sustainability

MDPI

Article

Evaluating the Sustainability of Community-Based Long-Term Care Programmes: A Hybrid Multi-Criteria Decision Making Approach

Baoan Song [1], Qiyu Sun [1,2,*], Ying Li [2] and Chuanqi Que [1]

1 School of Philosophy and Society, Jilin University, Chang Chun 130012, China; songba@jlu.edu.cn (B.S.); quecq0113@mails.jlu.edu.cn (C.Q.)
2 School of Social Work, University of Michigan, 1080 S. University, Room B660, Ann Arbor, MI 48109-1106, USA; yinglihf@umich.edu
* Correspondence: qiyusun@umich.edu; Tel.: +1-734-205-7941

Academic Editor: Kannan Govindan
Received: 2 May 2016; Accepted: 4 July 2016; Published: 12 July 2016

Abstract: Sustainability is a crucial factor in Long-Term Care (LTC) programmes, which implies whether the programmes have the capability of sustaining a quality service over the long term. To evaluate the sustainability of community-based LTC programmes, a novel hybrid framework has been demonstrated with a mixed Multi-Criteria Decision Making (MCDM) technique. According to extensive literature review and the fuzzy Delphi method, four pillars of initial criteria and twelve sub-criteria have been determined. Then a weighted hierarchy has been constructed with Analytic Hierarchy Process (AHP) to constitute the evaluation index system. In order to prove our framework, a case study of four community-based LTC programmes in Michigan is presented by applying the fuzzy technique for order preference by similarity to an ideal solution (TOPSIS) method. The results indicate that programme P2 has the best potential of sustainability, and sub-criteria associated with economy outweigh other sub-criteria. The sensitivity analysis verifies that the result of the ranking remains stable regardless of the fluctuation in sub-criteria weights, which proves the evaluation results and proposed model to be accurate and effective. This study develops a comprehensive and effective framework for evaluating community-based LTC programmes from the sustainability perspective.

Keywords: community-based LTC programmes; sustainability evaluation; hybrid MCDM; fuzzy Delphi; AHP; fuzzy TOPSIS

1. Introduction

Global aging is an inevitable trend, with the increased aging population, it is anticipated that the long term care need (LTC) for frail and disabled seniors is growing [1]. Nowadays, over 12 million American citizens of all ages with functional impairments rely on personal assistance and other LTC services, and varied programmes have been established to deliver services. However, a dramatic projected increase in LTC in the coming decades will confront significant constraints in resources available to provide LTC services [2].

The current LTC system depends almost exclusively on government programmes and out-of-pocket spending [3]. Sustainability has been an issue in many public programmes, which incur significant start-up costs in human, fiscal and technical resources, and many programmes see their resources withdrawn before activities have reached full fruition [4]. However, while there have been numerous contributions in terms of the development and implementation of healthcare programmes from the theoretical, empirical, and practical perspectives, less concern has been drawn from a sustainability perspective in this field.

Sustainability is a multi-dimensional issue in programme evaluation. However, there is no "Gold standard" for sustainability since the programme type, setting or resources can be varied [5]. Previous studies on the sustainability of LTC programmes mostly drew on a single perspective. Considering that this article aims to develop a framework with multi-dimensional indicators to evaluate the sustainability of community-based LTC programmes, we extended Scheirer and Dearing's [6] conceptual framework of programme sustainability and involved four pillars in this article to examine the sustainability of the LTC programme, namely economy, policy, organizational setting and community environment. The economy dimension includes varied financial resources, sufficient funding and unit cost of service. The policy dimension requires that effective collaboration, policy stimulation and institutional innovation are considered. For the organizational setting dimension, four indicators are involved, namely institutional strength, staff involvement and integration, leadership competence and organizational culture. The community environment dimension indicates community support and key community needs in coordination to be evaluated in the LTC programme.

Since this study evaluates the sustainability of the LTC programme with four aspects, we employed the Multiple Criteria Decision Making (MCDM) method to measure the alternatives systematically under various criteria. In order to define a comprehensive list of selection criteria, the indicators have been selected from the existing literature combined with the fuzzy Delphi method. In terms of setting up a weighted model, the Analytical Hierarchy Process (AHP) has been applied to decide and give weight to each criterion. The technique for order preference by similarity to an ideal solution (TOPSIS) is a well-known MCDM method that selects the best alternative among many flexible alternatives, by computing the distances from the positive ideal and the negative ideal solution. Nevertheless, the traditional TOPSIS is controversial for its weakness in solving uncertainties. When solving the real world problems, crisp values are difficult to handle the ambiguity and subjectivity of human judgement. A fuzzy method is adapted to embrace the fuzzy nature of the comparison or evaluation process and enhance the comprehensiveness and rationality of the decision making process. Therefore, our study employed a synthetic methodology with FDM, AHP and fuzzy TOPSIS to evaluate the sustainability of the LTC programme in Michigan.

The rest of this paper is composed as follows: Section 2 reviews the literature related to the issue of programme sustainability, programme evaluation criteria and methods. Then we illustrate the major contribution of this research. Section 3 is the introduction of the research method, the theory of FDM, AHP and fuzzy TOPSIS methods has been elaborated in this part. Section 4 builds up the evaluation framework of LTC programme sustainability. Section 5 illustrates the index system for LTC programme sustainability evaluation; Section 6 conducts an empirical study of four LTC programmes in Michigan under the research framework. Results are discussed and the sensitivity analysis is implemented to check validity and soundness of the proposed model; Finally, the conclusion has been drawn in Section 8.

2. Literature Review

Sustainability means taking different factors like social, environmental, financial, economic, and political factors into consideration to guarantee the survival in the long term. [7]. However, it remains a multi-dimensional, multi-factorial notion that is used somewhat inconsistently or ambiguously and takes on different meanings at various times or contexts [5]. Scheirer and Dearing define the sustainability of public health programmes as "the continued use of programme components and activities (beyond their initial funding period) for the continued achievement of desirable programme and population outcomes" [6,8]. Some researchers view sustainability as a set of processes that occur during the earlier stages of a life cycle of a programme [9,10], but Scheirer criticizes that the process definition of sustainability will present challenges for planning research or evaluation on this issue since without explicated definitions of outcome variables and measures, it is difficult for researchers to accumulate or disconfirm findings about predictors of sustainability [6].

There are numerous predictors influencing programme sustainability, though some similarities in factors identification and organizing structures could be found, the way how the authors categorize these predictors are differential. Stirman et al. proposed the framework of influences on sustainability as innovation characteristics, context, capacity, processes and interactions [11]. While Fleiszer et al. [5] sorted the indicators as innovation, context, leadership and process. Buchanan et al. [12] approached a synthesis with the influences on sustainability categorized as substantial, individual, managerial, financial, leadership, organizational, cultural, political, processual, contextual and temporal. Some authors indicate that there is overlap between categories of indicators, for example, leadership and process, and process and context. The interactive effect makes it hard to set up the relative importance of each factor [8,13].

Many studies set up a framework based on categories and sub-criteria for programme sustainability evaluation. In Savayaand Spiro's [14] study, 33 predictors were tested with bivariate analyses and multivariate analyses, and the results indicated the significance and co-relation between indicators and manifestations. However, its inherited bias is that the research design was based on relatively weak self-reports, as the informants who were the key person in the involved projects would lead to the rating being inflated. Mancini and Marek [15] constructed a framework to evaluate community-based programme sustainability with seven major elements including a 29-item Program Sustainability Index (PSI). However, the interplay of each sustainability element showed that some precede other factors, since they put all the indicators in an equivalent relationship. Considering that a weighting system should be established to build the scientific evaluation system, Maher et al. [16] developed an instrument based on the National Health Service Institute for Innovation and Improvement's Health Service Sustainability model with multilevel measurement. Even though the authors believed that this quality and service improvement tool could be applied at any phase of a project, it could be more appropriate to apply it at the early stage to evaluate the possibility of sustainability. Furthermore, this tool cannot be applied to estimate the degree of sustainability, since it is not possible to make a comparison of different programmes with this evaluation model.

In order to prepare the study to explore the sustainability of evidence-informed practice improvement programmes in the LTC sector, we noted that the literature related to LTC programme sustainability is insufficient. One of the few studies we found conducted a longitudinal case study by Demiglio and Williams [17] to examine the sustainability of the shared care model among five alternative care teams. Theurer et al. studied the mutual support group intervention in long-term care homes and addressed replication and sustainability [18]. Burack and Reinhardt [19] conducted a research on the cultural change model in long-term care communities, and the result indicated that the person-centred care intervention contributes to a positive impact on long term sustainability. Simmons [3] also tested the person-centred model for elderly people with Alzheimer's disease in a community-based LTC sustainable living arrangement. Slaghuis et al. [20] set up a conceptualized framework with routinization and institutionalization and developed a measurement to evaluate the sustainability of work practices in LTC programmes. Most of the literature related to LTC sustainability focused on the fiscal sustainability and policy perspective [21–24]. However, all the literature above just studied the sustainability of the LTC programme from a single perspective such as organizational formulation, internal human resources, economy and policy; no study integrated all the perspectives or discussed the sustainability of the LTC programme on a broader scale.

It was noted that the evaluation of sustainability in LTC programmes requires a consideration of multiple criteria, and so a multiple criteria decision-making strategy could be introduced in this research. The MCDM method has been applied by researchers and practitioners in evaluating, assessing and ranking alternatives with a number of studies [25]. Many multi-attribute decision making (MADM) methods have been developed to solve evaluation issues, such as the Analytical Network Process (ANP), Analytical Hierarchy Process (AHP), VIKOR, and the Preference Ranking Organisation Method for Enrichment Evaluations (PROMETHEE) [26]. TOPSIS is one of the prominent evaluation techniques and it is well respected in the literature [27–29]. However, in a real decision-making process, uncertainty and vagueness of the concepts associated with human beings' subjective judgements, including linguistic terms, satisfaction degree, and importance degree need a prevalence phenomenon. To tackle this issue, fuzzy set theory is proposed by Zadeh [30] to measure the equivocalness and uncertainness of the concepts. Upon this issue, the fuzzy TOPSIS technique can be introduced as an effective measurement in evaluating the sustainability of LTC programmes. Some researchers attempted to integrate MCDM with different weighting mechanisms; for example, combinations AHP and TOPSIS, ANP and TOPSIS, etc. Since the evaluation criteria could be arrayed into a hierarchy, we conduct an AHP-fuzzy TOPSIS approach in evaluating the LTC programmes. This approach extends the fuzzy TOPSIS method to a hierarchical one and has been conducted by many researchers, also named as hierarchical fuzzy TOPSIS method [31–33]. This method inherits the hierarchy mechanism of AHP method and provides greater superiority to classical fuzzy TOPSIS methods [34,35]. The hierarchical fuzzy TOPSIS does not have the disadvantages of the pairwise comparisons among criteria, sub-criteria and alternatives, while it also simultaneously overcomes the disadvantages for the necessity to assign an initial weight in fuzzy TOPSIS [31]. With the integrated application of AHP and fuzzy TOPSIS methods, the evaluation process has advantages of the two methods and effectively avoid the insufficiencies of each method [28].

The main contributions of this study:

1. Previous studies evaluating the sustainability of public programs mostly draw attention to health care; the issues related to LTC programme sustainability are limited and merely address a single aspect of sustainability in LTC projects. Meanwhile, studies for the evaluation of sustainability in public health care programmes do not provide an effective weighting framework and inherit the bias from subjective self-report. In order to cope the matters, we conducted a fuzzy Delphi method (FDM) involving the scholars and practitioners in LTC areas to establish an evaluation framework based their knowledge and experience combined with the existed literature.
2. A hybrid MCDM method based on FDM-AHP-Fuzzy TOPSIS has been pilot conducted in this study. This is a novel research method for evaluating community-based LTC programmes. This research method overcomes the defects of previous studies that lack a weighting strategy within indicators, and it could be applied to measure the degree of sustainability and make effective scoring and rating among different programmes.
3. Since experts with specialist knowledge backgrounds might select subjective orders on their preferred aspects, we, accordingly, conduct a sensitivity analysis to examine the impact of alternative weights on the final scores. This is the first attempt to research the economy, policy, organizational setting and community environment aspects of the sustainability evaluation in community-based LTC programmes through weights fluctuation.

3. Research Method

This section illustrates in detail the fuzzy Delphi method, AHP and fuzzy TOPSIS method.

3.1. Fuzzy Delphi Method

In order to make the decision process effective, systematic and objective to compose the framework and criteria, experts' perspectives have to be applied to decide the influential evaluation factors. Dijk [36] indicates that the Delphi Method (DM) is an appropriate communicative technique on the subjective base of norms and opinions in social research; it can be applied to generate a professional consensus for ambiguous, complicated and contentious issues [37]. First proposed by Dalkey and Helmer [38] in 1963, this technique has been applied in decision-making predictions to get the most reliable consensus with some groups of experts. However, the traditional DM is a time-consuming method, which is difficult to converge through repetitive survey. Aiming to handle the deficiency in processing equivocalness and uncertainness within the expert survey, the fuzzy logic set was introduced to upgrade the Delphi method to the fuzzy Delphi method (FDM) to overcome the disadvantages in the traditional Delphi method. With the FDM technique, experts will provide their opinions with three-point estimates by using triangular fuzzy numbers (TFNs), and not need to modify them repetitively [39]. Since all the judgements could be efficiently considered by membership degrees, all the important information could be preserved. Owing to these merits in summoning group decisions, FDM has been employed in a large number of researches to constitute evaluation. In order to find the key indicators for the sustainability evaluation of LTC programmes, the FDM is applied in this study. In previous studies, due to a lack of systematic classification, some criteria might have interactive effects. In order to avoid the interdependency of the criteria, all the indicators should pass a screening process by experts to make sure the potential interdependent indicators are excluded.

3.2. AHP Method

Developed by Thomas Saaty in 1980, AHP is one of the predominant MCDM approaches. It involves the structuring criteria for multiple opinions within a system hierarchy. Moreover, it contains the comparing alternatives, relative values for criteria, and defining the average importance of alternatives. On one hand, it encourages the active participation of stakeholders [8]. On the other hand, it provides practitioners a rational foundation toward which to make decisions [40]. AHP builds a structure for the decomposing problem into different levels that correspond to how one understands the goals, criteria, sub-criteria and alternatives [41]. The elements of each layer are compared as pairs regarding their importance in the decision-making process. A linguistic scale is applied in AHP that helps the evaluators to incorporate subjectivity, experience and knowledge in a presentative and natural way. Matrices are created after comparison and relative weights are generated from the various indicators. Composite weights were calculated by aggregating the weights throughout the system. The outcome is a normalized eigenvector of the global weight of the indicators. The AHP method enables decision-makers to break down a complex problem into a multi-hierarchy and rate a great numbers of quantitative and qualitative elements in a system [42].

3.3. Fuzzy TOPSIS Method

The TOPSIS method is proposed by Hwang and Yoon [27], which is a technique for order preference by similarity to ideal solutions. The TOPSIS approach selects the alternative that is not only closest to the positive ideal solution, but also farthest from the negative ideal solution. The positive ideal solution (PIS) consists of the optimal performance values for all criteria whereas the negative ideal solution (NIS) composes of the worst performance values. However, since the TOPSIS method cannot tackle the inherent uncertainty and imprecision of the evaluators' insight with crisp values, it has been criticized in handling ranking issues in real situations [43,44]. Personal judgements are scored crisp numbers in conventional TOPSIS while the human preference model is unpredictable and evaluators might be unable to allocate a crisp value to comparative judgements in many practical cases [45]. Therefore, in order to cope with the defects of traditional TOPSIS, linguistic values are incorporated with TOPSIS to handle uncertain factors in a fuzzy solution [46].

Fuzzy set theory is employed to overcome ambiguity during decision-making processes owning to the insufficient information. Instead of precise values, it applies linguistic values to figure evaluators' preferences, which can simplify the decision process [47]. Therefore, fuzzy TOPSIS and its extensions are developed to tackle ranking and justification problems. The elementary theory is that each indicator has a membership degree belonging to a fuzzy set. A fuzzy set $\widetilde{A}$ in a universe of discourse X is described by a membership function $\mu_{\widetilde{a}}$. This membership function associates with each element x in X a real number within [0,1]. To be specific, when the membership value equals to 1, it means that this indicator totally attributes to the fuzzy set. On the contrary, if the indicator does not affiliate to this fuzzy set, the membership value equals to 0.

Owing to the simple calculation process, fuzzy linguistic values are always represented by triangular fuzzy numbers (TFN), defined as a triplet $\widetilde{a} = [a_1, a_2, a_3]$. The membership function $\mu_{\widetilde{a}}(x)$ is defined as:

$$\mu_{\widetilde{a}}(x) = \begin{cases} 0 & x < a_1 \\ \frac{x-a_1}{a_2-a_1} & a_1 < x < a_2 \\ \frac{x-a_3}{a_2-a_3} & a_2 < x < a_3 \\ 0 & x \geqslant a_3 \end{cases} \quad (1)$$

In Equation (1), a_1, a_2, a_3 are crisp numbers $(-\infty < a_1 \leqslant a_2 \leqslant a_3 < \infty)$, a_1 and a_3 are the boundaries of available area for performance evaluation.

The linguistic value should be switched into TFN. Table 1 indicates the regulations of the transformation.

Table 1. Linguistic scales and the TFN.

Linguistic Scales	TFN
VL (Very Low)	(0, 0, 0.2)
L (Low)	(0, 0.2, 0.4)
F (Fair)	(0.3, 0.5, 0.7)
H (High)	(0.6, 0.8, 1)
VH (Very High)	(0.8, 1, 1)

4. The Research Framework

The proposed model for evaluating sustainability in LTC programmes based on hybrid MCDM includes the following three steps, as shown in Figure 1.

Step 1: Define the evaluation criteria according to the literature review and fuzzy Delphi method. At this stage, the decision-making group was set up by selecting experts from a related research background or direct managers of LTC programmes. An extensive literature review has been conducted to generalize the major criteria and alternatives to design the questionnaire for the FDM. Based on the decision-makers' opinion and the characteristics of LTC programmes, the evaluating criterions are voted through FDM.

Step 2: Decide weights of the evaluation criterion through AHP method. After determining the vital evaluation criteria with FDM, a hierarchy has been formulated with three layers: The top layer stands for the goal; the second layer stands for the major criteria; the sub-criteria is indicated by the third layer. The AHP technique has been applied to weight the criteria: Initially, relative weights are rated by experts through pairwise comparison. Then, the weight of each alternative has been calculated. Finally, the normalized eigenvector of the global weights has been computed as a result.

Step 3: Evaluate the sustainability of LTC programmes with fuzzy TOPSIS method. In the beginning, assembling the initial fuzzy decision matrix where the experts distribute the linguistic ratings to all the alternatives according to their subjective values. Next, assembling the fuzzy ratings of the alternatives related to the objective criteria based on the objective conditions. After that, fuzzy TOPSIS technique is introduced to assemble criteria ratings and compute the evaluation results of the alternatives. The results of LTC programmes are illustrated in decreased order in terms of the closeness coefficient values of all the alternatives.

There are three advantages in evaluating the LTC programmes with a hybrid evaluation model. First, the FDM technique helps to construct a scientific evaluation framework with criteria and alternatives particularly designed for community-based LTC programmes. Likewise, these criteria can reflect a comprehensive evaluation from multi-perspectives especially in sustainability. Other than that, the fuzzy technique combined with Delphi method is confident to solve the vagueness and uncertainty of the experts' judgements. Second, the AHP method endows the weights of criteria with the decision from the expert group, which makes the evaluation more feasible for scoring and ranking among different community-based LTC programmes. Finally yet importantly, fuzzy TOPSIS is an effective tool in handling ranking alternatives with multiple criteria enhanced fuzzy theory in the field of sustainability evaluation.

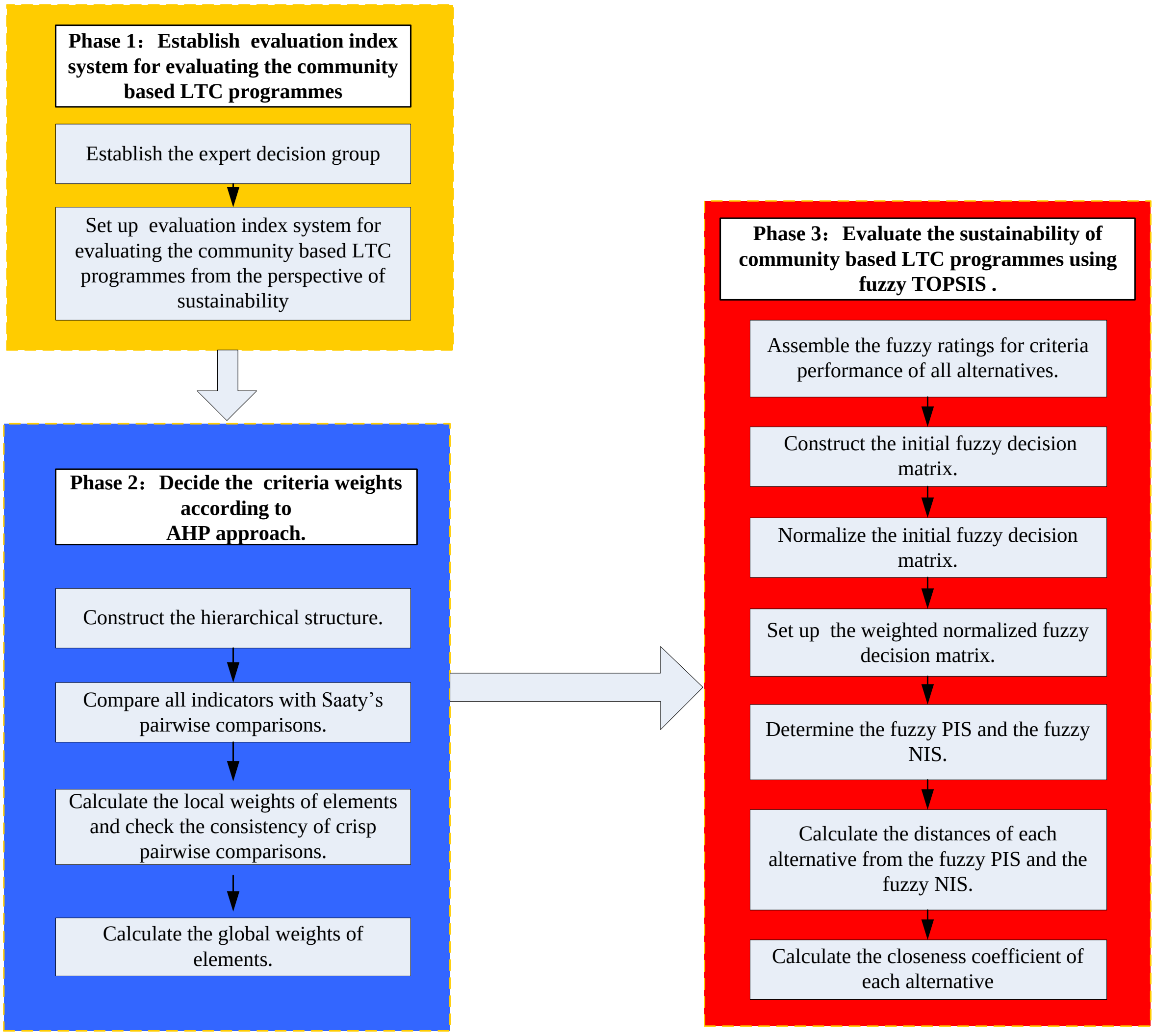

Figure 1. The framework for sustainability evaluation of Community based LTC programmes.

5. Evaluation Index System for LTC Programme Sustainability

In order to construct a comprehensive and scientific framework for the evaluation, the selection of the evaluation criteria is of great importance. Since the sustainability evaluation requires multi-dimensions including internal and external factors of the LTC programmes with varied alternatives ranging from economy, society, environment, organization, culture, policy, etc., while previous studies related to the evaluation of programme sustainability do not provide a confident research framework, we employed an expert group to help us set up the evaluation index system.

First of all, 16 experts in related fields are invited to set up the decision-making group. The background of our experts is LTC programme managers, professors and researchers who are familiar with programme evaluation and LTC services. Then, based on the extended conceptual framework of programme sustainability by Scheirer and Dearing and characteristics of the LTC programmes, 33 initial criteria were collected based on specific LTC programmes and agreements from the decision group, in which economy, policy, organizational setting and community environment perspectives are involved. Finally, the final evaluation sub-criteria are decided from the FDM technique.

Decision-making group contributes their views upon the importance of sub-criteria by conservative and optimistic values. Then scores the sub-criteria from 0 to 10 at the first stage. Next, the conservative TFN and optimistic TFN are computed (Table 2). Then verify the consistency of experts' agreement and repeat until all $M^i - Z^i$ values are above 0. Lastly, determine the final sub-criterions according to the consensus value G^i. In this study, the threshold value 6.0 has been agreed by 90% of the decision makers. Consequently, 12 final criteria are decided to measure the sustainability of LTC programmes. The final evaluation index system is presented in Figure 2.

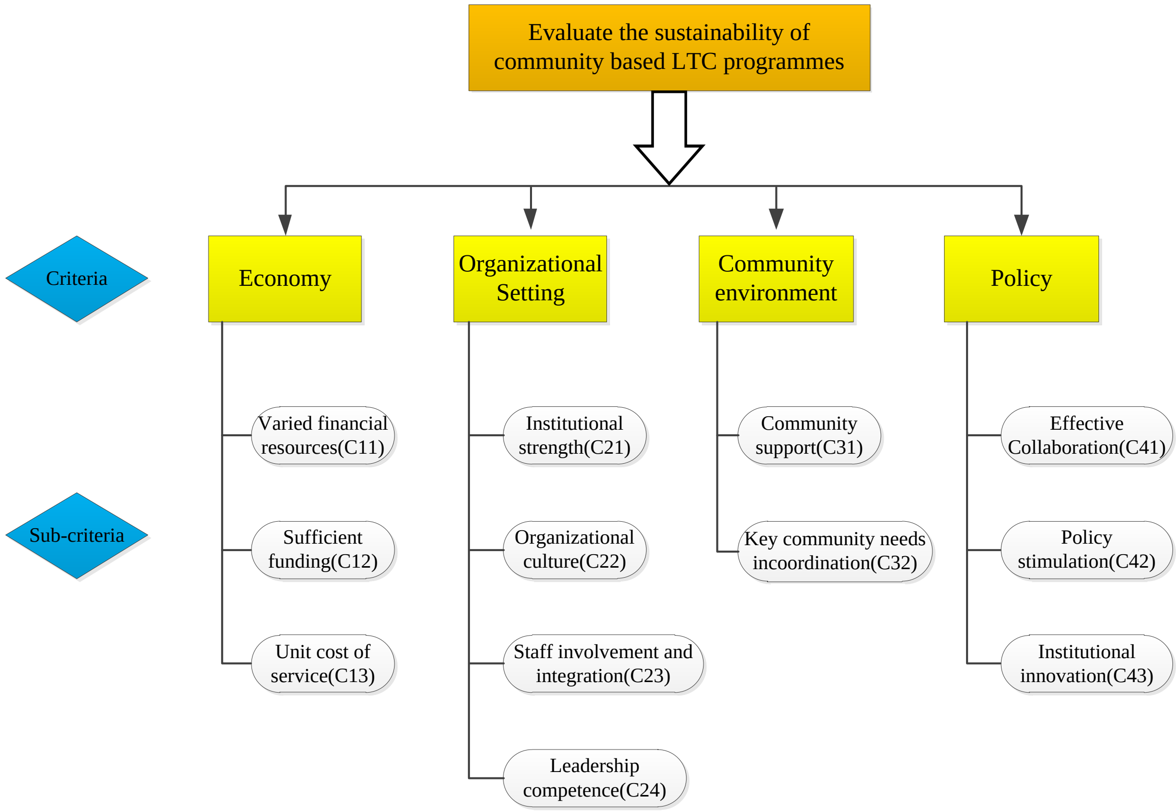

Figure 2. Evaluation index system for sustainability evaluation of community-based LTC programmes.

Table 2. The results of evaluation sub-criteria.

Perspectives	Sub-Criteria	Pessimistic Value		Optimistic Value		Geometric Mean		$M^i - Z^i$	Consensus Value
		C_L^i	C_U^i	O_L^i	O_U^i	C_M^i	O_M^i		G_i
Economy	Varied financial resources	1	5	7	10	4.59	8.89	3.11	6.74 > 6.0
	Affordable cost for customers	1	6	7	8	4.15	6.27	2.73	5.21 < 6.0
	Benefits for service	3	4	7	10	3.16	5.27	7.59	4.22 < 6.0
	Sufficient funding	1	6	7	9	4.37	7.84	2.16	6.11 > 6.0
	Annual operation cost	1	6	5	10	4.51	7.45	1.55	5.98 < 6.0
	Annual income	3	5	6	8	5.06	6.64	2.36	5.85 < 6.0
	Unit cost of service	2	8	7	10	5.14	7.59	1.41	6.37 > 6.0
	Total investment	1	6	7	9	4.52	7.01	2.99	5.77 < 6.0

Table 2. *Cont.*

Perspectives	Sub-Criteria	Pessimistic Value		Optimistic Value		Geometric Mean		$M^i - Z^i$	Consensus Value
		C_L^i	C_U^i	O_L^i	O_U^i	C_M^i	O_M^i		G_i
Organizational Setting	Institutional strength	1	6	8	9	4.64	7.44	3.56	6.04 > 6.0
	Prevailing organizational climate	2	4	7	8	3.94	7.35	3.65	5.65 < 6.0
	Workforce turnover rate	1	5	7	8	4.09	7.06	2.94	5.58 < 6.0
	Clear policies and procedures	2	5	7	10	4.68	5.64	6.36	5.16 < 6.0
	Organizational culture	2	6	7	10	5.16	8.59	2.41	6.88 > 6.0
	Staff involvement and integration	1	6	7	9	4.97	7.54	2.46	6.26 > 6.0
	Employee satisfaction	4	5	6	7	3.96	7.85	0.15	5.91 < 6.0
	Leadership competence	2	6	6	10	3.75	8.26	1.74	6.01 > 6.0
	Training and promotion ladder	2	6	7	9	3.64	6.84	3.16	5.24 < 6.0
	Project management structures	1	5	7	10	4.35	6.89	5.11	5.62 < 6.0
	Relationship among stakeholders	3	5	6	8	3.89	7.68	1.32	5.79 < 6.0
Community Environment	Community support	3	7	7	10	4.64	8.04	1.96	6.34 > 6.0
	Volunteer engagement	1	5	7	9	4.36	6.84	4.16	5.60 < 6.0
	Perceived helpfulness of community involvement	1	5	7	8	4.16	7.64	2.36	5.9 < 6.0
	Connection to the outside community	1	3	5	8	3.54	6.98	3.02	5.26 < 6.0
	Community climate	1	4	7	9	4.97	6.9	5.1	5.94 < 6.0
	Local government support	2	7	5	9	5.11	6.16	0.84	5.98 < 6.0
	Community resources available	1	6	7	9	4.36	7.59	2.41	5.98 < 6.0
	Key community needs in coordination	3	6	7	10	4.25	7.99	3.01	6.12 > 6.0
	Commitment level of the community	2	8	6	10	4.84	7.04	0.96	5.94 < 6.0
Policy	Effective Collaboration	2	6	7	10	5.31	7.65	3.35	6.48 > 6.0
	Deficient policy strategy	1	4	5	8	4.25	7.31	1.69	5.78 < 6.0
	Policy stimulation	3	7	7	9	4.96	7.07	1.93	6.02 > 6.0
	Legislative stabilization	2	5	7	9	3.75	5.68	5.32	4.72 < 6.0
	Institutional innovation	4	6	7	9	4.59	7.65	2.35	6.12 > 6.0

5.1. Economy Criteria

1. Varied financial resources: Refers to whether the LTC programmes can get a variety of financial resources such as Medicaid, Medicare, insurance company, other foundations, or out of pocket payment by the costumers [48]. (C11)
2. Sufficient funding: Refers to whether the funding of the programme is sufficient for current and future programme development and implementation. (C12)
3. Unit cost of service: Refers to the average cost for serving each customer, which implies the cost effectiveness of the programme. (C13)

5.2. Organizational Setting Criteria

1. Institutional strength: Refers to the integration of the institution and whether the goal structures fits the project goals [4]. (C21)
2. Organizational culture: Refers to the shared belief, value and norms in the programme that support and organize the staffs and stakeholders to be united and integrated. (C22)
3. Staff involvement and integration: Include the committed, qualified staff in programme design, implementation, evaluation and decision making [15]. (C23)

4. Leadership competence: Refers to the ability of programme champions especially to focus on programme planning and implementation, financial management, support, supervising teamand providing training. (C24)

5.3. Community Environment Criteria

1. Community support: Involves identification of relevant stakeholders who actively support programme goals and who have clearly identified responsibilities [24]. (C31)
2. Key community needs in coordination: Refers to whether the mission of the programme is not coordinated with key need in the community. (C32)

5.4. Policy Criteria

1. Effective collaboration: Refers to collaboration around the policy to support the programmes, and the collaborators are involved in the programmes. (C41)
2. Policy stimulation: Refers to the policy effectively promoting the development of the programme. (C42)
3. Policy innovation: Refers to the policy fits the organizational and professional goals, strategies and procedures. (C43)

6. Empirical Analysis

In this section, we conduct an empirical study with four community-based LTC programmes in Michigan. Village in the woods (P1) is a new model of community-based LTC service, which is organized and operated based on the local elderly and volunteers. It provides neighbour-to-neighbour volunteer connections, social programming and concierge services with screened and discounted providers to assist the community to remain independent and fully engaged. Huron Valley PACE (P2) provides members in the community the care and medical treatment they need in order to help them live in their homes as long as they can. It offers a full package of services provided by a professional healthcare team. The Oaks adult day programme (P3) is designed to improve social interaction and mental acuity for coping with cognitive, physical or mental disabilities for the elderly in the community. Brookdale senior living community (P4) is an assisted living community providing personalized assisted living and an Alzheimer's as well as dementia care service for seniors.

We combine the hierarchical fuzzy TOPSIS method to evaluate the sustainability of these community-based LTC programmes. Since this MCDM issue has been identified as including four major criteria (Economy, Organization setting, Community environment, and Policy) and twelve sub-criteria. With the aim of obtaining the criteria weights and the rating of sustainability of community-based LTC programmes, we organize the experts into four groups to process the evaluation. A detailed process is listed below:

6.1. Determine the Criteria Weights through AHP

1. After 12 evaluation criteria with four perspectives are selected through FDM, the multi-layer structure of the sustainability of LTC programmes is constructed. The hierarchy contains three levels, as shown in Figure 2.
2. The experts in the expert team are invited to form an individual pairwise comparison matrix by applying Saaty's pairwise comparison scale.
3. Calculate the values of the vector W_i. Table 3 indicates the values of pairwise comparison matrix provided by the decision makers. The vector of priorities is the principal eigenvector of the matrix, which gives the relative priority of the criteria measured on a ratio scale. The value is defined as λ, which is the principal eigenvalue of the matrix. CI is the consistency index and CR is the consistency ratio, they are gathered through AHP process. The result of CI is no more than 0.1, so that the estimated vector W_i is acceptable.

Table 3. Matrix for initial criteria.

	B1	B2	B3	B4	λ	W_i	CI	RI	CR
B1	1	4	5	9	3.662842	0.61164	0.036112	0.89	0.040575
B2	0.25	1	2	5	1.257433	0.209973			
B3	0.2	0.5	1	4	0.795271	0.132798			
B4	0.111111	0.2	0.25	1	0.273012	0.045589			

1. Decide the pairwise comparison matrices for each sub-criterion according to the mutual relation. An example of computing the values of local priorities w_i in B1 is shown in Table 4.
2. Compute the global priorities according to local priorities for each alternative. Table 5 illustrates the local and global priority and the ranking of all evaluated LTC programmes.

Table 4. Matrix for sub-criteria.

	C11	C12	C13	λ_{max}	w_i	CI	RI	CR
C11	1	5	4	2.714418	0.68334	0.012298	0.58	0.021203
C12	0.2	1	0.5	0.464159	0.11685			
C13	0.25	2	1	0.793701	0.19981			

Table 5. Criteria weights for the sustainability evaluation of community-based LTC programmes.

Main Criteria (Perspectives)	Local Weight	Sub-criteria	Global Weight	Ranking
Economy (B1)	0.61164	Diverse sources of funding (C11)	0.41796	1
		Sufficient funding (C12)	0.07147	5
		Unit cost of service (C13)	0.12221	2
Organizational Setting (B2)	0.20997	Institutional strength (C21)	0.09495	4
		Leadership competence (C22)	0.03933	7
		Staff involvement and integration (C23)	0.05182	6
		Organizational culture (C24)	0.02388	9
Community Environment (B3)	0.13280	Community support (C31)	0.09720	3
		Key community needs in coordination (C32)	0.03560	8
Policy (B4)	0.04558	Effective Collaboration (C41)	0.01556	11
		Policy stimulation (C42)	0.02206	10
		Innovations (C43)	0.00797	12

6.2. Evaluate the Sustainability of Four Programmes with Fuzzy-TOPSIS Method

1. Set up the initial fuzzy decision matrix

According to the programme evaluation report of four community-based LTC programmes, each decision-making group contributed the linguistic ratings to the sustainability of LTC programmes, which is presented in Table 6.

Table 6. Linguistic ratings for the sub-criteria of four community-based LTC programmes.

		C11	**C12**	**C13**	**C21**	**C22**	**C23**	**C24**	**C31**	**C32**	**C41**	**C42**	**C43**
P1	E1	H	F	VL	H	VH	F	F	VH	L	VH	H	VH
	E2	H	L	VL	F	H	L	H	VH	VL	VH	H	H
	E3	H	F	F	H	VH	H	H	VH	L	H	F	H
	E4	VH	F	L	H	H	F	F	H	VL	H	F	H
P2	E1	VH	H	H	F	F	VH	H	L	F	H	H	F
	E2	VH	VH	H	H	H	VH	H	F	H	H	VH	H
	E3	H	VH	VH	H	F	H	H	F	L	VH	H	H
	E4	H	VH	VH	F	H	VH	H	H	L	VH	F	F
P3	E1	L	H	F	H	VH	H	L	F	VH	H	F	F
	E2	F	VH	H	VH	H	VH	F	H	H	H	H	L
	E3	L	H	H	H	VH	H	L	H	H	VH	H	F
	E4	F	VH	H	F	VH	VH	L	F	VH	VH	H	F
P4	E1	L	H	VH	H	F	H	F	VL	H	L	VL	VL
	E2	L	VH	VH	F	VH	H	L	VL	VH	L	F	VL
	E3	F	H	H	H	L	VH	VL	L	H	F	F	L
	E4	H	H	VH	VH	H	H	L	L	F	VL	L	F

Next, establish the initial fuzzy decision matrix with the linguistic ratings from Table 6.

$$\widetilde{D} = \left\{ \begin{array}{ccc}
C11 & C12 & C13 \\
\begin{pmatrix} 0.6500 & 0.8500 & 1.0000 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.1500 & 0.3500 & 0.5500 \\ 0.2250 & 0.4250 & 0.6250 \end{pmatrix} &
\begin{pmatrix} 0.2325 & 0.4250 & 0.6250 \\ 0.7500 & 0.9500 & 1.0000 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.7000 & 0.8500 & 1.0000 \end{pmatrix} &
\begin{pmatrix} 0.2325 & 0.4250 & 0.6250 \\ 0.7500 & 0.9500 & 1.0000 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.7000 & 0.8500 & 1.0000 \end{pmatrix} \\
C21 & C22 & C23 \\
\begin{pmatrix} 0.5250 & 0.7250 & 0.8500 \\ 0.4500 & 0.6500 & 0.8500 \\ 0.5750 & 0.7750 & 0.9250 \\ 0.5750 & 0.7750 & 0.9250 \end{pmatrix} &
\begin{pmatrix} 0.7000 & 0.9000 & 1.0000 \\ 0.4500 & 0.6500 & 0.8500 \\ 0.7500 & 0.9500 & 1.0000 \\ 0.4250 & 0.6250 & 0.7750 \end{pmatrix} &
\begin{pmatrix} 0.3000 & 0.5000 & 0.7000 \\ 0.7500 & 0.9500 & 1.0000 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.6500 & 0.8500 & 1.0000 \end{pmatrix} \\
C24 & C31 & C32 \\
\begin{pmatrix} 0.4500 & 0.6500 & 0.8500 \\ 0.6000 & 0.8000 & 1.0000 \\ 0.0750 & 0.2750 & 0.4750 \\ 0.0750 & 0.2250 & 0.4250 \end{pmatrix} &
\begin{pmatrix} 0.7500 & 0.9500 & 1.0000 \\ 0.3000 & 0.5000 & 0.7000 \\ 0.4500 & 0.6500 & 0.8500 \\ 0.0000 & 0.1333 & 0.3333 \end{pmatrix} &
\begin{pmatrix} 0.0000 & 0.1000 & 0.3000 \\ 0.2250 & 0.4250 & 0.6250 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.5750 & 0.7750 & 0.9250 \end{pmatrix} \\
C41 & C42 & C43 \\
\begin{pmatrix} 0.7000 & 0.9000 & 1.0000 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.0750 & 0.2250 & 0.4250 \end{pmatrix} &
\begin{pmatrix} 0.4500 & 0.6500 & 0.8500 \\ 0.5750 & 0.7750 & 0.9250 \\ 0.5250 & 0.7250 & 0.9250 \\ 0.1500 & 0.3000 & 0.5000 \end{pmatrix} &
\begin{pmatrix} 0.6500 & 0.8500 & 1.0000 \\ 0.4500 & 0.6500 & 0.8500 \\ 0.2250 & 0.4250 & 0.6250 \\ 0.0750 & 0.1750 & 0.3750 \end{pmatrix}
\end{array} \right\}$$

2. Normalize initial fuzzy decision matrix

Because varied dimensions of criteria have been considered, a normalization process of the matrix should be executed.

After calculation, the normalized fuzzy decision matrix $\widetilde{R}$ is given below:

$$\widetilde{R} = \left\{ \begin{array}{ccc} C11 & C12 & C13 \\ \begin{pmatrix} 1.0769 & 0.8235 & 0.7000 \\ 1.0000 & 0.7778 & 0.7000 \\ 4.6667 & 2.0000 & 1.2727 \\ 3.1111 & 1.6471 & 1.1200 \end{pmatrix} & \begin{pmatrix} 3.2258 & 1.7647 & 1.2000 \\ 1.0000 & 0.7895 & 0.7500 \\ 1.0714 & 0.8333 & 0.7500 \\ 1.0714 & 0.8824 & 0.7500 \end{pmatrix} & \begin{pmatrix} 0.2000 & 0.4667 & 1.0000 \\ 1.8667 & 2.4000 & 2.6667 \\ 1.4000 & 1.9333 & 2.4667 \\ 2.0000 & 2.5333 & 2.6667 \end{pmatrix} \\ C21 & C22 & C23 \\ \begin{pmatrix} 0.5676 & 0.7838 & 0.9189 \\ 0.4865 & 0.7027 & 0.9189 \\ 0.6216 & 0.8378 & 1.0000 \\ 0.6216 & 0.8378 & 1.0000 \end{pmatrix} & \begin{pmatrix} 0.7000 & 0.9000 & 1.0000 \\ 0.4500 & 0.6500 & 0.8500 \\ 0.7500 & 0.9500 & 1.0000 \\ 0.4250 & 0.6250 & 0.7750 \end{pmatrix} & \begin{pmatrix} 0.3000 & 0.5000 & 0.7000 \\ 0.7500 & 0.9500 & 1.0000 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.6500 & 0.8500 & 1.0000 \end{pmatrix} \\ C24 & C31 & C32 \\ \begin{pmatrix} 1.3333 & 0.9231 & 0.7059 \\ 1.0000 & 0.7500 & 0.6000 \\ 8.0000 & 2.1818 & 1.2632 \\ 8.0000 & 2.6667 & 1.4118 \end{pmatrix} & \begin{pmatrix} 2.2500 & 2.8500 & 3.0000 \\ 0.9000 & 1.5000 & 2.1000 \\ 1.3500 & 1.9500 & 2.5500 \\ 0.0000 & 0.4000 & 1.0000 \end{pmatrix} & \begin{pmatrix} 0.0000 & 0.1000 & 0.3000 \\ 0.2250 & 0.4250 & 0.6250 \\ 0.7000 & 0.9000 & 1.0000 \\ 0.5750 & 0.7750 & 0.9250 \end{pmatrix} \\ C41 & C42 & C43 \\ \begin{pmatrix} 1.0000 & 0.7778 & 0.7000 \\ 1.0000 & 0.7778 & 0.7000 \\ 1.0000 & 0.7778 & 0.7000 \\ 9.3333 & 3.1111 & 1.6471 \end{pmatrix} & \begin{pmatrix} 0.4865 & 0.7027 & 0.9189 \\ 0.6216 & 0.8378 & 1.0000 \\ 0.5676 & 0.7838 & 1.0000 \\ 0.1622 & 0.3243 & 0.5405 \end{pmatrix} & \begin{pmatrix} 0.6500 & 0.8500 & 1.0000 \\ 0.4500 & 0.6500 & 0.8500 \\ 0.2250 & 0.4250 & 0.6250 \\ 0.0750 & 0.1750 & 0.3750 \end{pmatrix} \end{array} \right\}$$

3. Set up the weighted normalized fuzzy decision matrix

Multiply w_j through matrix $\widetilde{R}$ to set up the weighted normalized fuzzy decision matrix $\widetilde{V}$:

$$\widetilde{V} = \left\{ \begin{array}{cccc} (0.4501, 0.3442, 0.2926) & (0.4180, 0.3251, 0.2926) & (1.9505, 0.8359, 0.5319) & (1.3003, 0.6884, 0.4681) \\ (0.2305, 0.1261, 0.0858) & (0.0715, 0.0564, 0.0536) & (0.0766, 0.0596, 0.0536) & (0.0766, 0.0631, 0.0536) \\ (0.0244, 0.0570, 0.1222) & (0.2281, 0.2933, 0.3259) & (0.1711, 0.2363, 0.3015) & (0.2444, 0.3096, 0.3259) \\ (0.0539, 0.0744, 0.0872) & (0.0462, 0.0667, 0.0872) & (0.0590, 0.0795, 0.0949) & (0.0590, 0.0795, 0.0949) \\ (0.0275, 0.0354, 0.0393) & (0.0177, 0.0256, 0.0334) & (0.0295, 0.0374, 0.0393) & (0.0167, 0.0246, 0.0305) \\ (0.0155, 0.0259, 0.0363) & (0.0389, 0.0492, 0.0518) & (0.0363, 0.0466, 0.0518) & (0.0337, 0.0440, 0.0518) \\ (0.0318, 0.0220, 0.0169) & (0.0239, 0.0179, 0.0143) & (0.1910, 0.0521, 0.0302) & (0.1910, 0.0637, 0.0337) \\ (0.2187, 0.2770, 0.2916) & (0.0875, 0.1458, 0.2041) & (0.1312, 0.1895, 0.2479) & (0.0000, 0.0389, 0.0972) \\ (0.0000, 0.0036, 0.0107) & (0.0080, 0.0151, 0.0222) & (0.0249, 0.0320, 0.0356) & (0.0205, 0.0276, 0.0329) \\ (0.0156, 0.0121, 0.0109) & (0.0156, 0.0121, 0.0109) & (0.0156, 0.0121, 0.0109) & (0.1452, 0.0484, 0.0256) \\ (0.0107, 0.0155, 0.0203) & (0.0137, 0.0185, 0.0221) & (0.0125, 0.0173, 0.0221) & (0.0036, 0.0072, 0.0119) \\ (0.0052, 0.0068, 0.0080) & (0.0036, 0.0052, 0.0068) & (0.0018, 0.0034, 0.0050) & (0.0006, 0.0014, 0.0030) \end{array} \right\}$$

4. Calculate the FPIS and FNIS

The fuzzy PIS A^* and fuzzy NIS A^- are calculated as follows, respectively:

$$A^* = \left\{ \begin{array}{ccc} (0.417958, 0.325079, 0.292571) & (0.07147, 0.056424, 0.053602) & (0.244424, 0.309603, 0.325898) \\ (0.05902, 0.079549, 0.094945) & (0.029499, 0.037365, 0.039332) & (0.038863, 0.049226, 0.051817) \\ (0.023878, 0.017909, 0.014327) & (0.218698, 0.277017, 0.291597) & (0.024919, 0.032039, 0.035599) \\ (0.015556, 0.012099, 0.010889) & (0.013714, 0.018484, 0.022061) & (0.005181, 0.006776, 0.007971) \end{array} \right\}$$

and

$$A^{-} = \left\{ \begin{array}{ccc} (1.950472, 0.835917, 0.531947) & (0.230548, 0.126123, 0.085764) & (0.024442, 0.057032, 0.122212) \\ (0.04619, 0.066718, 0.087247) & (0.016716, 0.024583, 0.030482) & (0.015545, 0.025909, 0.036272) \\ (0.191025, 0.063675, 0.03371) & (0, 0.03888, 0.097199) & (0, 0.00356, 0.01068) \\ (0.145192, 0.048397, 0.025622) & (0.003578, 0.007155, 0.011925) & (0.000598, 0.001395, 0.002989) \end{array} \right\}$$

5. Compute the distance of each FPIS and FNIS

The distance of each alternative from the positive ideal solution and the negative ideal solution are as follows:

$$d_1^* = 0.905513,\ d_2^* = 0.386184,\ d_3^* = 1.08503,\ d_4^* = 1.486606$$

$$d_1^- = 1.57991,\ d_2^- = 2.152752,\ d_3^- = 1.460333,\ d_4^- = 1.015574$$

6. Compute the closeness coefficient of each alternative

$$CC_1 = 0.63567,\ CC_2 = 0.847895,\ CC_3 = 0.573723,\ CC_4 = 0.405876$$

7. Obtain the ranking of the alternative

The ultimate evaluation priority of each programme is determined based on the closeness coefficient value, which is shown in Figure 3. The result indicates that P2 and P4 are the best and the worst in the list of priorities, respectively.

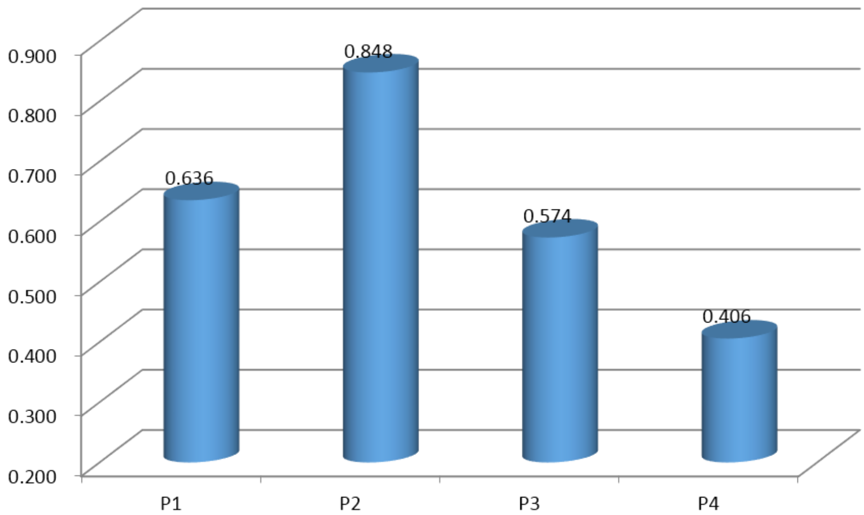

Figure 3. The final ranking of four community-based LTC programmes.

7. Discussions

The four community-based LTC programmes are evaluated through AHP and fuzzy TOPSIS techniques. As shown in Figure 3, the results of all LTC programmes in declining order are P2, P1, P3 and P4. Based on the above result, the proposed framework can easily evaluate and figure out which programme has the best potential of long-term sustainability. In this section, we conduct a sensitivity analysis to test the accuracy and effectiveness of the proposed framework and analyse the outcomes.

As illustrated in Figure 4, the final outcomes of P1 and P2 increase when sub-criterion C11 gets more weights, while P3 declines if the weight of C11 becomes less important. P4 reflects a steady change with the fluctuation of C11. When C12 has been given more weights, only P1 indicates a small downward trend, while the outcomes of others keep stable. In the case of C13, P1 and P3 indicate a relative opposite tendency with the weight fluctuation of C13, while P2 remains stable and P4 shows a steady increase with the increased weight of C13. Apparently, C11 and C13 are sensible sub-criteria that significantly influence the sustainability of the community-based LTC programme. However, P2 is always the best programme among all regardless of the weights change from economy perspective.

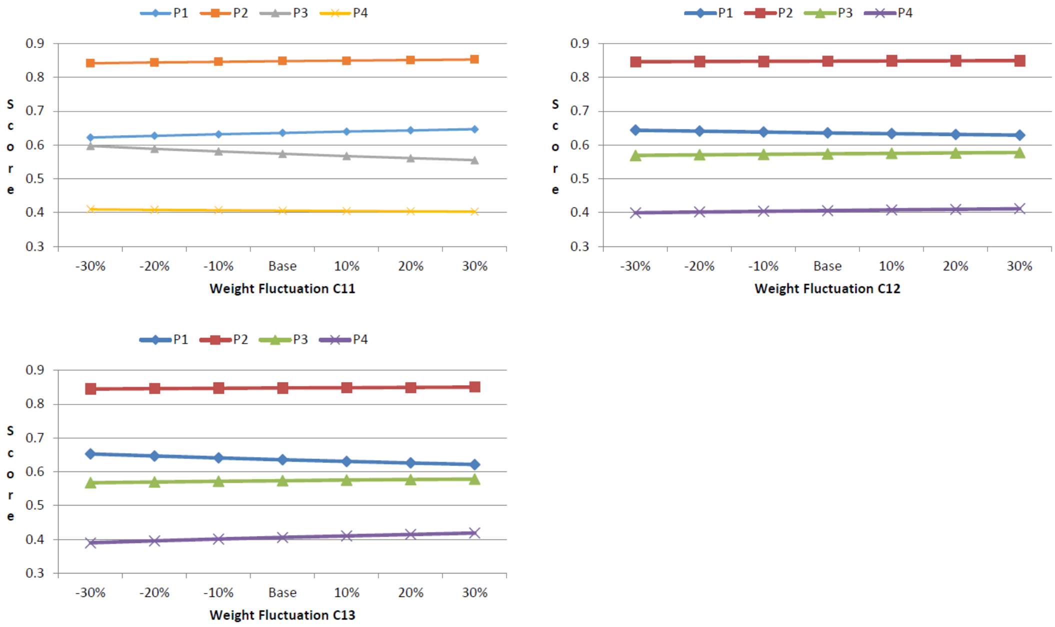

Figure 4. Sensitivity analysis in economy group.

Sensitivity analysis in the organizational setting group (Figure 5) indicates the results of all community-based LTC programmes illustrate tiny fluctuation, however the change of the sub-criteria from C21 to C23. Furthermore, the scores of P1 and P3 upon the fluctuation of C23 and C24 remain an opposite variation trend. Therefore, regardless of the sub-criteria weights in the organizational setting group change, P2 and P4 are the best and worst sustaining LTC programmes, respectively.

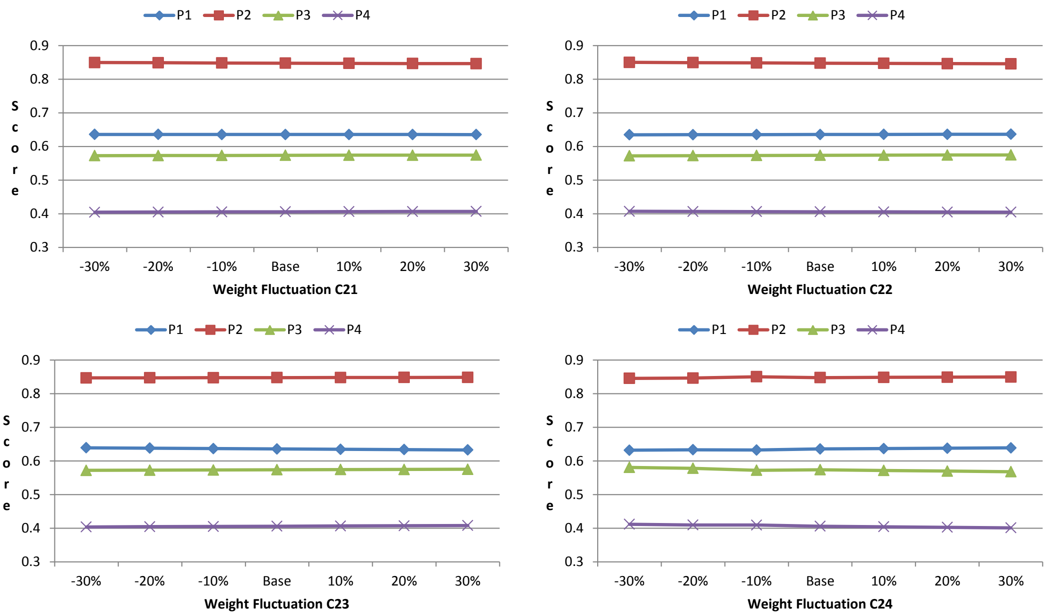

Figure 5. Sensitivity analysis in organizational setting group.

Figure 6 shows the weight fluctuation of C31 and C32 in the community environment group. The scores of all the community-based LTC programmes hold a small variation trend, though the fluctuation of P1 and P3 entails a more conspicuous decrease when the weight of C31 becomes less important. The ranks of the alternatives remain consistent with the base situation.

As the policy group holds a relatively small local weight among the initial criteria (Figure 7), when the weights of C41, C42 and C43 change with ±10%, ±20%, ±30%, the variation is not very obvious, which implies the sub-criteria in the policy groups are considered insensitive. Equals to economy, organizational setting and community environment groups, P2 and P4 are always the optimal and worst choice regardless of sub-weights in the policy group flucate.

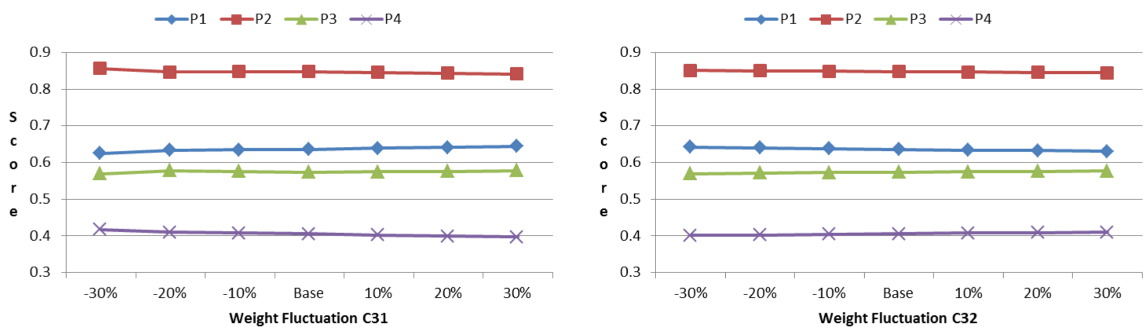

Figure 6. Sensitivity analysis in community environment group.

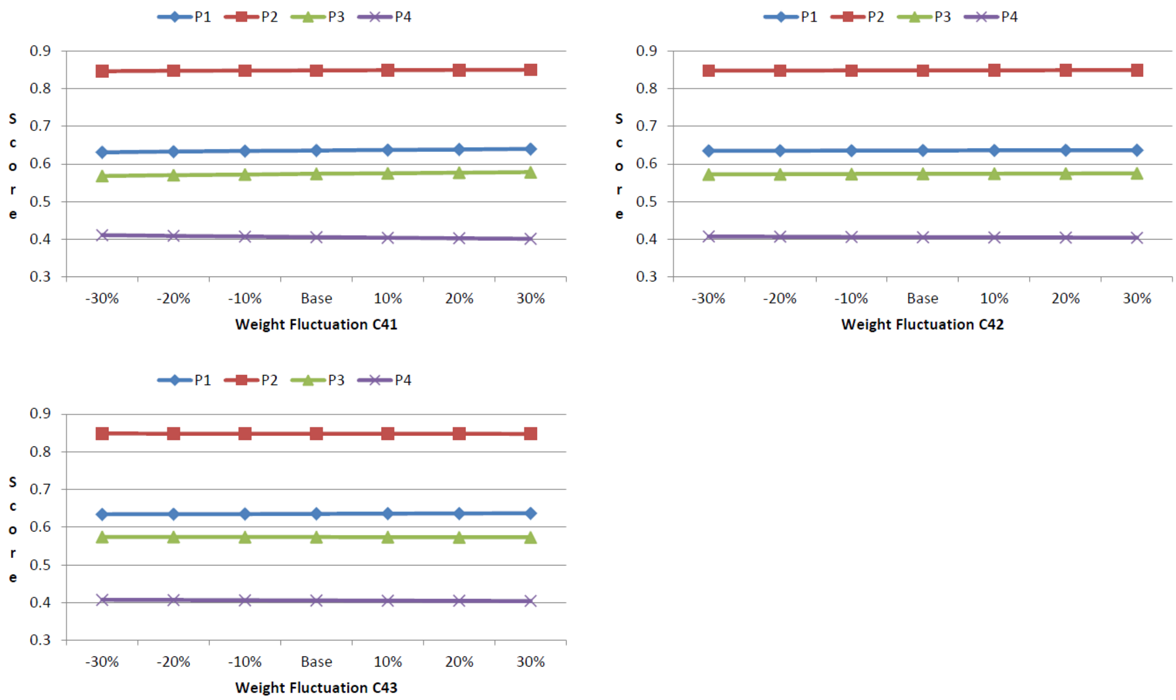

Figure 7. Sensitivity analysis in policy group.

Above all, all community-based LTC programmes always keep their ranks, whatever the changes of all sub-criteria weights. Through the sensitive analysis, it could be verified that the result of the evaluation is accurate, and the evaluation framework combining AHP and fuzzy TOPSIS has been effectively tested through the empirical study.

8. Conclusions

Maintaining the sustainability of the programme is a desirable goal for all the decision makers. For the community-based LTC programmes, a sustainable programme means it can service more elderly in the community with optimal resources for a long period to face the coming "silver tsunami". In this study, we invited LTC managers to join our expert group in order to get the practitioners' experience to enrich the study. The experience from the managers would make the study more practical since they contribute their judgement based on their daily affairs. We proposed a comprehensive evaluation framework for the sustainability of community-based LTC programmes including four pillars, namely economy, organization setting, community environment and policy. The final evaluation sub-criteria for evaluating the sustainability of community-based LTC programmes are identified by FDM technique. Furthermore, the sub-criteria weights are defined through AHP technique. Finally, a fuzzy TOPSIS technique is introduced to handle the uncertainty of the sub-criterions in the empirical evaluation of four community-based LTC programmes in Michigan. The result indicates that sub-criteria C11 and C13 associated with the economy group gain more priority from the decision makers, which means that fiscal sustainability as well as the cost-effectiveness of the programme play vitally important roles in the evaluation of programme sustainability [49]. Meanwhile the alternative P2 is determined as the best programme regarding the evaluation of sustainability. The sensitivity analysis is introduced to examine the evaluation outcomes. The result indicates that all the community-based LTC programmes always keep their ranks regardless of the fluctuation of the alternative weights. The result proves the evaluation framework combing AHP and fuzzy TOPSIS in this study is effective.

This framework proposed in this article proves strong potential in evaluating the community-based LTC programme from a sustainability perspective. The evaluation framework, criteria and weights proposed in this study are practical for researchers and LTC practitioners in their sustainability evaluation. Although this study realized the evaluation of community-based LTC programmes by using a hybrid MCDM technique with FDM, AHP and fuzzy TOPSIS, there are some limitations need to be noted. First, the evaluation criteria proposed through FDM with 16 experts indicates some of the indicators are marginally included or excluded, the reason is that the decision-making process is sensitive to the number and quality of evaluators [50], an appropriate solution is to involve a lot of evaluators to avoid marginal results [51]. Second, for the extension of this study, other MCDM techniques such as VIKOR, PROMETHEE and ELECTRE could be applied in the future research or simple MCDM methods such as Simple Additive Weighting (SAW) to make it easier to execute for LTC practitioners.

Acknowledgments: This study is supported by China Scholarship Council (No.201506170070). The authors are grateful for the research support from the Curtis Research Center in the School of Social Work, University of Michigan. The authors thank the anonymous reviewers for their insightful and constructive comments.

Author Contributions: Qiyu Sun, Baoan Song and Chuanqi Que conceived and designed the research method used in this paper; Qiyu Sun and Ying Li performed the empirical analysis; and Qiyu Sun wrote the paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Francesca, C.; Ana, L.-N.; Jérôme, M.; Frits, T. *Oecd Health Policy Studies Help Wanted? Providing and Paying for Long-Term Care: Providing and Paying for Long-Term Care*; OECD: Pairs, France, 2011; Volume 2011.
2. United, S. *Commission on Long-Term Care: Report to Congress*; U.S. Government Printing Office: Washington, DC, USA, 2013; p. 1.
3. Simmons, D. Sustainable living in long-term care: For people with dementia/alzheimer's. *Educ. Gerontol.* **2011**, *37*, 526–547. [CrossRef]
4. Shediac-Rizkallah, M.C.; Bone, L.R. Planning for the sustainability of community-based health programs: Conceptual frameworks and future directions for research, practice and policy. *Health Educ. Res.* **1998**, *13*, 87–108. [CrossRef] [PubMed]

5. Fleiszer, A.R.; Semenic, S.E.; Ritchie, J.A.; Richer, M.C.; Denis, J.L. The sustainability of healthcare innovations: A concept analysis. *J. Adv. Nurs.* **2015**, *71*, 1484–1498. [CrossRef] [PubMed]
6. Scheirer, M.A.; Dearing, J.W. An agenda for research on the sustainability of public health programs. *Am. J. Public Health* **2011**, *101*, 2059–2067. [CrossRef] [PubMed]
7. Schöning, M. What social entrepreneurs taught me about sustainability. In *Practicing Sustainability*; Springer: New York, NY, USA, 2013; pp. 181–185.
8. Scheirer, M.A. Is sustainability possible? A review and commentary on empirical studies of program sustainability. *Am. J. Eval.* **2005**, *26*, 320–347.
9. Johnson, K.; Hays, C.; Center, H.; Daley, C. Building capacity and sustainable prevention innovations: A sustainability planning model. *Eval. Program Plan.* **2004**, *27*, 135–149. [CrossRef]
10. Pluye, P.; Potvin, L.; Denis, J.-L. Making public health programs last: Conceptualizing sustainability. *Eval. Program Plan.* **2004**, *27*, 121–133. [CrossRef]
11. Stirman, S.W.; Kimberly, J.; Cook, N.; Calloway, A.; Castro, F.; Charns, M. The sustainability of new programs and innovations: A review of the empirical literature and recommendations for future research. *Implement Sci.* **2012**, *7*, 17. [CrossRef] [PubMed]
12. Buchanan, D.; Fitzgerald, L.; Ketley, D.; Gollop, R.; Jones, J.L.; Lamont, S.S.; Neath, A.; Whitby, E. No going back: A review of the literature on sustaining organizational change. *Int. J. Manag. Rev.* **2005**, *7*, 189–205. [CrossRef]
13. Gruen, R.L.; Elliott, J.H.; Nolan, M.L.; Lawton, P.D.; Parkhill, A.; McLaren, C.J.; Lavis, J.N. Sustainability science: An integrated approach for health-programme planning. *Lancet* **2008**, *372*, 1579–1589. [CrossRef]
14. Savaya, R.; Spiro, S.E. Predictors of sustainability of social programs. *Am. J. Eval.* **2011**, *33*, 26–43. [CrossRef]
15. Mancini, J.A.; Marek, L.I. Sustaining community-based programs for families: Conceptualization and measurement. *Fam. Relat.* **2004**, *53*, 339–347. [CrossRef]
16. Maher, L.; Gustafson, D.; Evans, A. Sustainability model and guide. *NHS Institute for innovation and Improvement*, 2007. Available online: http://www.institute.nhs.uk/sustainability_model/general/welcome_to_sustainability.html (accessed on 7 March 2016).
17. Demiglio, L.; Williams, A.M. A qualitative study examining the sustainability of shared care in the delivery of palliative care services in the community. *BMC Palliat. Care* **2013**, *12*, 32. [CrossRef] [PubMed]
18. Theurer, K.; Wister, A.; Sixsmith, A.; Chaudhury, H.; Lovegreen, L. The development and evaluation of mutual support groups in long-term care homes. *J. Appl. Gerontol.* **2014**, *33*, 387–415. [CrossRef] [PubMed]
19. Burack, O.R.; Reinhardt, J.P.; Weiner, A.S. Person-centered care and elder choice: A look at implementation and sustainability. *Clin. Gerontol.* **2012**, *35*, 390–403. [CrossRef]
20. Slaghuis, S.S.; Strating, M.M.; Bal, R.A.; Nieboer, A.P. A framework and a measurement instrument for sustainability of work practices in long-term care. *BMC Health Serv. Res.* **2011**, *11*, 314. [CrossRef] [PubMed]
21. Lundsgaard, J. Choice and long-term care in oecd countries: Care outcomes, employment and fiscal sustainability. *Eur. Soc.* **2006**, *8*, 361–383. [CrossRef]
22. De Belvis, A.G.; Ferrè, F.; Specchia, M.L.; Valerio, L.; Fattore, G.; Ricciardi, W. The financial crisis in italy: Implications for the healthcare sector. *Health Policy* **2012**, *106*, 10–16. [CrossRef] [PubMed]
23. Chan, H.M.; Pang, S. Long-term care: Dignity, autonomy, family integrity, and social sustainability: The hong kong experience. *J. Med. Philos.* **2007**, *32*, 401–424. [CrossRef] [PubMed]
24. Fernández, J.-L.; Forder, J.; Trukeschitz, B.; Rokosová, M.; McDaid, D. *How Can European States Design Efficient, Equitable and Sustainable Funding Systems for Long-Term Care for Older People?*; World Health Organization on behalf of the European Observatory on Health Systems and Policies, Joint HEN/European Observatory on Health Systems and Policies Policy Brief: Copenhagen, Denmark, 2009.
25. Wang, C.H.; Chou, H.L. Assessment of patient safety management from human factors perspective: A fuzzy topsis approach. *Hum. Factors Ergono Manuf. Serv. Ind.* **2015**, *25*, 614–626. [CrossRef]
26. Zhao, H.; Li, N. Performance evaluation for sustainability of strong smart grid by using stochastic ahp and fuzzy topsis methods. *Sustainability* **2016**, *8*, 129. [CrossRef]
27. Yoon, K.; Hwang, C. *Topsis (Technique for Order Preference by Similarity to Ideal Solution)—A Multiple Attribute Decision Making, w: Multiple Attribute Decision Making–Methods and Applications, a State-of-the-at Survey*; Springer Verlag: Berlin, Germany, 1981.
28. Min, H.; Perçin, S. Evaluation of third-party logistics (3pl) providers by using a two-phase ahp and topsis methodology. *Benchmark. Int. J.* **2009**, *16*, 588–604. [CrossRef]

29. Wang, Y.; Lee, H.; Lin, K. Fuzzy topsis for multi-criteria decision making. *Int. Math. J.* **2003**, *3*, 367–379.
30. Zadeh, L.A. Fuzzy sets. *Inf. Control* **1965**, *8*, 338–353. [CrossRef]
31. Roshandel, J.; Miri-Nargesi, S.S.; Hatami-Shirkouhi, L. Evaluating and selecting the supplier in detergent production industry using hierarchical fuzzy topsis. *Appl. Math. Model.* **2013**, *37*, 10170–10181. [CrossRef]
32. Kahraman, C. Multi-criteria decision making methods and fuzzy sets. In *Fuzzy Multi-Criteria Decision Making*; Springer: New York, NY, USA, 2008; pp. 1–18.
33. Wang, X.; Chan, H.K. A hierarchical fuzzy topsis approach to assess improvement areas when implementing green supply chain initiatives. *Int. J. Prod. Res.* **2013**, *51*, 3117–3130. [CrossRef]
34. BaykasoğLu, A.; KaplanoğLu, V.; DurmuşOğLu, Z.D.; ŞAhin, C. Integrating fuzzy dematel and fuzzy hierarchical topsis methods for truck selection. *Expert Syst. Appl.* **2013**, *40*, 899–907. [CrossRef]
35. Kahraman, C.; Büyüközkan, G.; Ateş, N.Y. A two phase multi-attribute decision-making approach for new product introduction. *Inf. Sci.* **2007**, *177*, 1567–1582. [CrossRef]
36. Van Dijk, J. Methods in applied social research: Special characteristics and quality standards. *Qual. Quant.* **1986**, *20*, 357–370. [CrossRef]
37. Hsu, P.-F.; Hsu, M.-G. Optimizing the information outsourcing practices of primary care medical organizations using entropy and topsis. *Qual. Quant.* **2008**, *42*, 181–201. [CrossRef]
38. Dalkey, N.; Helmer, O. An experimental application of the delphi method to the use of experts. *Manag. Sci.* **1963**, *9*, 458–467. [CrossRef]
39. Chang, I.S.; Tsujimura, Y.; Gen, M.; Tozawa, T. An efficient approach for large scale project planning based on fuzzy delphi method. *Fuzzy Sets Sys.* **1995**, *76*, 277–288. [CrossRef]
40. Ajami, S.; Ketabi, S. Performance evaluation of medical records departments by analytical hierarchy process (ahp) approach in the selected hospitals in isfahan. *J. Med. Sys.* **2012**, *36*, 1165–1171. [CrossRef] [PubMed]
41. Önüt, S.; Soner, S. Transshipment site selection using the ahp and topsis approaches under fuzzy environment. *Waste Manag.* **2008**, *28*, 1552–1559. [CrossRef] [PubMed]
42. Saaty, T.L. *Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World*; RWS publications: Pittsburgh, PA, USA, 1990.
43. Amiri, M.P. Project selection for oil-fields development by using the ahp and fuzzy topsis methods. *Expert Sys. Appl.* **2010**, *37*, 6218–6224. [CrossRef]
44. Verma, R.; Koul, S.; Govindan, K. Vendor selection and uncertainty. *Int. J. Bus. Perform. Supply Chain Model.* **2009**, *1*, 333–345. [CrossRef]
45. Chan, F.T.; Kumar, N. Global supplier development considering risk factors using fuzzy extended ahp-based approach. *Omega* **2007**, *35*, 417–431. [CrossRef]
46. Torfi, F.; Farahani, R.Z.; Rezapour, S. Fuzzy ahp to determine the relative weights of evaluation criteria and fuzzy topsis to rank the alternatives. *Appl. Soft Comput.* **2010**, *10*, 520–528. [CrossRef]
47. Bonissone, P.P.; Subbu, R.; Lizzi, J. Multicriteria decision making (mcdm): A framework for research and applications. *Comput. Intell. Mag. IEEE* **2009**, *4*, 48–61. [CrossRef]
48. Steckler, A.; Goodman, R.M. How to institutionalize health promotion programs. *Am. J. Health Promot.* **1989**, *3*, 34–43. [CrossRef] [PubMed]
49. Koskan, A.; Friedman, D.B.; Messias, D.K.H.; Brandt, H.M.; Walsemann, K. Sustainability of promotora initiatives: Program planners' perspectives. *J. Public Health Manag. Pract.* **2013**, *19*, E1–E9. [CrossRef] [PubMed]
50. Awasthi, A.; Chauhan, S.S.; Omrani, H. Application of fuzzy topsis in evaluating sustainable transportation systems. *Expert Sys. Appl.* **2011**, *38*, 12270–12280. [CrossRef]
51. Bueyuekoezkan, G.; Ruan, D. Evaluating government websites based on a fuzzy multiple criteria decision-making approach. *Int. J. Uncertain. Fuzziness Knowl. Based Syst.* **2007**, *15*, 321–343. [CrossRef]