *et al.*, 2020). A qualitative approach was used to explore the principle of ecological wisdom in a desert city using the deductive-comparative analysis method. A quantitative approach was then used to examine the correlation of the ecological wisdom principle.

Figure 6 shows that most researchers used a qualitative approach to explore and acquire ecological wisdom on site. It could be assumed that this approach is the most effective method, especially for studying human interactions and adaptation. However, Yang and Young (2019) argue that the performance and benefit of ecological wisdom projects/products could be quantified by scientific evaluation, which might be the reason for the researchers to develop some previous models.

CONCLUSION AND FUTURE WORK

This study aimed to identify, analyze, assess, and interpret the significant publication, research topic, site characteristics, and methodology applied of ecological wisdom research from 2011 to 2021 towards 33 selected primary studies. The analysis revealed that research on ecological wisdom was mostly published in Q1 journal and cited more than 30 times over decades. It also focused on four topics: evidence-based study (14 studies),

exploration studies (8 studies), in-depth concepts (6 studies), and method introduction (5 studies). In-depth concept studies have clarified the significance of ecological wisdom in sustainable landscape development. In comparison, the exploration studies discussed traditional settlement spaces and people's adaptation. Next, evidence-based studies attempted to reveal the ecological wisdom embedded in the site case to solve the contemporary landscape problem. Finally, a new method has been introduced to acquire or apply ecological wisdom.

The study site of ecological wisdom research was identified as one or more characteristics, such as unique landscape features, historical or preserved sites, sites with environmental problems or limitations, and abundant natural resources. Furthermore, four primary research designs were applied in ecological wisdom research: qualitative approach, spatial modeling, quantitative approach, and mixed method. Since most ecological wisdom studies are arguably qualitative, the quantitative approach still has the potential to be studied and developed.

Ecological wisdom studies have drawn the attention of scholars to leveling up traditional ecological knowledge, which is limited to the local context, becoming general and reusable knowledge through synthesis, communication, and theorization (Yang and Young, 2019). The potential topic to discuss in this field is still wide, either about learning best practice from heritage, then acquiring ecological wisdom from it or developing methods to assess the ecological wisdom of landscape projects to produce a good property design as well as a good strategy and policy to deliver prudent action for sustainable landscape development.

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