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Conducting Importance–Performance Analysis for Human–Elephant Conflict Management Surrounding a National Park in Vietnam

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Abstract: In this paper, we present a conceptual framework of human–elephant conflict (HEC) management embodying community aspects gleaned from the importance–performance analysis (IPA) for a National Park in Vietnam. Nine approaches were proposed to prevent and mitigate HEC (HEC indicators), of which six fell into different quadrants based on the respective estimations of farmer and non-farmer respondents. Both the levels of importance and performance (I-P) of the HEC indicators are evaluated between (I-P) among farmers and non-farmers. Locals perceived the importance of all HEC indicators highly, but they thought its performance is poor. Third, we confirm the factors affecting the locals' participation behavior towards HEC management based on their demographics, awareness, and behavior in terms of HEC, and their perceptions of HEC. Compared to the non-farmer residents, the farmers recognized that the management strategy of HEC must focus on the aspects of building an insurance scheme and implementing appropriate land use planning. The characteristics that affect the differentiation of the locals' participation of HEC management are: (1) higher income residents, (2) farmers, (3) residents who would like to participate in an insurance scheme, and (4) the HEC management factors. Theoretical insights and management implications are also addressed in this study.

Keywords: Asian elephant; Dong Nai Biosphere Reserve; mitigation strategies; HEC management; local governance

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1. Introduction

Human–wildlife conflict (HWC) in general, and human–elephant conflict (HEC) in particular, can be seen as one of the major threats to the survival of Asian elephants and has been considered by multiple types of researchers and research [1–3]. According to the International Union for Conservation of Nature and Natural Resources (IUCN) list, the Asian elephant (*Elephas maximus*) belongs to the endangered species category; is already extinct in West Asia, Java, and most of China [4,5]; and is considered as a flagship species due to its role in preserving biological diversity and ecological integrity on a larger scale [5,6]. Throughout the history of Asian civilizations, the Asian elephant has held a special place and has been variously worshipped as a God, used as a beast of burden, and pressed into service as a warrior in numerous wars [7,8]. The Asian elephant is thus considered a part of cultural heritage, and is a symbol of cultural and national pride across its geographical range [9]. At present, the species is distributed in 13 countries across South Asia (e.g., India, Bhutan, and Nepal) and South East Asia (e.g., China and Vietnam) [5,10]. There are an estimated 48,323–51,680 Asian elephants in the wild, with India accounting for

over 50% of the world's Asian elephant in situ population [11]. The populations of Asian elephants are relatively stable in South Asia, whereas the populations in Southeast Asian countries such as Vietnam, Indonesia (Sumatra), and Myanmar have come under great threat in recent years [4,10]. The severity and frequency of HWCs are increasing across the world and it will continue to intensify in future [12].

In fact, HWCs are widespread, and these scenarios threaten the survival of large mammals such as elephants [13,14]. HWC intensifies when local residents think that the authorities controlling protected areas emphasize the value of wildlife over that of local people and their needs [12,15]. HEC is a case in point, and is increasingly prevalent in elephant range countries [16]. HEC is defined as the direct or indirect negative effects of interaction between human societies and elephants, which potentially damages both species [17]. HEC is a grave threat to biodiversity conservation that raises significant challenges for local villages, protected area managers, and elephants alike, and measures are urgently needed to prevent further retaliation against conservation measures [4]. Vietnam is a country that contains the smallest and most fragmented population of Asian elephants among all its neighbors. In Vietnam, elephants are considered as national heroes, as they have an immense cultural and religious significance. Apart from their inclusion in Annex I of CITES, elephants are also listed as critically endangered species in the Red Book of Vietnam [18]. Vietnam's wild elephant populations are fragmented and isolated in small groups across northern, central, and southern regions of Vietnam, and many of the populations may be connected with the elephant populations in neighboring Laos and Cambodia [4]. HEC is one of the primary threats to the elephants' survival in Vietnam [19], and the elephants' population in Vietnam has declined from 1500–2000 (in the 1980s) to very few hundreds in recent years, due to the fragmentation of populations and habitat loss [4].

To prevent or mitigate HEC, numerous approaches varying from simple to innovative have been reported. Approaches commonly employed include the use of fire, spotlights, smoke, noise, dogs, etc., to chase elephants away [20–23]; rehabilitating or expanding the elephant habitat [23–27]; preventing elephant incursions with fences [23,28,29]; or monitoring elephant movements by early warning systems [30–32]. Mitigation strategies have typically been carried out by setting up compensation or insurance programs [2,23,33–36]. In addition, enhancing HEC management by improving locals' awareness [2,23], and establishing community-based natural resource management (CBNRM) [21,37,38] have also been discussed in the literature. Ensuring the effectiveness of these approaches is a long-term process for HEC management [39]. Thus, HEC management is a key issue for rural area development, especially in light of the close link between sustainable rural development and community well-being.

The importance–performance analysis (IPA) was initially designed for market research purposes [40,41]. However, it has been widely used in different fields, such as tourism management [42], health care services [43], and the education sector [44]. In terms of issues related to wildlife and protected area management, IPA has also been successfully applied in spheres such as conservation-based tourism [45], visitor management [46], visitor satisfaction [40,47], coral reef management [48], nature-based tourism [49], sustainable tourism [50], and protected area management [40,51]. However, no research to date has been conducted on devising a conceptual framework for HEC management surrounding a National Park in Vietnam that takes into account locals' perspectives revealed from an IPA, nor has work been carried out in this context to verify the importance and performance (I-P) levels of the HEC indicators between farmers and non-farmers. To effectively implement HEC approaches, a thorough understanding of the I-P of said HEC approaches is required. However, to our knowledge, as the time of writing, although there have been studies on people's perception of HEC [20,52–54], no empirical studies have been conducted that evaluated the I-P perceptions of HEC approaches. This study applies IPA methodology to carry out a systematic analysis of the locals' perceptions of HEC approaches in the Dong Nai Biosphere Reserve (DNBR), Vietnam. Our main objectives were to (1) determine HEC approaches based on a literature review and focus group discussions; (2) rate the

respective I-P levels of the local residents' perceptions of HEC approaches; (3) identify which factors affect the locals' participation behavior towards HEC management; and (4) build an evaluation framework for HEC management.

This study synthesizes a systematic review of the concept of HEC, management strategies on HEC, and locals' participation behavior towards HEC approaches in Section 2. In Section 3, we establish an evaluation framework that relates the study area, the IPA principles and applications, and the I-P indicators' design for management strategies for HEC. Third, we summarize the empirical outcomes of the matrix of the I-P levels of HEC indicators, the IPA of locals' perception towards HEC approaches, and the locals' participation behavior towards HEC approaches. Finally, we discuss systematic aspects from theoretical perspectives and make suggestions for HEC policy-making approaches that would promote sustainable rural development in the study site.

2. Literature Review

2.1. The Concept of Human–Elephant Conflict

HEC is one type of HWC and is broadly defined as the interactions between human and elephants, giving rise to negative effects on human social or economic well-being, and also relates to the issues of elephant conservation and environment protection [55,56]. Conflict between elephants and humans causes economic losses and damage [2], undermines local support for conservation, and creates major challenges for wildlife conservation [57]. In addition, it also adversely affects the livelihoods, well-being, and daily activities of people living in communities adjacent to protected areas [33]. The factors causing HEC can be related to (1) habitat (i.e., environmental factors), (2) the population and behavior of elephants, and (3) human and policy systems (i.e., management). The loss, degradation, and fragmentation of elephant habitat is often due to deforestation and other instances of degradation of natural forests, including the conversion of natural forests into commercial tree plantations or the expansion of agricultural lands [20,24,35,58].

As their habitat is diminished, elephants are forced into closer contact with people more frequently, resulting in more frequent and intense conflict stemming from limitations of space and resources [16]. Moreover, local overabundance of elephants in some regions can precipitate HEC, particularly in areas where populations of elephants are higher compared to other places [2]. It should also be remembered that elephants are intelligent, long-lived animals and prone to migration. To survive, elephants regularly migrate long distances to search for food, as well as social and reproductive partners [7]. Humans, for their part, can initiate, escalate, or sustain HEC [2] through actions and decisions, which include, but are not limited to, improper land-usage, engaging in activities that disturb elephants, or relying on poor HEC policy and management schemes. HEC seem to be an intractable problem that affects locals' well-being and livelihoods in Africa and Asia [56]. Conflict between humans and elephants has received a lot of attention in both Asia and Africa. HEC in Vietnam has been studied since the early 1990's [18]. Therefore, the researchers chose Vietnam as a representative area in which to examine and explicate HEC management.

2.2. Management Strategies on Human–Elephant Conflict

Numerous management strategies have been reported in the literature. Approaches range from the traditional and simple to the modern and innovative, and can be divided into prevention strategies [20–23,28–32], mitigation strategies [2,23,33–36], land use management strategies [20,23–27,32,58], and HEC management improvement strategies [9,13,21,37,38], as described below.

2.2.1. Prevention Strategies

To prevent HEC incidents from happening, various prevention measures have been used. Ranging from simple to innovative, they can be divided as follows. Firstly, when elephants come into local villages or fields, humans usually use traditional measures (i.e.,

shouting loudly, lighting fires, using dogs, etc.) to chase/drive elephants away [20–22]. In addition, electric and bio fences have seen widespread use and have proved their effectiveness. Electric fences are the most enduring exclusionary measure, but can be expensive to install. Furthermore, if an electric fence is improperly maintained, it will not be an effective deterrent [59,60]. Bio fences are mainly reliant on the use of chilis, including chili oil, chili briquettes, chili smoke, chili guns, and chili fences [28,29], although they also include beehive fences [29]. Studies have reported on the effectiveness of chili fences, citing their advantages of providing a high level of deterrence [28], low price compared to other fences [61], and eliminating the need for night time guarding [62]. Beehive fences have also been shown to be effective when applied properly [26]. Beehive fences can also provide locals with income from honey sales and increase the pollination and production yield of crops [63]. Finally, techniques for early detection of intruding elephants, also known as 'early warning systems', typically rely on mobile phones [30], satellite tracking of radio-collared elephants [31], or geophones [32].

2.2.2. Mitigation Strategies

When HEC incidents occur, various mitigation strategies can be used to reduce the impacts. Compensation is one such strategy to support the people who have suffered damage caused by elephants [2,33]. The type of compensation can involve providing direct relief (i.e., providing financial support to reimburse costs incurred from HWC) or using indirect methods (i.e., those involving alternative crops or sources of livelihood) [52]. According to Bandara and Tisdell (2002), compensation programs serve as an economic rationale by which to enhance farmers' tolerance towards elephants. Appropriate compensation programs can be seen as potentially more effective for conserving elephants than laws prohibiting the killing of elephants. With appropriate compensation schemes in place, farmers may allow elephants access to their crops for their sustenance and therefore reduce the possibility of elephants being killed [35]. However, farmers often consider compensation programs for the damage caused by elephants to be inadequate. Specifically, farmers have complained that the payments are insufficient, unfairly distributed, and long-delayed, and also that related procedures are complicated and lengthy [35]. In contrast to the aforementioned compensation schemes, insurance is a mechanism where "a premium is paid by an individual, a household, and /or a community in exchange for reparation" for damages [2]. Establishing insurance schemes can contribute to conserving elephants while also mitigating HEC, as such schemes tend to be supported by most farmers [35]. So-called community-based insurance schemes (CBICs) can also provide compensation for HWC losses out of the premiums paid by farmers themselves, which can be especially helpful for lower income households [36].

2.2.3. Managing Land Use

Improper land use and the loss, fragmentation, and degradation of elephant habitat are the main factors causing HEC. Therefore, managing land use plays an important role in preventing and mitigating HEC. Land use management can be subdivided into upgrading or restoring elephant habitat (or elephant food sources) and engaging in appropriate land use planning. Restoring elephant habitat can be accomplished by planting and rehabilitating forests or building buffer areas for elephants' migration [24,25]. Other methods, such as providing salt licks and water ponds, or mixing minerals and rock salt and spreading the mixture over areas that are kept watered, can reduce the frequency of crop raids by elephants seeking minerals to supplement their diet in the wild, thereby reducing property damage from HEC [26,64]. Appropriate land use planning involves carefully considering and striving to balance humans' housing needs and agricultural activities with the elephants' natural habitat [20,32,58]. Development projects that convert natural forest land into commercial plantations and/or farmland, as well as other infrastructure projects, especially ones involving construction, restrict elephants' access to habitat and often reduce that habitat's scope [20,24].

2.2.4. Improving HEC Management

Human factors are main reasons for the failure of the above-described HEC approaches. Locals typically lack sufficient understanding of elephant behavior and HEC strategies, or the strategies that they adopt for mitigation are poorly applied [2]. The negative attitude about elephants held by local area inhabitants is an unfavorable omen for the survival of those elephants in future, which is especially worrying in light of the drastic decrease in elephant populations seen in recent years [35]. Local people encroaching into forests for purposes such as collecting non-timber forest products (i.e., fuel wood, bamboo, medicinal plants, etc.), hunting, expanding agricultural land, or settling in the forest not only causes significant disturbances to elephants, but can also make elephants behave more aggressively toward people [20]. Moreover, if inappropriate measures are used to try to chase elephants away, this can also fuel the hostility of elephants toward people [20]. Therefore, improving locals' awareness plays an important role in effective HEC management strategies [13,23]. CBNRM programs have been established to assure that rural residents can reap the benefits that accrue from conservation programs [38]. It has been proved that the multiple scales from the benefits of wildlife conservation under the cost of HWC had a better distribution [38], and the design of CBNRM programs that combine the locals' economic development with elephant conservation can help mitigate HEC [38]. In CBNRM programs, the benefits that locals receive can increase their tolerance of conflict with elephants [21]. Therefore, improving the locals' awareness and designing CBNRM programs both play important roles in creating a harmonious and balanced coexistence between humans and elephants [7,24].

2.3. Locals' Participation Behavior towards HEC Approaches

HEC seems to be an intractable problem that affects human well-being and livelihoods in Africa and Asia [56]. Thus, strategies to prevent and mitigate HEC are urgently needed. The success of such schemes hinges on locals having a better understanding of the situation at hand, as that understanding will influence their behavior towards HEC management approaches. Previous studies have reported that the locals' participation behavior is a key determinant of the success of HEC management approaches [22]. Furthermore, devising HEC management approaches requires the active participation of local people because the process requires a complete understanding of the complex underlying core issues [52,65]. Locals' participation can also increase the level of trust between stakeholders, thereby leading to a reduction in conflict between these individuals or entities, which in turn makes HEC approaches more likely to succeed [66]. The socio-economic characteristic of locals has been shown to affect their participation in HEC management efforts. People who have experienced HEC firsthand are more likely to participate in HEC management programs [53,54]. In addition, people who received benefits from the presence of elephants (e.g., via ecotourism, employment, or personal enjoyment from seeing elephants) were more likely to support HEC management programs [67]. Members of groups comprising farmers, the less educated, and individuals who have suffered damage from elephants have been found to be more willing to participate in compensation programs [45]. Moreover, people's perceptions of elephants have been found to vary according to their gender, age, education, past experiences, and occupation type (i.e., farmer and non-farmer) [52,67], and these perceptions can influence individuals' participation behavior towards HEC approaches. Overall, understanding the locals' socioeconomic characteristics and their participation behavior is critical when designing HEC management approaches because such understanding helps ensure that programs will be sustainable and that local needs and concerns are heard and incorporated into these efforts [52,65]. Therefore, identifying the demographic and perception-related factors that affect locals' participation behavior toward HEC management approaches is a precursor for designing and implementing a sustainable HEC management policy framework.

3. Conceptual Framework

3.1. Study Area

The Dong Nai Biosphere Reserve (DNBR) (formerly the Cat Tien Biosphere Reserve), which was recognized in 2001 and extended in 2011, comprises the areas of Cat Tien National Park and Dong Nai Culture and Nature Reserve, as well as nearby forest companies. The DNBR was designated the 580th biosphere reserve in the world by UNESCO in 2011. It has a total area of 969,993 ha, including a core zone (172,502 ha), a buffer zone (349,995 ha), and a transition zone (447,496 ha) spread out over five provinces (Figure 1). This region is relatively flat, with landforms including rivers, streams, ponds, lakes, and wetlands of the eastern Nam Bo Delta [68]. The DNBR boasts a rich variety of forest types, including evergreen broad leaf forest, mixed bamboo forest, and plantation landscapes. There are seven different habitat types in all. The DNBR enjoys a high level of biodiversity, with many rare and special species living within its boundaries, including 1610 plant species, 6085 mammal species, 259 bird species, 64 reptile species, 33 amphibian species, and 99 fish species. These include endangered species such as white-shouldered ibis (*Pseudibis davisoni*), Indochinese tigers (*Panthera tigris corbetti*), Asian elephants, and the critically endangered Javan Rhinoceros (*Rhinoceros sondaicus annamiticus*), one of the world's rarest large mammals [68].

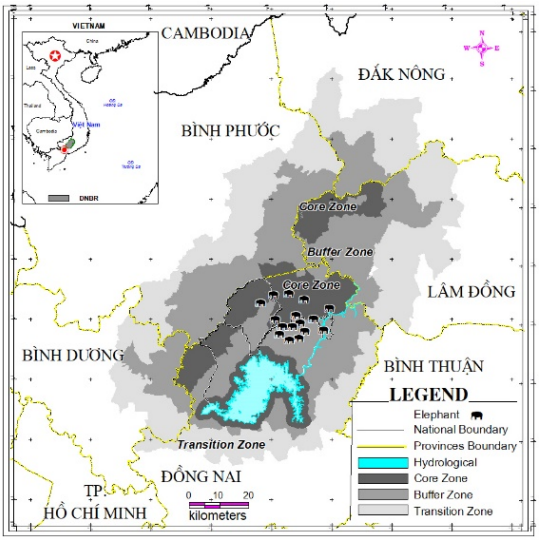

Figure 1. Map of the DNBR (revised from [68]).

This region also boasts rich cultural diversity, with 11 resident ethnic groups. These residents belong to three main groups, namely, the migrated minorities from Vietnam's Northern provinces, the Kinh or lowland Vietnamese, and indigenous ethnic minorities. Agriculture is one of the main productions of the local people, accounting for about 90% to 95% of households' livelihoods. Tourism, aquaculture, and fishing are also developed industries in this area [68]. However, the DNBR also faces impacts stemming from HEC issues [23,27,34,69]. According to Decision No. 763/QD-Ttg dated 21 May 2013, the DNBR is one of three priority areas for elephant conservation, as it has the second highest number of elephants among known populations in Vietnam (around 15 individuals) [23]. As an area in which elephants are distributed, DNBR has been faced with HEC issues [23,27,34,69]. Elephants have entered human settlement areas or fields, destroying crops and other assets, as well as frightening and hurting humans. However, little research has been carried out on HEC issues plaguing the DNBR, nor have comprehensive measures been put in place to prevent and mitigate damages from HEC [23,69]. Thus, there exists a strong imperative to conduct the present study and present an evaluation framework for IPA under HEC in the DNBR.

3.2. Research Methods

IPA is an effective assessment tool to identify positive indicators, as well as indicators that need to be improved through immediate action [42]. Moreover, IPA shows information regarding the service-related factors that residents think have a significant effect on their evaluation, as well as the service-related factors that the public would like to see improved, due to their dissatisfaction with the present conditions or situation. Therefore, our research applies IPA, as suggested by Martilla and James [41], to evaluate the discrepancies in perceived importance between what the locals think about HEC and their perceptions of the performance of current HEC mitigation measures (i.e., the status quo). The IPA technique has been a widely accepted and extensively used method across various fields for many years [70]. This technique is a decision-making tool [40,51] that facilitates the identification of priorities for improved management [40,47], the mobilization and allocation of resources where they are needed most for future improvements [51], and the harmonization of quality services to enhance relative competitiveness [40]. In addition, the IPA is a well-documented technique that is readily accessible by professionals working in protected areas and has the potential to deliver valuable insights to service managers in a clear and easily comprehensible format [51].

Martilla and James [41] presented their results in an I-P matrix format to make data interpretation easier for a strategic decision-making process. The interpretation of an IPA matrix plot is straightforward because the I-P matrix categorizes the I-P on a range of low or high. The scale means the importance and performance of indicators can be used to construct a two-dimensional grid that classifies the indicators into four quadrants, corresponding to four different suggestions [70]. Indicators located in Quadrant A (labelled 'keep up the good work') are performing well and should be continually maintained. In contrast, indicators located in Quadrant B, (labelled 'concentrate here') have low performance levels, despite being perceived by respondents as of higher importance, which reveals that resource managers ought to focus on, prioritize, and invest more resources in those indicators. Next, when indicators are located in Quadrant C (labelled 'low priority'), this indicates that reallocating resources to said indicators is not urgent because both respondents' perceptions of their importance and their performance ratings are lower than average, relative to other indicators. The last quadrant, Quadrant D (labelled 'possible overkill') indicates that resources may have been overinvested, and while these indicators perform well, resources could be reallocated to where they are needed most [42], as shown in Figure 2.

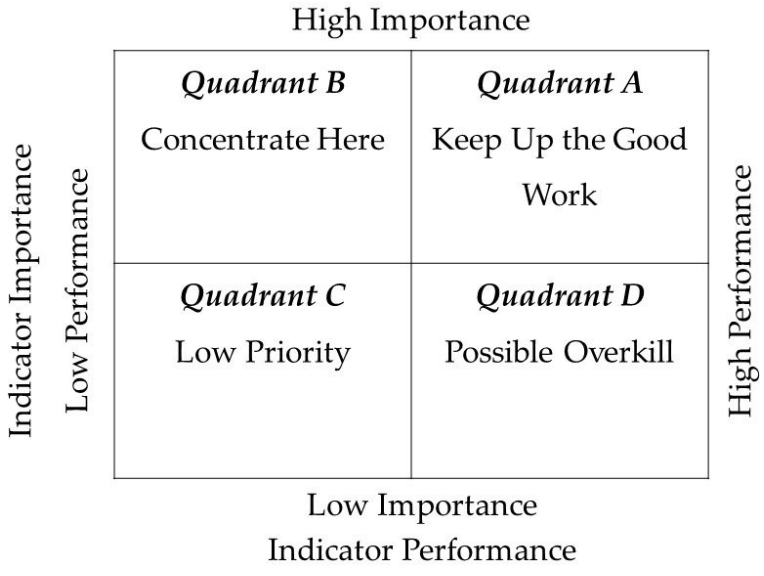

Figure 2. Evaluation framework for importance and performance analysis (revised from [42]).

Moreover, we examined the disparity—or, in other words, the difference between a given indicator's performance rating minus its importance rating—as the 'action gap'. A negative gap means that an indicator's perceived performance did not meet or exceed its perceived importance; inversely, a positive gap means that that the given indicator's perceived performance met or exceeded its perceived importance.

In addition, this study used a logistic regression model (LRM) to test several hypotheses regarding the relationship between socio-economic variables and perceptions of HEC management approaches [67]. Specifically, we evaluated how socio-economic variables (i.e., employment status and income), perceptions and attitudes towards HEC, experience of damage from HEC, perceived importance of HEC indicators, and perceived performance of HEC indicators affected respondents' 'willingness to participate (WTP) in the HEC approaches'. Employment was broken down into two categories, i.e., farmers and non-farmers. Similarly, income was broken down into groups: those earning less than 4,000,000 VND /month/respondent (≈176 USD) or, alternatively, those earning an amount greater than or equal to 4,000,000 VND/month/respondent. Questions to gauge respondents' perceptions and attitudes towards HEC, their experience of damage from HEC, as well as 'WTP in the HEC approaches' were answerable with a binary 'yes' or 'no'. In this study, two models were built to estimate the locals' behavior towards HEC management approaches. The first model takes the respondents' 'WTP in the HEC approaches' as the dependent variable, and considers the respondents' demographics (i.e., income and employment status), perceptions and attitudes towards HEC (i.e., interest in HEC mitigation measures, experience with HEC, WTP in an insurance scheme), respondents' experience of damage from HEC, and the overall mean of the HEC indicators' perceived importance as the independent variables. Similarly, the second model included the overall performance mean of the HEC indicators, while respondents' demographics, perceptions and attitudes towards HEC, and experience of damage from HEC were integrated in the LRM based on the above-described dependent and independent variables, respectively. In these models, the overall mean of the perceived importance of HEC indicators and the overall performance mean of the HEC indicators are quantitative variables, while the other variables are nominal. The goodness of fit (GOF) of the model was evaluated by reference to the −2Log-likelihood (−2LL) and Chi-square value (χ^2) [71–73].

3.3. Research Design

3.3.1. The Questionnaire Design

This study aims to evaluate various approaches to preventing and mitigating HEC. Thus, HEC approaches were firstly proposed based on a review of literature relating to HEC. Then, interviews and focus group discussions (FGDs) with stakeholders were carried out. The stakeholders included local residents and experts (policymakers, educators, park rangers, members of NGOs, scientists, park managers, and social economists) from the area surrounding the DNBR. Next, a set of HEC approaches or indicators was compiled. The set of HEC approaches was divided into four groups (or categories), which included nine indicators (Table 1). The pre-test questionnaire survey was established and administered to fifty respondents to test for content validity. Minor modifications were subsequently performed to improve the comprehensibility and clarity of the questionnaire before a formal questionnaire was finally developed. The formal questionnaire contained three aspects. The first section asked about respondents' perceptions and attitudes towards HEC (i.e., interest in HEC approaches, WTP in an insurance scheme, WTP in a HEC management program, experience with HEC, and experience of damage from HEC). The second section asked respondents to rate the importance and their perceptions of the performance of HEC management approaches. The ratings for I-P used a 5-point Likert scale ranging from 5 (very important/strongly satisfied) to 1 (very unimportant/strongly dissatisfied) [49]. In addition, the questionnaire included items to elicit socio-demographic information about the respondents (i.e., gender, marriage status, age, education, income, and employment status).

Table 1. Indicators of the HEC management approaches.

Item	Indicators of the HEC Management Approaches (Abbreviations)	Literature
1.	Prevention Strategies	
A	Use traditional measures to drive elephants (TRADITIONAL MEASURES)	[20–23]
B	Build electric and bio fences (FENCES)	[23,28,29]
C	Early warning systems (WARNING SYSTEMS)	[30–32]
2.	Mitigation Strategies	
D	Improve compensation programs (COMPENSATION)	[2,23,33,34]
E	Build an insurance scheme (INSURANCE SCHEME).	[2,35,36]
3.	Managing Land Use	
F	Upgrade or restore the elephant habitat (ELEPHANT HABITAT)	[23–27]
G	Implement appropriate land use planning (LAND PLANNING)	[20,24,32,58]
4.	Improving HEC Management	
H	Improve the locals' awareness (LOCALS' AWARENESS)	[2,23]
I	Design community based natural resource management (CBNRM)	[21,37,38]

3.3.2. Data Collection

The sample chosen in this study included local people from an area in which HEC often happened. Specifically, four villages surrounding the DNBR where HEC had happened were chosen [23] (Figure 1). Using a systematic random sampling method, face-to-face personal interviews in the form of a semi-structured questionnaire were conducted with a total of 440 respondents for the study. Ethical issues were deeply considered to protect the dignity, right, welfare, safety, privacy, and confidentiality of participants [74,75]. We obtained informed consent from all participants and assured them that no harm would come from participating or not in the study. Moreover, only respondents who provided their verbal consent were interviewed. We first went to the village chiefs to present the purpose of the study, and the chiefs then informed all the households living in their respective villages. After that, we explained the aim and scope of the study to the respondents and told them how the study results would be used before the interviews started. Since some of the respondents' personal information was being recorded in the questionnaire, the research team guaranteed the respondents' anonymity as a precondition for their participation. All respondents were volunteers and were advised they were free to opt out of the study at any time, if they wished to do so. Each household selected a person over 20 years of age to be interviewed. Only persons who indicated they were familiar with HEC in a family or living in HEC area were selected as respondents. The interviews were conducted in March 2021 and constituted a comprehensive investigation, with questions covering local peoples' perceptions, attitudes, and behaviors towards HEC, perceptions of the importance and performance of HEC management approaches, and household socio-economic information.

3.3.3. Data Analysis

The data in this study were analyzed using SPSS 20 (Statistical Package for the Social Sciences). First, descriptive statistics were used to analyze locals' socio-demographic data (i.e., gender, marital status, age, education, income) and their perceptions and attitudes (i.e., damage from HEC, interest in HEC management approaches, experience with HEC, WTP in an insurance scheme, WTP in HEC management program). Second, the matrix framework was applied to evaluate the ratings local people gave to the importance and performance of HEC management approaches, which reflected their respective perceptions. The statistically significant differences between respondents' perceptions of the performance and importance of HEC approaches were explored by using paired sample *t*-tests (PSTT) with $p < 0.05$. Third, the IPA method, first proposed by Martilla and James [41], was used to map the data to the IPA grid. In this grid, the I-P mean scores for HEC approaches were plotted on the vertical axis and the horizontal axis, respectively (Figure 2). As a result,

the spot each indicator occupies clearly indicates the status of the HEC approaches as perceived by the local people. Finally, LRM was used to estimate the locals' perceptions towards HEC management approaches.

4. Results

4.1. Respondents' Socio-Economic Backgrounds, HEC Perceptions and Attitudes

The questionnaires were distributed and collected at popular locations throughout the DNBR where HEC incidents happened (Figure 1). Based on the 95% confidence level and 4.7% estimation bias, and this study assumed the local residents had the same preferences for the HEC management program, and then analyzed a total of 435 samples. We applied on-site random sampling from March to July 2021 to understand the respondents' perceptions and preferences. As a result, a total of 440 households were investigated successfully, and a summary of the statistical data gathered is shown in Table 2. The proportions of male and female respondents were roughly equal, while the number of farmers (70.68%) was greater than that of non-farmers (29.32%). A majority of the respondents were married (90.68%) and above 30 years old, with about 33.18% being aged between 30 and 39, 27.05% being aged between 40 and 49, and 22.73% being aged between 50 and 59. A majority of respondents (54.41%) were educated at the secondary school level or lower, whereas only 2.27% of the respondents had received education at the university level or higher. Nearly half of the respondents (46.59%) reported having an income between 2,000,000 and 4,000,000 VND per month, while only a very small number of respondents (7.27%) reported having an income above 8,000,000 VND per month. The majority of respondents had suffered damage from HEC (79.5%), while just under half of the respondents (44.41%) were interested in HEC mitigation measures. Similarly, just under half of the respondents (48.18%) had experience with HEC, while the percentages of respondents who expressed their WTP in an insurance scheme and HEC management program were 57.27% and 44.55%, respectively.

Table 2. Respondents' social backgrounds and HEC attitude and behavior.

Characteristics	All Respondent		Farmer		Non-Farmer	
	F	Pct (%)	F	Pct (%)	F	Pct (%)
Number	440	100	311	70.68	129	29.32
Male	218	49.55	161	51.77	57	44.19
Female	222	50.45	150	48.23	72	55.81
Single	41	9.32	22	7.07	19	14.73
Married	399	90.68	289	92.93	110	85.27
Age						
20–29	49	11.14	30	9.65	19	14.73
30–39	146	33.18	111	35.69	35	27.13
40–49	119	27.05	79	25.40	40	31.01
50–59	100	22.73	76	24.44	24	18.60
≥60	26	5.91	15	4.82	11	8.53
Education						
Secondary or lower	257	58.41	187	60.13	70	54.26
High school	120	27.27	107	34.41	13	10.08
College/Vocational education	53	12.05	17	5.47	36	27.91
University or above	10	2.27	0	0.00	10	7.75
Income (VND/Month/Respondent)						
Less than 2,000,000	25	5.68	12	3.86	13	10.08
2,000,000–4,000,000	205	46.59	147	47.27	58	44.96
4,000,000–6,000,000	117	26.59	87	27.97	30	23.26
6,000,000–8,000,000	61	13.86	44	14.15	17	13.18
8,000,000–10,000,000	29	6.59	19	6.11	10	7.75
Above 10,000,000	3	0.68	2	0.64	1	0.78

Table 2. *Cont.*

Characteristics	All Respondent		Farmer		Non-Farmer	
	F	Pct (%)	F	Pct (%)	F	Pct (%)
Damage from HEC (Yes)	350	79.5	260	83.6	90	69.8
Interest in HEC Management Approaches (Yes)	213	48.41	153	49.20	60	46.51
Experience with HEC (Yes)	212	48.18	155	49.84	57	44.19
WTP in An Insurance Scheme (Yes)	252	57.27	186	59.81	66	51.16
WTP in HEC Management Program (Yes)	196	44.55	148	52.41	48	37.21

F: frequency; Pct: percentage (%).

4.2. The Matrix of the I-P Levels of HEC Indicators

In this study, the respondents were asked to rank their I-P level based on location indicators (Table 3). According to Table 3, farmers and non-farmers, as well as all respondents, attached a high level of importance to all HEC management approaches, with the overall mean score being 4.07, 4.17, and 4.10, respectively. However, the respondents also thought the HEC management-related indicators performed poorly, with the overall performance means for farmers, non-farmers, and all respondents being 2.18, 1.98, and 2.12, respectively. The importance levels corresponding to the indicators were significantly higher than the respondents' evaluations of the HEC management performance levels, with a difference of over 1.11 points (the gap P-I in Table 3).

Table 3. Mean scores and PSTT among farmers and non-farmers for the HEC indicators on I-P levels.

Item	Indicator	Importance (Rank)	Performance (Rank)	Gap (P-I)	T-Value	2-Tailed Sig.
	Overall (n = 440)					
A	Use traditional measures to drive elephants	3.85(8)	2.64(1)	−1.21	28.93	0.000
B	Build electric and bio fences	4.39(1)	2.04	−2.35	38.44	0.000
C	Build early warning systems	3.94(7)	1.87(7)	−2.07	39.27	0.000
D	Improve compensation programs	4.18(3)	2.25(3)	−1.93	39.33	0.000
E	Build an insurance scheme	4.16	1.74(9)	−2.42	45.19	0.000
F	Upgrade or restore the elephant habitat	3.76(9)	2.09	−1.67	33.48	0.000
G	Implement appropriate land use planning	4.13	1.97	−2.15	49.26	0.000
H	Improve the locals' awareness	4.18(3)	2.63(2)	−1.55	39.27	0.000
I	Design CBNRM	4.32(2)	1.83(8)	−2.48	49.84	0.000
	Overall mean	4.10	2.12			
	Farmer (n = 311)					
A	Use traditional measures to drive elephants	3.76(8)	2.65(2)	−1.11	26.09	0.000
B	Build electric and bio fences	4.45(1)	2.12	−2.33	31.47	0.000
C	Build early warning systems	3.78(7)	1.97(8)	−1.81	33.63	0.000
D	Improve compensation programs	4.13	2.41(3)	−1.72	35.42	0.000
E	Build an insurance scheme	4.26(3)	1.79(9)	−2.46	36.57	0.000
F	Upgrade or restore the elephant habitat	3.55(9)	2.06	−1.49	24.60	0.000
G	Implement appropriate land use planning	4.21	2.01	−2.21	47.62	0.000
H	Improve the locals' awareness	4.14	2.68(1)	−1.46	32.95	0.000
I	Design CBNRM	4.36(2)	1.92(7)	−2.44	39.64	0.000
	Overall mean	4.07	2.18			
	Non-farmer (n = 129)					
A	Use traditional measures to drive elephants	4.08(7)	2.64(1)	−1.44	15.09	0.000
B	Build electric and bio fences	4.26	1.86	−2.4	20.71	0.000
C	Build early warning systems	4.33(1)	1.63(7)	−2.71	25.57	0.000
D	Improve compensation programs	4.29(2)	1.86	−2.43	23.45	0.000
E	Build an insurance scheme	3.91(8)	1.60(9)	−2.31	27.27	0.000
F	Upgrade or restore the elephant habitat	4.26	2.16(3)	−2.11	28.74	0.000
G	Implement appropriate land use planning	3.91(8)	1.89	−2.02	19.60	0.000

Table 3. *Cont.*

Item	Indicator	Importance (Rank)	Performance (Rank)	Gap (P-I)	T-Value	2-Tailed Sig.
H	Improve the locals' awareness	4.29(2)	2.52(2)	−1.77	22.43	0.000
I	Design CBNRM	4.22	1.63(7)	−2.6	24.06	0.000
	Overall mean	4.17	1.98			

Farmers were more concerned with the indicators that relate to their livelihood and safety, such as 'build electric and bio fences' (item B), 'design CBNRM' (item I), and 'build an insurance scheme' (item E), with these being more important across all of the indicators. The indicators that might be said to less closely related to farmers' daily lives, such as 'upgrade or restore the elephant habitat', had the lowest importance to farmers. The farmers assigned the highest performance rating to the indicator 'improve the locals' awareness', followed by 'use traditional measures to drive elephants' and 'improve compensation schemes'. Farmers gave the lowest performance rating to the indicator 'build an insurance scheme'. Farmers rated the 'early warning systems' indicator as both relatively unimportant and performing poorly (item C). Similarly, the indicators 'build an insurance scheme' and 'design CBNRM' were relatively important to farmers, but were also rated by them as performing poorly (items E, I). Farmers perceived the indicator 'using traditional measures to drive elephants away' to be less important than other indicators (m = 3.76) but also perceived this method as performing relatively well (mean = 2.65 on item A). It bears noting that overall, farmers' perceptions of the I-P indicators were relatively in line with those of all other respondents (see Table 3).

Turning to non-farmers, given the same set of indicators, they were concerned more about indicators such as 'early warning systems' (item C), 'improving the locals', awareness' (item H) and 'improving compensation programs' (item D). In comparison, non-farmers perceived 'implement appropriate land use planning' (item G) and 'building an insurance scheme' (item E) to be of lower importance. In terms of various indicators' performance, non-farmers also rated the performance of 'using traditional measures to drive elephants' and 'improving the locals' awareness' as better, relative to the performance of the other indicators. In particular, non-farmers gave poor performance ratings to the indicators 'build an insurance scheme', 'early warning systems', and 'design CBNRM' (see Table 3).

The analysis of the 'action gap' found that all indicators had absolute negative gaps (Table 3). That means the perceived HEC management measures' importance levels were significantly higher than the perceived levels of those measures' performance, for most HEC management indicators. In addition, a PSTT was performed to compare the mean reaction of indicators' perceived importance and perceived performance. The results revealed a significant difference between the I-P levels for all indicators across both the farmer and non-farmer groups—or, in other words, for all respondents (Table 3). The results indicated that respondents were not satisfied with the performance of indicators overall. The gap analysis revealed the widest I-P gaps for the indicators 'build an insurance scheme' and 'design CBNRM' for all respondents. Breaking it down further, 'build electric and bio fences' had the widest gap among all indicators for all respondents and for farmers, while 'early warning systems' had the widest gap for non-farmers.

4.3. The IPA of Locals' Perception towards HEC Approaches

The I-P levels of the nine indicators corresponding to HEC management approaches indicators were analyzed and summarized, and the data from the interviewed farmer and non-farmer groups are shown and compared Figure 3. We see from the comparison of the locals' perceptions of the IPA that the indicator 'improve the locals' awareness' is located in Quadrant A as a reflection of the perceptions of both farmer and non-farmer groups perceptions. Other indicators in Quadrant A ('keep up the good work') include 'build electric and bio fences' and 'improve compensation programs' (both perceived by farmers as performing well), and 'upgrade or restore the elephant habitat' (both perceived

by non-farmers as performing well). Three indicators were rated by farmers as falling in Quadrant B ('concentrate here'). They were 'build an insurance scheme', 'implement appropriate land use planning', and 'design CBNRM'. On the other hand, there were four indicators rated by non-farmers as falling into the same quadrant (Quadrant B), namely, 'build electric and bio fences', 'early warning systems', 'improve compensation programs', and 'design CBNRM'.

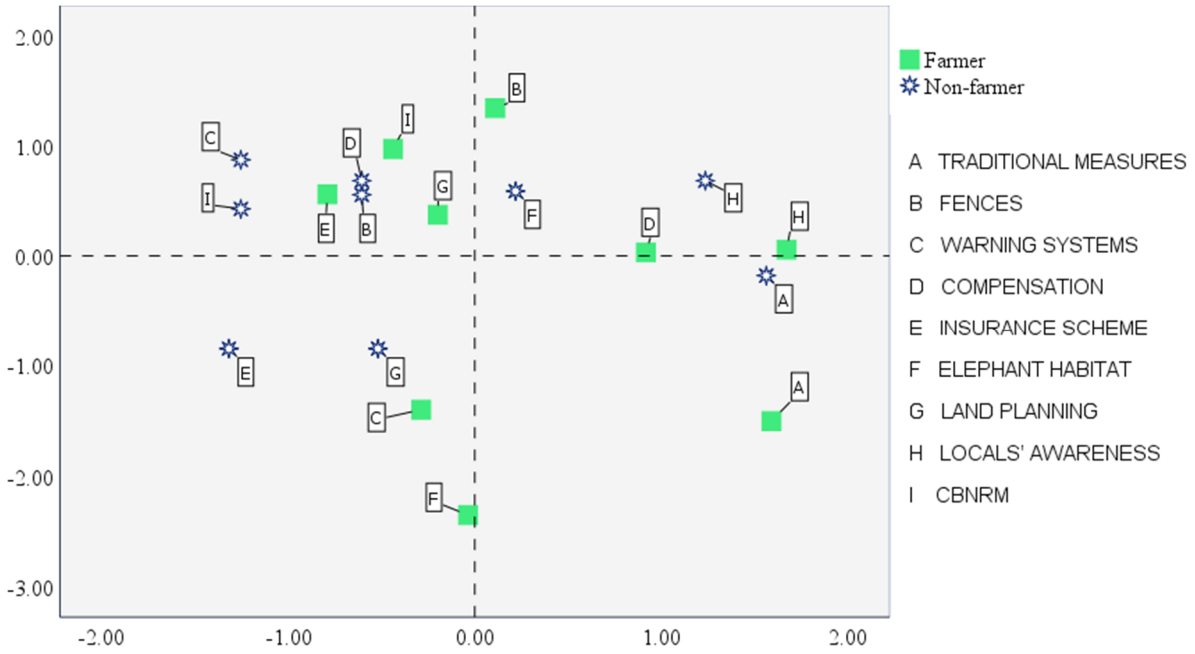

Figure 3. Differences between farmer and non-farmer overall perceptions of HEC management approaches.

It is noteworthy that six indicators are located in different quadrants, as rated by farmers and non-farmers (Figure 3). Firstly, the indicator 'upgrade the elephant habitat' was located in Quadrant C ('low priority') and Quadrant A ('keep up the good work') by the farmers and non-farmers, respectively. Secondly, the indicators 'building an insurance scheme' and 'implement appropriate land use planning' were both perceived as falling into Quadrant B ('concentrate here') by the farmers, while non-farmers perceptions located them in Quadrant C ('low priority'). Another difference emerged in farmers rating the 'build early warning systems' indicator as belonging in Quadrant C ('low priority'), while non-farmers placed it in Quadrant B ('concentrate here'). Finally, the indicator 'improving compensation programs' and 'build electric and bio fences' were placed in Quadrant A ('keep up the good work') by farmers, while non-farmers perceived it as belonging to Quadrant B ('concentrate here').

4.4. Locals' Participation Behavior towards HEC Management Approaches

To estimate the locals' behavior in the context of HEC management approaches, the study took the respondents' perceptions of their WTP in HEC management approaches as the dependent variable, and treated respondents' socio-economic backgrounds as the independent variables. As a result, two LRMs were built, based on these variables (Table 4).

Model I captures six variables that were found to be positively correlated with participants' participation behavior. This means that these factors significantly influenced the locals' WTP in HEC approaches. The residents who were farmers, were interested in HEC mitigation measures, had suffered damage from HEC, were willing to participate in an insurance scheme, attached a higher rating to the importance of HEC approaches, and had higher income were significantly more likely than other respondents to participate in HEC management approaches. However, in terms of predicting participants' WTP in

the aforementioned management schemes, the participants' experience of HEC was not found to be a significant indicator. Furthermore, from Model II, four determinants for respondents' WTP in HEC management approaches emerge. Most of the factors have a positive correlation with the locals' WTP in HEC management approaches, with the sole exception being their status as farmers. The residents who were interested in HEC mitigation measures, assigned a higher rating to the performance of HEC approaches, and had a higher income were significantly more likely to participate in the HEC management approaches. However, residents who were farmers were significantly less likely to participate in the HEC management approaches, which was an unexpected result. The prediction accuracy of Model I and Model II were 85.2% and 95.5%, respectively, the −2Log likelihood and Chi-square value indicated that our modeling of local people's participation behavior toward HEC management approaches produced robust results with the acceptable GOF [71–73]. Thus, our evaluation of IPA for HEC management is solidly grounded in terms of both the theoretical aspects and model specificity, as evidenced by the GOF test results, which means our findings accurately captured the situation on the ground in the DNBR, Vietnam.

Table 4. Estimation results of locals' participation behavior towards HEC approaches.

Variable Names	Importance on HEC Management (Model I)		Performance on HEC Management (Model II)	
	Coeff.	**Std. Error**	**Coeff.**	**Std Error**
Constant	−15.885	2.025 ***	−25.129	3.941 ***
Income (1 represents income is greater than or equal to 4,000,000 VND per month, otherwise is 0)	0.901	0.306 ***	3.653	0.900 **
Farmer (1 represents farmer, otherwise is 0)	0.584	0.348 *	−1.770	0.703 **
IntHEC (1 represents interested in HEC mitigation measures, otherwise is 0)	2.753	0.307 ***	2.238	0.548 ***
ExHEC (1 represents experienced of HEC, otherwise is 0)	−0.046	0.304 ^{ns}	0.660	0.503 ^{ns}
Dam (1 represents damaged from HEC, otherwise is 0)	2.512	0.667 ***	0.460	1.230 ^{ns}
Insurance (1 represents WTP in the insurance scheme, otherwise is 0)	0.966	0.311 ***	−0.857	0.579 ^{ns}
Mean_IP	2.568	0.442 ***	-	-
Mean_PR	-	-	10.301	1.700 ***
Prediction accuracy (%)	85.2		95.5	
−2Log likelihood	292.65		112.08	
Chi square value	χ^2 (7, 0.01) = 18.48			

***, **, * are significance at $p < 0.01$, $p < 0.05$, and $p < 0.1$, respectively. IntHEC: interested in HEC mitigation measures; ExHEC: experience of HEC; Insurance: WTP in the insurance scheme; Dam: damage from HEC; Mean_IP: overall importance mean of HEC indicators; Mean_PR: overall performance mean of HEC indicators. ^{ns}: not statistically significant ($p > 0.05$).

5. Discussion and Conclusions

Using the IPA method, this study established an evaluation framework for HEC management approaches, comprising indicators which respondents were asked to rate. The constituent attributes making up these approaches were subdivided into four groups: prevention strategies, mitigation strategies, managing land use, and improving HEC management. Within these groups of approaches, we posited nine corresponding indicators, which included traditional measures to chase/drive elephants away [20–23], electric and bio fences [23,28,29], and early warning systems [30–32]; compensation programs [2,23,33–35] and insurance schemes [2,35,36]; restoring the elephant habitat [23–27] and implementing appropriate land use planning [20,24,32,58]; improving the locals' awareness [9,13] and designing CBNRM programs [21,37,38] (see Table 1 and Figure 4). We then analyzed the matrix of the I-P levels of HEC management approaches to attempt to identify differences in perceptions of the nine HEC approaches among the overall sample, the farmer group, and the non-farmer group, under an IPA evaluation framework [76,77] solidly grounded in relevant theoretical constructs. Finally, we identified the factors that affect the local people's

WTP in HEC approaches based on their demographics, their perceptions of those HEC approaches, and their attitude towards HEC (i.e., interest in HEC mitigation measures, experience of HEC, WTP in an insurance scheme, suffering damage from HEC) under the GOF of model specification [78–80].

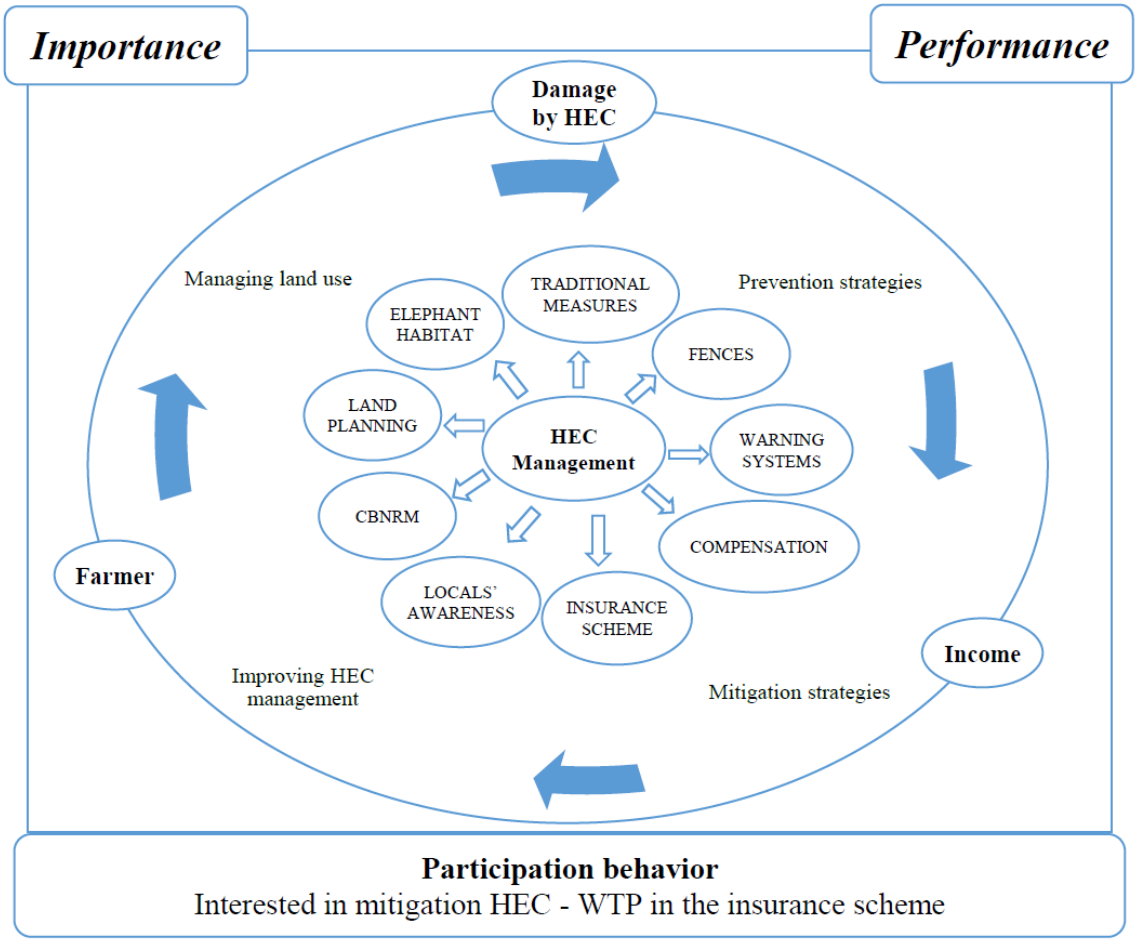

Figure 4. The evaluation framework of IPA for HEC management.

The scatter IPA plot and the corresponding improvement index for the considered HEC management approaches provide solid and comprehensive data about among the local stakeholders' perceptions and needs. These data and the implications drawn from them can guide policymakers who are tasked with prioritizing areas for resource allocation under sustainable HEC management schemes. The fact that the evaluation framework of HEC management approaches in this study was conducted based on proven theoretical constructs (Figure 4) serves to bolster the credibility of the findings. Key indicators evaluated included commonly used approaches to managing HEC, including improving the locals' awareness, using traditional measures to chase elephants, providing compensation, restoring elephant habitat and building fences. These approaches have been used regularly to prevent and mitigate HEC [2,16,20,23,67]. The results showed that locals confirmed the importance of the HEC approaches; however, the performance of these approaches failed to measure up to their importance, in the respondents' estimation. In fact, I-P gaps were detected for all HEC approaches (Table 3), indicating that room for improvement exists, as the performance of these critical indicators lagged behind their perceived importance. These issues should be addressed immediately to enhance the sustainability of HEC management strategies.

All local respondents demonstrated a clear understanding of the importance of HEC management approaches and had opinions about their effectiveness. Farmers, in compari-

son with non-farmers, considered them less important, but were more satisfied with their performance, as expressed through their perceptions of HEC management approaches (Table 3). However, there were similarities in terms of the overlapping perceptions of farmers and non-farmers regarding the importance and performance of HEC approaches. Breaking down the results of the overall sample, farmers and non-farmers had similar perceptions of HEC approaches, with many being located in the same quadrants. Three indicators, 'design CBNRM', 'improve the locals' awareness' and 'use traditional measures to drive elephants', were located in Quadrant B (concentrate here), Quadrant A (keep up the good work), and Quadrant D (possible overkill), respectively, as a reflection of the perceptions of both farmer and non-farmer groups perceptions. This means that farmers and non-farmers assigned the same rating to these three indicators in terms of their importance and performance. Firstly, the indicator 'improve the locals' awareness' being located in Quadrant A means this indicator is perceived as valuable by farmers and non-farmers alike, and is also perceived as performing well by both groups. This can be explained by the fact that this indicator recently has been used to manage HEC in DNBR and it has been somewhat effective [23]. Nonetheless, this indicator shows negative gaps as revealed by the gap analysis (Table 3), which means that even here, there is room for improvement. This suggests that local authorities ought to redouble their efforts in this endeavor to capitalize on its advantages for preventing and mitigating HEC. Similarly, the indicator 'design CBNRM' being located in Quadrant B reveals that this indicator is important for farmers and non-farmers, but it performed poorly. The possible reason that 'design CBNRM' plays an important role for both farmer and non-farmer groups is because it combines the development of locals' livelihood and conservation. However, managers have not found the best way to perform this indicator, leading to its performance being poor. This inference suggests that managers would be well-served to concentrate their actions on strengthening and improving these measures in the future. Finally, the indicator 'use traditional measures to drive elephants' being located in Quadrant D means this indicator is perceived less important by farmers and non-farmers. This could be explained by the fact that locals have long used some simple tricks to scare off elephants (e.g., making loud noises or shining bright lights), although sometimes these methods no longer work [23].

Six indicators stand out by virtue of their falling into different quadrants based on the respective estimations of farmer and non-farmer respondents (Figure 3). Firstly, the indicator 'upgrade the elephant habitat' is located in the 'low priority' zone by the farmers, but in the 'keep up the good work' zone by non-farmers. This might suggest that farmers are less keen to expand or restore the forest because doing so would affect their land or their work. This finding is in line with many previous studies that show HEC can happen when the range of elephants overlaps with human habitations, causing competition for resources (water, food, space), and when humans encroach into natural forests illegally, for activities such as settling, hunting, logging [2,20,32]. Conversely, non-farmers rate the indicator 'upgrade the elephant habitat' highly, which is reflected in this approach mostly being carried out by non-farmers, local governments, or NGOs [23,27]. Secondly, the indicators 'building an insurance scheme' and 'implement appropriate land use planning' were rated as being more important by farmers than by non-farmers. One possible explanation is that farmers stand to reap benefits relating to these indicators, as they are the ones who suffer crop losses and other damages as a result of HEC. Farmers have also been found to be in favor of implementing appropriate land use planning [20,32,58] and insurance schemes [35]. In contrast, the farmers considered 'build early warning systems' to be less important than non-farmers. This could be due to farmers having lower education and living in remote areas, and being less likely to consider techniques for early detection of elephants as a result. Furthermore, early detection techniques require internet network coverage, require training, and have costs associated with their use [30]. Finally, the indicators 'improving compensation programs' and 'building electric and bio fences' were rated as performing better by farmers in comparison with non-farmers. One possible reason is that farmers incur damage from HEC more often than non-farmers [23,69]. Additionally, farmers who incur

damages from HEC are more likely to have been compensated in recent years, and this compensation somewhat reduces the impacts of HEC [23,33,34,69]. Moreover, farmers have expressed the opinion that electric fences can prevent elephants from entering residential areas and can protect their crops and other assets [23,27]. Overall, the differences found between the two groups—farmers and non-farmers—are due, in large part, to the perceived scale of the safety and other benefits linked to specific indicators.

Indicators' placement in Quadrant A by both farmers and non-farmers means these indicators are perceived as being important and performing well in terms of preventing or mitigating HEC, so local authorities ought to maintain these indicators to take advantage of their benefits when building HEC management strategies. In addition, indicators being located Quadrant B by both farmers and non-farmers means both groups consider them valuable, but perceive them as performing poorly in terms of preventing or mitigating HEC. Therefore, the local authorities must strengthen these indicators to improve them in the future. Finally, we identified the factors that affect the respondents' awareness of HEC approaches based on the local people's perceptions revealed through the LRM. It has been noted that HEC management strategies will not be successful without locals' participation [22,81]. Thus, it is essential to explore the factors influencing the participation of locals in various HEC management approaches. In Model I, which treats the overall means of the perceived importance of the HEC indicators as the independent variable, IntHEC tends to exert the greatest influence on the locals' WTP in HEC approaches, followed by Mean_IP and Dam. Similarly, in Model II, with the overall means of the perceived performance of the HEC indicators as the independent variable, we see that the perceived performance of the HEC approaches strongly influences the locals' participation in those HEC approaches, while other positive but less influential factors included the respondents' household income and IntHEC. This proves that the perceived importance and perceived performance of HEC approaches strongly influence the local residents' WTP in the HEC management strategies. Notably, the ExHEC factor did not affect locals' WTP in the HEC management approaches. This result is contrary to the results from other studies that have suggested that people who have experienced HEC are more likely to engage in HEC prevention and mitigation programs [53,54]. However, the result in this study is in line with many previous studies that have indicated that socio-economic factors affect locals' perceptions of HEC management approaches [52,67].

The main contribution of this research is to design HEC approaches for HEC management strategies surrounding a National Park in Vietnam. Moreover, we compared the perceptions of local farmers and non-farmers with a paired sample test and IPA for all HEC indicators and identified the factors that affect the locals' awareness of HEC approaches as they relate to the local people's perceptions, through the LRM. The findings provide both the theoretical constructs and policy implications for building sustainable HEC management strategies aimed at conservation, socio-economic development, and environmental protection. This paper is the first detailed study of HEC using IPA at the DNBR in Vietnam, and thus contributes to a more comprehensive understanding of HEC in Vietnam, as well as in the rest of Asia.

6. Policy Implications

The preliminary findings of this study provide insights to inform the development and implementation of HEC management approaches, particularly by highlighting which approaches are most highly evaluated by local residents. However, the results show that locals' perceptions of the performance of these approaches are uniformly low; thus, the local governments need to pay particular attention to improving the level of their efficiency in the future. Specifically, designing CBNRM is vitally important for local residents, so local authorities should give this high priority when establishing HEC management strategies. Moreover, raising locals' awareness is inherently advantageous for building sustainable HEC management schemes, so the local authorities likewise need not only to maintain but also enhance the performance of this approach. Furthermore, developing

HEC management requires cooperation amongst various stakeholders, and in particular, the local residents. Locals' participation affects their perception of and tolerance towards elephants, as well as the probability of success of various HEC approaches. Understanding locals' socioeconomic characteristics and WTP in the process is essential to ensuring that HEC management approaches will be efficient in both the short and long term. Additionally, those in charge of preventing and mitigating HEC and developing approaches should consider maintaining and improving measures such as implementing appropriate land use planning, building electric and bio fences, building early warning systems, improving compensation programs, and building an insurance scheme. Above all, to enhance the effectiveness of the aforementioned approaches to HEC management, said approaches must be used flexibly or combined to capitalize on the resulting synergy.

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