The Literature Review of De Novo Programming

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Naglaa Ragaa Saeid Hassan

Associate Professor - Dept. of Operations Research and Management, Faculty of Statistical Studies and Research, Cairo University, Egypt.

Abstract: *De novo programming (DNP) is a system design approach which links system flexibility efficient and optimal system design. It shows that within single or multi-objective decision making framework. DNP allows the decision maker to achieve an ideal or meta-optimal system performance, or improve the performance of compromise solutions through the modification of the feasible region of decision alternatives. This paper considers a brief review of DNP, which provides a brief insight DNP and its applications.*

Keywords: *De Novo Programming – Optimization techniques –Redesign Systems – Resources allocation – The Optimum path ratios – Improving the Performance*

1. Introduction

Traditional linear programming (LP) is a good way to obtain the optimal allocation of limited resources. But the modern view has been shifted from an allocation of the limited or fixed resources optimally for a given system to design an optimal system for the existed resources. The process of optimization is pivotal to the areas of economics, engineering, as well as management and business, etc. [1] presented the concept of DNP to deal with optimal designing of a system where all the objectives are optimized simultaneously, no trade-offs among the objectives are necessary and no resources are left unused. So, the major characteristic of DNP is to realize the optimal system design instead of optimizing a given system. In 1986, [2] introduced a new way of resolving multiple-criteria decision making problems depending on the DNP to pursue the requirements of modern production which characterized by no-waste, no-buffer, just-in-time operations, full utilization of scarce resources,…etc.[3] explained the purpose of optimizing the system not just to improve the performance of a given system but rather to find the best one (design an optimal system). Many researches rarely dealt with system design. Rather, they focused on valuation of a given system, searching for decision variables that maximize a single or multiple objectives. This review introduces to discuss a theory, methodology and different techniques of DNP and its applications.This paper is as follows: In Section 2 introduces "The De Novo programming", its general model, formulation, and optimum-path ratios for selecting the optimal system designs to solve DNP problems. Section 3 represents "A review over De Novo Programming" which includes a brief review insight the DNP. Section 4 represents "Theanalysis & summary of literature review" including the applications used and the methods or techniques applied. We also show the percentage of each type of applications on the DNP. The conclusion is given in Section 5.

2. The De Novo Programming

In 1980, [1] presented the concept of DNP to deal with optimal designing of a system. This method was first designed for single-criterion decision making and later it is extended to multi-criteria (MC) decision-making, containing the maximizing type of objectives only [4]. [5] considered the general model of DNP by denoting the available amounts of resources $\boldsymbol{b_i}, \boldsymbol{i} = \boldsymbol{1}, \dots, \boldsymbol{m}$and their corresponding prices $\boldsymbol{p_i}$,then $\boldsymbol{p_1 b_1} + \cdots + \boldsymbol{p_m b_m}$ represents the total valuation of resources. The individual $\boldsymbol{b_i}$'s are not "given" constants but rather decision variables affecting the value of the objective functions involved. Suppose that $\boldsymbol{B}$indicates to the available budget for the purchases of the resources. We want to maximize profits $\boldsymbol{C}$ for single or multiple objective problems, and the representation of the resource allocation (RA) can be formulated as in the following LP model:

$$\begin{gathered} \textit{Maximize } \boldsymbol{Z = CX} \\ \textit{s.t.} \boldsymbol{AX - b \le 0, \ pb \le B, X \ge 0} \end{gathered} \quad (1)$$

Where $C \in R^{q*n}$ and $A \in R^{m*n}$ represent matrices with dimensions $q \times n$ and $m \times n$ respectively, and $b \in R^m$with m-dimensional unknown resource vector, $X \in R^n$ is n-dimensional vector of decision variables, $p \in R^m$ is the vector of the unit prices of m resources, and $\boldsymbol{B}$is the given total available budget.

Solving problem eq. (1) means finding the optimal allocation of B so that the corresponding to resource portfolio b maximizes simultaneously the values $Z = CX$of the product mix x. It is obviously that to transform problem (1) into problem (2) as follows:

$$\begin{gathered} \textit{Maximize } \boldsymbol{Z = CX} \\ \textit{s.t.} \boldsymbol{VX \le B , X \ge 0} \end{gathered} \quad (2)$$

Where $Z = (z_1, \dots, z_q) \in \mathrm{R}^q$and $V = (v_1, \dots, v_n) = pA \in \mathrm{R}^n$

Let $\boldsymbol{z_{k*}} = max \ \boldsymbol{z_k}$, $\boldsymbol{k = 1, \dots, q}$, be the optimal value for $\mathbf{k^{th}}$ objective of Problem (2) subject to $VX \le B, X \ge 0$, $X \ge 0$.Let $z^* = (z_{1*}, \dots, z_{q*})$ be the q-objective value for the ideal system with respect to $\boldsymbol{B}$. Then, a meta-optimum problem (problem (3)) can be constructed as follows:

$$\begin{gathered} \textit{Minimize } \boldsymbol{B = Vx} \\ \textit{s.t} \boldsymbol{Cx \ge Z^* , x \ge 0} \end{gathered} \quad (3)$$

Solving problem (3) yields x^*, B^* (= $\mathrm{V}x^*$) and b^* (= $\mathrm{A}x^*$). The value $\mathbf{b}^*$ identifies the minimum budget to achieve $\mathbf{Z}^*$through $\mathbf{x}^*$and $\mathbf{b}^*$. At$B^* \le B$, the optimal design reached. Since $B^* \ge B$, the optimum-path ratio for achieving the ideal performance $\mathbf{Z}^*$ for a given budget level $\boldsymbol{B}$is defined as in (4):

$$\boldsymbol{r^*} = \frac{\boldsymbol{B}}{\boldsymbol{B^*}} \quad (4)$$

And establish the optimal system design as (x, b, Z), where $x = r^* x^*$, $b = r^* b^*$ and $Z = r^* Z^*$. The optimum-path ratio $\boldsymbol{r^*}$ provides an effective and fast tool for efficient optimal redesign of large-scale linear systems.

2.1 The optimum-path ratios

[6] summarized several optimum-path ratios depending on the basic optimum-path ratio $\boldsymbol{r^*}$, as alternatives for selecting the optimal system designs to solve DNP problems.She summarized the relationships between the budgets $B^{**}, B^*, B,$ and b_j^k that serve as the basis of the optimum-path study.

$$\boldsymbol{B^{**} \ge B^* \ge B \ge b_j^k} \textbf{, for } \boldsymbol{k = 1, \dots, q} \quad (5)$$

The Theorem in eq 5 could be defined in six types of optimum-path ratios as follows:

(i) $r^1 = \frac{B^*}{B^{**}}$; (ii) $r^2 = \frac{B}{B^{**}}$; (iii) $r^3 = \frac{\sum \gamma_k b_{jk}^k}{B^{**}}$

(iv) $r^4 = \frac{B}{}$; (v) $r^5 = \frac{\sum \gamma_k b_{jk}^k}{}$; (vi) $r^6 = \frac{\sum \gamma_k b_{jk}^k}{}$

The above optimum-path ratios represent the basic optimum path ratio studied by Zeleny. Assume the given initial budget level B in problem (1) or (2) can be replaced by either B^*using these optimum-path ratios, the following optimal system designs can be established.

(i) $x^1 = r^1 x^{**}$, $b^1 = r^1 b^{**}$, and $Z^1 = r^1 Z^{**}$

(ii) $x^2 = r^2 x^{**}$, $b^2 = r^2 b^{**}$, and $Z^2 = r^2 Z^{**}$

(iii) $x^3 = r^3 x^{**}$, $b^3 = r^3 b^{**}$, and $Z^3 = r^3 Z^{**}$

(iv) $x^4 = r^4 x^{**}$, $b^4 = r^4 b^{**}$, and $Z^4 = r^4 Z^{**}$

(v) $x^5 = r^5 x^{**}$, $b^5 = r^5 b^{**}$, and $Z^5 = r^5 Z^{**}$

(vi) $x^6 = r^6 x^{**}$, $b^6 = r^6 b^{**}$, and $Z^6 = r^6 Z^{\text{nd}}$

The meaning of the above optimal system design$(x^{\text{i}}, b^{\text{i}}, Z^{\text{i}})$ from 1 to 6 is that b^{i}represents the optimum portfolio of resources to be acquired at the current market prices, p, allows one to produce x^{i} and realize the multi-criteria performance Z^{i}.. When the problem (1) or (2) is actually applied to solve real world problems, these designs may be presented to the decision maker as candidates for the final optimal system design.

3. A Historical Review Over De Novo Programming

In this section, the review of DNP for the various optimization problems is presented.[1] developed an approach, known as the DNP model. This model seeks for an 'optimal system' by reshaping the feasible solution set, reaching to the optimality. Thus, the concept of DNP is to design an optimal system instead of finding an optimum in a given system with fixed resources. In 1981, [4], [7] presented another two papers about DNP. First one is about considering the main shortcoming of LP which is neither its linearity assumption, nor inefficiency, nor its single-objective but it is its inability to design an optimal system. This method was first designed for single-criterion decision making. The second papers, it is considered about the difference between "optimizing a given system" and "designing an optimal one" showing the new concepts for optimality, presenting new ways of resolving Multiple Criteria Decision Making (MCDM) conflicts & new conditions for optimal. In 1986, [2] extended the model to MCDM, containing the maximizing type of objectives only resolving MCDM problems using DNP for optimal and continuous system improvement. [8] considered the concept of an optimally designed for product-mix system formulating the corresponding duality theory. They showed that although the system is degenerate, the optimality of design "overcomes" its own degeneracy allowing unique valuation of all resources. [9] introduced the subject of soft optimization using DNP formulation of single and MOLP optimization techniques which incorporate MOs for increasing the utility of forest planning models. [10] showed that the DNP formulation deal with the best mixture of input specified as well as the best mixture of the output. [11] illustrated the potential use of designing optimal forest systems in the face of conflictive objectives. A MOLP model is used to illustrate this approach reaching to compromise solution under DNP conditions. [3] explained the purpose of optimizing the system, it is not just to improve the performance of a given system but rather to find the best system configuration itself (design an optimal system). Thus, Zeleny presented a theory and methodology of optimal system design embodied in DNP.

[12] & [13] extended Zeleny's basic method to identify fuzzy system design for de Novo problems by considering the fuzziness in coefficients. They proposed a two-step fuzzy approach based on the ideal and negative ideal solutions. They showed that this approach is very efficient and applicable to the general MCDNP. They also formulated and analyzed a fuzzy version of this problem. Also, [14] developed fuzzy goals and coefficients for the DNP model depending on a numerical approach which could be solved as either linear or nonlinear programming problems. [15] introduced fuzzy DNP as Fuzzy Optimization. [16] proposed several optimum-path ratios for enforcing different budget levels of resources so as to find alternative optimal system designs for solving MCDNP problems. The problem is formulated as DNP with a given initial budget level and

an optimal pattern preferred by the decision maker. An interactive algorithm is developed to continuously reshape the problem for matching the optimal pattern. [17] considered MC production planning using DNP approach. The production plan for a real system is defined taking into account financial constraints and given objective functions. This study illustrated how to design an optimal production model reaching to the optimal functioning and maintenance. [16] presented MCDNP to formulate and solve problems of system design that involve multiple decision makers and a possible debt. In the framework the decision maker has involved his or her own preference for the budget availability level associated with MC under consideration. The model allows flexibility for decision makers to borrowadditional money from the bank with a fixed interest rate so as to keep the production process feasible. [18]considered the two fundamental dimensions of management: what is your system and how do you operate it. The main foundation of the competitive advantage already recognized managing the optimally designed, high-productivity, and tradeoffs-free systems. He summarized the basic formalism applying DNP.

[19] presented the impossibility of optimization when crucial variables are given showing the eight basic concepts of optimality. He showed a more realistic problem of LP to be optimized with MO functions using DNP. [20] suggested an optimal resource portfolio using DNP. A numerical example demonstrated the criteria of strategic alliances. The authors explained the formation of strategic alliances providing solutions for RA in achieving the desired level.

[21] considered DNP problems by extending to a fuzzy dynamic programming problem. First, a traditional DNP problem is modified to DNP problem with multiple fuzzy goals, fuzzy constraints and multiple stages. Second, they regard this model of fuzzy multi-stage DNP problem as a fuzzy dynamic programming problem.

[22] introduced the use of MC approach in designing the optimal production system. They combined the MC and DNP in a productionmodel. Moreover, they applied in a real production system which produces various ferroalloys using a number of different raw materials. Lastly, the paper demonstrated how the usual MC problems could be handled in a different concept of optimization using DNP approach.

[23] proposed fuzzy MO dummy programming model to overcome the problems to achieve the goal such as the correct alliance partners and the appropriate RA. Depending on the numerical results, they suggested model to provide the best alliance cluster, the maximum synergy effects, and the optimal alliance satisfaction

[24] integrated information technology into instruction to build an education RA planning model using DNP. They expected building an efficient planning model for school education using DNP to achieve a desired level of RA with minimum cost. The efficiency planning model is reached to the optimal RA and also enhanced the performance of teaching activities.

[25] considered a combined DNP with MODM techniques to solve RA problems for Environment-watershed resource management. The model is designed from the DNP perspective to help environmental-watershed optimize their maintenance resource portfolio. [26] applied DNP as an alternative strategic alliance to achieve optimal RA in supply chain (SC) systems. They developed an efficient resource planning model for best optimal RA.[27] introduced inexact DNP approach to design an optimal water resources management system under uncertainty. The optimal supplies of good-quality of water are obtained in considering different revenue targets under a given budget.[28] introduced the essential multi-dimension of an economic Problem: Towards tradeoffs-free Economics. He used DNP through a feasible set of opportunities towards an optimal to tradeoffs-free configuration.[5] in the handbook of MC analysis explored some topics beyond traditional MCDM, he explained the simplest possible terms of what MO optimization is, defining the subject matter, and discussing the role of tradeoffs-based versus tradeoffs-free thinking.

[29] presented approaches for solving the MODNP. He also introduced possible extensions, methodological, and real applications.

[30]applied DNP as a methodology of optimal system design by reshaping the feasible sets in linear systems. He summarizes the basic concepts of the DNP optimization, extensions,

methodological and actual applications. He formulated& solved the SC problem using the DNP approach.

[31] introduced a new interactive framework for sensitivity-informed de Novo planning to confront the deep uncertainty within water management problems. The framework couples global sensitivity analysis using Sobol variance decomposition with MO evolutionary algorithms to generate planning alternatives. The study examined a single city's water supply in Texas, using 6 objectives problem formulations that have increasing decision complexity for 10 years planning horizon. The planning framework showed how to adaptively improve the value and robustness of the problem formulations. [32] suggested a new approach for solving multi-stage and MODM problem using DNP.[33] applied MOGP for solving priority with the pavement maintenance works in the pavement management system. The DNP is used reaching to the ideal point. They tried to use this method to solve Taiwan Freeway's maintenance work programming. The analytical results completed by DNP. The performance is improved by budget. So DNP is applied on pavement maintenance as a new way to solve the problem.

[34] presented DNP as a new technique for optimal system design. The advantage of the proposed approach is that it requires less number of variables to be introduced in the solution procedure and thus reducing the processing time in comparison with the existing method.

[35] suggested Min-max Goal Programming (GP) approaches using positive and negative ideals to solve the MODNP problem.

[36] considered brief history of De Novo technique, mathematical definitions of MCDNP, and global criterion method is given with their respective principles. They presented a real firm applications given the budget for the same level of production is significantly can be reduced by an improvement in problem constraints.

[37] proposed planning water resources systems under uncertainty using an interval-fuzzy DNP method.

[38] adopted the DNP for achieving firm's strategic goal. They used the DNP to help firms finding out an optimal resource integration based on financial consideration.

They planed model provided reliable systematize approach that combines alliances from external resources and change them to internal resources application. The project team adopting open innovation concept through outsourcingreduces design cost and enhances design performance. DNP not only obtains optimal resource integration but also promotes the conceptual of strategic alliances for firm's cooperation between each other.

[39] presented the capacity determination in a closed-loop SC network when a queuing system is established in the reverse flow. Since the queuing system imposes costs, the decision maker faces the challenge to determine the capacity of facilities which represent a compromise between the queuing costs and the fixed costs of opening new facilities.They developed DNP approach to determine the capacity of recovery facilities in the reverse flow using a mixed integer nonlinear programming model integrated with the DNP and uncertainty of the parameters.

[40] considered a bi-objective integrated model for supplier location-allocation, capacity allocation and supplier selection, and order allocation problems in two level SCs. First, they proposed a single-objective model to minimize the total costs. Second, they used DNP to determine the optimal capacity of selected supplier(s).[41] presented an alternative approach for solving the general MODNP Problem under fuzzy environment in one step using Luhandjula's compensatory $\boldsymbol{\mu_{\theta}}$-operator.

The solution obtained represents an efficient solution under the assumption. The method has been illustrated by a numerical example. They showed that the suggested methodology requires less processing time in comparison with the existing ones because the problem can be solved in one step only. To make the problem more flexible, instead of crisp coefficients, fuzzy, type2 fuzzy coefficients can be considered.

[42] considered the potential use of the meta-GP approach for solving MCDNP problems. The objectives of the DNP problem are converted into meta-goals during formulation to arrive at the most satisfactory decision in the MODM context. This approach is shown superior. It provides decision-makers with more flexibility in expressing their preferences, by merging the original explicit goals as meta-goals. The proposed model is provided the best plan for the exploitation of wind energy sourcing.

[43]developed a Fuzzy MCDNP problem. The fuzzy parameters are characterized by fuzzy numbers. A fuzzy GP approach is applied for the corresponding MCDNP (α - MDNLP) problem defining suitable membership functions and aspiration levels. The advantage of the approach is that the decision maker's role is only the specification of the level α and hence evaluate the α – coefficient solution for limitation of his/her incomplete knowledge about the problem domain.[44] proposed weighted GP approach for solving MODNP problems. In this approach, the weighted GP technique has been used, where only one deviation variable has been taken. [45] suggested the goal objectives using the average concept for objectives that have the same interests. Determination of goals with an average each concept considers the objectives of other goals in determining a goal. Determination of goal objectives using the average concept applied to the GP to solvethe MO problem of the DNP. The computational results with benchmark problems show that the proposed method gives satisfactory results and more practical work.

4. Analysis of The Literature Review

From the previous analysis of the Literature Review in Table 1, the DNP is a good field for building the optimal system design. Figure 1 represents the different area of applications covered using DNP technique as follows:

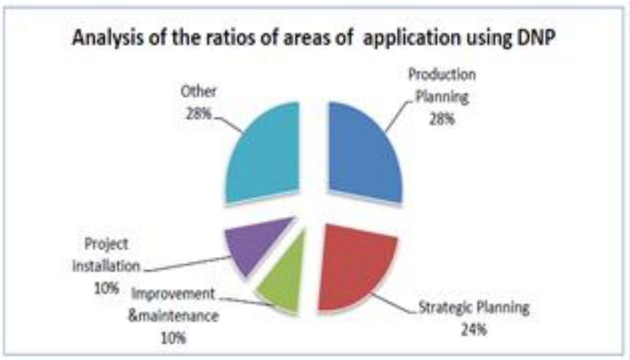

Figure 1. The ratios of areas of application using De Novo Programming

Table 1 Analysis of the Literature Review

No	Author(s) Ref. No.	Application	Single / multi - objectives	Method
1	[1]	Numerical examples	Single objective	He suggested the concept of DNP to design an optimal system instead of finding an optimum in a given system with fixed resources.
2	[4]	Resources allocation	Single objective	He showed that the main shortcoming of LP is its inability to design an optimal system. Thus, this method was first designed for single-criterion DM.
3	[7]	Numerical examples	Multiple Criteria Analysis	He showed the difference between "optimizing a given system" and "designing an optimal system" presenting the new concepts of optimality.
4	[2]	Production system continuous	Multiple Criteria	He applied DNP to resolve MCDM model with conflicts and continuous system.

Continue Table 1

No	Author(s) Ref. No.	Application	Single / multi - objectives	Method
5	[8]	Resources allocation	Single objective / duality	They considered the concept of optimally designed formulating the corresponding duality theory. They showed that although the system is degenerate, the optimality of design "overcomes" its own degeneracy and allows unique valuation of all resources.
6	[9]	Forest planning model	Single and Multi objective / Utility	They introduced the subject of soft optimization using DNP formulation of single and MO optimization problems.
7	[10]	Resources allocation	Multiple criteria decision making	He showed that the DNP formulation deal with the best mixture of input as well as the best mixture of the output.
8	[11]	Forest system	A multiple objective LP model	They designed optimal forest systems with conflictive objectives. A multiple objective LP model is used .A compromise solution under De Novo conditions is discussed.
9	[3]	Numerical example	multiple criteria decision making	A theory & methodology of optimal system design embodied using DNP.
10	[12],[13]	Numerical example	Fuzzy multi-criteria	They extended Zeleny's basic method to identify fuzzy system design considering the fuzziness in coefficients. They proposed a two-step fuzzy approach based on the ideal and negative ideal solutions. They showed that this method is very efficient and applicable
11	[14]	Numerical example	Fuzzy multiple criteria goals	The general MCDNP problem is solved where both the goals and the coefficients are treated simultaneously.
12	[15]	Numerical example	Fuzzy	He presented a Fuzzy DNP
13	[16]	Numerical example	Multi-criteria	He proposed several optimum-path ratios on different budget levels of resources to find the alternative of optimal system designs for solving MCDNP problems.

Continue Table 1

No	Author(s) Ref. No.	Application	Single / multi - objectives	Method
14	[17]	Production program	multi-criteria	They presented the possibilities for optimal production plan design using MCDNP approach.
15	[16]	Budget availability and possible debt	multi criteria	He made the framework of the system design model using a MCDNP approach.
16	[18]	Production system	Single	He summarized the basic formalism of DNP as it applies to linear systems.
17	[19]	Numerical example		He drawn attention to the impossibility of optimization when variables are given and present eight basic concepts of optimality including DNP.
18	[20]	Strategic alliances		They provided an optimal resource portfolio using DNP in strategic alliances and RA.
19	[21]	Numerical example	Fuzzy multi-stage dynamic	They extended the traditional DNP problem to a DNP problem with multiple fuzzy goals, fuzzy constraints and multiple stages. Then, they regarded this fuzzy multi-stage DNP as a fuzzy dynamic programming
20	[22]	Production system	multi-criteria	They combined the MC and DNP in a production model to design the optimal production system.
21	[23]	allocating optimal alliance resources	fuzzy multi-objective	They choose the best alliance partners and allocating optimal alliance resources using the fuzzy MO dummy programming model
22	[24]	An education resources allocation		They formulated RA model using DNP for school by integrating information technology into instruction to achieve the aspired/desired level.
23	[25]	Environment-watershed resource management	fuzzy multi-Criteria decision making	They combined DNP with Multiple objective decisions making to solve resource allocation problems for Environment-watershed resource management.
24	[26]	strategic alliances and resource allocation in supply chain	Supply chain	They used the DNP approach as a strategic alliance alternative to achieve optimal RA in SC systems.

Continue Table 1Continue Table 1

No	Author(s) Ref. No.	Application	Single / multi - objectives	Method
25	[27]	water resources systems		They considered inexact DNP for water resources systems planning
26	[28]	Economic Problem	multidimension al	He introduced multi-dimension of an economic problem
27	[5]	Numerical example	Multi objective	He explained the terms of MO optimization & discussed the role of tradeoffs-based versus tradeoffs-free thinking using DNP
28	[29]	Illustrative example	Multi objective	He presented approaches for solving the multi objective DNP problem, extensions, examples, and applications.
29	[30]	Supply chain problem	Multiple Objectives	He used DNP for optimal system design reshaping the feasible set in linear systems. He formulated & solved the SC problem using DNP.
30	[31]	Single city water supply in Texas	Water supply portfolio planning Many-objective Under uncertainty	They presented DNP to and uncertainty within water management problems by coupling global sensitivity analysis using Sobol' variance decomposition with MO evolutionary algorithms.
31	[32]		Multi-stage and multi-objective	They suggested a new approach to solve multi-stage &MODM problem using DNP
32	[33]	Taiwan Freeway's maintenance work system (Pavement Maintenance)	Multi-objectives goal	They used MOGP to solve priority with the pavement maintenance works in the pavement management using the De Novo method to approach the ideal point.
33	[34]	Numerical example	Multi-objective DM	They applied DNP technique for optimal design of a system. The advantage of the proposed approach is that it requires less number of variables, thus reducing the processing time.
34	[35]	Numerical example	multi-objective Goal	He suggested DNP and Min-max GP approaches using positive and negative ideals. He identified compromise solutions using min-max approach
35	[36]	A production system that produces four types of plastic balls	Global Criterion Method	They built an optimum Production Settings solving the problem using Global Criterion Method with DNP. It is seen that both Global Criterion Method and De Novo solutions give the same values.

No	Author(s) Ref. No.	Application	Single / multi - objectives	Method
36	[37]	Planning water resources systems	interval-fuzzy DNP	They used an interval-fuzzy DNP for planning water resources systems under uncertainty
37	[38]	IC Design Service Firms Resources Integration	Resource integration	He Adopted the DNP to help firms to find out an optimal resource integration base on firm financial consider. They planed model provided reliable systematize approach that combines alliances from external resources and change them to internal resources application.
38	[39]	Supply chain	Fuzzy programming	They developed a DNP to determine the capacity of recovery facilities in the reverse flow. A mixed integer NLP model is integrated with the DNP and the robust counterpart model is proposed with uncertainty. So, interactive fuzzy approach combined with the hard worst case robust prog.
39	[40]	Bi-objective location allocation inventory network	Single-objective & bi-objective	First stage, they proposed a single-objective model to minimize the total costs. In second stage, they used DNP to determine the optimal capacity to select supplier(s). They proposed bi-objective mix-integer nonlinear model to solve the problem.
40	[41]	Numerical example	Fuzzy multi-objective	They presented an alternative approach to solve the general MODNP Problem under fuzzy environment in one step using Luhandjula's compensatory $\mu_\theta$operator.
41	[42]	Build wind energy sites	Multi-criteria	The objectives of DNP are converted into meta-goals reaching to the most satisfactory decision in the MODM context.
42	[43]	Numerical example	Fuzzy Multi-criteria & GP	Fuzzy goal programming approach is applied on MCDNP
43	[44]	Illustrative example	Multi-objective goal programming	The weighted GP has been used and only one deviation variable has been taken.
44	[45]	benchmarking problems	Multi-Objective	The average concept is applied to the GP model to solve the MODNP. The computational results with benchmark problems showed that the proposed method gives satisfactory results and more practical

Comment on analysis

28% of the applications used in production planning to find the optimum resource portfolio for different type of products (Plastic balls, wood utilization, ferroalloys, clothes, hardware, software, and health care), 24% used in Strategic planning (strategic alliances, funding, supply chains, and inventory design), 10% used in improvement & maintenance (pavement maintenance, Freeway's maintenance, and watershed resource maintenance), 10% used in project installation (installing wind energy farm, water supply portfolio, and building an education system), and 28% on other types of different applications.The DNP technique made a new evolution for the concept of optimality. This technique is more helpful for the decision maker to allocate the optimum resource portfolio specially while having tradeoffs between the objectives of the multi criteria decision making problems to meet the ideal point of the solution which is frequently outside the feasible set of solutions. The most critical problem with the DNP is that the required budget could be exceed the subject budget using the DNP, so that the optimum path ratio in some situations is used to avoid the raised level of required budget related to the available one.

5. Conclusion

The DNP is a technique which uses to redesign a system reaching to the optimal solution. A brief review of DNP is presented in this paper, then analysis and summary of the literature review. Applications of DNP for various optimization problems are also discussed.

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