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USING A HYBRID MODEL TO EVALUATE DEVELOPMENT STRATEGIES FOR DIGITAL CONTENT

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Abstract. Digital content (DC) is one of the most important areas of growth within the global creative and knowledge-based economy. The paper aims to propose a systematic approach to evaluating strategies to develop DC industry and how it should be effectively implemented. Our analysis employs a hybrid multiple criteria decision making (MCDM) approach by using the interpretive structural modelling (ISM) method to deal with the interrelationship among criteria, and the analytic network process (ANP) method is employed to determine the relative weights of each criterion. Finally, in order to choose the alternative for the ideal solution of this problem, a technique for order performance by similarity to ideal solution (TOPSIS) is used. To demonstrate the validity of this method, the Taiwan's DC industry is used as an illustrative case. The study generates results that can serve as a reference for decision-makers in the formulation of their development strategies for DC. Moreover, the evaluation model constructed in this study goes beyond existing measures and may serve as a reference for a decision-maker.

Keywords: digital content, development strategies, interpretive structural modelling, analytic network process, multiple criteria decision making, Technique for Order Preference by Similarity to Ideal Solution.

JEL Classification: C61, L78, L86.

Introduction

Digital content (DC) is the essence of the digital economy. In DC, various types of material are processed via digital technology and are converted from traditional media into digital formats. DC includes the creation and design of digital products and services that are managed and distributed through multiple delivery platforms and channels including information and communication technologies (ICT) hardware and infrastructures, consumer electronics, mobile and hand devices. Moreover, the global DC industry is forecast

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to grow at a rate of between 6 and 10 per cent per annum over the next three years. As a result, the DC is the most crucial concerns of ICT application for government and businesses in unprecedented ways.

Despite the growing importance of the DC, academic research on the competitiveness of this industry is insufficient (Choi, Oh 2009). The previous studies tend to focus on the concepts and contents of DC. Moreover, while other success differentiators have been extensively researched, studies that derive the details of the anatomy of a DC industry and the formulation and selection of the emerging DC industry are few in number. Besides, planning and investment in emerging DC industries may include different criteria, such as the emergence of new technologies, economic effectiveness, and environmental regulation.

This study attempts to bridge this gap, using an empirical case to propose the framework for evaluating strategies to develop the DC industry and how it should be effectively implemented. In this study, we propose a useful evaluation model based on a hybrid multiple criteria decision making (MCDM) approach. First, use the interpretive structural modelling (ISM) method to build the interrelationship among criteria for DC evaluation measurement and evaluation. Second, the analytic network process (ANP) method is employed to determine the relative weights of each criterion. Finally, in order to choose the alternative for the ideal solution of this problem, a technique for order performance by similarity to ideal solution (TOPSIS) is used. To demonstrate the validity of this method, the Taiwan's DC industry is used as an illustrative case.

The rest of the article is organised as follows. Section 1 addresses some related theoretical foundations of DC. The proposed evaluation framework for DC by the hybrid MCDM approach is described in Section 2. Section 3 we present an empirical example of the evaluation model, including the selection of the criteria of DC, the construction of the evaluation model, and the resulting analyses and discussions. Finally, conclusions and suggestions are presented in the last section.

1. Literature review

The practical concept of DC can be defined as data, information or knowledge products traded exclusively through online networks and characterized by indestructibility, transmutability, reproducibility, intangibility (understood specifically as immateriality, or absence of any tangible components), and by the fact that usually product quality can be learned only by actually using the good (Loebbecke, Huyskens 2007). This definition of DC is valid independently of the technological platform for content distribution and use. Therefore, the DC industry is composed of various sub-sectors, each of which has distinctive characteristics.

There has been a substantial amount of research efforts in the area of DC. However, most DC studies focus mainly on evaluating DC from perspectives of education (Rosen, Beck-Hill 2012), efficiency analysis (Choi, Oh 2009), valuation (Hsiung, Wang 2012), marketing (Rowley 2008; Feng *et al.* 2009), regulation (Loos *et al.* 2011), government policy (O'Regan, Ryan 2004; Lehdonvirta, Virtanen 2010), business models (Conway 2008) and information system (Agosti, Ferro 2007). Moreover, how to cope with the complexity of DC in strategic level decision making has seldom been addressed in the literature. Developing DC should be viewed as an effective means of nurturing a competitive advantage (Tsai *et al.* 2008; Chiu, Lin 2012). However, DC has rarely been examined from a strategy planning perspective (Turba 2011).

Moreover, based on the DC problem in the classification of DC products, previous literature could be classified broadly as media (O'Regan, Ryan 2004; Preston *et al.* 2009; Regner *et al.* 2010; Buckingham 2010), digital television (Toletti, Turba 2009; Turba 2011), and the video game (Guttenbrunner *et al.* 2010). Moreover, previous studies on DC include case studies (Toletti, Turba 2009), field surveys and interviews (Rosen, Beck-Hill 2012). Apart from an empirical study on DC, Choi and Oh (2009) indicated that quantitative models for DC have received growing attention.

Despite the attention paid to DC, there is still no consensus on the decisions related to how industries within the emerging DC sector are selected and formulated. Besides, DC is a collaborative endeavour, involving interdisciplinary fields such as computing, architecture, industrial design and engineering (Loebbecke, Huyskens 2007). As far as policy makers are concerned, a selection and evaluation method is needed rather than the DC content or typology. Under these conditions, policy makers fail to make objective decisions that lead to worse solutions. In this research, we propose a hybrid MCDM approach for evaluating and selecting the proper DC industry. The related hybrid approach is reviewed in the following section.

2. Proposed approach and method

The proposed a hybrid MCDM approach to construct a model to evaluate strategies to develop DC industry and the analytical method, ISM, ANP, and TOPSIS are delineated in this section.

2.1. Proposed framework of the evaluation model

In this section, an evaluation framework for selecting the DC development strategies is constructed. First, the ISM method is applied to distinguish the interrelations among criteria and determine the structure of related criteria in the complex problem. ISM is a well-established methodology for identifying and summarizing relationships among specific items and helps to construct a multi-level structural model. Second, the ANP is used to construct the interdependence relationship among the criteria, and to obtain their criteria weights. Next, based on the interdependent weights of the criteria, the fourth step is to build a decision- making matrix. The final step is to apply the TOPSIS method to achieve the final ranking results. A detailed description of each step is provided in each of the following sub-section.

2.2. Interpretive structural modelling

Interpretive structural modelling (ISM), proposed by Warfield (1974a, 1974b, 1976), is a computer-assisted methodology to construct and understand the fundamentals of the relationships of the elements in complex systems or situations. In this proposed framework, ISM is applied next to understand the interaction among criteria and among sub-criteria. The first step of ISM is to identify the variables relevant to the problems or issues. It then extends to a group problem-solving technique. A structural self-interaction matrix (SSIM) is then developed based on a pairwise comparison of variables. The SSIM is formed by asking questions such as, "Will element e_i affect element e_j?" If the answer is yes, then π_{ij} = 1. If the answer is no, then π_{ij} = 0. SSIM can be described as below:

$$\boldsymbol{A} = \begin{matrix} & e_1 & e_2 & \cdots & e_n \\ e_1 \\ e_2 \\ \vdots \\ e_n \end{matrix} \begin{bmatrix} 0 & \pi_{12} & \cdots & \pi_{1n} \\ \pi_{21} & 0 & \cdots & \pi_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \pi_{n1} & \pi_{n2} & \cdots & 0 \end{bmatrix}. \quad (1)$$

The e_i means the i^{th} element, the π_{ij} means the interrelationship between the i^{th} and the j^{th} elements, and D is an SSIM. After establishing the SSIM, it is converted into a reachability matrix, and that its transitivity is then checked using equations (2) and (3) (Huang *et al.* 2005):

$$R = D + I; \quad (2)$$

$$R^* = R^k = R^{K+1} \text{ if } k > 1 \text{ the computation ends (stable reachability)}, \quad (3)$$

where I is the unit matrix, k denotes the powers, and M^* is the reachability matrix. Note that the reachability matrix is under the operations of the Boolean multiplication and addition (i.e., $1 \cdot 1 = 1$, $1 + 1 = 1$, $1 \cdot 0 = 0$, $1 + 0 = 0 + 1 = 1$, $1 \cdot 0 = 0 \cdot 1 = 0$). For example:

$$R = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix},\ R^2 = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}.$$

2.3. Analytic network process

The ANP is a multiple criteria decision-making tool, proposed by Saaty in 1996, releases the restriction of hierarchical structure and independence among elements (Saaty 1996 2001). Basically, ANP decomposes a problem into different criteria, where each criterion contains multiple elements or sub-criteria. Outer dependence exists between criteria, and the sub-criteria within criteria are dependent upon one another (Lee 2013; Lee, Y. H., Lee, Y. H. 2012; Fouladgar *et al.* 2012; García-Melón *et al.* 2010; Tsai, Chang 2013). An extensive review of the limitations of AHP is given in Sipahi and Timor (2010), Liou and Tzeng (2012) and Peng and Tzeng (2013).

The ANP uses a "supermatrix" to obtain the composite weight to deal with the relationships of feedback and interdependence among the criteria. After the supermatrix is created, weights are assigned to individual blocks in the unweighted supermatrix according to the priorities of the clusters so that they become a column stochastic (the weighted supermatrix). Then, the limited weighted supermatrix M^* is obtained based on equation (4), and the gradual convergence of the interdependence relationship results in obtaining the accurate relative weights among the criteria:

$$M^* = \lim_{k \to \infty} M^k. \quad (4)$$

2.4. Technique for Order Preference by Similarity to Ideal Solution

Hwang and Yoon (1981) provide the technique for order preference by similarity to ideal solution (TOPSIS). TOPSIS is a popular method for solving multi-objective decision problems (Chu *et al.* 2007; Tsou 2007; Wang, Chang 2007; Zavadskas *et al.* 2014). The basic concept of this method is that the chosen alternative should have the shortest distance from the ideal solution that maximizes the benefit and also minimizes the total cost, and the farthest distance from the negative-ideal solution that minimizes the benefit and also maximizes the total cost (Opricovic, Tzeng 2003).

The TOPSIS consists of the following steps:

Step 1. Calculate the normalized decision matrix. The normalized decision matrix and the formula is as follows as in Eq. (3):

$$\mathrm{r}_{ij} = X_{ij} \Big/ \sqrt{\sum\nolimits_{i=1}^{m} X_{ij}^{2}}, \tag{5}$$

where i is the i^{th} alternative, j is the j^{th} evaluation indicator, r_{ij} is the indicator value after vector normalization for the i^{th} alternative and j^{th} evaluation indicator, x_{ij} is the original value of indicators for the i^{th} alternative and j^{th} evaluation indicator and m is the number of alternative.

Step 2. Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as in the following:

$$\mathrm{v}_{ij} = \mathrm{w}_i \mathrm{r}_{ij},\ i = 1,\ldots,n;\ j = 1,\ldots,k, \tag{6}$$

where w_i is the weight of the i^{th} attribute or criterion.

Step 3. To determine ideal (A^+) and worst (A^-) solution:

$$\begin{aligned} \mathrm{A}^{+} &= \left\{(\max_i \mathrm{r}_{ij} \,\middle|\, j \in J),(\min_i r_{ij} \,\middle|\, j \in J') \,\middle|\, i = 1,2,\ldots,m\right\} = \\ &\left\{\mathrm{A}_1^{+}, \mathrm{A}_2^{+}, \ldots \mathrm{A}_j^{+}, \ldots \mathrm{A}_k^{+}\right\}; \\ \mathrm{A}^{-} &= \left\{(\min_i \mathrm{r}_{ij} \,\middle|\, j \in J),(\max_i r_{ij} \,\middle|\, j \in J') \,\middle|\, i = 1,2,\ldots,m\right\} = \\ &\left\{\mathrm{A}_1^{-}, \mathrm{A}_2^{-}, \ldots \mathrm{A}_j^{-}, \ldots \mathrm{A}_k^{-}\right\}, \end{aligned} \tag{7}$$

where $J = \{ j = 1, 2, \ldots, k | k$ belongs to benefit criteria$\}$, benefit criteria implies a larger indicator value and a higher performance sore; $J' = \{ j = 1, 2, \ldots, k | k$ belongs to cost criteria$\}$, cost criteria implies a smaller indicator value and a higher performance score.

Step 4. To calculate the separation measure, using the n-dimensional Euclidean distance. The separation of each alternative from the ideal one (S_i^+) and the worst one (S_i^-) is given by:

$$\begin{aligned} \mathrm{S}_i^{+} &= \sqrt{\sum\nolimits_{j=i}^{k} (\mathrm{r}_{ij} - \mathrm{A}_j^{+})^2},\ i = 1,2,\ldots,m; \\ \mathrm{S}_i^{-} &= \sqrt{\sum\nolimits_{j=i}^{k} (\mathrm{r}_{ij} - \mathrm{A}_j^{-})^2},\ i = 1,2,\ldots,m. \end{aligned} \tag{8}$$

Step 5. Calculate the relative closeness to the ideal solution (C_i^*) as in:

$$C_i^* = S_i^- / S_i^+ + S_i^-, \; i = 1,2,..., m, \tag{9}$$

where $0 \le C_i^* \le 1$ that is, an alternative i is closer to A^+ as C_i^* approaches to 1.

Step 6. Rank the preference order according to the descending order of C_i^*. Larger index values indicate better performance of the alternatives.

3. Empirical study

This study conducts an empirical analysis by taking the Taiwan's DC industry as an example. The background information of Taiwan's DC industry as well as the results of all the processes of analyses and evaluation are elaborated as follows.

3.1. Taiwan's DC industry status

According to the statistics from Ministry of Economic Affairs (MOEA) (2011), it is estimated that Taiwan's DC industrial value output in 2011 was 20 billion USD, a 14.89% increase compared to the 17.4 billion USD generated in 2010. This growth rate is more than triple the average growth rate in the rest of the world. The fastest growing sub-category is the digital publishing and archives industry.

In order to effectively guide the expansion of DC industries, in May 2009 the Executive Yuan officially announced "DC industry flagship development project", an initiative that was scheduled to be implemented from 2009 to 2013. The purpose of which is to build on the existing foundations of these industries and strengthen and enhance them so that they can assume the role of industry leaders and drive the growth of other less developed industries. Moreover, the industrial technology innovation centre program currently promoted by the MOEA has expanded its support for Taiwan's DC industry and provided new directions for technological development. Through the program, research and development capabilities for the DC and related service industries can be built up, and Taiwan's leading position in the Asian market can be secured, providing precedents for gaining access to the global market.

3.2. Problem descriptions and evaluation of criteria

DC is a fast emerging technology with multiple potential applications which is bound to affect various technological and social domains. The evaluation models for these technologies are deficient and lack proper evaluation guidelines. In order to better determine the suitable criteria and sub-criteria of each criterion, this study further interviewed domain experts in DC to screen for the suitable criteria and sub-criteria.

Moreover, the model is developed and then validated using data from the expert team in the Taiwan DC arena, which contained 15 experts with extensive experience consulting in this study. Among the 15 experts, 10 were from the innovative DigiTech-enabled applications & services institute (IDEAS) at the institute for information industry, 3 were from government officials were involved in planning or managing the ICT industries, such as the Industrial Development Bureau, Ministry Of Economic Affairs, and the remaining 2 were university professors from non-technical arena. The average industry experience of the experts was about five years. Although this study did not have a large number of experts, it still represented a well industrial perspective on the Taiwan's DC industry issue because of the professional and management positions of the 15 experts. They not only replied to the questionnaires for constructing this evaluation and selection model, but they also provided their professional knowledge and experience in DC, along with an industrial perspective.

The evaluation criteria were developed on the basis of a series of discussions with expert team. This discussion with the expert team helped us to classify the various criteria of decision-making into four criteria are most suitable and summarized in Table 1. There are four criteria, namely, "E: Establishing the comprehensive infrastructure", "C: Cultivating digital content talent", "G: Global market promotion", and "O: Outstanding product development". These criteria were then divided into various sub-criteria; there are 12 criteria under the above-mentioned four criteria, as shown in Table 1. Finally, at the bottom level,

Table 1. The criteria and sub-criteria for DC development strategy

Criteria	Sub-criteria	Descriptions
(E) Establishing the comprehensive infrastructure	(E1) Providing investment, financing and product development subsidies	The degree of providing investment, financing and product development subsidies
	(E2) Establishment of a research centre	The degree of establishment of a research center
	(E3) Refining the Intellectual laws protection	The degree of refining the intellectual laws protection
(C) Cultivating digital content talent	(C1) Promoting DC industry-related academic course	The level of promoting DC industry-related academic course
	(C2) Recruiting people with DC-skilled professional from abroad	The level of recruiting people with DC-skilled professional from abroad
	(C3) Encouraging Industry-academic collaboration	The level of encouraging industry-academic collaboration
(G) Global market promotion	(G1) Organising sales promotions and expanding the domestic market	The level of encouraging industry-academic collaboration
	(G2) Participating in major exhibitions and expos, both in Taiwan and internationally	The level of participating in major exhibitions and expos, both in Taiwan and internationally
	(G3) Assisting foreign firms contact with domestic firms	The level of assisting foreign firms contact with domestic firms
(O) Outstanding product development	(O1) Joint development by domestic and international enterprise	The degree of joint development by domestic and international enterprise
	(O2) Providing open sharing services at the DC academy to support SME product development	The degree of providing open sharing services at the DC academy to support SME product development
	(O3) Promoting cross-industry alliances and collaboration	The degree of promoting cross-industry alliances and collaboration

we utilized these criteria and sub-criteria to set up the evaluation model for evaluating and selecting the suitable DC industry, such as "A1: Digital games", "A2: Computer animation", "A3: Digital video applications", "A4: Digital learning", "A5: Digital publishing", and "A6: Digital archive".

3.3. Using ISM to analyse the interrelationships among criteria

Since evaluating and selecting a suitable DC industry is a complex problem, it is not appropriate to assume the elements within evaluation process are independent. Therefore, we sought to find the important criteria for the various criteria and measure the relationships among these criteria. Experts were asked to score the relationships among criteria and among sub-criteria following the ISM procedures described in methodology. The geometric mean of experts' opinions on the relationship between a pair of criteria (sub-criteria) was calculated. Set the threshold value 0.50 which represents that more than 50% of the experts determine the interrelationship. If the value of the element is less than 0.50, the value is counted as 0. Hence, the interrelationships matrix (***D***) was calculated, and the reachability matrix (***R***) was thus derived, as shown in Tables 2 and 3.

Finally, the reachability matrix can be obtained by using equation (3). The correlations of each criterion are shown as Table 4 and Figure 1.

Table 2. The interrelation matrix

Criteria	E	C	G	O
(E) Establishing the comprehensive infrastructure	0	1.00	1.00	1.00
(C) Cultivating digital content talent	1.00	0	1.00	1.00
(G) Global market promotion	1.00	1.0	0	1.00
(O) Outstanding product development	1.00	1.00	1.00	0

Table 3. The matrix of all criteria

Criteria	E	C	G	O
(E) Establishing the comprehensive infrastructure	1.00	1.00	1.00	1.00
(C) Cultivating digital content talent	1.00	1.00	1.00	1.00
(G) Global market promotion	1.00	1.00	1.00	1.00
(O) Outstanding product development	1.00	1.00	1.00	1.00

Table 4. The reachability matrix (R^*) of all criteria

Criteria	E	C	G	O
(E) Establishing the comprehensive infrastructure	1.00	1.00	1.00	1.00
(C) Cultivating digital content talent	1.00	1.00	1.00	1.00
(G) Global market promotion	1.00	1.00	1.00	1.00
(O) Outstanding product development	1.00	1.00	1.00	1.00

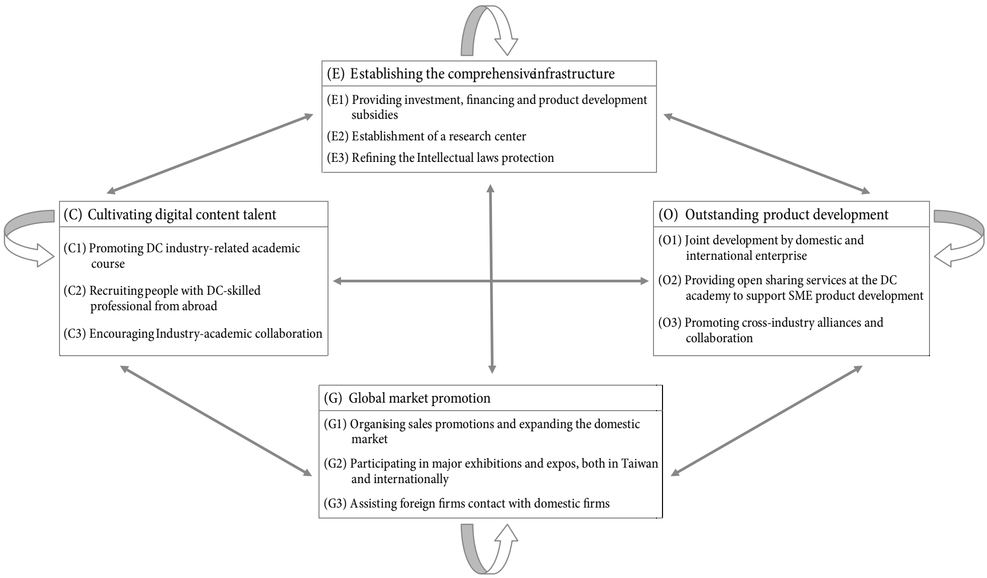

Fig. 1. Dimension interrelation structure for DC development strategy

According to the $\boldsymbol{R}^{*}$, the interrelationship among the four criteria can be depicted as in Figure 1. The direction of an arrow signifies dependence, and a two-way arrow represents the interdependency between criteria. For example, while "E: Establishing the comprehensive infrastructure", "C: Cultivating digital content talent", "G: Global market promotion", and "O: Outstanding product development", the criterion was also affected by these three criteria. Such kind of interrelationships also applied to the other three criteria "C: Cultivating digital content talent", "G: Global market promotion", and "O: Outstanding product development".

3.4. Utilizing ANP to calculate the relative weight for each criterion

After the previous stage which uses ISM to analyse the interrelationships among the criteria and setting up networked level evaluation structure is done, ANP professional questionnaire is developed based on the previous stage. In this study, the opinions of experts were collected and then entered into ANP software of Super Decision to obtain the relative weights of each sub-criterion of each evaluated criteria.

Based on the relationship of the four criteria in Figure 1, aiming the criteria belongs to each criterion designing ANP questionnaire, as well as using geometric mean (Dyer, Forman 1992) from the experts' opinions to construct a pair-wise comparison matrix. An unweighted supermatrix, a weighted supermatrix, and eventually the supermatrix is made to converge to obtain a long-term stable set of limiting supermatrix (Table 5) are obtained by introducing pairwise comparison values of sub-criteria in the matrix into ANP software of Super Decision.

Table 5. The limiting matrix

		E			C			G			O		
		E1	E2	E3	C1	C2	C3	G1	G2	G3	O1	O2	O3
(E) Establishing the comprehensive infrastructure	E1	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162	0.162
	E2	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165	0.165
	E3	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173	0.173
(C) Creative human resource	C1	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179	0.179
	C2	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166	0.166
	C3	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155	0.155
(G) Global market promotion	G1	0.178	0.178	0.178	0.178	0.178	0.178	0.178	0.178	0.178	0.178	0.178	0.178
	G2	0.172	0.172	0.172	0.172	0.172	0.172	0.172	0.172	0.172	0.172	0.172	0.172
	G4	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
(O) Outstanding product development	O1	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182	0.182
	O2	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154	0.154
	O3	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164	0.164

3.5. Ranking the alternatives using TOPSIS

At the next level of the decision procedure, the experts were asked to establish the decision matrix by comparing candidates under each of the sub-criteria separately. The experts were asked to provide a set of crisp values within the range 1–10 to represent the performance of each alternative in terms of each sub-criterion. By using equations (5) and (6), the weighted normalized decision matrix of the alternatives – calculated by multiplying the normalized decision matrix and the weights – is obtained, as presented in Table 6.

The final ranking procedure begins by determining the ideal and negative-ideal solutions. The ideal and negative-ideal solutions are defined via equation (7) and shown in Table 7.

Since the sub-criteria weights are obtained from ANP, the weighted Euclidean distances, between r_{ij} and A_j^+, and between r_{ij} and A_j^- can be calculated using equation (8). Finally, equation (9) can be used to calculate the relative closeness of each alternative to the ideal solution are presented in Table 8. Based on the closeness coefficient, the six alternatives are ranked in the order digital archive (0.518), digital video applications (0.494), computer animation (0.380), digital learning (0.323), digital publishing (0.312) and digital games (0.257), clearly, the ideal selection in digital archive.

3.6. Analyses and discussions

The proposed evaluation framework has been effectively applied to select the suitable alternative in DC industry for Taiwan. Especially, it has provided policy makers and researchers with better understanding of the differences in DC industry needs and specific management interventions by examining the twelve sub-criteria. These criteria serve as a

Table 6. The weighted normalized decision matrix

	E			C			G			O		
	E1	E2	E3	C1	C2	C3	G1	G2	G3	O1	O2	O3
(A1) Digital games	0.042	0.051	0.151	0.206	0.073	0.064	0.139	0.363	0.045	0.042	0.051	0.151
(A2) Computer animation	0.219	0.051	0.227	0.068	0.077	0.400	0.125	0.182	0.134	0.219	0.051	0.227
(A3) Digital video applications	0.367	0.089	0.283	0.316	0.072	0.282	0.093	0.081	0.362	0.367	0.089	0.283
(A4) Digital learning	0.175	0.164	0.075	0.193	0.212	0.041	0.104	0.078	0.287	0.175	0.164	0.075
(A5) Digital publishing	0.098	0.201	0.108	0.080	0.375	0.078	0.114	0.103	0.086	0.098	0.201	0.108
(A6) Digital archive	0.098	0.444	0.157	0.137	0.190	0.135	0.425	0.193	0.086	0.098	0.444	0.157

Table 7. The ideal solution and negative solution

	E			C			G			O		
	E1	E2	E3	C1	C2	C3	G1	G2	G3	O1	O2	O3
A^+	0.367	0.444	0.283	0.316	0.375	0.400	0.425	0.363	0.362	0.367	0.444	0.283
A^-	0.042	0.051	0.075	0.068	0.072	0.041	0.093	0.078	0.045	0.042	0.051	0.075

Table 8. The final ranking of digital content industry

	S^+	S^-	C^*	Ranking
(A1) Digital games	0.976	0.338	0.257	6
(A2) Computer animation	0.827	0.507	0.380	3
(A3) Digital video applications	0.740	0.722	0.494	2
(A4) Digital learning	0.823	0.393	0.323	4
(A5) Digital publishing	0.851	0.387	0.312	5
(A6) Digital archive	0.647	0.694	0.518	1

bridging mechanism, which is very helpful in DC. It can also provide decision maker with a mechanism to monitor and establish the platform of DC industry.

What factors provide policy makers should stress more in the Taiwan's DC should be understood so that more effort can be put on improving the performance of these factors? As shown in Table 5, the weights of the four criteria, "E: Establishing the comprehensive infrastructure", "C: Cultivating digital content talent", "G: Global market promotion", and "O: Outstanding product development", with respect to the goal, were 0.21, 0.38, 0.11, and 0.29, respectively.

It is also worth noting that based on the Table 8 the ranking order of the six alternatives are "A6: Digital archive", ""A2: Computer animation", "A3: Digital video applications", "A4: Digital learning", "A5: Digital publishing", and "A1: Digital games". In other words, the "A6: Digital archive" are the best alternative because it has the highest closeness coefficient of 0.518 compared to the other alternatives, implying that it was the best alternative. So we can understand the most suitable alternative is the digital archive, so the government has to establish mechanisms to encourage the digital archive industry to make use of the various types of human policy and to obtain information about human resource, and to exploit the various preferential training schedules.

Conclusions

The DC industry is one of the most important areas of growth within the global creative and knowledge based economy. Moreover, the evaluation models for these technologies are deficient and lack proper evaluation guidelines. In this regard, a useful and applicable DC is becoming more important. This study addressed this issue in more rational and objective approach. By combining ISM and ANP approaches used in this study offered a more precise and accurate analysis by integrating interdependent relationships within and among a set of criteria. Moreover, TOPSIS method helped to choose the alternative for ideal solution of this problem efficiently.

Therefore, the contribution of the study for the practical implementation the proposed approach provide a systematic framework of evaluating strategies to develop DC industry in Taiwan and to secure a consensus on its effective implementation. The results are useful and valuable reference for the policy makers in DC development strategy related decisions.

Managerial implications

According to our study, some of the important managerial implications are summarized as follows. First, a new evaluation model for DC development strategies has been developed. Such a framework has never being found in the previous literature. This framework capture multiple dimension of information as well as the evaluation criteria which are suitable to be used in real practice are selected by expert team who have practical experiences of DC. For example, referring to the evaluation model developed for Taiwan, several important criteria involving "E: Establishing the comprehensive infrastructure", "C: Cultivating digital content talent", "G: Global market promotion", and "O: Outstanding product development". This framework is to provide a thorough evaluation of the factors important to DC, and these factors can be a reference for government to conduct the evaluation model for DC development strategies and to promote the DC.

Moreover, the evaluation model constructed in this study goes beyond existing measures and may serve as a reference for decision-maker. The results of criteria weights determined in the case study can also be adopted as a reference. It has also revealed that by providing "E: Establishing the comprehensive infrastructure", "C: Cultivating digital content talent", "G: Global market promotion", and "O: Outstanding product development", governments can boost the DC success rate. Especially under constraints of limited time and resources, focusing on these vital few criteria would be useful as policy makers' first concern. In addition, the policy makers can adopt the presented model, which includes all the criteria for understanding the competence of its alternatives and prioritizing the alternatives. And from the illustrated example this model shows that the most suitable alternative is the digital archive, so the government should integrate research institutes, universities, the private sectors, and other government agencies to help newly formed digital archive industry to establish successful industrial development.

Future research

Although the present model proves valuable, this case study can still be improved. First, since DC includes different tasks and thus the criteria involved in DC evaluation is a complex problem; there may be additional criteria and sub-criteria that should be considered and added in future research. Second, a different group of decision-makers could also influence the results. Future research could compare the results from different groups of decision-makers. Based upon these differences, some managerial implications could be identified. Finally, the outcome of the ANP model conducted in this study is determined by expert team. However, due to problems such as incomplete information and subjective uncertainty, even experts find it difficult to quantify the precise ratio of weights for the different criteria for the DC; the other analytical techniques (e.g., fuzzy integral) can be employed for future research.

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