J Supercomput
DOI 10.1007/s11227-017-1978-x

Analysis of performance measures in cloud-based ubiquitous SaaS CRM project systems

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Abstract Customer relationship management (CRM) traditionally uses software as a service (SaaS) technology in ubiquitous cloud computing SaaS CRM solutions. In this study, the opinions of experts and of three case companies in Internet application fields were studied. In cloud CRM projects, DEMATEL-based analytical network processes and the VIKOR technique are multi-criteria decision-making analysis tools that do not require prior assumptions to explore the weights and performances among project risk, project management, and organizational performance, based on the research framework of the Stimulus–Organism–Response model. The empirical results showed that the greatest criterion of relative weight is primarily associated with the risk dimension, representing experts' evaluations of project risk. Furthermore, cloud CRM experts and companies revealed that financial performance should be improved during the course of a project. The findings of this study provide a valuable reference for cloud CRM Internet service solutions.

Keywords DEMATEL-based ANP (DANP) · VIKOR · Cloud CRM · Ubiquitous cloud computing · Internet service · Project risk

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Published online: 13 February 2017

1 Introduction

The development of cloud service based on Internet technology (IT) can enhance the quality of service for customers. In particular, cloud services based on IT that have been reported in related studies have been popularly discussed. The three categories of cloud service are infrastructure as a service (IaaS) [26,41], platform as a service (PaaS), and software as a service (SaaS) [9,44,46]. Furthermore, because computerized systems are so widely used in various organizations, it is particularly advantageous for management strategies to incorporate information technology. In addition, information systems are crucial to business organizations because they are frequently used as tools in transaction processing, decision-making, and business intelligence for strategy analysis. Information technology departments should seek to achieve their organizational performance goals by using the four major dimensions of the balanced scorecard (BSC), namely financial, learning and growth, internal business process, and customer dimensions. Enterprise organizations enjoy the convenience of cloud services, although there are also associated risks. Cloud computing security involves data security, access security, virtual environment security, information security monitoring, and other issues. Many of the world's largest enterprises use SaaS customer relationship management (CRM) to abandon on-the-premise systems and use the SaaS platform to manage salesmen's actions and to manage sales opportunities. Traditional CRM differs from SaaS CRM in that companies do not need to invest in machinery, equipment and manpower to maintain the operation of CRM systems, which is suitable for a variety of enterprises. Particularly, the SaaS model is currently the favored approach for automation for cloud CRM through CRM cloud computing systems. Personal computers connected to the cloud through this system can use all the features of the CRM system from a web browser. Therefore, users of the cloud CRM can achieve greater productivity regarding business processes through increased mobility via Internet service [25]. Thus, the research objectives of this study are as follows: (a) investigating the variables of the effects on cloud CRM projects related to project risk, project management, and organizational performance; and (b) examining empirical case findings that will provide suggestions for improvements in cloud CRM project risk management.

2 Literature review

This section introduces relevant literature on various application areas, including project risks, project management, organizational performance measurements, and the risks of cloud CRM projects with cloud service.

2.1 Project risks

In a guide to the project management body of knowledge (PMBOK) [37], project risk [20,22] management is composed of the five stages, which include risk management planning, risk identification, risk analysis, risk response planning, and risk monitoring and control. Risk identification primarily involves determining which risks might

Table 1 Explanation of project risk criteria

Criteria	Explanation
User risk	Users hold negative attitudes toward the project and therefore do not participate in project development, thus increasing the risk of project failure
Requirements risk	Uncertainties concerning system requirements have an adverse effect on the project performance
Project complexity risk	The uncertainties inherent in software projects increase the difficulty of project development
Planning and control risk	The software development planning process and lack of control are unsuitable, leading to impractical schedules, budgets, and project evaluation milestones
Team risk	Team dynamics increase the uncertainty concerning the result of the project
Organizational environment risk	Uncertainty stemming from the organizational environment impacts project performance

negatively affect the project objectives and the associated impact of the various risks. Risk monitoring and control is an ongoing process in project management whereby the uncertainties surrounding risk factors are identified to assist managers in adopting appropriate response measures and mitigating and disseminating risk impacts. In other words, risk monitoring and control facilitates the success of a project. This study explores the relationship among project risk, project management, and organizational performance, together with strategies for avoiding generally predictable risks in general information technology projects such that the smooth implementation of projects improves organizational performance. Project risk has been widely applied in various fields, such as agricultural development [50] and capital investment [30]. We further explore the methods by which information regarding project risks under Internet service of cloud computing can be minimized with reference to the six risk dimensions of Han and Huang [16], as listed in Table 1.

2.2 Project management

Pinto and Slevin [31] proposed 10 critical success factors (CSFs) in project implementation based on project attributes and the perspectives of project managers. The results of Pinto and Slevin's [31] study indicated that support from senior management is another key to understanding project success. When information technology projects are implemented without the support of senior management in terms of financial, human, and material resources, together with scheduling, entire projects are more likely to fail. Therefore, on the basis of the extant literature, this study relies on the four project management dimensions shown in Table 2.

Table 2 Explanation of project management criteria

Criteria	Explanation
Top management support	Executives emphasize information system (IS) professionals and provide related resources
Project planning and control	Record a formal project plan and oversee project using management tools
Internal integration	Ensure that the project team operates in a consistent manner using the project management technology
User participation	Integrate project team members and organize each level of users of the project management technology

2.3 Organizational performance measurement: a balanced scorecard

The application of a BSC [21,32] is linked to performance measurement; however, the true purpose of a BSC is to define strategies and goals through communication with employees in various departments. Recent BSC studies have been undertaken by Hoque [17] and Shaverdi et al. [34]. As its name indicates, the concept of a BSC is based on the need for "balance." Thus, the BSC divides performance indicators into financial, customer, internal business, and innovation and learning perspectives. The customer perspective and the learning and growth perspective questionnaire project was studied by Wang et al. [45], Jun et al. [19], and Devine et al. [7], who described the project development process and the learning and growth perspective. These studies are used as the basis of our BSC questionnaire. BSC has been widely studied in relation to outsourcing [1] and enterprise resource planning (ERP) [35]. Therefore, our further exploration of the organizational performance can be referenced to the four organizational performance dimensions of Wu and Chang [48], as shown in Table 3.

Table 3 Explanation of organizational performance criteria

Criteria	Explain
Customer performance	Project outcomes meet the needs of the users
Internal business process performance	Project development process is efficient
Financial performance	Project has a favorable investment for learning and growth opportunity
Learning and growth performance	Project provides personal or organizational learning and growth opportunities

2.4 Customer relationship management

Customer relationship management, CRM, is a process used to collect customer data, to understand the features of customers, and to then apply the findings in marketing activities with cloud service [40]. In the mid-1990s, customer management techniques using IT (termed CRM), together with IT, were used to explore customer activities [24]. As possibly the most important concept of modern marketing [2] in internet service of cloud computing techniques, CRM nurtures and maintains mutually beneficial customer relations by delivering customer value and satisfaction. CRM encompasses all aspects of acquiring, retaining, and increasing purchases by customers.

2.5 Issues of customer relationship management project implementation

Bull [4] noted that traditional CRM projects may be faced with issues including the organizational environment, corporate strategy, and business processes, all of which can affect project success. CRM is a complex and all-inclusive systems concept that requires overall planning of the integration of business processes and information technology. The previous study also emphasized that successful implementation of CRM projects requires effective leadership, procurement, objectives, and assessment strategies.

2.6 Cloud customer relationship management with cloud service

Cloud computing [3,6,8,10,12,36,49,51] services mainly provide processing power, together with storage and business applications. The most common model is SaaS. SaaS has been widely applied in ERP and CRM [25]. Although operating a web browser is very convenient, there are some limitations of cloud CRM system, such as changing screens, adding fields, and there are concerns regarding sensitive data stored by the service provider [25].

Because there has been little empirical investigations of cloud CRM projects, the current empirical case studies can provide a reference for cloud CRM experts and bridge the knowledge gap under cloud computing perspective to improve the direction of project risk management. This study is motivated by such a challenge for providing Internet service of cloud computing.

2.7 Risk of cloud customer relationship management service

The cloud vendor implements security checks to protect the security of data and to prevent malicious damage. The three service models of cloud computing, SaaS, PaaS, and IaaS, provide infrastructure resources. The three different application platforms and software service models have different security requirements [39]. According to Fitó and Guitart [11], cloud organization and services need to develop relevant risk management processes based on traditional risk strategies and policy reference. The risk factors for cloud services include (1) legal risks (agreement or

contract, privacy, jurisdiction), (2) hardware risks (burglary, damage or alteration by employees, intentionally or accidentally, natural disaster, normal wear and tear or malfunction), and (3) non-hardware risks (system vulnerability, social engineering, mistakes made by employees intentionally or accidentally, cross-cloud compatibility).

This study explores the impact of project risk management and BSC in cloud CRM projects. Therefore, an introduction of project risks, project management, BSC, and cloud CRM are included in the literature review. Because the cloud CRM project belongs to the scope of information technology projects, the collection of the literature is related to information technology topics. The amount of published literature discussing ERP, supply chain management (SCM), traditional CRM, the success factors of projects related to senior management, and cloud CRM is relatively small. Therefore, the literature review of this study, as outlined in Sect. 3, is an important research foundation, for identifying innovative management methods from different topics.

3 Methods and materials

This section describes related techniques and materials used in cloud service of internet applications, including the decision-making trial and evaluation laboratory (DEMATEL)-based analytical network process (ANP) model, the VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) technique, and the research methodology.

3.1 The DANP method

This study collected and reviewed relevant literature from published books, journal articles, and online resources to compile an overall research framework based on various performance indicators. Subsequently, we designed a pairwise comparison-based questionnaire that was distributed to study participants. The retrieved questionnaires were then analyzed using a DEMATEL-based ANP (DANP) model to determine the relationships among the weights of the criteria. Figure 1 illustrates the DANP model,

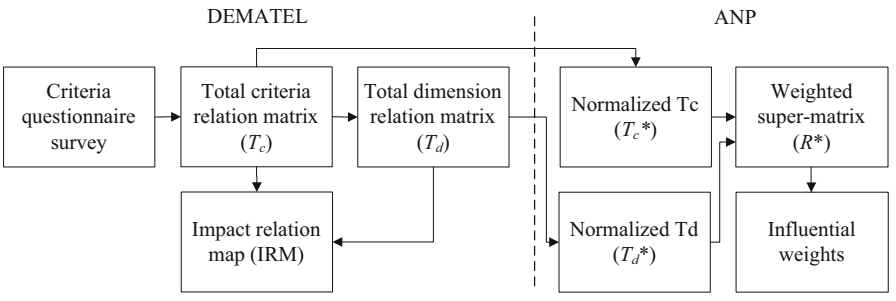

Fig. 1 Process flow of the DANP model

whose steps are mainly organized into two parts: (1) building an impact relationship map (IRM) using the DEMATEL technique (Steps 1–3) and (2) finding influential weights using the ANP technique (Steps 4–6). The steps are addressed in greater detail below for the ease presentation and understanding.

3.2 The decision-making trail and evaluation laboratory method

Decision laboratory analysis (i.e., DEMATEL) can help to solve complex racial, hunger, environmental protection, and energy problems [13,14] by providing a structural model of causality based on expert knowledge. Using DEMATEL is more suitable than traditional evaluation methods for addressing complex real-world issues. Decision-makers can identify problems from a structured model of complex problems to improve and understand the causal relationship among dimensions and criteria, thereby enhancing overall performance. The steps of DEMATEL are described in detail as follows.

Step 1: Establishing the direct-relation matrix $\boldsymbol{G}$ is an $n \times n$ direct-relation matrix that is based on an expert questionnaire with degrees ranging from 1 to 4, where g_{ij} is the degree to which element i affects element j, i.e., $G = \left[g_{ij}\right]_{n\times n}$.

Step 2: Implementing normalization of the initial direct-relation matrix to gain total influence-relation matrixes The normalized initial direct-relation matrix $Z = \left[z_{ij}\right]$ can be obtained from Eqs. (1) and (2).

$$k = \max_{ij}\left[\max_{1\le i\le n}\sum_{j=1}^{n} g_{ij}, \max_{1\le j\le n}\sum_{i=1}^{n} g_{ij}\right] \tag{1}$$

$$Z = \frac{1}{k}G \tag{2}$$

The total-relation matrix is defined as Eqs. (3) and (4).

$$T = U + U^2 + \cdots + U^p = U \times (I - U)^{-1} = \left[U_{ij}\right]_{n\times n},\ p \to \infty \tag{3}$$

$$T = \left[t_{ij}\right]_{n\times n}, \quad i, j = 1, 2, \ldots, n \tag{4}$$

The total criteria relation matrix (T_c) takes the form of Eq. (5), which helps to indicate the relation between the criteria and extents, and the total dimensions relation matrix (T_d) is defined as Eq. (6), which is determined from the total criteria relation matrix.

$$T_C = \begin{array}{c} \\ c_{11} \\ D_1 \begin{matrix} c_{12} \\ \vdots \\ c_{1n_1} \end{matrix} \\ \vdots \\ c_{i1} \\ D_i \begin{matrix} c_{i2} \\ \vdots \\ c_{in_i} \end{matrix} \\ \vdots \\ c_{m1} \\ D_m \begin{matrix} c_{m2} \\ \vdots \\ c_{mn_m} \end{matrix} \end{array} \begin{array}{c} \begin{array}{cccccc} D_1 & & & D_j & & D_m \\ c_{11} \cdots & c_{1n_1} & \cdots c_{j1} \cdots & c_{jn_j} & \cdots c_{m1} \cdots & c_{mn_m} \end{array} \\ \begin{bmatrix} T_c^{11} & \cdots & T_c^{1j} & \cdots & T_c^{1m} \\ \vdots & & \vdots & & \vdots \\ T_c^{i1} & \cdots & T_c^{ij} & \cdots & T_c^{im} \\ \vdots & & \vdots & & \vdots \\ T_c^{m1} & \cdots & T_c^{mj} & \cdots & T_c^{mm} \end{bmatrix} \end{array} \tag{5}$$

$$T_d = \begin{bmatrix} t_d^{11} & \cdots & t_d^{1j} & \cdots & t_d^{1m} \\ \vdots & & \vdots & & \vdots \\ t_d^{i1} & \cdots & t_d^{ij} & \cdots & t_d^{im} \\ \vdots & & \vdots & & \vdots \\ t_d^{m1} & \cdots & t_d^{mj} & \cdots & t_d^{mm} \end{bmatrix} \tag{6}$$

Step 3: Creating the impact relationship map (IRM) The IRM is derived from T_c and T_d, which are also established by the sum of the rows (vector r) and columns (vector s). Individually, they are given as Eqs. (7) and (8) below:

$$r = [r_i]_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \tag{7}$$

$$s = [s_j]_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right]_{1\times n} \tag{8}$$

where r_i refers to criteria i (or dimensions) on behalf of the reasons and refers to criteria j (or dimensions) on behalf of the results. The IRM is built by $(r_i + s_j, r_i - s_j)$, where $(r_i + s_j)$ is the horizontal axis vector regarded as "Prominence" to show the importance of the element, and $(r_i - s_j)$ is the vertical axis named "Relation." Additionally, if $(r_i - s_j)$ is negative, the element belongs to the effect group; otherwise, the element belongs to the cause group [52].

3.3 The analytical network process method

Saaty [33] proposed an analytical network process (ANP) method to solve complex nonlinear network relationship problems; however, filling out the ANP survey ques-

tionnaire has been considered too laborious [5,18]. To solve this problem, we used the total criteria matrix (T_c) and a total dimensions matrix (T_d) generated by DEMATEL to conduct the further procedures required in ANPs to manage problems of dependence and feedback among criteria, as shown in Steps 4–6, which are the latter parts of the DANP model. The influential weights were determined using the ANP technique, as follows.

Step 4: Implementing normalization of the total criteria relation matrix T_c^* is the effect of the total degrees and the effect of the dimensions described by the normalization of the total criteria relation matrix T_c , as shown in Eq. (9).

$$
\begin{aligned}
t_{ci}^{11} &= \sum_{j=1}^{m_1} t_{ij}^{11}, \ i = 1, 2, \ldots, m_1, \\
T_{c*}^{11} &= \begin{bmatrix}
t_{c11}^{11}/d_{c1}^{11} & \cdots & t_{c1j}^{11}/d_{c1}^{11} & \cdots & t_{c1n_1}^{11}/d_{c1}^{11} \\
\vdots & & & & \vdots \\
t_{ci1}^{11}/d_{ci}^{11} & \cdots & t_{cij}^{11}/d_{ci}^{11} & \cdots & t_{cin_1}^{11}/d_{ci}^{11} \\
\vdots & & & & \vdots \\
t_{cn_11}^{11}/d_{cn_1}^{11} & \cdots & t_{cn_1j}^{11}/d_{cn_1}^{11} & \cdots & t_{cn_1n_1}^{11}/d_{cn_1}^{11}
\end{bmatrix} \\
&= \begin{bmatrix}
t_{c11*}^{11} & \cdots & t_{c1j*}^{11} & \cdots & t_{c1n_1*}^{11} \\
\vdots & & & & \vdots \\
t_{ci1*}^{11} & \cdots & t_{cij*}^{11} & \cdots & t_{cin_1*}^{11} \\
\vdots & & & & \vdots \\
t_{cn_11*}^{11} & \cdots & t_{cn_11*}^{11} & \cdots & t_{cn_1n_1*}^{11}
\end{bmatrix} \\
\text{and } T_c^* &= \begin{bmatrix}
T_{c*}^{11} & \cdots & T_{c*}^{1j} & \cdots & T_{c*}^{1m} \\
\vdots & & \vdots & & \vdots \\
T_{c*}^{i1} & \cdots & T_{c*}^{ij} & \cdots & T_{c*}^{im} \\
\vdots & & \vdots & & \vdots \\
T_{c*}^{m1} & \cdots & T_{c*}^{mj} & \cdots & T_{c*}^{mm}
\end{bmatrix}
\end{aligned}
\tag{9}
$$

Step 5: Implementing normalization of total dimensions relation matrix T_d^* is the weight of the dimension calculated by Eq. (10) to normalize the total dimension matrix (T_d).

$$
\begin{aligned}
t_d^i &= \sum_{j=1}^{m} t_d^{ij} \\
T_d^* &= \begin{bmatrix}
t_d^{11}/t_d^1 & \cdots & t_d^{1j}/t_d^1 & \cdots & t_d^{1m}/t_d^1 \\
\vdots & & \vdots & & \vdots \\
t_d^{i1}/t_d^i & \cdots & t_d^{ij}/t_d^i & \cdots & t_d^{im}/t_d^i \\
\vdots & & \vdots & & \vdots \\
t_d^{m1}/t_d^m & \cdots & t_d^{mj}/t_d^m & \cdots & t_d^{mm}/t_d^m
\end{bmatrix}
\end{aligned}
$$

$$= \begin{bmatrix} T_{d*}^{11} & \cdots & T_{d*}^{1j} & \cdots & T_{d*}^{1m} \\ \vdots & & \vdots & & \vdots \\ T_{d*}^{i1} & \cdots & T_{d*}^{ij} & \cdots & T_{d*}^{im} \\ \vdots & & \vdots & & \vdots \\ T_{d*}^{m1} & \cdots & T_{d*}^{mj} & \cdots & T_{d*}^{mm} \end{bmatrix} \tag{10}$$

Step 6: Establishing the weighted super-matrix and obtaining the elements of influential weights Equation (11) is defined as the value of T_{c}^{*} used to multiply the value of T_{d}^{*} to gain the weighted super-matrix $\boldsymbol{R}$. A limit super-matrix $\boldsymbol{R^*}$ is formatted as Eq. (12). By limiting $\boldsymbol{R^*}$ increase it to a sufficiently large power ϕ (i.e., $\lim_{\phi\to\infty}(R^*)^{\phi}$), and each criterion weight is obtained through calculating the transposed processes.

$$R = \begin{bmatrix} T_{c*}^{11} \times T_{d*}^{11} & \cdots & T_{c*}^{1j} \times T_{d*}^{1j} & \cdots & T_{c*}^{1m} \times T_{d*}^{1m} \\ \vdots & & \vdots & & \vdots \\ T_{c*}^{i1} \times T_{d*}^{i1} & \cdots & T_{c*}^{ij} \times T_{d}^{ij} & \cdots & T_{c*}^{im} \times T_{d*}^{im} \\ \vdots & & \vdots & & \vdots \\ T_{c*}^{m1} \times T_{d*}^{m1} & \cdots & T_{c*}^{mj} \times T_{d*}^{mj} & \cdots & T_{c*}^{mm} \times T_{d*}^{mm} \end{bmatrix} \tag{11}$$

$$R^* = \begin{bmatrix} T_{c*}^{11} \times T_{d*}^{11} & \cdots & T_{c*}^{i1} \times T_{d*}^{i1} & \cdots & T_{c*}^{m1} \times T_{d*}^{m1} \\ \vdots & & \vdots & & \vdots \\ T_{c*}^{1j} \times T_{d*}^{1j} & \cdots & T_{c*}^{ij} \times T_{d}^{ij} & \cdots & T_{c*}^{mj} \times T_{d*}^{mj} \\ \vdots & & \vdots & & \vdots \\ T_{c*}^{1m} \times T_{d*}^{1m} & \cdots & T_{c*}^{im} \times T_{d*}^{im} & \cdots & T_{c*}^{mm} \times T_{d*}^{mm} \end{bmatrix} \tag{12}$$

3.4 The VIKOR method

Positive and negative ideal points make up the basic concept of the VIKOR technique, which was first put forth by Opricovic [28] and Opricovic and Tzeng [29]. The VIKOR is a compromise programming of the MCDM method. VIKOR calculation steps are as follows: (1) establish a positive-ideal solution and a negative solution, (2) establish the largest overall efficiency of the program and the largest individual regret, and (3) establish the benefits of all programs and sort.

1. Identify the program of the positive-ideal solution and the negative solution. f_j^* is the best performance value (positive-ideal solution). f_j^- is the worst performance value (negative solution). f_{ij} is the criterion performance value of the interview questionnaire. f_j^* is the maximum performance scale. f_j^- is the minimum performance scale.

$$f_j^* = \max_i \quad f_{ij}, \quad i = 1, 2, 3, \ldots, m, \tag{13}$$

$$f_j^- = \min_i \quad f_{ij}, \quad i = 1, 2, 3, \ldots, m. \tag{14}$$

2. Establish the largest overall efficiency of the program and the largest individual regret. S_i is the value of the overall program performance, which is the sum of the positive-ideal solution gap. w_j is the attribute impact weight value obtained by the DANP calculation. Q_i can be found to improve the attribute of priority.

$$S_i = \sum_{j=1}^{n} w_j \left(f_j^* - f_{ij}\right) / \left(f_j^* - f_j^-\right), \tag{15}$$

$$Q_i = \max_j \left[\left(f_j^* - f_{ij}\right) / \left(f_j^* - f_j^-\right)\right], \tag{16}$$

   where w_j is the weight of jth criterion.
3. Establish the benefits of all programs and sort.

$$R_i = v\left(S_i - S^*\right) / \left(S^- - S^*\right) + (1 - v)\left(Q_i - Q^*\right) / \left(Q^- - Q^*\right) \tag{17}$$

S^* is the positive-ideal solution of the program group utility. S^- is the negative solution of the program group utility. Q^* is a regrettable positive-ideal solution. Q^- is the regrettable negative solution. The v is the decision weight value. The v is a greater weight value representing more people agreeing upon. The v is a smaller weight value representing more people disagreeing upon. The v value is usually set to 0.5, representing the maximum benefit and the minimum individual regret.

3.5 Research methodology

This subsection outlines the research process, including the research framework, research design, and data collection.

3.5.1 Research framework

Based on the literature review and the Stimulus–Organism–Response [15,43] model that was built, which posits that environmental factors act as stimuli that affect individuals' cognitive reactions and then their behavior [23], Fig. 2 shows the research framework of the Stimulus–Organism–Response (also abbreviated as S-O-R) structure used to investigate the relationship among the three dimensions of project risk, project management, and organizational performance, including a total of 14 related constructs. Therefore, the criteria in the three dimensions must pass the pairwise comparisons (using the expert questionnaire) after the data analysis, which reveals the causal relationships between the criteria.

3.5.2 Research design

This study distributed questionnaires to cloud CRM experts and to the experts of three companies with extensive experience in cloud CRM project management. Subsequently, the completed questionnaires were analyzed using a DANP model, a hybrid

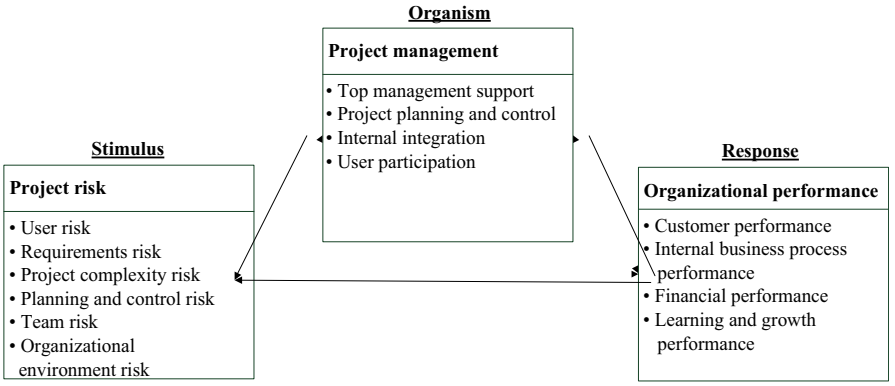

Fig. 2 Research framework of this study

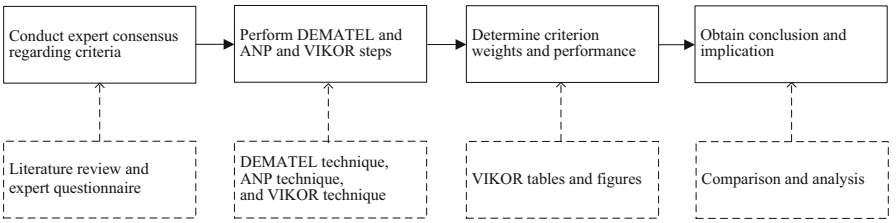

Fig. 3 Flowchart of the proposed method

MCDM framework-based DEMATEL model and an ANP technique to determine the weights between the various dimensions and criteria. Accordingly, VIKOR obtains the criterion performance of the gaps. Figure 3 illustrates roughly the flowchart of the proposed method and the corresponding criteria and methods used in this study.

3.5.3 Data collection

This study briefly delineates the process of surveying experts, including an introduction to the research participants, topics, and dimensions and criteria used in this study validation.

1. *Research participants* We conducted a survey of 18 cloud CRM experts with multiple years of practical experience in Internet service project management. This was based on the recommendation of Northcutt and McCoy [27] that a focus group should comprise 12–20 experts.
2. *Research topic* Eighteen experts with extensive experience in cloud CRM Internet service project management were invited to participate in this study. A hybrid DEMATEL and ANP method was first used to help the participants understand the relationships among the research variables (see Fig. 2). When a group consensus was determined, we conducted the relevant analyses. Empirical cases through VIKOR understand business were used to execute the real situation of the cloud CRM project. The 18 expert questionnaires were used in the DANP model to

Table 4 Dimensions and influential criteria of the research framework

Dimension	Influential criterion
A—Project risk	a1 User risk
	a2 Requirements risk
	a3 Project complexity risk
	a4 Planning and control risk
	a5 Team risk
	a6 Organizational environment risk
B—Project management	b1 Top management support
	b2 Project planning and control
	b3 Internal integration
	b4 User participation
C—Organizational performance	c1 Customer performance
	c2 Internal business process performance
	c3 Financial performance
	c4 Learning and growth performance

generate the relative weights and the interview data of the three companies to determine the performances of the criteria that should be improved.

3. *Dimensions and criteria* Based on the related literature review, this study organizes project risk, project management, and organizational performance dimensions to propose a research framework. In the research framework, an expert questionnaire and a company questionnaire were designed based on the three dimensions and distributed via surveys to be completed by the cloud CRM experts and the case companies. Based on the principle of information saturation, 18 expert consensus data and DANP weight data were obtained, and then the DANP weight data were input into the VIKOR model for the operation analysis. The major dimensions and criteria of this study are summarized and shown in Table 4.

4 Experiment and data analysis

This section discusses the three empirical cases used to validate the proposed method for Internet applications based on expert questionnaires and implementation of the DANP and VIKOR techniques.

4.1 Expert demographics and background of surveyed empirical cases

Cloud CRM experts and three companies were recruited to participate in the study validation. Company-X is a traditional manufacturing industry. Due to the need for

Table 5 Demographic data of the cloud CRM experts

Feature	Demographic variable	No. of people	Percentage
Gender	Male	13	72.22
	Female	5	28.78
Age	31–40 years	13	72.22
	41–50 years	5	28.78
Education level	Bachelors	4	22.22
	Masters	13	72.22
	Ph.D.	1	5.56
Occupation	Business manager	1	5.56
	Information personnel	10	55.56
	Information manager	4	22.22
	R&D Engineer	2	11.11
	Educators	1	5.56
Seniority	0–2 years	1	5.56
	3–5 years	3	16.67
	6–10 years	9	50.00
	11 years and more	5	27.78
Years of experience in cloud CRM project management	4–5 years	9	50.00
	6–10 years	8	44.44
	11 years and more	1	5.56

business development, the progress of business and customer trends can be maintained, and therefore, the application of cloud CRM is very suitable in business management units. Company-Y is an electronic information industry. Cloud CRM is mainly used to understand the customers' uses of information products and for new customer development. Company-Z is an information service industry. Cloud CRM is mainly used for customer data management, visiting customers and understanding customer needs. The number of participants was determined based on the principle of information saturation. We asked the experts the questions presented on the questionnaire in person, while providing them with detailed explanations and examples to ensure that they understood the actual meaning of the research framework. Table 5 presents demographic information for the surveyed experts, and Table 6 presents information for the surveyed cases.

4.2 Calculating criterion weights using ANP

For the ANP technique processing, Steps 4–6 were executed. Table 7 presents the results of the criterion weights.

Table 6 Demographic data of the cloud CRM experts in three companies

Feature	X-Company	Y-Company	Z-Company
Gender	Female	Female	Female
Age	41–50 years	31–40 years	Under 30 years
Education level	Ph.D.	Bachelors	Bachelors
Occupation	Information manager	Information manager	Sales
Seniority	11 years and more	11 years and more	Under 2 years
Years of experience in cloud CRM project management	2–3 years	11 years and more	Under 1 year
Cloud CRM system	Marketing expert	V-Point CRM	SalesLogix
Industrial classification	Traditional manufacturing industry	Electronic information industry	Information service industry
Capital (Unit: NT$)	Under 50 million	10–50 billion	50 million–1 billion
Employees	Under 100	2001 and more	Under 100

Table 7 Weights of each dimension, criterion, and weight rank

Dimension	Criterion	Dimension		Criterion	
		Weight	Weight rank	Weight	Weight rank
A	a1	0.403	1	0.082	3
	a2			0.069	11
	a3			0.071	8
	a4			0.069	10
	a5			0.063	12
	a6			0.049	14
B	b1	0.275	3	0.058	13
	b2			0.075	5
	b3			0.070	9
	b4			0.072	7
C	c1	0.322	2	0.075	4
	c2			0.089	1
	c3			0.084	2
	c4			0.074	6

4.3 Calculating the criterion performance using VIKOR

For the VIKOR processing, Steps 1–3 were executed. Based on the experimental results, Table 8 presents the results of criterion performance. Table 9 describes the results of the three companies' performances. Figures 4, 5, 6, 7, 8 and 9 show the results of the cloud CRM project's priority gaps by presenting effective and useful radar charts. Figure 10 depicts the empirical performance results of the three companies.

Table 8 Performance values combined with the influential weights of the criteria of the empirical case

	Company-X					Company-Y		Company-Z	
	G-weight (DANP)	L-weight (DANP)	Aspiration value	Performance (X)	Gap (VIKOR)	Performance (Y)	Gap (VIKOR)	Performance (Z)	Gap (VIKOR)
A		0.403		5.726	0.409	5.519	0.435	5.119	0.485
a1	0.082	0.204	9.000	3.000	0.750	5.333	0.458	6.111	0.361
a2	0.069	0.170	9.000	7.778	0.153	5.333	0.458	4.667	0.542
a3	0.071	0.177	9.000	7.778	0.153	3.000	0.750	4.000	0.625
a4	0.069	0.172	9.000	5.556	0.431	6.667	0.292	3.000	0.750
a5	0.063	0.157	9.000	3.778	0.653	6.667	0.292	6.889	0.264
a6	0.049	0.120	9.000	7.222	0.222	6.667	0.292	6.444	0.319
B		0.275		7.532	0.183	7.137	0.233	6.402	0.325
b1	0.058	0.210	9.000	9.000	0.000	7.750	0.156	6.600	0.300
b2	0.075	0.273	9.000	6.000	0.375	7.400	0.200	7.200	0.225
b3	0.070	0.254	9.000	8.000	0.125	6.750	0.281	5.800	0.400
b4	0.072	0.263	9.000	7.500	0.188	6.750	0.281	6.000	0.375
C		0.322		7.614	0.173	6.613	0.298	4.472	0.566
c1	0.075	0.234	9.000	8.000	0.125	7.000	0.250	6.800	0.275
c2	0.089	0.277	9.000	8.000	0.125	7.000	0.250	2.800	0.775
c3	0.084	0.260	9.000	6.500	0.313	5.500	0.438	2.800	0.775
c4	0.074	0.229	9.000	8.000	0.125	7.000	0.250	6.000	0.375
Total	1.000	1.000		6.829	0.271	6.315	0.336	5.262	0.467

Table 9 Ranking indexes of performances for the empirical cases

Company	S	Q	R
Company-X	3.736	0.750	2.243
Company-Y	4.648	0.750	2.699
Company-Z	6.361	0.775	3.568

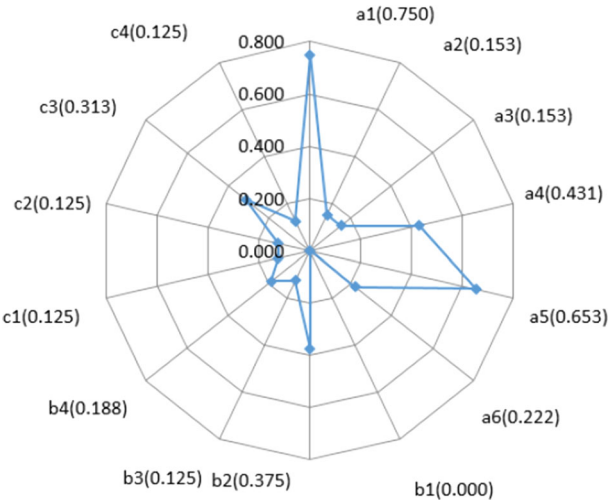

Fig. 4 Company-X project performance in radar chart

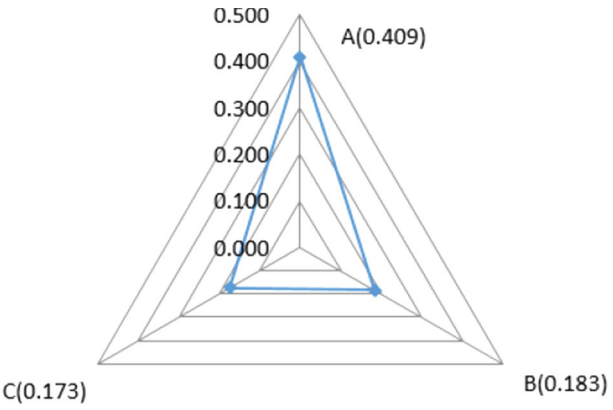

Fig. 5 Company-X project performance in radar chart—dimensions

5 Results and discussion

By using the practical experience of cloud CRM experts and the MCDM-based DANP model and VIKOR method, we determined the dimensions and criteria that have weights and the performance of the gaps.

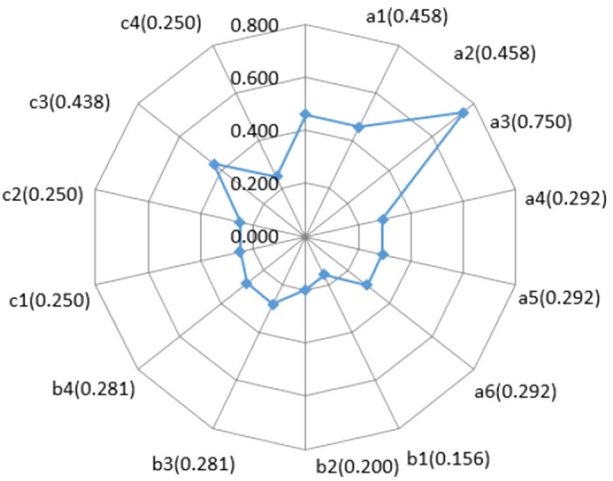

Fig. 6 Company-Y project performance in radar chart

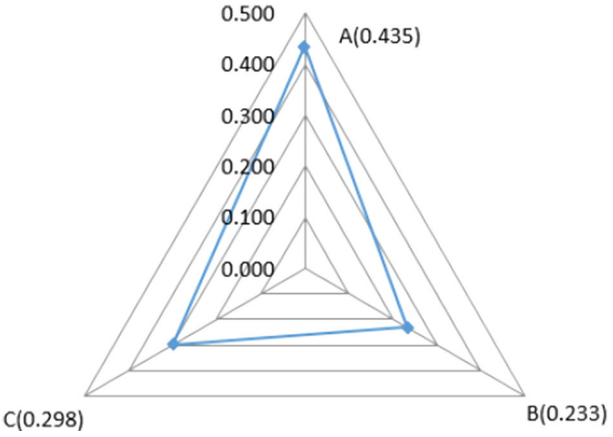

Fig. 7 Company-Y project performance in radar chart—dimensions

5.1 Findings

This study reports that there are different breadths and depths that differ from traditional CRM projects [38,47] as reported in related studies. Traditional CRM projects implementing an enterprise are more inclined to explore the success factors, organizational environment and customer responses. Using DANP and VIKOR models, complex problems can be structured to better elucidate the impact between the dimension and criterion and to obtain improvement suggestions based on objective expert and case company opinions.

The cloud CRM project strategies were defined using the data in Table 8. According to the DANP model based on the basic concept of ANP, the data in Table 7 were

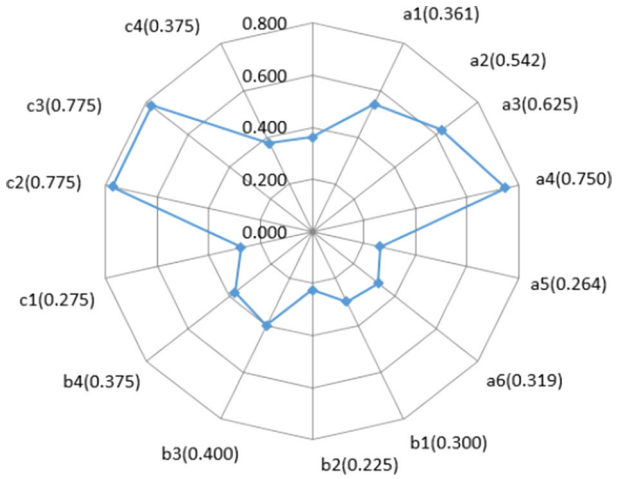

Fig. 8 Company-Z project performance in radar chart

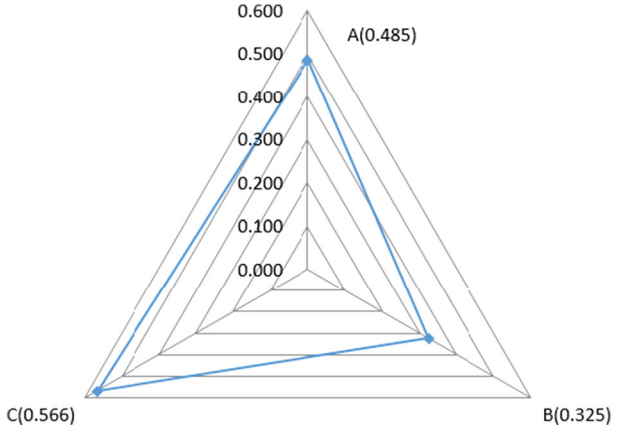

Fig. 9 Company-Z project performance in radar chart—dimensions

designed and obtained to calculate weighted and unweighted super-matrices to determine the influential weights based on the total-influential normalized matrix.

Table 8 shows the cloud CRM project criteria weighted super-matrix indices and the performance gaps of Company-X, Company-Y, and Company-Z. Each row represents the weight of each criterion (see Table 7). Therefore, based on the results previously provided in this paper, the influence of the criteria and index was determined using the DEMATEL technique and the DANP in conjunction with the VIKOR model for performance evaluation.

Cloud CRM project priority gaps (see Table 8 ; Figs. 4, 5, 6, 7, 8, 9) for improvement are listed as follows.

1. **Company-X** The priority indices for improving dimensions include project risk, project management, and organizational performance. The priority indices for

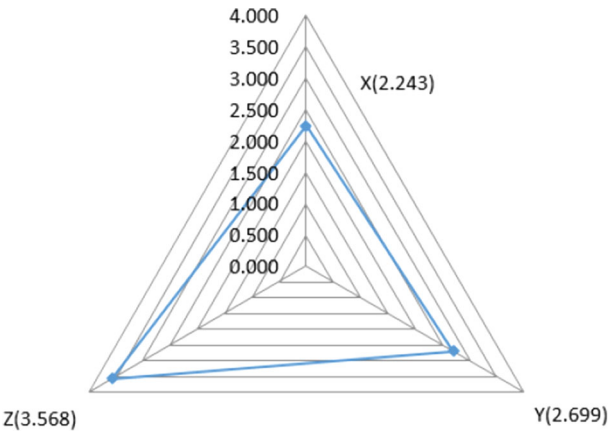

Fig. 10 Project performance in radar chart for Companies X, Y, and Z

improving criteria include user risk, team risk, planning and control risk, project planning and control, financial performance, organizational environment risk, user participation, requirements risk, project complexity risk, internal integration, customer performance, internal business process performance, learning and growth performance, and top management support.

2. **Company-Y** The priority indices for improving dimensions include project risk, organizational performance, and project management. The priority indices for improving criteria include project complexity risk, user risk, requirements risk, financial performance, planning and control risk, team risk, organizational environment risk, internal integration, user participation, customer performance, internal business process performance, learning and growth performance, project planning and control, and top management support.
3. **Company-Z** The priority indices for improving dimensions include organizational performance, project risk, and project management. The priority indices for improving criteria include internal business process performance, financial performance, planning and control risk, project complexity risk, requirements risk, internal integration, user participation, learning and growth performance, user risk, organizational environment risk, top management support, customer performance, team risk, and project planning and control.

The empirical case study results (see Table 9 and Fig. 10), which ranked three companies' performances, revealed that Company-X surpassed Company-Y but Company-Y surpassed Company-Z, which indicates that Company-X (X) > Company-Y (Y) > Company-Z (Z).

5.2 Academic and managerial implications

The academic and managerial implications of this study are based on the VIKOR method as follows.

5.2.1 Academic implication

This study revealed that, regarding financial performance, there is a need to improve cloud CRM projects, which is consistent with the findings of Thoumy and Vachon [42], who reported the following:

> A positive linkage between organizational size and project's financial performance has been supported, as larger organizations have more capabilities to implement such green initiatives.

We recommend that project management information system (PMIS) management can improve project costs and financial performance. Project costs must be periodically evaluated to curb cost increases and to ensure compliance with the ultimate goal of the project, thus allowing enterprises to obtain effective control over the investment costs of cloud CRM systems.

5.2.2 Managerial implications

Through the results of the three case studies, several guidelines can be proposed to improve the cloud CRM project management of Internet service.

1. Company-X When the cloud CRM project was initiated, we first understood the potential risks and then developed the planned risk response. A cloud CRM project includes the organization of work and the relationship among people in close collaboration (such as information technology staff, users, and managers). Thus, the interaction among people, communication, and coordination are closely related to the risks of cloud CRM projects. The user's learning attitude is also very important. If the users are not suited to operate the new system, a lack of confidence will be generated in the cloud CRM project. Thus, the education and training of users and the user's familiarity with the operation of the new system should be strengthened to enhance the degree of success of the project. The project managers should strengthen their effective project planning and control technology, and project managers should implement effective project planning that can enable enterprises to reduce project costs. Cloud CRM implementation of Internet service cannot control the progress of the project duration if the project demand is not clear, and this will increase the project costs.

2. Company-Y Before implementing a cloud CRM project, it is necessary to establish a project risk plan to avoid project risks. However, both the business environment and management are dynamic, and therefore, the project in progress needs to control developing risks, which include enterprise environment changes, to prevent the occurrence of risk events. A cloud CRM project has uncertainties, and the project will use new technologies; therefore, attention must be paid to the process of converting from the old system to the new one. Professionals with appropriate experience can assist in the development of new technologies to reduce the complexity of the project. Active participation of the project members in the project can strengthen internal integration of the business under Internet service.

3. Company-Z When implementing cloud CRM projects, it is necessary to consider them from the users' perspective. Because the cloud is a new technology, most business people need to spend time to adapt to the new cloud CRM system, and thus, enhanced user training is necessary. Because the project schedule is a high priority, it is recommended that the goals and demands should be clear to reduce the project's time cost. If project planning does not consider other potential risk management costs, the project implementation may lead to organization stress and an uncertainty in budget allocation. Therefore, communication can help project members and users understand the basic concepts of project risk management. The main cloud CRM systems are intended for business and customer service staffs, who do not participate in the discussion of the project, and this information can lead to an information gap. Project members should continue to be informed of major decisions related to the project, project members should strengthen the problem-solving consensus and expect to complete their tasks within the projected time. The internal integration and cloud CRM project budget control are all part of the project process, and they should be strengthened. Cloud CRM projects require cross-departmental discussion, and thus, communication within the enterprise is very important. The communication issues within the project should be strengthened so that members of the staff are more confidence in the project. In addition, monitoring and controlling costs oversee the progression of the project. Project managers need to ensure that the applications of all changes can be enacted, and they should appropriately manage its financial performance.

6 Conclusions

In this study, DANP and VIKOR approaches were applied with the following features. First, we recognize the dynamic and iterative nature of project risk management and BSC and present a real-world situation. DEMATEL can be used to establish the relationship between the dimension and criterion. In the absence of a preset relationship, the data can be analyzed to determine the extent of the influence of each criterion. The results of this study will provide insightful contributions. Second, the participants interviewed are domain experts who have rich experience with cloud CRM. In addition, the quality of the interviewed experts is well controlled. The ultimate consensus of these experts was determined by objective mathematical calculations rather than subjective judgments. Therefore, the results of this study are characterized by satisfactory reliability and effectiveness.

Using VIKOR to determine cloud CRM project performance under cloud computing perspectives for three case studies, the order of the performance of the companies was as follows: Company-X (X) > Company-Y (Y) > Company-Z (Z). Recommendations to improve criterion were addressed to the three companies as follows. First, Company-X should improve dimensions and criteria in the following order: "Project risk (A)," "User risk (a1)," "Project planning and control (b2)," and "Financial performance (c3)." Second, Y-Company should improve dimensions and criteria in the following order: "Project risk (A)," "Project complexity risk (a3)," "Internal integration (b3)," "User participation (b4)," and "Financial performance (c3)." Third, Company-Z should improve dimensions and criterions in the following order: "Organizational per-

formance (C)," "Planning and control risk (a4)," "Internal integration (b3)," "Internal business process performance (c2)," and "Financial performance (c3)."

Business decision-makers or project managers are constrained by limitations of staff, time and budget; thus, it is necessary to determine the dimensions and criteria where improvements can be made, which can increase the effectiveness of a cloud CRM Internet service project. "Project risk (A)" is the most in need of improvement. Most of the enterprises bear project risk for online project on time, without optimizing software, thus creating many project risks. In the A, B, and C dimensions, "User risk (a1)" is the most in need of improvement. If the users are not familiar with using the cloud CRM system, these users will avoid operating the system. A cloud CRM project is different from general IS projects because the cloud virtual technology costs are much higher, and therefore, "Financial performance (c3)" is a concern for businesses.

The financial performance of Companies X, Y, and Z corresponds to different suggestions for improvement, as described below. Company-X: Importing a cloud CRM project cannot control the schedule and does not fully discuss demand planning, resulting in an extra demand for functionality and increased budget costs. Company-Y: Strengthening the project time management reduces the time cost of the project, and corporate finances can be properly grasped. Company-Z: in implementing the project, the project manager needs to ensure all project changes to the application and timely action that can properly manage financial performance.

The contribution of this study discuss the relevance of cloud CRM project risk management and performance. The results suggest that enterprises that implement cloud CRM projects need to pay attention to project risk and financial performance management. Project risk management emphasizes what should occur prior to a risk event, rather than remedial measures taken after the event. In order for the project to be successful, it is necessary to prioritize or minimize the impact of such risks as much as possible. The BSC discussion highlights that companies also attach great importance to financial performance; controlling project costs and overall business operating costs have great impacts.

The main conclusions of this study are the following two key points. (a) The greatest criteria of relative weight primarily belong to the risk dimension, which indicates that experts value the project risk. (b) The result of the empirical case studies revealed that "financial performance" is unanimously considered to be in great need of improvement. Finally, we hope that this study provides an effective reference for cloud CRM experts for Internet service.

Acknowledgements The authors declare that there is no conflict of interests regarding the publication of this paper.

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