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# The Key Factors Influencing Safety Analysis for Traditional Settlement Landscape

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**Abstract:** The secure layout of traditional settlements is key to their sustainability. The criteria and assessment framework for spatial safety have not yet been systematically summarized, and their safety assessment criteria and dimensions have not yet been established. Therefore, this study aims to develop the constructs, assessment framework, and relational network, and analyze the association among and roles of key criteria of the spatial safety of traditional settlements using the Delphi method, DANP (DEMATEL (Decision Making and Trial Evaluation Laboratory)-based ANP (Analytic Network Process) method), and IPA (Importance–Performance Analysis) for case studies. Based on the results, this study extracted the localized elements of traditional settlements to create special local settlements. This study found that: (1) the dimensions of spatial safety include spiritual, physical, and behavioral aspects, and 16 criteria, eight of which are key criteria; (2) religious beliefs are important and have mutual influence on the organization and source of other criteria; (3) the use of IPA found that key criteria together makes up safe living places. Spiritual defense combines trust with the sense of belonging; the physical defense constructs a spatial environment; and behavioral defense involves daily life activities. Spiritual defense consists of psychological consolation and has a complementary relationship with physical defense. Behavioral defense has a social organizational system, which it reflects in spiritual and physical defenses. The spiritual, physical, and behavioral defenses are related to each other, and are reflected in the psychological, spatial, and living aspects. Overall, when taken together, the spiritual, physical, and behavioral aspects of the spatial safety criteria of settlements construct safe living places.

**Keywords:** safety sustainable development; traditional settlement; safe layout; DEMATEL; ANP

## 1. Introduction

The economic model of traditional settlements, from traditional agriculture and the handicraft industry to industrialization, has promoted the transformation of the spatial layout of traditional settlements [1]. These spatial layouts are deeply influenced by the social background and actual environment, while the form, space, and internal organization of settlements dominate the social background and change the lifestyle [2]. Over time, the internal space and external form of settlements have undergone tremendous changes; however, regardless of such changes, the safety of the space remains one of the important elements for the survival of settlements. For better safety, tribes tend to concentrate in settlements [3]. The concentration of ethnic groups in settlements is based on the identity arising from geographical proximity and blood ties; for example, the Oceanian ethnic cultural identity is based on "con-social personhood", while western society establishes ethnic identity according to blood ties [4]. In addition, geographical identity, as defined by action and geographic

proximity, shows the relationship between residential area and behavior [5]. Settlement concentration is a safe, identity-based living place, and the rural settlement is one of the most primitive forms of the spatial layout of settlements [3]. Bunce suggested that the functions, forms, architectural types, structural materials, and spatial layout of residences determine the form of the spatial layout of rural settlements [6]. Norberg-Schulz proposed that the overall environment of settlements includes four aspects: nature, collectivism, public space, and private dwellings, while inhabitation implies some meaningful relationship between mankind and the environment [7]. Traditional settlements are the common life intention and architectural form of the local environment, and the settlements formed by the collectively recognized hierarchical system have the traditional function of social adjustment [8]. A traditional settlement is a living place that integrates social space, physical space, and ecological space, in which group life features a significant unity of values, an outlook regarding the environment, and a culture [9]. A settlement is an ecological circle that constantly adjusts itself to achieve ecological balance. Traditional settlements represent a balanced and sustainable relationship between human and ecological environments. Sustainability presents itself in economy, politics, and society, as well as low crime rates, high penetration, and strong transparency, which all contribute to the safe spatial layout of the environment [10]. Economically, a study that took Japan, the U.S.A., and Europe as samples, showed that environmental spillover exerts a significantly positive impact on corporate employment, meaning that policymakers take actions to promote the impact of green technology on economic transition [11]. Given that environmental spillover imposes a negative impact, the author proposes a two-pronged measure. First, our economic measures should focus more on technological transition; moreover, we should take effective actions to promote environmental innovation for the overall sustainable achievement of enterprises [12]. Research and development (R&D) collaboration exerts an impact on the sustainable development of enterprises in the chemical industry. When enterprises acquire knowledge through their internal resources, innovation and sustainable performance will be improved [13]. Politically, Australia proposed the vision of "sustainably safe homes" [14], which indicates that the government must devote a huge public budget to disaster relief and safety management [15], and systematically explored environmental security on three levels (the national level, federal level, and Russian entities) and held that the developed research method made it possible to solve environmental security issues [16]. Ecology limits the sustainable development of some countries or regions. Social economy, ecological conditions, and human capabilities are utilized to develop environmental safety assessment technologies and provide a reference for the development of effective ecological safety management strategies for regional and homogeneous groups [17]. In the social aspect, sustainable design principles are proposed based on learning from the natural system, as well as respecting humans, local areas, and the future; respecting humans and local areas include respecting human activities and ecosystem principles [18]. Sustainable design principles adhere to the co-existence of humans and nature, respects the relationship between material and spirit, and creates safe objects with long-term value [19]. The 11th goal of the Agenda for Sustainable Development 2030 is to build a living environment that features inclusiveness, the capability of regional disaster relief, and sustainable development. In short, the economy provides a material basis for sustainability, while politics and policies provide a mechanism of guarantee for sustainability, and society provides the code of conduct for sustainability. This shows that a safe spatial layout lays the foundation for the life and development of traditional settlements, and is also one of the important indicators of sustainable development both nationally and world-wide.

G.R. Willy, an American archaeologist, held that settlements show the mutual reflection of human and natural environments, and the study of the form of settlements enables us to understand how our ancestors lived in peace with nature. The study of settlement form also contributes to the research of traditional social structures and political systems [20]. By dating back to the issues of settlement form and human concentration to discuss the urban form, K. Lynch pointed out that 'the most fundamental question is to determine which elements constitute human settlements. Is human behavior one of the elements? What about social structure? What about the economic

system? What about the ecological environment? What about the definition and significance of space?' [21]. These questions serve as testimony to the importance of research on traditional settlements. What is a settlement? Heidegger interpreted dwellings according to the words '*bauen*' and '*wunian*'. '*Bauen*' means "to remain" or" to stay in a place"; '*Wunian*' means "to be at peace", "to be brought to peace", and "to remain in peace". The word for peace, '*Friede*', means being protected from harm and threats [22]. Compared with the traditional metaphysical "purpose-means", Heidegger broke the conventional thinking between buildings and residence by making buildings focus on the residential function, granting them site memory, and paying attention to the human–space and huma–human relationships in the space; such changes provide the possibility for the localization, ethnic features, and diversification of the architectural space. With scholars both at home and abroad paying more attention to traditional settlements, a literature review from 1990 to 2017 showed that the studies of the safe layout of traditional regional settlements in China and Taiwan have gained momentum [23]; however, these studies had the problems of content, theory, and structure. First, the research content mainly focused on building space and military defense without considering safe spatial layout; second, methodologically qualitative research accounted for 6.4% of the total, and thus, lacked the experimentation and application of quantitative research methods; third, in terms of the research theory and assessment framework, the defensive space of settlements is discussed from the perspectives of physical environment, social behavior, and spiritual safety, in both a separate and combined manner. Firstly, while physical environment and social behavior provide theoretical reference for the physical space and behavior of safety assessment, these two elements cannot theoretically explain the spiritual level. Newman's Defensive Space proposed the effective monitoring of the physical environment design, in order to curb crime inside settlements [24]; Jeffery proposed the Theory of Crime Prevention through Environmental Design (CPTED) to reduce crime through environmental and institutional mechanisms [25]; Altman studied environment and social behavior, and proposed that privacy is regarded as a process of interpersonal boundaries, and that the interaction of individuals or groups with others in this process should observe its norms [26]. Secondly, while physical environment and spiritual defense provide physical and spiritual theories for safety assessment, they cannot provide theoretical reference for the behavioral level. "Peripheral linear defense" and "local point defense" were proposed from the perspective of physical space and summarized the key criteria of physical space safety [27]. The main elements of spiritual defense were summarized from the perspectives of geomancy, religion, clan beliefs, and the defensive virtual image effect [28]. In sum, while the safety assessment framework includes the factors of physical environment, social behavior, and spirit, there is no aspect or criterion regarding systematic safety assessment. Questions that remain unsolved include: What is the safe layout of defensive traditional settlements? What are the key criteria of safety? Which criteria constitute the framework of assessment for traditional settlement safety? Are the criteria relevant, and what is such relevance?

Traditional settlements integrate social, humanistic, ecological, and other aspects, and the criteria of safe layouts are interdependent. The ANP (Analytic Network Process) is one of the methods widely used for solving the interdependence of key criteria, as well as for analyzing their relative importance. Based on the defensive traditional settlements in Taiwan, this paper screens the aspects and key criteria of safe spatial layouts, adopts Delphi expert interviews to obtain the safety assessment framework of traditional settlements, and uses the DEMATEL(Decision Making and Trial Evaluation Laboratory)-based ANP (DANP) method to analyze the importance and relevance of the criteria and draw a network diagram of the key criteria. The following three points are the objectives of this study; first, the assessment criteria of the safe layout of traditional settlements are determined to improve the assessment framework; second, the importance of key criteria and the network diagram are obtained through DANP; the final part is case analysis, in which IPA (Importance–Performance Analysis) is adopted to analyze the distribution of the pros and cons of the key criteria in the case.

This paper consists of six parts: the first part is the introduction, which presents the motivation, objectives, methodology, and results of this study; the second part is a brief literature review regarding

safe layouts; the third, fourth, and fifth parts present the methods, results, case analysis, and discussion of this study; the final part offers the summary and conclusions. The research results are significant for extracting the localized elements of traditional settlements, obtaining effective resources to create special local settlements, and providing a theoretical reference for settlement safety assessment.

## 2. Literature Review

The literature review of the traditional settlement safe layout reveals that the theory mainly comes from two aspects: first, traditional settlements and spatial safety, and second, safety assessment and the safety model.

### *2.1. Traditional Settlement and Spatial Safety*

Settlement means that people settle down between heaven and earth. Geographically, in a broad sense, Hu defined settlements as the houses of farmers, and houses, towns, and cities with other special functions; in the narrow sense, it refers to a rural settlement [3]. This study defines settlement in a narrow sense, meaning a settlement is a community in which humans live regardless of scale [9]. The spatial layout of traditional settlements is composed of a natural environment, a physical environment, and an artificial environment, which exert effects on each other [2]. Paragraph 1, Article 3 of the *Rules for the Implementation of Law on Cultural Heritage Preservation* (2005) stipulates that "traditional settlements refer to buildings with a complete historical context and texture, a coordinated landscape, historical features, and regional or industrial characteristics". "Rural settlements refer to a society composed of people dedicated to agriculture" [29]. Traditional settlements are influenced by tangible and intangible natural and social backgrounds. Compared to the effects of material, climate, and defense, the effect of social culture on settlements is more important [8]. Blij and Murphy classified rural settlements into five types: linear village, cluster village, round village, walled village, and grid village [30]. The layout of a round village takes advantage of the surrounding topography to form the safest defensive periphery; moreover, as it features a periphery boundary and centripetal space, it is safer than other settlement forms. Unlike the large-scale mechanical construction of urban residential areas that mainly serve for residential functions, since the Industrial Revolution, traditional settlements refer to a living environment of a certain scale where people of a specific background are concentrated [31]. However, the above definitions fail to clearly define the traditional settlement. This paper defines the traditional settlement as the scaled concentration of people under specific production conditions where primary industries or handicraft groups collaborate. Such collective life is based on blood ties and geographical proximity to sustain ethnic reproduction and safety in a certain context.

The safe spatial layout aims at resisting foreign invasion or avoiding natural disasters to create a benevolent and stable society, meaning it prevents natural disasters and man-made calamities to ensure safe living conditions for its occupants. Hu suggested that settlements came into being for political, economic, cultural, life, and defensive needs [3]. Hall held that human history is mostly dedicated to seizing the space of others, while defending one's own [32]. In order to achieve safety and settlement development, a certain group of people must ally on the basis of trust to resist foreign invasion [33]. Wang discussed the characteristics of the safe spatial layout of a fortress from the perspectives of spiritual and physical defense [34]. Jacobs proposed that the "natural surveillance" of streets, squares, and other public areas is essential to settlement safety [35]. Newman proposed that the planning of a safe layout varies among different types of spaces, such as the private areas of residential zones, as well as public spaces, which aim to prevent crime and create a safe living space [24]. Jeffery proposed the first- and second-generation Crime Prevention through Environmental Design (CPTED) theory, and established the ICA Association [25], which is significant to the "safe urban layout". Although there are numerous cases of crime prevention through environmental design, these theories aim at the study of crime prevention in the internal space of traditional settlements. Safety is embodied in politics, the economy, society, and space; the safety assessment of this paper mainly refers to the safe spatial layout.

A traditional settlement space, and its safety, refers to a residential environment spontaneously built by residents who consider their social background and natural environment, and is a living site that integrates physical space, social culture, and work, and forms part of its cultural heritage. Compared with that of common settlements, the safe layout of the traditional defensive settlement reflects the close relationship between humans and nature. Therefore, the study of the safe layout of traditional settlements provides a reference for how people interact with nature, space, and other people in modern settlements.

### *2.2. Space Assessment and Safety Mode*

The design of the physical environment and the methods involved—meaning the defensive space—play an important role in reducing crime [36]. Brunson et al. discussed the influence of the different forms of the public areas of building environments on community safety, as based on the theory of defensive space (DS) and a simulation method, and showed that a public housing context in support of the adjacent public area is of great importance to the DS theory; the support relationship among people living in the areas of public housing is closer than those living in undivided areas, and the former community is safer [37]. The two important indicators of a safe layout are visibility and open space [38]. The space syntax is used to test the innovative pedestrian size modeling tool, which is a method to reduce the risk faced by pedestrians and enhance their safety [39]. Glinskiy et al., adopted the multivariate average method, and considered human development, ecological development, and social economy to assess environmental safety; the results can be applied to the assessment of municipal and regional management [17]. Interviews and spatial analysis were adopted to analyze the effect of drug injection abuse on the public space safety of Smith Street in Melbourne, Australia [40], adopting a three-phase, multi-tier, mixed method to analyze the best position of a game space to make the public urban space more open, attractive, and secure [41]. Rasmussen analyzed the application of "safe spaces" and "queer spaces" to campus space by using Foucault's concepts of "dividing practice" and "heterotopias" [42]. In addition, the AVONA analytical method was adopted to determine whether residents' sense of safety was enhanced by video surveillance. Studies show that women, the well-educated, and long-term residents, believe that a surveillance system promotes safety and enhances the sense of safety, while the elderly think that the surveillance system makes people feel uneasy and makes young people less alert [43]. While the theory of Crime Prevention through Environmental Design (CPTED) is a practical and effective preventative tool, how CPTED and its components work remains unclear [44]. When a crime occurs, the physical environment is favorable for investigation and targeting crime [45], thus, the theory of CPTED contributes to reducing robberies [46]. Through surveillance, access control, the field involved, maintenance, and other criteria of the CPTED environmental design, the safety and reduction of theft in a residential area was assessed. By means of a questionnaire survey, and the combination of confirmation factor analysis and Scanning Electron Microscope (SEM), the safety of a residential area and its ability to prevent theft were assessed to determine whether the environmental design of a residential area was effective in reducing theft [47]. This assessment model focuses on sustainable, safe, and inclusive governance of society, the economy, and environment [48]. Crime prevention through environmental design is used to reduce crime inside settlements or residential areas, while the safe layout of traditional settlements is used to prevent external crime or reduce crime, thus, this theory is not directly applicable to traditional settlements. The literature review of Mainland China and Taiwan summarizes three aspects of a safe layout, as based on thirteen criteria [23]. The primary assessment framework is integrated, as shown in Table 1.

**Table 1.** Integrated preliminary criteria and aspects.

| Aspects | Criteria | Reference |
| --- | --- | --- |
| Spiritual defense | Fengshui Landscape, religious culture, physical defensive reflects. | [3,23,27,28] |
| Physical defense | Topography, border defense, access control, street network, nodes, planting. | [3,23,27,38] |
| Behavioral defense | Image, surveillance, social capital, activity support. | [23,38,47] |

The defense exerted by the safe spatial layout of traditional settlements mainly aims to prevent external attacks and natural disasters, while the CPTED theory is mainly applied to the design of internal settlement environments to prevent crime, which is why the theory of CPTED cannot be directly applied to the assessment framework of traditional settlements, meaning that the assessment framework of safe spatial layouts must consider the spatial layout theory of the localized elements of traditional settlements. However, neither crime prevention through environmental design nor the theory of safe layout can fully or appropriately cover the significance and components of the safe layout of traditional settlements. Therefore, this paper, as based on the theory of CPTED and spatial layout, combines various research methods, such as Delphi expert interviews and DANP, to build the assessment framework of safe spatial layouts.

## 3. Research Methods

This paper combines a qualitative research method with a quantitative method. The former includes a literature review that summarizes the hierarchical structure of safe layouts, while the latter includes the Delphi Method, DANP, and IPA: (1) the Delphi Method is used to conduct expert interviews and establish and improve the hierarchical structure; (2) the DEMATEL-based ANP method (CPTED) is adopted to calculate the key criteria and determine cause and effect; (3) the IPA analysis method is used to analyze the distribution of key criteria in the case.

### *3.1. Delphi Method*

The Delphi Method is a group decision-making method, and literature [49] argues that, for the Modified Delphi Method, Delphi items should be proposed based on literature, and then, experts are asked to express their opinions in the first round of a semi-structured questionnaire. In this study, seven experts from different fields discussed the safety assessment framework, as determined through peer recommendation and screening (Table 2). In the first round of the questionnaire interviews, experts from different fields put forward their views from different perspectives, and the opinions of each expert were summarized. In the second questionnaire interviews, the experts listened to the opinions of other experts through discussion and changed their opinions to reach consensus. The interviews mainly included the following parts: the first part was the question decision-making framework, which explains the decision-making framework of the questionnaire; the second part was a survey on how the dimensions of each criterion are attributed, which provided the opinions and evaluative criteria for this study, and assessed whether the dimensions of evaluative criterion attribution are proper; and the third part was a survey on the criteria of prototypal architecture. The criteria of this study explain whether the opinions are given or reserved; if there are items to be improved, experts were asked to enter the opinions in the column of "other suggestions"; the fourth part was the questionnaire on expert scoring consistency. The scoring ranged from 0 to 100, where 0 is definitely unnecessary, 50 is necessary, and 100 is definitely necessary. Experts scored anonymously for the purpose of consensus among them. To sum up, by means of semi-structured written questionnaires, this paper uses the expertise and knowledge of experts, and exchanges opinions with experts, until reaching consensus, in order to establish and improve the dimensions and criteria of safety assessment architecture.

**Table 2.** Backgrounds of experts for Delphi interviews.

| Code of Expert | Degree | Research Focus | Experience |
| --- | --- | --- | --- |
| Expert A | Honorary professor | Geography | Major in geography, urban planning, and landscape design; one of the judges of global settlement preservation; long-term study of settlement culture; one of the deputy editors of SSCI (Social Sciences Citation Index) with 44 years of teaching and experience in related fields. |
| Expert B | Professor | Assessment of landscape design | Member of various committees, such as Scenic Area Assessment, Urban Planning and Urban Design, Environmental Effect Assessment, B.O.T. (Build-operate-transfer) Greening and Hillside Land Development with 40 years of teaching and experience in related fields. |
| Expert C | Associate professor | Architecture | 11 years of teaching and practical experience in settlement space creation, urban design and planning theory, urban sociology, the study of spatial culture and local history, etc. |
| Expert D | Professor | Assessment of disaster prevention | 12 years of teaching and experience in urban planning and urban design, disaster and risk management, sustainable development, preservation and sustainable management of cultural assets. |
| Expert E | Associate professor | Sustainable design | 12 years of teaching and experience in urban planning and urban design, sustainable development, preservation, and sustainable management of cultural assets. |
| Expert F | Associate professor | Urban planning | Major in urban planning, 10 years of research and teaching in traditional settlements. |
| Expert G | Associate professor | Anthropology | Anthropologist, 22 years of teaching and practical experience in related fields, such as traditional settlement culture industry and community activation. |

### 3.2. *DEMATEL-Based ANP Method (DANP)*

In the DEMATEL-based ANP method (DANP), DEMATEL constructs a network relationship map (NRM), while ANP produces a limiting supermatrix to obtain criterion weights. The characteristics of DANP are described as follows (see Figure 1 for details). First, the network established by DEMATEL and ANP build the relative weights to determine the key factors of assessment. In other words, DEMATEL and ANP have the right to vote on key factors; for more details, see Figure 1 (voting). Second, with the focus on the cause and effect of key criteria, if the former is larger than the latter, the arrow points from one criterion to another, which simplifies the interaction between key criteria. The process of the DANP is depicted in Figure 1.

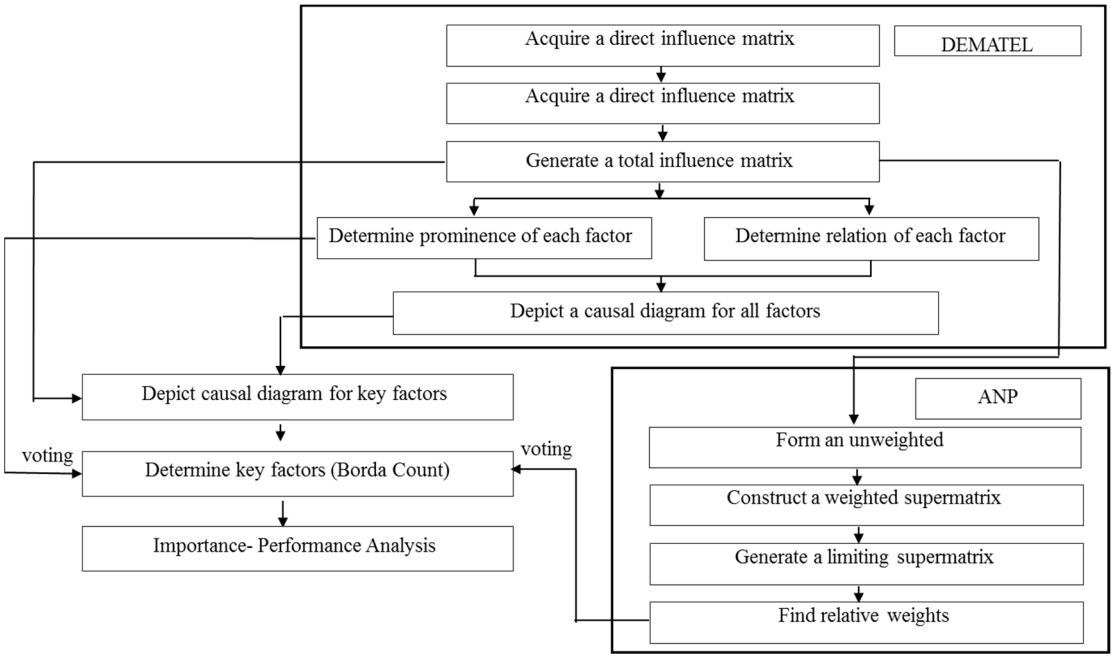


**Figure 1.** Proposed DANP (DEMATEL (Decision Making and Trial Evaluation Laboratory)-based ANP (Analytic Network Process) method) framework.

#### 3.2.1. Building a Total Influence Matrix

This phase includes two parts: research questionnaire and calculation.

(1). Research questionnaire

This study adopts DEMATEL to discuss the association of criteria, and the association of criteria in Table 3 is scored. The questionnaire is designed to express the effect of one criterion on another: 0 (no effect), 1 (some effect), 2 (strong effect). The scoring criteria are shown in Table 4.

**Table 3.** Description of revised assessment criteria.

| Aspects | Criteria | Criteria Descriptions |
| --- | --- | --- |
| Spiritual defense (A) | Fengshui Landscape (A1) | The settlement space is laid out according to Fengshui Landscape to retain the auspicious and prevent the ominous. |
| | Religious Beliefs (A2) | The impact of religious beliefs on the spirit of settlements:<br>1. Religious beliefs refer to human worship, as practiced by a certain culture;<br>2. Praying for peace and happiness;<br>3. Religious beliefs are materialized as patterns that prevent evil; symbolized building components and other landscapes constitute partial significance.<br>4. Folk beliefs, such as Bogong Temple and Five Camps, form intangible boundaries. |
| | Symbol of Physical Defense (A3) | Warning against intruders:<br>1. The implication of the physical defense spatial layout to intruders;<br>2. The metaphor of the physical defense spatial layout, namely, the warning signs;<br>3. The symbolic system of written titles expresses defensive implications. |
| | Trust (A4) | Trust promoted by:<br>1. Local identity, sense of security, and local self-awareness;<br>2. Psychological safety;<br>3. Blood ties, marriage, kinship, etc. |
| | Sense of Belonging (A5) | 1. Understanding local meaning to promote the identity of people or groups.<br>2. Residents, owners, space users, and other groups share a common group life.<br>3. Identity of important historical figures, historical events, and unique spatial elements.<br>4. Land ownership. |
| Physical defense (B) | Topography(B1) | The influence of topography and terrain on traditional settlements: review layout (location, orientation, form, etc.).<br>Complex topography and terrain constitute a natural defense barrier for settlements; thus, settlements are recommended to be built along mountains or waters. |
| | Boundary Defense (B2) | Natural boundaries, symbolic boundaries, and other artificial or natural boundaries are located at the outermost part of the settlement defense boundary:<br>1. Division of land (reclamation);<br>2. Building enclosure;<br>3. Intangible boundaries (see Religious Beliefs for details). |
| | Access Control (B3) | 1. Public and private spaces are separated by clear spatial boundaries.<br>2. The path of access is clear.<br>3. Connected to the artery. |
| | Nodes (B4) | The winding and twisting layout of the street network scares intruders. |
| | Street Network (B5) | 1. Setting up one or more spatial nodes that enhance security inside the settlement.<br>2. It has the function of social communication in the settlement's public activities. |
| | Planting (B6) | 1. Closer to buildings for enclosed linear defense.<br>2. Plants serve as shelterbelts or shelter. |

**Table 3.** *Cont.*

| Aspects | Criteria | Criteria Descriptions |
| --- | --- | --- |
| Behavioral defense (C) | Institution (C1) | The functions of managers in managing and maintaining settlements are, as follows:<br>1. Improving the management organization structure.<br>2. Maintaining the overall style.<br>3. Ensuring an orderly life in the settlement. |
| | Social Normal (C2) | The standardized social conventions are ethical and customary. While not legally-binding, social conventions are capable of restraining unconventional acts; such conventions feature the following:<br>1. Standardization of the form of open discussion;<br>2. Fair settlement and adjudication of internal disputes and controversy in settlements;<br>3. Definition of the rights and obligations of space use. |
| | Territory (C3) | 1. Creating or expanding the scope of influence to express a kind of "positive" space.<br>2. Creating clear boundaries, in order that people can naturally feel the boundaries of the space. |
| | Affordance (C4) | Crime prevention through activity support, meaning the reactivation of decaying and chaotic areas:<br>1. Holding public activities, such as regular temple fairs and annual festivals. Promoting memorial places, festivals, and events in settlements through activities.<br>2. Encouraging residents to participate in local activities or organizations, and inviting external communities and neighbors to participate in activities to enhance friendly relations among residents.<br>3. Developing a habit of caring about people and the public environment. |
| | Social Network (C5) | There is a good relationship between the establishment of an interpersonal network and the extension of neighborhoods.<br>1. Promoting good interpersonal relationships through common beliefs and sacrificial ceremonies;<br>2. Collective labor.<br>3. Extending social networks.<br>4. Establishing network relationships with external communities. |

**Table 4.** Rating scale.

| Criteria | 0 | 1 | 2 |
| --- | --- | --- | --- |
| Association | no effect | some effect | strong effect |

(2). Research calculation

Establishment of a direct relation matrix (Z). The effects of the criteria are obtained through the questionnaire, and the direct influence matrix Z is established to express the effect of one criterion on another. Among them, $z_{ij}$ represents the effect of criterion $i$ on criterion $j$, and the diagonal influence of element $z_{ij}$ is set as 0.

$$\boldsymbol{Z} = \begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1n} \\ z_{21} & z_{22} & \cdots & z_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nn} \end{bmatrix} \quad (1)$$

According to the direct relation matrix (Z), as obtained in (1), the matrix is normalized, as follows:

$$\boldsymbol{X} = \lambda \boldsymbol{Z} \quad (2)$$

$$\lambda = \frac{1}{\max\limits_{i,j}\left\{\max\sum\limits_{i=1}^{n} z_{ij}, \max\sum\limits_{j=1}^{n} z_{ij}\right\}} \quad (3)$$

After normalizing Z, the total influence matrix T can be obtained by calculating the formula ($\boldsymbol{T} = \boldsymbol{X}(\mathrm{I} - \mathrm{X})^{-1}$), in which O is the zero matrix and I is the unit matrix.

$$\lim_{\mathrm{K}->\infty} X^{\mathrm{k}} = 0$$

$$\boldsymbol{T} = \lim_{\mathrm{x}->\infty}\left(X + X^2 + \cdots + X^k\right) = X(I - X)^{-1} \quad (4)$$

The results of the above questionnaires are listed in Equations (1)–(4) for the total influence matrix *T*. *T* indicates the direct or indirect influences of the criteria. The main functions of T: first, in terms of ANP unweighted supermatrix, T can be used to identify key factors; second, it can be used to draw the cause and effect diagram. T is considered an unweighted supermatrix, which is used to normalize the total influence matrix to obtain the weighted matrix W of ANP. Finally, W is multiplied by itself several times till convergence, in order to obtain the global weights of the limiting supermatrix and all elements. T is regarded as the unweighted supermatrix of ANP, and the total influence matrix is normalized to generate weighted matrix W. Finally, after W is multiplied by itself several times, the limiting supermatrix W* is generated to obtain the weight of each element.

#### 3.2.2. Building a Network Relationship Map (NRM)

The value of *d* is determined from the sum of each row of the total influence matrix; the value of *r* is the sum of each column of the total influence matrix. The sum of rows and columns, namely $d + r$, is called the prominence. The sum of the rows minus the sum of columns ($d - r$) is called the relation [50]. If the relation is positive, the element tends to actively affect other elements and is referred to as a cause. If the relation is negative, the element tends to be affected by other elements, and is referred to as an effect.

### *3.3. Importance-Performance Analysis*

According to the IPA method, the pros and cons of the case are analyzed, and the resources are allocated according to the reasonable planning of spatial distribution. James proposed Importance–Performance Analysis (IPA), which is a commonly used reference method for the optimization of resource allocation. IPA takes the importance degree as the vertical axis and the performance value as the horizontal axis to generate four quadrants, respectively. Quadrant I in Figure 2 represents the disadvantage that must be urgently rectified; Quadrant II represents the advantage that should be maintained (see Figure 2 for details). Section 5 of this paper analyses the distribution of the criteria of physical defense, spiritual defense, and behavioral defense in the case study of the Wugoushui settlement in Hakka, Pingdong.

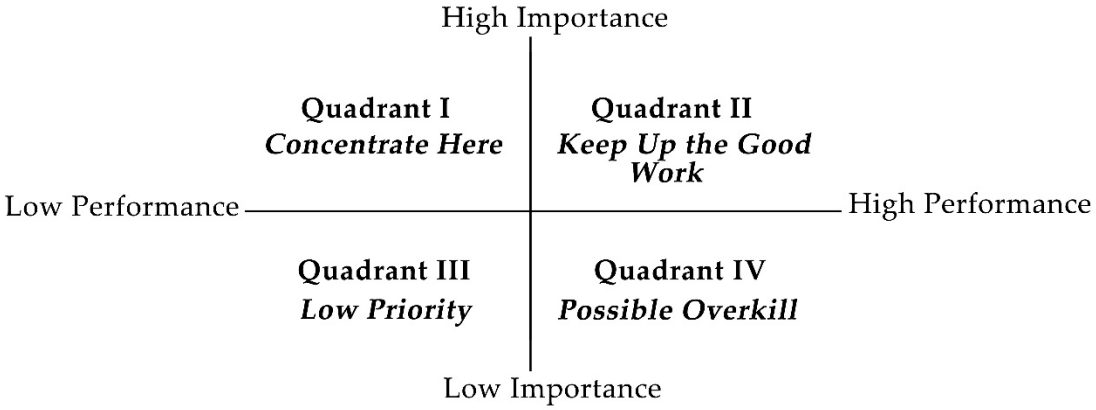


**Figure 2.** Importance–performance analysis.

## 4. Research Results

### *4.1. Building a Hierarchical Structure*

The Delphi semi-structured interview questionnaire is designed based on the aspects and criteria of Table 1, and the steps are as follows. First, the Delphi method questionnaire is designed to collect the opinions of the expert group. The assessment framework of safe layouts includes three aspects, in which the "technical defense" of Table 1 is changed to "behavioral defense". There are 16 criteria, and the revised criteria are detailed in Table 3. Second, the score of the consensus is made, as reached by the expert group. The threshold value of consensus difference set by this study is (CDI) ≤ 0.1. In the first questionnaire, criteria with CDI value >0.1 include A1 "Fengshui landscape", A2 "Religious beliefs", and so on, which means they fail to reach consensus. In order to reach a consensus, expert opinion is revised in the second expert questionnaire, and the CDI values of 16 assessment criteria must all be ≤0.1. When the assessment criteria of the expert group reach consensus, all criteria are maintained after expert discussion. All 16 revised criteria and their descriptions are detailed in Table 3.

### *4.2. Importance Analysis for Criteria*

In this study, experts assessed the 32 screened and valid questionnaires regarding the safe spatial layout of traditional settlements, which focused on teaching, building, preservation, and residents of settlements. With the DEMATEL-based ANP (DANP) method, this study uses the importance and relevance among the calculation criteria of Equations (1)–(4), where each column of the total influence matrix is added up separately to obtain the sum of each column ($d$), and each row is added up separately to obtain the sum of each row ($r$). The results of $d + r$ and $d - r$ are calculated (see Table 5). Judging from the value of $d - r$, if the row difference is positive, it means that the criterion tends to "influence other criteria" and tends to be a "cause"; if the row difference is negative, it means that the criterion tends to be "influenced by other criteria" and tends to be a "result". The results are listed in Table 5, in which A2 "Religious Beliefs" obtains the highest positive value of $d - r$, thus, this criterion becomes the "cause" of the effect criteria of the traditional settlement safe layout, and thus summarizes the "cause" and "effect" among the criteria.

**Table 5.** Prominence and relation of each criterion.

| Criteria | $d$ | $r$ | $d + r$ | $d - r$ |
|---|---|---|---|---|
| A1 | 3.742 | 3.387 | 7.129 | 0.354 |
| A2 | 4.692 | 3.247 | 7.939 | 1.445 |
| A3 | 3.000 | 3.584 | 6.584 | −0.584 |
| A4 | 3.936 | 4.471 | 8.407 | −0.535 |
| A5 | 4.061 | 4.758 | 8.818 | −0.697 |
| B1 | 3.987 | 2.856 | 6.842 | 1.131 |
| B2 | 3.728 | 4.012 | 7.740 | −0.284 |
| B3 | 3.414 | 3.904 | 7.318 | −0.489 |
| B4 | 3.891 | 3.770 | 7.661 | 0.120 |
| B5 | 3.792 | 4.250 | 8.042 | −0.458 |
| B6 | 2.532 | 3.182 | 5.714 | −0.650 |
| C1 | 4.089 | 3.872 | 7.961 | 0.217 |
| C2 | 3.739 | 3.472 | 7.211 | 0.267 |
| C3 | 4.049 | 4.081 | 8.130 | −0.032 |
| C4 | 3.761 | 3.673 | 7.434 | 0.088 |
| C5 | 4.027 | 3.922 | 7.949 | 0.106 |

The smaller the score of the overall ranking, the more important the criterion. According to expert opinion, the top 8 key criteria in Table 6 include: A1 "Religious Beliefs", A4 "Trust", A5 "Sense of Belonging", B4 "Nodes", B5 "Street Network", C1 "Institution", C3 "Territory", and C5 "Social Network".

**Table 6.** The overall ranking for criteria.

| Criteria | DEMATEL | DANP | Sum of Rankings | Overall Rankings |
|---|---|---|---|---|
| A1 | 13 | 11 | 24 | 12 |
| A2 | 7 | 1 | 8 | 4 |
| A3 | 15 | 15 | 30 | 15 |
| A4 | 2 | 7 | 9 | 5 |
| A5 | 1 | 3 | 4 | 1 |
| B1 | 14 | 6 | 20 | 9 |
| B2 | 8 | 13 | 21 | 11 |
| B3 | 11 | 14 | 25 | 14 |
| B4 | 9 | 8 | 17 | 8 |
| B5 | 4 | 9 | 13 | 7 |
| B6 | 16 | 16 | 32 | 16 |
| C1 | 5 | 2 | 7 | 2 |
| C2 | 12 | 12 | 24 | 12 |
| C3 | 3 | 4 | 7 | 2 |
| C4 | 10 | 10 | 20 | 9 |
| C5 | 6 | 5 | 11 | 6 |

In Table 5, the positive relevance ($d - r$) is a cause, while the negative relevance is an effect. Combining the data of these two tables creates Table 7, as follows.

**Table 7.** Cause/effect properties of criteria.

| Cause/Effect | Criteria |
|---|---|
| Cause | Religious Beliefs (*A2*), Nodes (*B4*), Institution (*C1*), Social Network (*C5*) |
| Effect | Trust (*A4*), Sense of Belonging (*A5*), Street Network (*B5*), Topography(*C3*) |

Comprehensive analysis of the importance of key criteria to the safe layout of a traditional settlement is, as follows:

*Religious Beliefs (A2)*—The settlement is a living space sheltered by gods that reject ghosts and evil spirits. Religion according to Eliade distinguishes the sacred features of a space according to its secular features [51]. "Holy land" is a symbol of orderly, meaningful, and strong spaces, and is different from non-sacred spaces without specific form, structure, or consistency. The religious and cultural beliefs of traditional settlements prevent ghosts from invading, and represent the wish for peace, happiness, promotion, and wealth.

*Institutions (C1)*—The institutions of a traditional settlement include religious institutions and geo-institutions. The geo-settlement forms a sacrificial circle with a "village temple", and families organize religious institutions through blood ties, which are centered on the sacrificial circle of a temple [52]. Institution is the social structure, operation mechanism, and means of management of traditional settlements.

*Sense of Belonging (A5)*—The local culture of traditional settlements expresses the individuality of the regional society, and stipulates the order observed by the public, to become an internal information network. This network connects everyone, forges cohesive settlement institutions, fosters the cohesion of settlements and the identity of the regional culture, and allows the local characteristics of settlements to remain [33]. Identity is one of the most important prerequisites for the sense of belonging.

*Territory (C3)*—Sennett (2018) proposed that a border is a mixture of different levels of culture. Borders, such as river banks, are not only the end of a settlement, but also the beginning of another [53]. On the one hand, traditional settlements effectively monitor their own space to prevent invasion; on the other hand, there are clear borders within and outside the field, including tangible border defense, and intangible borders, such as Bogong and ancestral graves.

*Trust (A4)*—In order to achieve safety and development, a settlement must be built on trust and be united to resist foreign invasion [33]. Traditional settlements are mainly formed through blood ties and geographical proximity, and settlement trust led by traditional culture creates a significant sense of belonging, which promotes internal unity [54]. Trust is one of the important elements for the cohesion of settlements.

*Social Network (C5)*—The interpersonal network of traditional settlements is mainly composed of the internal activities of settlements. On the one hand, traditional settlements establish interpersonal networks through public activities, such as agricultural festivals, sacrificial festivals, commemorative festivals, and celebrations. On the other hand, interpersonal relationships are reflected by the form of traditional settlements [33]. The interpersonal relationships of traditional settlements feature blood ties or geographical proximity.

*Street Network (B5)*—There is at least one spatial node with defensive functions, such as surveillance, guarding, refuge, and forceful counter-attack [55]. The spatial nodes that connect public buildings, such as stages and temples, show the functions of connective defense and provide a recognizable visual cognitive center.

*Nodes (B4)*—Streets and alleys in traditional settlements are relatively narrow and closed, which function like a spider's web to connect each household and form a unique spatial network system of narrow streets and deep alleys. This structure aims for quietness and safety [33]. Jacobs proposed the importance of the safe layout of streets and alleys for settlements. A node is a path of action, as well as a public space for activity and communication, and while it seems disorderly, it is actually a complex safety network system [35]. The street network of settlements is like the roots of a tree, which have the functions of connection and transportation.

### *4.3. Cause and Effect Analysis*

As shown in Table 8, by calculating Equation (4) through D-ANP, T (Total Influence Matrix) can be obtained.

**Table 8.** The total influence matrix.

| T | A1 | A2 | A3 | A4 | A5 | B1 | B2 | B3 | B4 | B5 | B6 | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | 0.170 | 0.221 | 0.241 | 0.270 | 0.293 | 0.188 | 0.259 | 0.261 | 0.246 | 0.273 | 0.220 | 0.214 | 0.203 | 0.248 | 0.212 | 0.224 |
| A2 | 0.283 | 0.204 | 0.288 | 0.344 | 0.368 | 0.220 | 0.300 | 0.284 | 0.286 | 0.329 | 0.246 | 0.318 | 0.287 | 0.306 | 0.306 | 0.323 |
| A3 | 0.177 | 0.168 | 0.143 | 0.223 | 0.239 | 0.142 | 0.206 | 0.207 | 0.203 | 0.214 | 0.157 | 0.187 | 0.165 | 0.214 | 0.175 | 0.180 |
| A4 | 0.204 | 0.220 | 0.221 | 0.238 | 0.338 | 0.175 | 0.254 | 0.238 | 0.234 | 0.273 | 0.183 | 0.281 | 0.261 | 0.270 | 0.261 | 0.286 |
| A5 | 0.216 | 0.222 | 0.237 | 0.322 | 0.259 | 0.186 | 0.260 | 0.257 | 0.250 | 0.280 | 0.200 | 0.284 | 0.259 | 0.272 | 0.268 | 0.288 |
| B1 | 0.250 | 0.217 | 0.240 | 0.272 | 0.292 | 0.154 | 0.291 | 0.286 | 0.272 | 0.294 | 0.244 | 0.231 | 0.201 | 0.274 | 0.227 | 0.242 |
| B2 | 0.214 | 0.197 | 0.226 | 0.278 | 0.285 | 0.197 | 0.200 | 0.271 | 0.247 | 0.269 | 0.215 | 0.238 | 0.197 | 0.265 | 0.207 | 0.222 |
| B3 | 0.212 | 0.172 | 0.211 | 0.246 | 0.265 | 0.180 | 0.255 | 0.180 | 0.238 | 0.263 | 0.192 | 0.197 | 0.175 | 0.242 | 0.187 | 0.198 |
| B4 | 0.227 | 0.189 | 0.245 | 0.297 | 0.309 | 0.196 | 0.265 | 0.266 | 0.195 | 0.292 | 0.209 | 0.244 | 0.210 | 0.273 | 0.228 | 0.246 |
| B5 | 0.223 | 0.199 | 0.227 | 0.277 | 0.291 | 0.193 | 0.262 | 0.260 | 0.242 | 0.214 | 0.215 | 0.230 | 0.204 | 0.266 | 0.238 | 0.252 |
| B6 | 0.159 | 0.129 | 0.153 | 0.173 | 0.199 | 0.152 | 0.192 | 0.182 | 0.159 | 0.191 | 0.109 | 0.142 | 0.128 | 0.176 | 0.142 | 0.146 |
| C1 | 0.211 | 0.232 | 0.244 | 0.314 | 0.333 | 0.183 | 0.269 | 0.247 | 0.254 | 0.280 | 0.203 | 0.215 | 0.264 | 0.282 | 0.265 | 0.293 |
| C2 | 0.204 | 0.212 | 0.221 | 0.292 | 0.310 | 0.154 | 0.243 | 0.229 | 0.216 | 0.260 | 0.188 | 0.264 | 0.177 | 0.252 | 0.245 | 0.271 |
| C3 | 0.230 | 0.215 | 0.243 | 0.304 | 0.327 | 0.198 | 0.281 | 0.272 | 0.259 | 0.287 | 0.223 | 0.263 | 0.230 | 0.219 | 0.241 | 0.256 |
| C4 | 0.195 | 0.220 | 0.217 | 0.299 | 0.313 | 0.160 | 0.224 | 0.221 | 0.223 | 0.256 | 0.183 | 0.273 | 0.253 | 0.254 | 0.189 | 0.279 |
| C5 | 0.214 | 0.229 | 0.227 | 0.320 | 0.336 | 0.176 | 0.250 | 0.241 | 0.246 | 0.275 | 0.196 | 0.293 | 0.258 | 0.269 | 0.280 | 0.216 |

According to Table 8, this paper identified each criterion exerting the biggest influence, and drew the cause and effect diagram, as shown in Figure 3; for example, the biggest value of the A3 range is 0.228, which corresponds to the influencing criterion of A2.

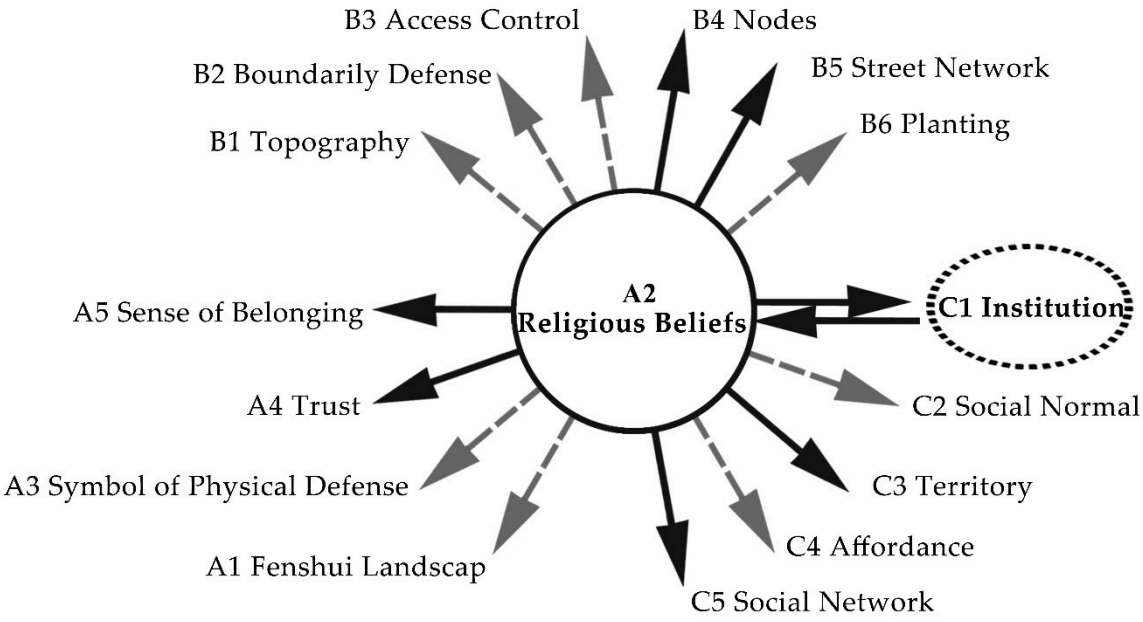


**Figure 3.** Cause and effect diagram of key criteria.

The effects of expert opinion and the eight key criteria (A2, A4, A5, B4, B5, C1, and C4), as shown in Tables 5 and 7, are represented by solid arrows. The effects of eight non-key criteria (A1, A3, B1, B2, B3, B6, C2, and C4) are represented by dashed arrows. The cause and effect diagram, as based on these criteria, is shown in Figure 3, and the mutual effect among the key criteria was analyzed, as follows: First, "Religious Beliefs (A2)" and "Institution (C1)" exert mutual effect, where religious beliefs contribute to the cohesion of the institution, while enhanced management strengthens the recognition of religious beliefs. Second, "Religious Beliefs" and "Institution" are important criteria affecting the safe layout of traditional settlements. Table 5 shows that the $d - r$ difference for both criteria is positive, thus, they can be used as the driving criteria for improvement. According to the DNAP criterion, the more positive the $d - r$ value, the better it serves as a driving criterion for improvement. Therefore, the criterion of "Religious Beliefs" is considered to be the source criterion for

traditional settlement safety assessment (see Figure 3 for details). The effect of Religious Beliefs on key criteria was analyzed as follows.

*Trust (A4)*—The trust forged by the consciousness of common religious beliefs is more likely to establish close neighboring ties and an intimate sense of belonging.

*Sense of Belonging (A5)*—Traditional settlements center on ancestral temples and feature a house-shaped intensive layout to establish settlement order [33]. With the evolution of settlements, religion evolves into a meaningful symbol and an imaginary community [56]; therefore, religious beliefs play an important role in the cohesion of a traditional settlement.

*Nodes (B4)*—The street-and-alley network layout features a tree-structured order with a clear focus. Religion serves as the spiritual, cultural, and political center of traditional settlers [33]. Streets and alleys wind to connect buildings and temples, demonstrating the relevance that includes physical space and spirit.

*Street Network (B5)*—Traditional settlements use the ancestral temple as the space node of public activities. With the development of settlements, space nodes related to religion become the political, spiritual, and cultural center of settlers [33]. The square in front of a temple (a symbol of religious beliefs) is the space node of settlement activities.

*Territory (C3)*—Settlements center on the main temple, and an invisible border defense is formed by five temples located in four directions of the land to build a sacred site [57]. Religious beliefs constitute the field definition of the "inner", "invisibility", "space", and "tangibility" of traditional settlements.

*Social Network (C5)*—Residents of traditional settlements live together and are tied by the interpersonal network of religious affinity and blood [33]. Settlements hold regular public activities to enhance cooperation among residents [58], and religion-related activities create the interpersonal network of traditional settlements.

The key criteria of a traditional settlement's safe layout include three aspects and 16 criteria. The three aspects are spiritual, physical, and behavioral defense; the 16 key criteria include religious beliefs, institution, a sense of belonging, territory, trust, social network, street network, and nodes. The safe spatial layout of traditional settlements meets the spiritual, physical, and behavioral demands for safety. Religious Beliefs (A2) play an important role as the source of traditional settlement safety assessment and exert a mutual effect with Institution (C1): religious belief is thus essential to a safe layout. On the one hand, Religious Beliefs exert an important effect on cohesion and spiritual defense, such as the trust of the settlement, but on the other hand, Religious Beliefs affect the "tangible" physical living site composed of streets and space nodes. Furthermore, activities formed by Religious Beliefs promote orderly organization and interpersonal networks. The establishment of the relationship network diagram of the traditional settlement spatial safety assessment criteria contributes to exploring an important issue, which is applied to the IPA analysis of the traditional settlement safe layout. The following is a discussion of the IPA analysis of the distribution of key criteria in the Wugoushui settlement.

## 5. Empirical Study of Wugoushui Settlement

Wugoushui is a Hakka settlement, and is located in the area between the territories of indigenous people and the Pingpu Tribe. To ensure a safe living space, it was constructed into a typical defensive traditional settlement of consolidated safety. Its safe layout includes three aspects: physical defense, spiritual defense, and behavioral defense. Meanwhile, it is also a relatively complete traditional settlement preserved in Taiwan, with a relatively large indigenous population. Therefore, the IPA analysis of the safe layout of the Wugoushui settlement can be considered to be representative.

### *5.1. IPA Assessment*

In this study, 14 experts, including 9 researchers and 5 permanent residents of Wugoushui (Pingtung, Taiwan), scored the performance of each criterion. The average score after discussion was 70, which serves as the threshold value. Criteria scoring over 70 indicate good performance,

which should be continuously maintained, while criteria scoring below 70 indicate poor performance, which should be urgently improved. A diagram of the degree of importance and performance score was formulated, as shown in Figure 4. The safety of the Wugoushui settlement performed well in various criteria, such as Religious Beliefs (A2), Trust (A4), Sense of Belonging (A5), and Institution (C1), which are the aspects of "spiritual defense" and "behavioral defense" and should be well maintained. However, Nodes (B4) and Street Network (B5) for "physical defense" and Territory (C3) for "behavioral defense" are the key criteria that should be immediately improved (see Figures 2 and 4 for details). The analysis result is shown, as follows.

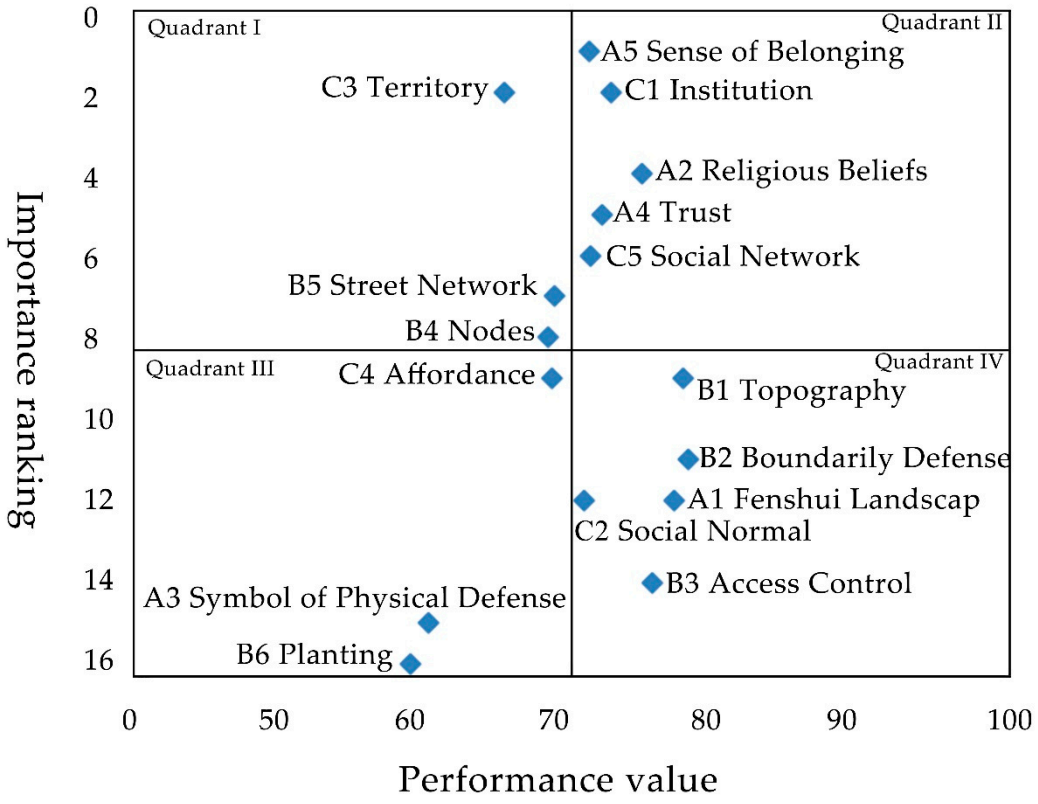


**Figure 4.** IPA Analysis of Wugoushui settlement.

(1) Key Criteria with Better Performance (Quadrant II)

*Religious Beliefs (A2)*—The Wugoushui settlement features a folk belief consisting of the ancestral temples of three families and 13 Bogong temples. The temples in the four directions of the settlement guard Wugoushui, while the houses are located in the Ming Tang (bright hall) of the settlement. Villagers worship ancestors and celebrate sacrificial ceremonies in the Bogong temples, the neighborhood center, and ancestral temples, where the sacrificial ceremonies include daily sacrifices, relatively large sacrifices, and large-scale sacrificial ceremonies (Figure 5). However, there is still room for improvement in the performance of religious belief in Wugoushui. The prevalent religious belief, as composed of multiple families, prevents the formation of a unified belief center, but the religious beliefs of the settlement are scattered by three rivers.

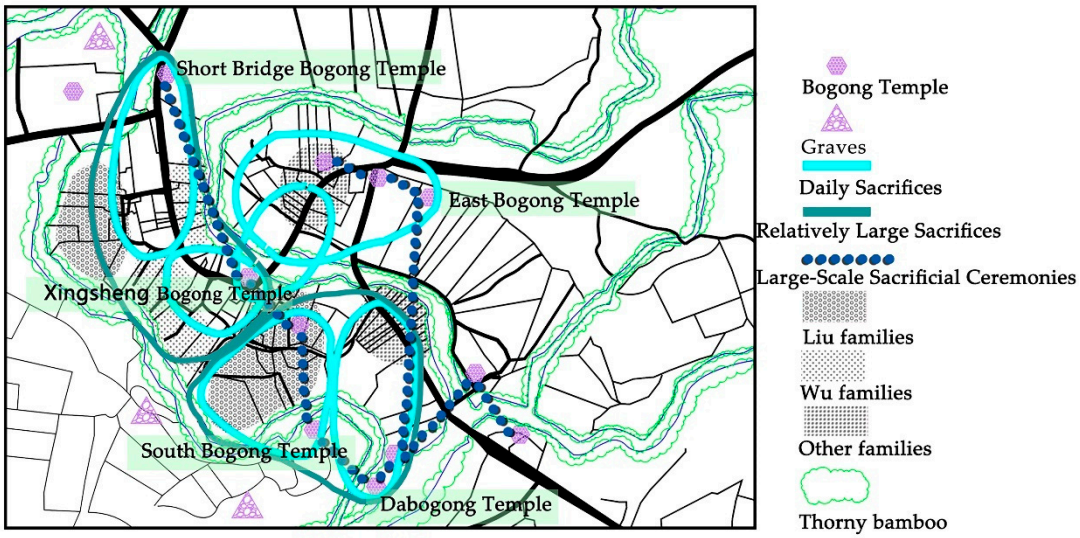


**Figure 5.** The Wugoushui settlement activity (proportion: 1:5000, formulated according to [59]).

*Institution (C1)*—Religious institutions are based on the relationship of sacrificial groups, and the members can clearly trace their "pedigree relationship" [52]. Public property is an important factor in religious continuity; without the sacrificial rites sustained by public property, it is difficult for religious relations to continue. In the process of the religious development of Wugoushui, the pedigree institution and public property are complementary, meaning they are one of the basic conditions for the development of the religion and prosperity of Wugoushui Settlement.

*Trust (A4)*—The people of Wugoushui constitute a complete group for production and living. During peaceful periods, settlements like Dongxing and Xingsheng were independent farming communities. When the Gaoshan (High Mountain) people invaded, the communities trusted each other and cooperated to fight together against the enemy.

*Sense of Belonging (A5)*—The sense of belonging in Wugoushui is reflected in two aspects. The Wu and Liu families live in the center of the settlement, while other families gather at the edge of the settlement. The temple marks the folk belief of the Wugoushui settlement, thus, the daily and large sacrificial ceremonies enhance the cooperation among Wu, Liu, and other families to offset their geographical differences and consolidate the sense of belonging.

*Social Network (C5)*—There are 13 ancestral temples in the Wugoushui settlement. The Wugoushui residents visit one or two Bogong temples near their residences as the center of daily sacrifice. However, some special sacrificial rites require the participation of all Wugoushui residents, meaning they develop a village-wide sacrificial circle to connect all Bogong temples, thereby enhancing the communication and recognition of interpersonal networks.

(2) Key Criteria with Worse Performance (Quadrant I)

*Nodes (B4)*— The Wugoushui settlement is surrounded by ditches. Early residents walked along winding water courses and the winding street network, which became the best barrier for the collective defense of the settlement. However, as the three waters divide the settlement into three parts (Figure 5), communication is hindered to some extent, thus, it is necessary to build bridges to enhance the internal connection of the settlement.

*Street Network (B5)*—The folk beliefs of Wugoushui, such as the temples of the three families, Bogong Temples, and Guangquan Hall, form multi-spatial nodes in the settlement. However, the spatial nodes of Wugoushui are scattered into several points by the water courses, and only when large-scale sacrificial ceremonies are celebrated can the points, lines, and planes of the settlement space be connected.

*Territory (C3)*—The field definition of Wugoushui includes two aspects: externally, the settlement is surrounded by graves, rivers, and thorny bamboo bars, and this collective tangible and intangible

defense defines the field; internally, the behavior of religious beliefs defines the center field [59]. However, due to the families having multiple surnames, the field of the settlement is intangibly defined by three to four surnames, resulting in the scattered field definition.

The eight criteria that should be maintained and urgently improved for the safe layout of the Wugoushui settlement are the key criterion of a safe layout, where A2 is the criterion that should be maintained in the IPA distribution. However, as an important source of a safe layout, the Religious Beliefs of the Wugoushui settlement (A2) can be further improved.

### 5.2. Analysis and Discussion

The safe spatial layout of settlements is jointly built at the psychological, spatial, and life levels. The religious beliefs that reinforce spiritual defense combine trust with the sense of belonging. The nodes and street network construct a spatial environment that reinforces physical defense. Behavioral defense organization, territory, and interpersonal networks are daily life activities. As Heidegger said, 'we should strive to turn the focus of architecture back to living, which is the fundamental meaning of life' [22]. The cohesive nature of daily life is the core of settlements. The physical space provides a safe place where people can live, protect themselves from alien intrusion and natural disasters, and create a sustainable environment in harmony with nature. Spatial safety is the foundation of sustainability, and such safe layouts are manifested in three main aspects: the spiritual, physical, and behavioral defense. The relevance of its key criteria (see Figure 6 for details) is as follows: First, the religious beliefs, trust, and sense of belonging of the spiritual defense are the psychological safety criteria based on cultural identity, among which religious beliefs forge a sense of belonging and the trust of cohesion. Temples where residents pray to the Holy Spirit provide a communication channel between mankind and the gods. The Wugoushui settlement features a belief circle of 13 temples, including the village center, the neighborhood center, and Guangquan Palace, which manages the rivers.

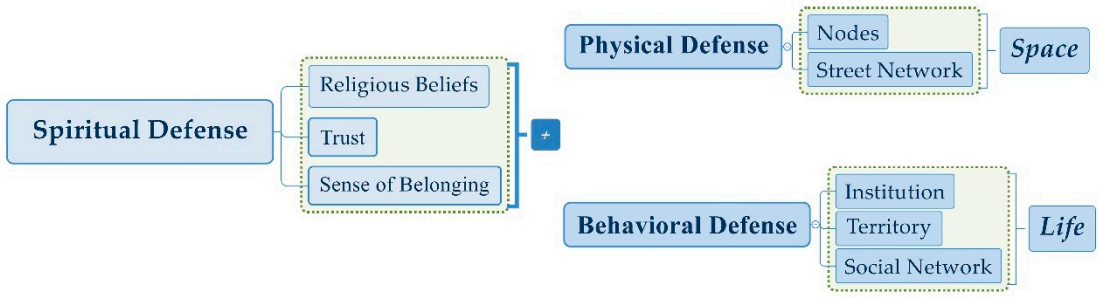


**Figure 6.** Relationship diagram of the safe layout.

When the Hakka people hold regular sacrificial ceremonies, they organize themselves into family groups based on surnames, and the entire settlement would gather for the annual festival. The sacrificial ceremonies enhance the mutual understanding, recognition, trust, and identification of folk culture among the residents of Wugoushui, thus enabling spiritual protection unique to the Wugoushui settlement. Second, the spatial safety criteria of physical defense include nodes and the street network. In terms of the field of influence, the safe layout refers to the effort to take the space of others, but it also refers to the safeguarding of its own territory from invasion. The street network of the Wugoushui settlement connects the internal part of the settlement and links it with the outside world. The streets linking with the outside world enable people to come and go, while the internal streets winding along the rivers aim to enhance security, as they have thorny bamboo planted on both sides of the water course to prevent invasion. The spatial nodes of the Wugoushui settlement are characterized by squares in front of the temple, such as the village and neighborhood centers, where the elderly can take a break, chat with each other, and sell small things on normal days. When major incidents occur, these locations are where the community gathers to discuss countermeasures or even take refuge; however, the water courses also divide the Wugoushui settlement into several spot-like spatial nodes.

Third, when taken together, the institution, field definition, and social network of behavioral defense constitute the criteria of a safe life. Kurt Lewin, a German American psychologist, proposed the group dynamics theory, that is, behavior = F (coefficient). People, environment, and space fall into the category of the environment, while life is considered to be behavior. Safe behavior in a safety layout is equal to the safe spatial environment jointly created by spiritual defense, behavioral defense, and the nodes and street network of physical defense. In terms of environmental behavior, spiritual belief is the heart of residents: the stronger the need for spiritual reassurance, the more united the behavioral defense, and the stronger the physical defense, the safer the layout of the settlements. The Wugoushui settlement is like an ecological circle, in which mankind, the natural environment, and space strike an internal balance. When the spiritual beliefs and behavioral patterns of the group change, its physical space genuinely reflect the spiritual and behavioral patterns. According to Norberg-Schulz, human living places provide shelter for safety, as well as the spiritual attachment to a place, such as its field characteristics and memory, meaning the safe spatial layout of settlements integrates social, physical, and ecological spaces. The spiritual defense of traditional settlements consists of psychological consolation and spiritual prevention of invasion, and has a complementary relationship with physical defense. Physical defense refers to intuitive and physical defense means, such as enclosure, closure, and group, which serve as the practical basis of physical safety in the event of an armed conflict. The social organizational system, operational institution, and means of organization and management of behavioral defense form an overall safety space in psychological, physical, and behavioral aspects, and influence each other. In sum, the unity of the values and cultural basis of the groups living in such space, as well as an ecological circle coexisting harmoniously with the natural environment, together constitute a safe living place.

The contribution of current studies is confined to the safety assessment of Taiwan's defensive spaces, and experts in these studies focused on Taiwan, meaning they understand the relevance of the spiritual defense, physical defense, and behavioral defense, as well as the key criteria in a defensive space. Taiwanese residents are composed of immigrants and indigenous people, which makes settlements into complex safe living environments. As the regions covered by such studies and experts do not represent the general rules, the results are not generally applied to the safe spatial layout of other settlements in the world. While we intend to study more settlements in different countries, the study of the safe layout of urban defensive settlements has become a great challenge. In addition, due to regional differences in topography, climate, and culture, the credibility of such large-scale studies may be questionable.

## 6. Conclusions

While traditional settlements were one of the main living sites in pre-industrialized societies, with the development of the industrial society, the infrastructure gradually failed to meet the needs of modern civilization. However, traditional settlements are also places that integrate social, physical, and ecological spaces, where safety is one of the basic conditions for the existence and development of such settlements. The literature review of studies in Mainland China and Taiwan regarding the safe spatial layout of traditional settlements shows that, to date, there are no systematic criteria for the safety of traditional settlements, and there is no assessment structure for the safe spatial layout of traditional settlements. Based on the general criteria of safety assessment and the relevance of such criteria, this paper establishes a safety assessment framework by using the Delphi expert interview method, calculates the key criteria affecting "safe layout" through DANP, and formulates a network relationship map of the criteria and their importance. This study provides a theoretical reference for extracting the localized elements of traditional settlements and obtaining effective resources to create special local settlements. On the one hand, the safety assessment framework provides a feasible method to address environmental safety issues; on the other hand, the safety assessment framework can be used to determine the type of settlement area, and develop effective ecological safety management strategies for regional organizations and groups. Thus, it is of great significance for the government and designers

to practice the spatial layout of settlement construction, settlement development, and new rural areas. The results of this study show that a safe layout includes three aspects: spiritual space, physical space, and behavioral space. The psychological, living, and spatial aspects of safety are associated with each other, and jointly construct the safety spatial layout of traditional settlements. By exploring the assessment framework of safe settlement layouts according to the traditional ways in which people interact with nature, space, and other people, this paper draws the following three conclusions:

1. According to the hierarchical assessment structure of the traditional settlement's safe spatial layout, as established by the expert group, the three aspects are spiritual defense, physical defense, and behavioral defense. There are 16 criteria, including Fengshui Landscape and Religious Beliefs, among which there are five criteria for the spiritual aspect, six criteria for the physical aspect, and five criteria for the behavioral aspect.
2. The importance of key criteria in Border Score analysis was calculated through DANP. The eight key criteria are Religious Beliefs, Trust, Sense of Belonging, Nodes, Street Network, Institution, Territory, and Social Network. The network diagram of the criteria of a safe layout was plotted based on the total influence matrix (T). Religious Beliefs are the source of a safe layout, which interact with Institution C1 and influence other criteria. See Figure 3 for more details.
3. The IPA analysis of the Wugoushui settlement shows that the criteria of a good performance include "Religious Beliefs (A2)", "Trust (A4)", "Sense of Belonging (A5)", "Institution (C1)", and "Social Network (C5)". The criteria that should be improved are "Nodes (B4)", "Street Network (B5)", and "Territory (C3)". The Religious Beliefs of spiritual defense combine trust with the sense of belonging, the space of physical defense, and the lifestyle supporting behavioral defense, meaning they jointly construct the safe spatial layout of settlements as safe living places.

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