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Analysis of new product development between product innovation and product financial performance assessment: a case of Doosheh Dairy Company

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Abstract
Recent supply and innovation literature emphasizes the importance of foreign participation in product development. Based on this work flow, this study distinguishes four novel interagency new product development strategies (NPDs) based on two dimensions: the external source "supply chain supplies [SCS] and non-supply chain resources (NSCS)" and the form of interaction (united and purchasing). Using theoretical arguments from a knowledge-based perspective, we compare the effects of these four strategies on product innovation and product financial performance. Therefore, multi-criteria decision-making models are used to find the best inter-organizational strategy for developing a new product conducting a case study. The results indicate that some strategies are more effective to enhance product innovation, while others are more effective in improving product financial performance. In addition, this study shows that there is no distinction between the supply chain and the supply chain effects on product innovation. We also show that interdependence of technology plays an important role in increasing the positive relationship between product innovation and product financial performance. In general, the study suggests that companies need to carefully design their interagency NPD strategies with the various needs of innovation projects.

Keywords Inter-organizational new product development · Knowledge management · Technology affiliation · Green supply chain · Multi-criteria decision making

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1 Introduction and literature review

The green concept is a significant concept in the management of organizations. Green decision refers to decisions that focus on environmental constraints with an emphasis on protecting natural resources in improving quality of life (Muralidhar et al., 2012; Rajesh, 2020a, b). Green management aims to maintain resources and improve the quality of the physical environment and improve the process. Environmental compatibility and social responsibility of the organizations are increasingly the subject of relevant issues in economic terms (Gholizadeh et a., 2020; Gholizadeh et al., 2020; Hervani et al., 2005; Lin et al., 2011). In recent studies in industries that are susceptible as well as in industries that are not sensitive, it is argued that green management is a successful factor in organizational and competitive strategies (Qianhan et al., 2010; Rajesh & Rajendran, 2020; Razavi et al., 2020; Rostamzadeh et al., 2015). In fact, according to research results that have been done so far, the commitment of management to green management, the goals of economic growth and environmental quality are always in conflict. Over the past decades, the growth of a number of organizations has been the pioneer of a new strategy for integrating the environment into business strategy and simultaneously improving the environment and business performance (AlKhidir & Zailani, 2009; Singh & Trivedi, 2016; Stonebraker & Liao, 2006). Also, environmental concerns have increasingly increased in managerial research. Green management is a concept that combines environmental aspirations with organizational goals, product design, product development, marketing, financial, and other variables in business management (Gholizadeh & Fazlollahtabar, 2020; Gholizadeh Fazlollahtabar & Khalilzadeh, 2020a; Gholizadeh et al., 2020; Xu et al., 2013).

Inter-organizational new product development (NPD) has become a growing issue in the practical and theoretical discussion of product innovation. Firms expand their organizational boundaries to connect foreign knowledge to their product innovation processes. By providing a wide range of heterogeneous external resources, the NPD extends inter-organizational options for companies to increase their innovation efforts. However, the NPD between the organizations is also challenging (Gholizadeh et al., 2021). The challenge is to consider foreign knowledge because the knowledge of foreign participants is farther away from what lies at the center of the company (He et al., 2014). Coordinating the tasks of mutual projects and dealing with conflicts of communication with aliens are a variety of costs that can lead to the diversion of the attention of managers from the main work of development. These challenges are especially highlighted when the goal of an interagency NPD project is to develop highly innovative products with good financial returns (Huatuco et al., 2013).

Recent green supply chains and innovation literature emphasize the importance inter-organizational cooperation in product development (Li et al., 2020; Rajesh, 2020a, b). Based on this work flow, from a focal point of view, a new product is fundamentally different from the company's existing products (Ayag, 2005; Govindan & Gholizadeh, 2021). What we learn from the NPD literature is that while many new products in the market can be profitable and potentially provide a good return on investment, they can also be extremely dangerous for development, because they require expertise, technology and basic resources (Sarkis et al., 2011). Despite the dangers, many firms are still looking for new products, often as an interdisciplinary NPD for risk sharing among participating companies; because of the long-term competitive advantage of providing new products, it is important to know how NPD interagency strategies affect product innovation and product financial performance (Nikabadi & Shahrokhnia, 2019). Understanding this is challenging,

however, since the International Labor Organization (ILO) literature has failed to provide an accurate assessment of how different forms of NPD interagency strategies affect innovation performance (Peng et al., 2014). NPD strategies between organizations can be different in two respects: Foreign Knowledge Resources (Luthra et al., 2011) and Interaction Form (Acur et al., 2012), which are usually expressed by focusing on one or two types of interagency strategies at the same time. Literature does not provide comprehensive comparisons of different types of strategies. Although an NPD project can simultaneously adopt several types of strategies when working with external organizations, it is also important to allocate limited project resources to support strategies that are effective in increasing the efficiency of products (Wang et al., 2009). Therefore, it is important to know what kinds of NPD strategies are inter-organizational to enhance product innovation. Many NPD studies between organizations focus on demonstrating the benefits of inter-organizational NPD. Nowadays, with the shortening of the life cycle of the goods and technology used in them, the issue of innovation has become increasingly important in business (Birou et al., 1998; Hamel & Prahalad, 2005). The process of past innovation has been dependent on in-house intellectual resources and efforts to develop and commercialize them within the organization. Technology transfer can result in long-term economic growth, innovative performance and capabilities, improved technological capabilities, competitive advantage, increased productivity, and the development of local industries. New technologies have enabled companies to create new and innovative products. Of course, it is possible to integrate new technology with the existing technology for the production of new products (Göçer, 2020; Ravi & Shankar, 2005). New product development has become a key strategic activity for many organizations as new products have a significant contribution to the company's sales and profits (Lasso et al., 2020a; Zang et al., 2014). In other words, new products, indicating hidden resources, have a competitive advantage. In fact, the development of a new product can be considered as a problem-solving cycle based on the interaction of different knowledge sources (Yan & Azadegan, 2017). These studies share the interagency NPD's ability to diversify risk and uncertainty (Mata & Woerter, 2013), reduce the cost of innovation (Smith, 1997; Zheng & Yang, 2015), and accelerate the innovation process (Janeiro et al., 2013; Narasimhan & Narayanan, 2013) and income growth (Peres et al., 2010). Assessments are required to determine how the NPD streams between an organization and its challenges. These studies examine the ways in which the combination of external knowledge is more challenging because outsourcing of expertise is away from the focal company (Govindan et al., 2014), the costs of coordinating activities among various foreign organizations can be expedited rapidly. Existing relationships with diverse aliens will cost a lot and may lead to a distraction from the attention of managers (Yang et al., 2016). An academic study also looks at the benefits and challenges of an NPD between the organizations when the purpose of the new innovative products is. However, studies focusing on the impact of inter-organizational NPD on product innovation are limited.

Therefore, because of the importance of the subject, this study examines the moderating effects of technology dependence whose moderating effects in inter-organizational NPD projects are not fully understood and show that it is a field of work relying on technology that boosts the positive relationship between product innovation and product financial performance. The aim of this study is to provide a better understanding of the relationship between product innovation and product financial performance that the flexibility of the new product is also discussed in this study. Most NPD studies focused on the various enablers for product development continually and in a whole new way considering the limited review of whether new potential products are necessarily financially efficient as, with more sales, return on investment and profitability. Among some of those who study

this important relationship between product innovation and product financial performance are mixed conclusions (Xie et al., 2019). In particular, NPD literature has not found a meaningful relationship between product innovation and product financial performance (McNally et al., 2010), neither the positive relationship between product innovation and product financial performance (Wagner et al., 2012), nor a negative relationship between product innovation and financial performance of the product (Nerkar & Roberts, 2004). The reason for these mixed findings is that the new product produces a higher level of work uncertainty with potential costs, in which in addition to these new products offer unique ideas that make the relationship between product innovation and financial performance of the product (Stanton et al., 2004). Therefore, the role of technology dependency (new product) as defined as the interdependence between product modules and the interdependence between development stages is examined. Technology dependence is an important factor in the NPD project, which can complicate the development of NPD projects (Salvador & Villena, 2013). What we learn from the NPD literature on technology dependence is that while a high degree of dependence on technology can create opportunities for finding new products (Yeh et al., 2014), this can make further efforts in combining foreign knowledge more complicated (Tatikonda & Rosenthal, 2000).

A company that is able to present its product to market faster has more time to develop or encourage others to develop complementary products (which adds value to the product's attractiveness). If all the conditions are the same, products that are introduced to the market sooner may have the advantage of longer life cycle and the availability of complementary products than other competitors (Birou et al., 1998; Hamel & Prahalad, 2005). New product development has become a key strategic activity for many organizations as new products have a significant contribution to the company's sales and profits (Stonebraker & Liao, 2006; Yeh et al., 2014). In other words, new products, indicating hidden resources, have a competitive advantage (Kessler et al., 2000). Considering the competitive conditions that surround the enterprises, the development of new products is the only way to survive (Passemard & Kleiner, 2000). In fact, the main purpose of any organization is to gain competitive advantage and to maintain long-term profitability (Kuan et al., 2012). Therefore, process-oriented new product development projects are required to turn market opportunities into organizations' profit. The new product will be successful, which will be available at the right time, having the required quality and competitive costs (Tripathy & Eppinger, 2013). The term "new" refers to the product that is launched for the first time on the domestic or global market, or to include new product groups or add new products to the company's production line, or improve in current products (Yan & Azadegan, 2017).

Given the importance of institutional theory, resource-based view (RBV) theory and the concept of GSCM (Li et al., 2020) have conducted an investigation, aimed to identify the relationship between GSCM pressures, practices, and performance concerning the moderating impact of quick response (QR) technology. The outcomes through statistical analysis of the real data and case studies that applied to China reveal that market and export pressures have direct considerable influences on GSCM among varied GSCM pressures, while on the contrary cost pressure does not impact on GSCM practices relatively. Moreover, internal improvement practice puts forth a crucial effect on GSCM practices, whereas external improvement practice affects economic performance negatively. Eventually, QR technology prevents to increase positive impact among internal improvement practice and negative economic performance. A study (Rejesh, 2020) developed an integrative decision-making model for SSCM, which contemplated various strategies, interfaces, and regulations for sustainability. Besides, a network model is designed from an initial flow model, and the weightings for components were evaluated applying the method of paired

in comparison with the analytic hierarchy process (AHP). Afterward, the analytic network process (ANP) has been extended for the comparison of alternative strategies for the selection of a specific SSCM policy into accomplishment. Next, scholars have evaluated two alternative schemes practically for sustainability, and the finding shows that Scheme 2 surpasses Scheme 1, taking into consideration sustainability capabilities. Additionally, from the element weightings, standardization of nature-friendly (NF) technologies and green segment size develops as crucial factors in the supply chain. Xu et al., (2013) conducted a comparative study of pressures that consequence the adoption of GSCM. Additionally, thirty-two pressures are allocated from widespread literature reviews and evaluated into five separate groups according to their similarities. Then, a precise questionnaire is collected and distributed between industries in various sectors to rate the effectiveness of each pressure. The analysis of statistical data concerning one-way single-component analysis of variance (ANOVA), followed by pairwise comparison of means relating to Tukey's test, was employed. Rajesh & Rajendran, (2020) investigated practical evidence for the association binding of ESG scores and sustainability performances of industries. Scholars have analyzed the ESG performance scores of 1820 companies globally for 5 years, from 2014 to 2018 on 10 crucial topics and over 400 varied factors by using the Bloomberg terminal data. Also, a partial least square (PLS) analysis and standard bootstrapping employing Smart PLS 3.0 software were applied, and the conclusion represents the decreasing effects of latent variables contributing to sustainability performances. This research was formulated by Rajesh, (2020a, b) to illustrate the application of grey theory in analyzing ESG score for Indian companies. So, the sustainability performances of 39 industries in India were measured for their environmental, social, and governance performances, for 5 years. A grey incidence analysis was conducted to contemplate the most vital indicators or aspects of sustainability in Indian companies. The outcomes indicate that the resource use score, the environmental innovation score, and the corporate social responsibility (CSR) strategy score seem to the extensively critical indicators regarding environmental, social, and governance performances of Indian corporations. While the shareholder score, the management score, and the human rights score arise to be the least specifying indicators related to the above concepts, research by Mathiyazhagan et al., (2015) implemented with the aiming of guiding managers to determine the fundamental pressure among existing pressures for GSCM adoption. The fundamental goal of their study was to analyze the pressures for GSCM adoption and to rank the pressures according to experts' opinion within an analytical hierarchy process (AHP) technique and implement it in the mining and mineral firms. A summary of the related literature and the corresponding specifications are given in Table 1.

In fact, the key to success in gaining competitive advantage for companies in the future is the successful and continuous development of new and improved products as an influential factor in product development performance and related strategies. Due to the importance of the issue of the development and development of new products, here a case study is conducted in Doosheh Dairy Company, one of the largest dairy companies in the north of Iran. The Doosheh Dairy Company was founded in 2007 in the city of Amol. The company's products include yogurt, cheese, buttermilk, dessert, milk, cream and butter. This company is one of the first flavored yoghurt producers in Iran. Also, the products of this company are exported to other countries. Therefore, in this research, the indicators of evaluation of the key factors in the development of new products are identified and then prioritized by choosing the best strategy using multi-criteria decision-making models.

The general research model and the proposed decision support are illustrated in Fig. 1. Here, the NPD projects are considered with respect to product innovation and product

Table 1 A brief review of the related literature

References	Type of research		Green	Parameters		Ally and buy	Methodology	Case study
	SA	DT		D	F			
(Kuan, 2012)		✓		✓			DEMATEL-based ANP (DANP), VIKOR	
(Chang, 2013)		✓	✓	✓			TOPSIS, ANP	✓
(Yeh et al., 2014)		✓			✓		FAHP, FDEMATEL	
(Chen et al., 2015)		✓			✓		FANP	✓
(Kłos, 2015)		✓		✓			AHP	
(Yan & Azadegan, 2017)	✓		✓	✓		✓	SEM tests	
(Biju, 2017)		✓	✓	✓			AHP	
(Oliveira et al., 2018)		✓	✓		✓		AHP, FTOPSIS	✓
(Hosseini et al., 2018)	✓			✓			Kolmogorov–Smirnov and parametric tests	✓
(Lasso et al., 2020b)	✓				✓		Kruskal–Wallis test method	
(Puzović et al., 2019)		✓			✓		FAHP	✓
(Wardah & Baidawi., 2020)		✓			✓		FAHP	
Current study		✓	✓	✓		✓	AHP, BWM, VIKOR, TOPSIS	✓

SA, Statistical analysis; DT, decision theory; D, deterministic; F, fuzzy

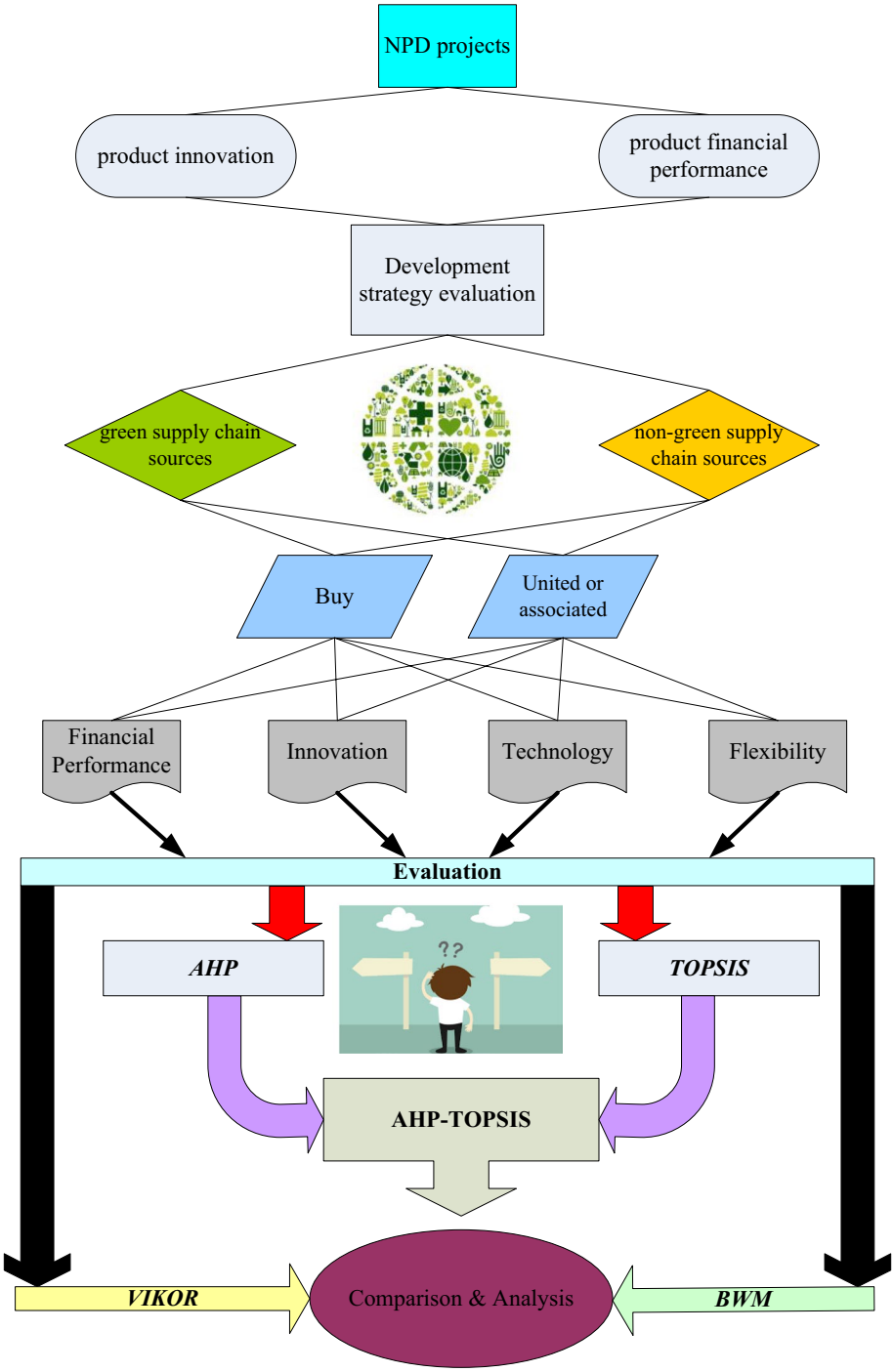

Fig. 1 The research model and decision support

financial performance. To provide development strategies and regarding the current sustainable considerations, two separate sources of the green and non-green supply chain are investigated. Two policies of a buying or making united are analyzed with respect to financial performance, innovation, technology, and flexibility as indicators collected from the literature. This way the criteria and sub-criteria are prepared to be evaluated and prioritized development strategies composed from the integration of indicators and sub-criteria are in hand. For the decision-making part, AHP, TOSIS, and integrated AHP-TOPSIS are applied to find out their efficiency in providing reasonable results. For further comparison and analysis, two methods, VIKOR (as an already developed approach) and BWM (as a recently developed method), are employed.

In the following, methodology is expressed in Sect. 2. In the third section, the case study is implemented, analyzed and discussed; finally, in the fourth section, the conclusion of the paper is stated.

2 Methodology

In this model, financial performance, technology, flexibility, R&D and technology are among the key factors in the development of new products and considered as the main criteria. The sub-criteria of research based on the evaluation of key factors for the development of new products and based on the structure of network analysis creates the research hypotheses; it is conceptualized in the form of a hierarchical model of Fig. 2.

2.1 Determining sample size

A sample is a part of a surveyed society that is selected in a predetermined manner. Insofar as it is possible to deduce from this sample inferences about the whole society, the selection of a number of people, events, and objects from a defined society as a representative of that society is the first step in sampling; Cochran formula is one of the most widely used methods for calculating the sample size. For this study, the size of society is clear; the parameters are formulated as follows:

N: Volume of statistical population.

n: Sample size.

Z: The normal value of the standard unit at the 95% confidence level is equal to 1.96.

P: is the ratio of the attribute in the community.

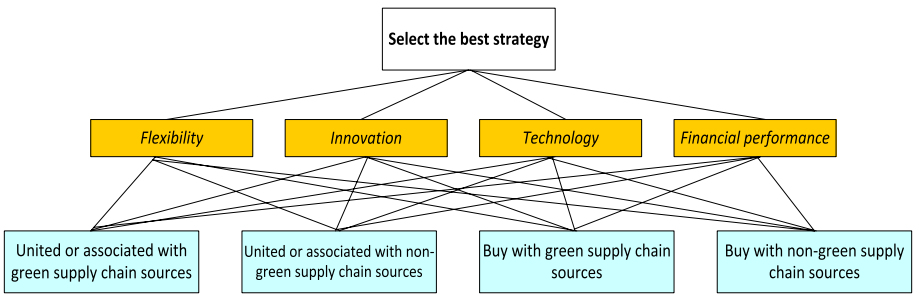

Fig. 2 Hierarchy model of the research

Table 2 Scoring questions in the Likert spectrum

Very a lot	A lot	Medium	Low	Very low	Selective option
5	4	3	2	1	Point

Table 3 Valuation of indicators relative to the nine-hour scale

Explain	Condition Comparison of i with j	Value
The index i is equal to j	Equally preferred	1
The option or index i is more important than j	Moderately preferred	3
The option or index i is more important than j	Strongly preferred	5
The option i has a much higher priority than j	Very strongly preferred	7
The option i of j is absolutely more important and not comparable to j	Extremely preferred	9
Boundary values	Midway	2–4-6

q: The percentage of people who do not have that attribute in the community ($q = 1\text{-}p$).
d: Allowed wrong value.

$$n = \frac{\frac{z^2 pq}{d^2}}{1 + \frac{1}{N}\left[\frac{z^2 pq}{d^2} - 1\right]} \tag{1}$$

Therefore, in this study, in the above formula, the maximum allowed error (d) is equal to 0.05, the confidence coefficient is 0.95, $t = 1.96$, and the values of p and q are equal to 0.5; society size = N, and the value obtains P equal to 0.5. Because if $P = 0.5 = n,$, it will find its maximum value, which will cause the sample to be large enough. On the other hand, the volume of society in this research is 360 executives, experts, specialists of Doosheh Dairy Company. By using the Cochran formula with a percentage error of 0.05, 186 samples are selected for the dissemination of the questionnaire.

A questionnaire was used to collect data. Preparation and setting of the questionnaire will be based on the literacy spectrum. The questionnaire is a set of questions designed either openly or closed (with a scale) to assess the attitude of individuals toward a reality through which they are assessed. The questionnaire consists of two parts:

Public Responsive Information This section of the questionnaire tries to collect aggregated general and demographic information for respondents, including five questions (gender, age, education, work record, and earnings).
Specific information This section contains specialized questions that have been tried to be as simple as possible in their design. For designing this part, the 5-Likert spectrum has been used, which is one of the most commonly used measurement scales. The general form and how to rate the spectrum are shown in Table 2.

Also, in order to prepare an expert questionnaire, a paired-wise comparison model is used to design an expert questionnaire. Using this model, the relative importance of criteria is estimated using the numbers that the principles assigned and evaluated using the

AHP-TOPSIS method are shown in Table 3. To score a nine-point scale, the following is used:

2.2 Reliability of the questionnaire

Reliability is one of the technical features of measuring instruments, which shows how the measuring instrument achieves the same results in similar conditions. One of the methods for calculating reliability is the Cronbach's alpha coefficient. In order to calculate Cronbach's alpha, first, the variance of the scores of each question, the questionnaire and the total variance of the test must be calculated; then, using the formula, the coefficient is calculated. If the Cronbach's alpha coefficient is more than 0.7, the reliability of the questionnaire is confirmed.

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum s_i^2}{s_x^2}\right) \tag{2}$$

α = Cronbach's alpha coefficient, K = Number of questionnaire, Si^2 = Questionnaire variance, Sx^2 = Total test variance.

Here, SPSS software is used for calculating Cronbach's alpha for the research questionnaire, which is confirmed according to the following information.

Cronbach's alpha	*N* of items
0.733	24

The calculated Cronbach's alpha coefficient in this study was calculated in a preliminary study by distributing 24 questionnaires for the study, and it is equal to 0.733. Therefore, the reliability is highly desirable, and the questionnaire is verified.

2.3 Implementation procedures of the proposed method

Collecting and analyzing the questionnaire, the most effective criteria and factors were identified. Reliability analysis of the questionnaire was performed using Cronbach's alpha coefficient. To differentiate and categorize the criteria, the general correlation factors of one of the factor analysis methods were used as the main components analysis method, and then, using the AHP-TOPSIS technique, the effective ranking was determined. The following steps show the implementation of the proposed method.

Step 1 Determining the purpose of the problem, options and indicators, criteria and formation of the hierarchical structure.
Step 2 Formation of the decision matrix; in this matrix, the element d_{ij} represents the value of the index *j* of the choice of the index *i*.
Step 3 Unconfirmed the decision matrix using the following equation:

$$R_{ij} = \frac{d_{ij}}{\left\{\sum_{j=1}^{M} d_{ij}^2\right\}^{0.5}} \tag{3}$$

Step 4 Generate paired comparisons of the criteria and obtain the relative importance of the criteria using a special vector or its approximate methods, such as arithmetic or geometric meanings. In this matrix, element a_{ij} indicates that the index i is preferred by the expert in comparison with the index j.
Step 5 Creating an unmatched weight matrix must be composed of the PCM inconsistency rate.

Comprehensive coupling matrix of expert opinions

$$\mathrm{GM}_i = \left\{ \prod_{j=1}^{N} a_{ij} \right\}^{\frac{1}{N}} \tag{4}$$

$$n_{ij} = \frac{a_{ij}}{\sum_{j=1}^{N} a_{ij}} \tag{5}$$

$$w_i = \frac{\sum_{j=1}^{N} n_{ij}}{n} \tag{6}$$

$$V_{ij} = w_j * R_{ij} \tag{7}$$

So far, we have used the AHP method and we will use the TOPSIS approach next step.

Step 6 Formulate the positive and negative ideals

$$V^+ = \left\{ \left(\sum_i^{max} v_{ij} | j \in J \right), \left(\sum_i^{min} V_{ij} | j \in J' \right) | i = 1, 2, .., M \right\} = \left\{ v_1^+, v_2^+, \ldots, v_n^+ \right\} \tag{8}$$

$$V^- = \left\{ \left(\sum_i^{min} v_{ij} | j \in J \right), \left(\sum_i^{max} V_{ij} | j \in J' \right) | i = 1, 2, .., M \right\} = \left\{ v_1^-, v_2^-, \ldots, v_n^- \right\} \tag{9}$$

Step 7 Calculate the gap distance to the positive and negative ideals.

$$S_i^+ = \left\{ \sum_{j=1}^{N} \left(V_{ij} - V_j^+ \right)^2 \right\}^{0.5} \quad i = 1, 2, \ldots, M \tag{10}$$

$$S_i^- = \left\{ \sum_{j=1}^{N} \left(V_{ij} - V_j^- \right)^2 \right\}^{0.5} \quad i = 1, 2, \ldots, M \tag{11}$$

Step 8 Calculate the relative closeness of each option to the ideal solution

Step 9 Ranking the options based on the relative closeness of the 9th step.

$$C_i = \frac{S_i^-}{\left(S_i^+ + S_i^-\right)} \tag{12}$$

The options are sorted in a descending order according to preferential values that indicate the highest and the least preferred solution.

2.4 Design process model

Since more than one expert has been used in this study, the geometric mean technique has been used to prioritize the viewpoints of experts. One of the best ways to combine the table of members of the group is to use the geometric mean. The geometric mean will help judge the judgment of each member, regardless of any pair comparison.

The geometric mean is the most appropriate mathematical rule for combining judgments in AHP because this average maintains the inverse property in the pairwise matrix.

2.5 Best Worst Method (BWM)

The BWM technique, proposed by Rezaei (2015), is one of the most efficient multi-criteria decision-making techniques based on pairwise comparisons. BWM requires less pairwise comparisons and access to more consistent comparisons, and compared to other similar techniques such as AHP, BWM is more efficient and leads to more reliable results (Rezaei, 2015). The model used in the present research is a linear version of the initial model presented by Rezaei (2015) that has no problem with the initial nonlinear model and provides unique answers.

Step 1. Determining a set of decision criteria.
Step 2. Determining the most important and least important criteria.
Step 3. Determining the degree of preference of the most important criteria over the other criteria using numbers 1 to 9: Preference vector of the most important criterion compared to other criteria is indicated as $A_B = \left(a_{B1}, a_{B2}, \ldots, a_{Bn}\right)$. a_{Bj} denotes the degree of preference for the most important criterion (B) over the criterion j. It is obvious that $a_{BB} = 1$.
Step 4. Determining the degree of preference of the other criteria over the least important criterion using numbers 1 to 9: Preference vector of the other criteria over the least important criterion is indicated as $A_W = \left(a_{1W}, a_{2W}, \ldots, a_{nW}\right)^T$. a_{jW} denotes the degree of preference of j criterion over the least important criterion (w). It is obvious that $a_{WW} = 1$;
Step 5. Determining the final weights of the criteria $\left(w_1^*, w_2^*, \ldots, w_n^*\right)$: In order to determine the optimal weight for each of the criteria for every couple of w_B/w_j and w_j/w_W should be satisfied $w_B/w_j = a_{Bj}$ and $w_j/w_W = a_{jW}$ for all j. Therefore, a solution should be found where the maximum absolute value differences $\left|\frac{w_B}{w_j} - a_{Bj}\right|$ and $\left|\frac{w_j}{w_W} - a_{jW}\right|$ minimize for all j. Due to the nonnegative weight of each criteria ($\sum_{j=1}^{n} w_j \geq 0$) and the constraint that satisfies the sum of weights ($\sum_{j=1}^{n} w_j = 1$), the optimization model is formulated as Eq. 13. By solving this model, the optimal weights of all criteria ($w_1^*, w_2^*, \ldots, w_n^*$) and value ξ^L were obtained.

where w_B denotes the weight of the most important criterion, w_W denotes the weight of the least important criterion, w_j shows the weight of j, a_{Bj} denotes the degree of preference of the most important criterion over the criterion j, and a_{jW} shows the degree of preference of j over the least important criterion.

In order to calculate the inconsistency ratio, the value ξ^L obtained in the previous step and consistency index (CI) reported for different values of a_{BW} are used.

3 Results and analysis

The indicators, criteria and sub-criteria associated with their symbols used in this study are shown in Table 4. The indicators are collected from the literature.

3.1 Results of AHP calculations

The results of the prioritization of indicators based on each of the criteria using the AHP method are as follows (Table 5):

The calculations performed to determine the weight of the criteria and to determine the priority of the criteria according to the results of the paired comparison of the criteria are shown in Table 6.

Based on the results of a pair comparison:

The standard technology with a normalized weight of 0.370893404 is the first priority. The financial performance criterion with a normalized value of 0.235305278 is in the top priority. The benchmark of innovation with the normalized weight of 0.201465429 is in the top priority. And finally, the flexibility criterion with a normalized weight of 0.192335888 is in the top priority. Also, the incompatibility rate of the comparisons was 0.075, which is less than 0.1, so it is possible to make comparisons. Finally, according to the calculations made, the ranking of the best strategy with the AHP solution method is shown in Table 7.

3.2 Results of TOPSIS calculations

According to the opinion of the experts and managers of the organization in relation to the indices' relations with the criteria, we ask for the information obtained from their answers in numerical order between the intervals 1 to 9 and form the decision matrix. Then, we form the unbalanced matrix (see Table 8).

Step Three: Identify the positive and negative ideals, the options created are actually the worst and best solution. The best values for positive indicators, the largest values, and the negative ones are the smallest values; the worst for the positive indicators, the smallest values, and the negative indicators are the largest values. The Rhine is the core of the ideals on this issue as Table 9.

CL is a number between zero and one. The closer this approach is to the solution, the better is the solution to the ideal (see Table 10).

According to the table above, the ranking of process indicators that are related to the problem-related strategies is shown in the table below. As it is seen in Table 11, the strategy of united or with the resources of the green supply chain is considered as the best choice of strategy, and the purchase strategy with the green supply chain resources is also the second priority.

Table 4 Indicators and criteria of the model and symbols used

The main criteria	Symbol	Sub-criteria	Symbol	Reference
United or associated with green supply chain sources	C1	Financial performance of green suppliers and green customers	S11	Yeh et al., 2014; Göçer, 2020; Ayag 2005; Yan & Azadegan, 2017; Garcia & Calantone, 2002; Tripathy & Eppinger, 2013; Tatikonda & Rosenthal, 2000; Wei et al., 2014
		Innovation green suppliers and green customers	S12	
		Technology green suppliers and green customers	S13	
		Flexible green suppliers and green customers	S14	
United or associated with non-green supply chain sources	C2	Financial performance of non-green supply chain	S21	Yeh et al., 2014; Göçer, 2020; Ayag, 2005; Yan, & Azadegan, 2017; Tripathy & Eppinger, 2013; Nerkar, & Roberts, 2004; Wei et al., 2014
		Innovation of non-green supply chain	S22	
		Technology of non-green supply chain	S23	
		Flexible of non-green supply chain	S24	
Buy with green supply chain sources	C3	Financial performance of green suppliers and green customers	S31	Yan, & Azadegan, 2017; Peng et al., 2014; Salvador & Villena, 2013; West & Gallagher, 2006; Gao et al., 2015; Stanko et al., 2007
		Innovation green suppliers and green customers	S32	
		Technology green suppliers and green customers	S33	
		Flexible green suppliers and green customers	S34	
Buy with non-green supply chain sources	C4	Financial performance of non-green supply chain	S41	Yan & Azadegan, 2017; Peng et al., 2014; West & Gallagher, 2006; Gao et al., 2015; Salvador & Villena, 2013; Smith, 1997
		Innovation of non-green supply chain	S42	
		Technology of non-green supply chain	S43	
		Flexible of non-green supply chain	S44	

Table 5 The results of the prioritization of indicators based on each of the criteria

Indicator Criteria	United or associated with green supply chain sources	United or associated with non-green supply chain sources	Buy with green supply chain sources	Buy with non-green supply chain sources
Financial performance	0.598774847	0.172906512	0.155116854	0.073201787
Technology	0.395687646	0.192501943	0.316822067	0.094988345
Innovation	0.210220598	0.50859909	0.215556479	0.065623833
Flexible	0.184031064	0.180010153	0.260651006	0.375307777

Table 6 Results of paired comparisons of criteria

Innovation	Flexible	Technology	Financial performance
0.201465429	0.192335888	0.370893404	0.235305278

3.3 Proposed integrated method

In this research, we used two methods of AHP and TOPSIS to prioritize options, and the results of these two methods were expressed. AHP was used to prioritize according to a set of criteria and TOPSIS to prioritize options based on their distance from the positive and negative ideals. After comparing the results, there are variations in them that may cast doubt on the decision maker's decision; therefore, in order to arrive at a single answer that has the characteristics of both decision-making techniques, the following is suggested:

We use the weight of the criteria obtained by the AHP method in TOPSIS (see Tables 12, 13, 14, 15).

3.4 Validation of the proposed method

To analyze the effectiveness and efficiency of the integrated approach, it is necessary to evaluate the results using other popular MCDM methods. In this section, to examine the efficiency and validity of the proposed approach, the weights of the indicators are calculated by the BWM and compared with the AHP method. BWM includes more robustness to the weight computation process. Further it reduces the pairwise comparisons versus AHP.

The results of the BWM are given in Tables 15 and 16. As can be seen in Table 16, the ranking results of AHP and BWM are the same, but there is a minor difference between the weights of indicators obtained by the two methods. To better understand, the comparing results are depicted in Fig. 3.

On the other hand, to investigate the performance and validity of the obtained results by the TOPSIS, these results are compared with the results of the VIKOR method. Table 17 shows the results of ranking the alternatives using the VIKOR method. Based on Table 17, when the problem is solved by the VIKOR method, the best alternative is united or associated with green supply chain sources, and the worst criteria is buy with non-green supply chain sources that is completely the same as the results of the TOPSIS method. The mentioned points show the validity and efficiency of the employed approach.

Final ranks of strategies in different methods are given in Table 18.

The final rankings of different MCDM methods are given in Table 18. Ranks of AHP, TOPSIS, VIKOR and BWM are the same for the first strategy "United or associated with green supply chain sources." Also, the fourth rank is also the same. The integrated method provides a different rank for three of the strategies, but the last one has rank four similar to the obtained ranks of other methods. The reason is the effectiveness of the integrated method encompassing the pairwise comparisons and criteria linear weighing of AHP and closeness computation considering ideal solutions leading to more precise weighing and ranking.

Finally, the graphical comparison of the methods separately and the integrated AHP-TOPSIS are charted in Fig. 4.

Figure 5 shows the effective orientations in each of the criteria in which direction.

Table7 Results of final decision making by AHP method

Indicator	United or associated with green supply chain sources	United or associated with non-green supply chain sources	Buy with green supply chain sources	Buy with non-green supply chain sources
The final weight of the strategies	0.365401	0.249171	0.247567	0.137861
Ranking strategies	1	2	3	4

Table 8 Unbalanced matrix

Criteria Indicator	Financial performance	Technology	Flexible	Innovation
United or associated with green supply chain sources	0.47	0.53	0.55	0.4
United or associated with non-green supply chain sources	0.51	0.48	0.46	0.48
Buy with green supply chain sources	0.57	0.58	0.42	0.6
Buy with non-green supply chain sources	0.43	0.39	0.55	0.51

Table 9 Identify the positive and negative ideals

Indicator	d_j^+	d_j^-
United or associated with green supply chain sources	0.021	0.052
United or associated with non-green supply chain sources	0.038	0.031
Buy with green supply chain sources	0.027	0.063
Buy with non-green supply chain sources	0.063	0.027

Table 10 The relative closeness of each option to the ideal

Indicator	CL_i
United or associated with green supply chain sources	0.707204348
United or associated with non-green supply chain sources	0.454018086
Buy with green supply chain sources	0.698044812
Buy with non-green supply chain sources	0.301955188

Table 11 Final ranking of TOPSIS

Indicator	Ranking
United or associated with green supply chain sources	1
United or associated with non-green supply chain sources	3
Buy with green supply chain sources	2
Buy with non-green supply chain sources	4

Table 12 Positive ideal and negative ideal

Indicator	d_j^+	d_j^-
United or associated with green supply chain sources	0.038695686	0.066717859
United or associated with non-green supply chain sources	0.043374805	0.048701796
Buy with green supply chain sources	0.040888253	0.081341159
Buy with non-green supply chain sources	0.084392645	0.018399714

Table 13 The relative closeness of each option to the ideal

Indicator	CL_i
United or associated with green supply chain sources	0.633
United or associated with non-green supply chain sources	0.529
Buy with green supply chain sources	0.665
Buy with non-green supply chain sources	0.179

Table 14 Final ranking of the combined method

Indicator	Ranking
United or associated with green supply chain sources	2
United or associated with non-green supply chain sources	3
Buy with green supply chain sources	1
Buy with non-green supply chain sources	4

Table 15 Results of final weights of main criteria by BWM method

Financial performance	Technology	Flexible	Innovation
0.232685	0.372554	0.191846	0.202914

4 Discussions and implications

This research aims to provide a new structure for assessing the use of new product development strategies in the green supply chain using a multi-factor decision-making technique. So, at first, a deep study of the literature of the subject and of the domestic and foreign studies was undertaken to provide the basic foundations for defining the necessary assumptions to evaluate the use of new product development strategies in Doosheh Dairy Company.

According to the purpose of this research, the present research is aimed at the field of applied research. On the other hand, considering the fact that in this research, library methods and field methods such as questionnaires have been used; it can be stated that the present research is based on the nature and method of a descriptive survey of survey type. Data collection methods were divided into two groups of libraries and fields. In order to collect information about the subject literature and the history of the research, library methods were used and information was collected using field method to answer the research questions. In this research, interviews and questionnaires were used to collect the research data.

This study provides an empirical theory-based test of inter-organizational NPD strategies in two dimensions: the type of external source (which the company opens the door to innovation) and the form of interaction (how a company communicates with an external source). Our results indicate that NPD strategies between organizations that engage with buying processes with foreigners are very suitable for the development of new high-quality products. Although our theoretical argument is that green supply sources need to supply the green supply chain resources in order to boost product innovation more quickly, our experimental results show that the difference is negligible. Experimental results confirm that affinity with technology can positively reap the benefits of purchasing radical products from green supply sources. However, the moderating effects of technology dependence

Table16 Results of final weights of strategies by BWM method

Indicator	United or associated with green supply chain sources	United or associated with non-green supply chain sources	Buy with green supply chain sources	Buy with non-green supply chain sources
The final weight of the strategies	0.366261	0.248583	0.246246	0.13891
Ranking strategies	1	2	3	4

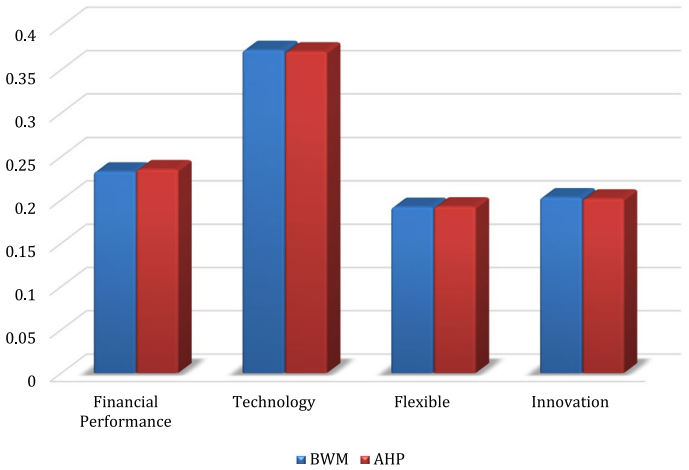

Fig. 3 Comparing the results of the BWM and AHP

Table 17 Final ranking of VIKOR

Utility index (S), dissatisfaction index (R), VIKOR index (Q)	S	Ranking	R	Ranking	Q	Ranking
United or associated with green supply chain sources	0.456	2	0.107	1	0.722	1
United or associated with non-green supply chain sources	0.354	4	0.0686	2	0.13	3
Buy with green supply chain sources	0.603	1	0.0686	2	0.63	2
Buy with non-green supply chain sources	0.385	3	0.055	4	0.062	4

Table 18 Compare ranking

	United or associated with green supply chain sources	United or associated with non-green supply chain sources	Buy with green supply chain sources	Buy with non-green supply chain sources
AHP	1	2	3	4
TOPSIS	1	3	2	4
VIKOR	1	3	2	4
BWM	1	2	3	4
AHP_TOPSIS	**2**	**3**	**1**	**4**

are not significant in the other three inter-organizational NPD strategies. The research also confirms the positive relationship between product innovation and financial performance of a new product. In short, this shows that following the product's newness can bring its benefits despite its dangers. Finally, our finding highlights the effective role of technology-related dependency at the project level and suggests that technological dependence can increase new impacts on financial performance. We find that buying strategies

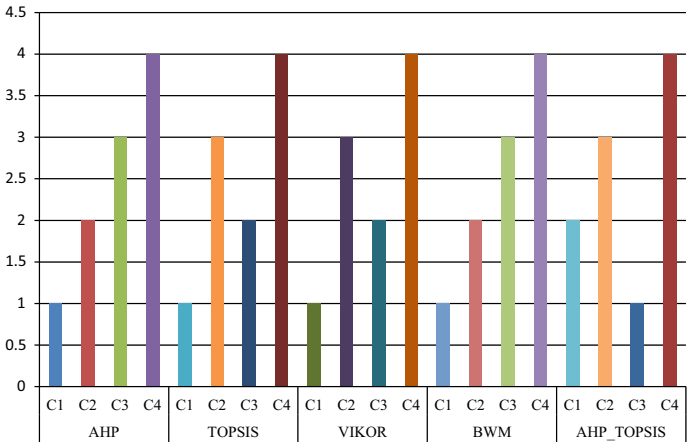

Fig. 4 Comparison of methods prioritization

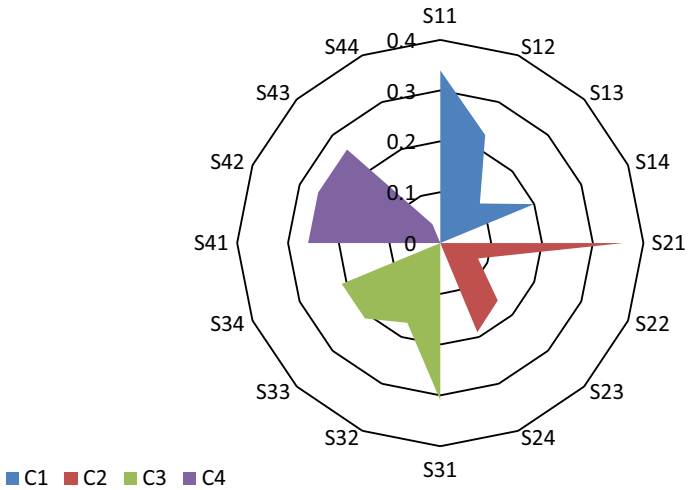

Fig. 5 Radar diagram of each of the criteria

are better than joint strategies (united) in creating innovative products, regardless of the type of external source of the company that they are involved with. This finding may be due to limited involvement of the company in the development of knowledge and a wide range of searches with shopping strategies. In addition, knowledge providers that are active in purchasing strategies are more independent. They are free of the corporate culture and processes of the focal point, which increases the likelihood of producing highly innovative products. The negative effect of the two strategies of allies and non-supply chain purchasers on the new product represents a potential probability of a common approach to innovation. Theoretically, our findings indicate the need for future studies to judge the qualitative differences between the various inter-organizational NPD strategies, so that we can understand how such differences affect the various outcomes of innovation. In other words, the main mechanism through which purchasing strategies from green supply chain resources

contributes to product financial performance is through the increase of the new product. This finding may be due to the initial objectives of the purchase approach, which means that it will acquire new knowledge. As you can see in Sect. 3, the final ranking is related to the fusion method. Therefore, after identifying the main indices of the research, in the first step, prioritizing the research indices was determined. Based on the results of the AHP method, the highest priority is the use of the technology criterion, with the weight of 0.37. The second priority, the financial performance criterion, is 0.23, and the third priority is the innovation benchmark with a weight of 0.20, and ultimately the final benchmark is 0.19.

In the next step, research options were ranked so that purchasing with green supply chain resources, united with or along with green supply chain resources, united, or with non-supply chain green supply sources with non-supply chain green supply, respectively, were the most important alternatives of unique four were ranked.

Therefore, Doosheh Dairy Company should focus on developing new products, taking into account environmental laws in the field of purchasing with green supply chain resources.

5 Conclusion

In the present study, because of the research approaches used in the operation, the community is considered by experts and senior experts in the field of study. In each of the phases of the study, the group of experts is determined according to the used technology. The first phase of the study is weighted with the AHP fan and the options are ranked. In the second phase, using the TOPSIS technique, the selected options are ranked, and in the third phase, a combination of two methods is examined, and finally options are ranked. After ensuring the reliability and psychological status of the existing questionnaire as the main tool for collecting data, the questionnaire was distributed among experts of the field of study. Therefore, raw data were collected for processing, analyzing and answering research questions. The summary of the results of these tests is presented below.

The findings of this study have been used to analyze the questionnaire among experts in the field of study. The main objective of the data analysis is to weigh the indices of the use of prefabricated concrete blocks in repairing port harbors. The panel was selected based on a combination of experts with various specializations, and a sample of 186 people was used. After determining and weighing the criteria in question, priority is given to the options.

The following areas are recommended for further research, and a further research is recommended:

1. The issue of reviewing and evaluating the use of the new product development strategy in other companies can increase the range of results and promote future studies as a tool.
2. The ANP technique can be used to rank the criteria; using Friedman test to rank the criteria and compare the results with the findings of this research is suggested.
3. Another similar approach is to use a grayscale or fuzzy relationship analysis that has a different environment than the current research environment.
4. Use of innovative methods in decision-making indicators.
5. Use multi-objective linear programming models to optimize the choice of strategies.

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