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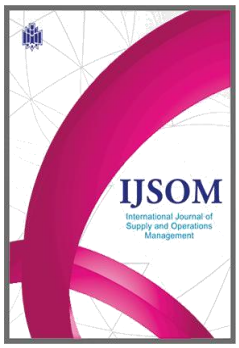

Evaluate The Role of Policies in The Sustainability of the Supply Chain Through a Comprehensive Mathematical Approach

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Abstract

This study has two policies to support supply chains. In the first model, three types of subsidies are provided for each supplier. In the second model, the government enters the chain directly by creating an integrator facility, which is responsible for packaging and coordination between facilities, and assumes the cost of packaging, and by merging publications together in one package, reduces the number of submissions and it supports the supply chain. For each of the above cases, a mathematical model was defined and a case study was conducted for 6307 customers and 119 districts of Tehran. According to the output of the models, the profit of each supplier including subsidies was more than the second model in the first model. However, the amount of subsidies paid in the first model is much higher than in the second model. By considering this issue and eliminating subsidies from profit calculations of the two models, the second model showed a more favorable performance in equal and full welfare in all regions. However, the first model had a better performance in conditions with different welfares in various regions. According to the results, in addition to subsidies, the government must enact laws that oblige publishers to complete welfare.

Keywords: Economic Savings; Supply Chain Management; Supplier; a Comprehensive Mathematical Approach; Sustainability Policies and Sustainability.

1. Introduction

Social justice has long been a central issue in societies. In general, social justice can be considered as relatively equal attention to all areas of socio-economic, political, social and cultural life and their core values (wealth, power, commitment and knowledge) in terms of freedom of action, equality of opportunity and conditional inequality in the production and distribution of values (Sazvar, et al., 2021; Piraee & Seif, 2011). Social justice is one of the issues that need attention in modern societies and the development of urbanization with regard to the urban environment. Harvey defined societal and spatial justice of cities as the fair allocation of urban facilities and resources, such that people become aware of their rights with minimal gaps and protests and are able to meet their demographic needs at various levels (Rezaee, 2013; Farooq, et al., 2021).

Social justice is established by planning and implementation of social welfare improvement programs. Given the wide range of social welfare-related programs and activities, ensuring the welfare of the individual and the community has always been discussed by thinkers and experts of various societies. Based on the experience of developed countries, social service supply must occur such that it is comprehensively implemented by the government and then is followed up by more targeted interventions (Mehrjerdi & Shafiee, 2021; Wood & Gough, 2006). Accordingly, governments are

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the first comprehensive social welfare suppliers. In fact, social welfare programs are a part of the responsibilities of the government (Allameh, Esmaeili, & Tajvidi, 2014; Esmaeili & Zandi, 2018).

Government policies can affect various economic variables, including welfare and poverty, through cost policies, tax policies and affairs related to rules and regulations (Farahani et al., 2014; Luo et al., 2014). In this regard, various recent studies have focused on the government's role in the social welfare area. Overall, the research conducted in this field can be divided into two classes: the first class is related to the effect of macro policies such as fiscal policies Madani, & Rasti-Barzoki, 2017; Melo et al.,٢٠٠٩, government budget, and subsidy reform on social welfare, whereas the second class involves government's role and programs in supply chains related to social welfare. The present study's topic is related to the second class. In this field, Rafeei & Sayadi, (2018); Ali, (2021), was performed to evaluate the role of government in the design of reward mechanisms for electric cars based on a news-vendor model with pricing. The goals of government interventions included coordinating the price and increase the accessibility to the good to increase social welfare. In another research, Luo et al. (٢٠١٤) evaluated an electric car supply chain involving a manufacturer, a retailer and heterogeneous customers. One of the assumptions of the foregoing study was the use of a price-discount incentive scheme by the government to increase electric car purchase rates and reduce air pollution.

Hadi evaluated competition in an open and closed-loop supply chain (CLSC) with government intervention (Farooq et al. 2021). Mahmoudi and Rasti-barzoki (2017)modeled the conflict between government and manufacturer's objectives and used the game theory method for the first time. They considered three scenarios of government profit optimization and setting an upper bound for environmental impacts, environmental effect optimization and setting a lower bound for government profit and creating a balance between government profit and environmental impacts. Heydari et al. (2017), evaluated reverse and closed-loop supply chain coordination by considering government roles. They analyzed the government role in improving coordinated supply chains through donating different incentives (tax exemption and subsidy) to supply chain members.

In another study, Xie and Ma (2016) assessed the recycling supply chain of China's color TVs market. They introduced a Duopoly market of color TV recycling, where the government sells its old TVs to one of the two sellers both as a subsidy provider and as a large seller. By creating a game among two recyclers and a processor in a Duopoly market of color TV recycling, they concluded that as government spending increases, the amount of social welfare as well as the amount of recycling and profits of the two sellers' decreases. Esmaeili and Zandi (2018) evaluated two green and non-green three-layer supply chains based on the intervention of the government in the amount and price of green and non-green goods. They saw the government as a leader in reducing economic and environmental costs and increasing the social welfare index by setting tariffs. In a study, Madani and Rasti-Barzoki (2017)presented a competitive mathematical model, in which they considered the leader role for the government and the follower role for two green and non-green supply chains, both encompassing a manufacturer and a retailer. By doing so, they assessed the policies of pricing, greening strategies and government tariffs by considering the direct supervision of the government.

Integration of location-inventory problem in a supply chain network is one of the classic topics in the area and has been covered by researchers such as Dai et al. (2018), who developed an optimization model with fuzzy capacity and carbon emission limitations. The mentioned scholars formulated a mixed-integer non-linear model and used a hybrid genetic algorithm (GA) and harmony algorithm to minimize costs. The issue of logistics and supply chain design is one of the most important strategic decisions that has been considered by many researchers. In this type of design problem, the number of types, locations, capacity levels and technology level of the facilities in the network are determined. In addition, transport channels and material flow rates between facilities are specified. Given that operational and tactical decisions are often executed following the implementation of strategic and long-term decisions, strategic decisions are an important factor influencing short-term decisions such as tactical and operational decisions (Ghavamifar, 2015). Comprehensive studies have been conducted in this area in the past few years, which have been able to present a comprehensive classification of supply chain network design models. In this respect, some of the studies in the area have been performed by (Melo et al. 2009, Farahani et al. 2014 and Govindan et al. 2017).

Today, three welfare modes of "informal supply", "non-supply" and "welfare state" can be identified depending on various development levels of different countries Rafeei, & Sayadi (2018). There is a formal legal system in companies with an informal supply system, and even democratic principles are properly adhered to in countries such as India. Nonetheless, lack of balanced development of capitalism and existence of large rural areas and staggering poverty in urban areas have caused poor welfare and the prevalence of insecurity. In this respect, institutional arrangements are

the most important cause of a non-supply system, which results in extreme insecurity (Al-waeli et al., 2020). This is a core reality in most poor countries in the world, including Sub-Saharan Africa, (the West Bank and the Gaza Strip 2006). The welfare state is a type of welfare organization in which governments play a pivotal role (Hanoon et al., 2020a). This military-related term refers to the provision of residents' welfare by the government through service provision and income transfer in order to meet their basic needs and adhere to their social rights (Hanoon et al., 2020). There is a relatively independent government in a welfare state system. This government operates regularly and its institutional perspective includes a welfare mix of market, (government and family Rafeei, 2018 ; Hanoon et al., 2021). The study contributes through supply chains that conceder one of the most important economic pillars of any country that can have a great impact on sustainability. In this regard, this article has two policies to support supply chains. In the first model, three types of subsidies are provided for each supplier. In the second model, the government enters the chain directly by creating an integrator facility, which is responsible for packaging and coordination between facilities, and assumes the cost of packaging, and by merging publications together in one package, reduces the number of submissions and it supports the supply chain.

2. Literature Review

Barman et al., (2022) the objective of this work is to maximize the supply chain profit by minimizing the amount of carbon emissions. To determine optimal outcomes, a centralized system, manufacturer-leadership Stackelberg game and retailer-leadership Stackelberg game are employed. A comparison among the centralized system and the two Stackelberg games is also carried out. The results presented that to enhance the profits of the manufacturer as well as retailer and to decline carbon emissions, manufacturer-leadership Stackelberg game is the adequate game policy. Ali et al., (2021) & Al-Waeli et al., (2022), A study is undertaken to comprehend the supply chain framework that handles perishability issues in production and distribution. Researchers propose a multi-objective mixed-integer non-linear supply chain coordination model under uncertain environments to minimize the cost of transportation, offset wastage of products, and neutralize the losses due to insufficiencies of transit and storage amenities. The proposed model is meant for managing the delivery with lesser deterioration losses for producers, warehouses, and retailers (Dey et al., 2023& Singh et al., 2024).

Dey et al., (2022) the present study focuses on supply chain management to improve its sustainability from economic, environmental, and social perspectives. Numerical examples show that autonomation technology increases the system's reliability by 64%, where eco-production reduces carbon emission by up to 16%, and the total profit increases by up to 25%. Moreover, the application of advanced SSMD reduces the transportation cost by up to 34%. Jana et al., (2023); Sabour & Al-Waeli, (2023) For the first time, the critical problem of selecting the most sustainable strategy for urban parcel delivery is addressed and solved in this paper. Three alternatives for organizing urban parcel delivery are defined, which are traditional, united consolidation center, and inner-city hubs. According to the three pillars of sustainability, an assessment framework for practitioners is proposed. These research findings show that the united consolidation center is the most sustainable strategy for organizing urban parcel delivery (Barman et al., 2021 & Pervin et al., 2023).

A literature review in the field of social welfare and supply chain revealed that most studies have focused on the legislative area or provision of financial subsidies to increase social welfare in a supply chain. Despite the direct role of the government as a welfare state and one of the members in the activities of most supply chains (sometimes the entire chain), no study has been conducted in this field, especially the issue of supply chain network design and strategic decisions made in it. The present study compares two government approaches, including subsidizing and direct financial support of chain members and entering the supply chain as a member and with the role of management and coordination of chain members after their description. Notably, a supply chain design is required based on the second approach. The problem is stated and its different perspectives are explained. Afterwards, the components of the two models are presented and their mathematical models are described. In the next stage, the supply chain sharing scheme is introduced as a case study and the data used are presented. In the end, the two government approaches are compared and the conclusion is made based on the results, The following Table 1 summaries our review of the literature.

Table 1. Summary of literatures

Authors'	The Objective Of Study	The Results Of Study
Barman et al., (2022)	The objective of this work is to maximize the supply chain profit by minimizing the amount of carbon emissions.	The results presented that to enhance the profits of the manufacturer as well as retailer and to decline carbon emissions.
Ali et al., (2021)	A study is undertaken to comprehend the supply chain framework that handles perishability issues in production and distribution.	The proposed model is meant for managing the delivery with lesser deterioration losses for producers, warehouses, and retailers.
Dey, Yilmaz, et al., (2022)	The present study focuses on supply chain management to improve its sustainability from economic, environmental, and social perspectives.	Numerical examples show that autonomation technology increases the system's reliability by 64% and the application of advanced SSMD reduces the transportation cost by up to 34%.
Barman et al., (2022)	The objectives of this study are to maximize the manufacturer's profit and minimize the greenhouse gases emissions for producing green products. The multi-objective model is solved by utilizing the fuzzy goal programming approach.	The results indicate that the system profit is increased by 16.1% by investing in both preservation and green technology. Furthermore, a sensitivity analysis is performed along with some managerial insights for practitioners. Finally, the paper is ended with conclusions and future research tips.
Barman et al., (2023)	This study aims at developing a multi-objective supply chain inventory management by considering deteriorating products together with imperfect quality production under neutrosophic environment.	A comparison between two types of reworking processes, and a comparison among crisp, intuitionistic fuzzy and neutrosophic models are drawn. A sensitivity analysis regarding important parameters is also taken into consideration to accentual managerial intuitions.
Pervin et al., (2023)	This study proposes a sustainable inventory model to reduce carbon emission.	The results show that the total profit for non-instantaneous deteriorating items is higher than for instantaneously deteriorating items. A sensitivity analysis is conducted based on the important parameters. Finally, the paper ends with conclusions and an outlook to future research.
Singh et al., (2024)	Aim to study rapid depletion of fossil fuels and the adverse environmental effects of combustion has growing concerns about the sustainability of fossil fuel and the world turns its focus on cleaner energy sources.	The model demonstrates the biodiesel supply chain network under a sustainability framework and addresses the environmental and social impact based on the life cycle assessment which accelerates the transition to a renewable energy future.
Dey et al., (2023)	In this study, the retailer remanufacturers faulty items under different carbon emission reduction policies and multi-period trade credit financing to control the shortage. Shortages arise due to imperfect products.	Limited carbon regulation provides 0.23% and 0.16% better profit than the other two carbon reduction policies. Green investment increases the system profit by 0.063% and reduces emissions by 112 kg per cycle. Adaptation of trade credit policy increases the profit up to 1.55%.
Jana et al., (2023)	It aims to help not only postal and logistics companies but also regulatory agencies and city authorities find an environmentally friendly, socially responsible, and economically viable solution.	This research findings show that the united consolidation center is the most sustainable strategy for organizing urban parcel delivery.

Dey, Park, et al., (2022)	In this study, we optimize the production plan along with the investments for applying green technology and autonomated inspection in an assembled product manufacturing-remanufacturing system.	The numerical result shows that the appropriate green technology decreases carbon emissions up to 2.81% and autonomated inspection reduces the waste up to 2.37%, along with a reduction of entire production cycle cost up to 18.26%. In addition, the setup cost reduction is considered due to the characteristics of assembled product production.
Contribution of the current study	This study has two policies to support supply chains. In the first model, three types of subsidies are provided for each supplier. In the second model, the government enters the chain directly by creating an integrator facility, which is responsible for packaging and coordination between facilities, and assumes the cost of packaging, and by merging publications together in one package, reduces the number of submissions and it supports the supply chain.	The results showed that the amount of subsidies paid in the first model is much higher than in the second model. By considering this issue and eliminating subsidies from profit calculations of the two models, the second model showed a more favorable performance in equal and full welfare in all regions. However, the first model had a better performance in conditions with different welfares in various regions. According to the results, in addition to subsidies, the government must enact laws that oblige publishers to complete welfare.

The current study differs from previous studies by addressing supply chains that conceder one of the most important economic pillars of any country that can have a great impact on sustainability. In this regard, this article has two policies to support supply chains. In the first model, three types of subsidies are provided for each supplier. In the second model, the government enters the chain directly by creating an integrator facility, which is responsible for packaging and coordination between facilities, and assumes the cost of packaging, and by merging publications together in one package, reduces the number of submissions and it supports the supply chain.

3. Materials and Methods

In this study, we evaluate a publication subscription supply chain, which includes three layers of: 1) suppliers, each supplying (manufacturing) a unique product. 2) distributors, who receive packages from suppliers and distribute them, and 3) customers, who make orders and are the final receivers of the product. The flow in the supply chain is such that after registering the orders in the subscription of the country's publications by the customer, the order information is sent to the suppliers based on the requested products and the suppliers prepare the customer order and send it to the distributor. Following that, the distributor will deliver the packages to customers. This type of allocation and activity is due to a lack of coordination at each level, meaning that suppliers have no communication with each other and operate independently. This allows suppliers and distributors to deliver products to customers promptly and separately regardless of the other orders of a customer. In such situations, two products of a customer may be delivered by two suppliers and a distributor in one day. The government interferes with this supply chain due to its responsibilities related to social welfare provision. In this respect, social welfare refers to the number of individuals and geographical areas whose demand is met and the amount of demand met by each person (region). The government can intervene in two ways: first, granting subsidies, financial exemption of chain members, allocating government currency, and staff insurance. In this way, the government influences supply chain activities indirectly and ultimately increase social welfare (this model is being implemented in current situations). In the second model, the government is involved in the activity as one of the chain members or increases social welfare by changing the chain levels.

First Model: Granting Public Subsidies to Suppliers

The premises and symbols used in the model are expressed below based on indices and sets of parameters and decision variables:

Premises

The distribution costs include packaging, delivery to distributor and delivery to customer costs. With regard to the age of publications, there is no inventory or warehouse in the model. The subsidies granted to suppliers include insurance subsidies, paper currency subsidies, and cash subsidies. Over a contract, the supplier obtains a part of the distributor's capacity and must pay the penalty for empty capacity in case of a lack of filling the warehouse. Due to its long-term

goals, the government allocates an amount as a budget for the subscription plan, and the total amount of subsidies in all periods is less than this amount. If the amount of demand is more than the capacity of the facility, the model will face a shortage and its cost will be considered.

Indices and Sets

s = {1,2,...,S} : s Supplier index

d = {1,2,...,D} : d Distributor index

c = {1,2,...,C} : c Customer index

t = {1,2,... ,T} :t Time index

Parameters

p_s : The sales price of each unit from of supplier s

rp_s :Production cost per unit of supplier s

md_{ds} :Distributed capacity allocated from distributor d to supplier s

$y1_d$:Insurance subsidy of supplier s

$Y2_d$:Paper subsidies per unit sent from supplier s

$Y3_d$:Cash subsidies per unit sent from supplier s

sd_{ds} :Shipping cost per unit of product s to distributor d

dc_{sds} :The cost of transporting each unit of product s from the distributor d to the customer c

bd_d :Cost per unit of empty capacity of the distributor d

de_{stc} :Customer demand c in period t of product s

g :Maximum budget allocated by the government

Decision Variables

xbd_{dst} :The amount of empty capacity of distributor d for the product and in period t

xs_{sdtc} :Amount sent from supplier s to distributor d in period t for customer c

b_s :The amount of subsidy allocated to each supplier in the first model

f_{st} :Delivery percentage of each supplier s in each period t which will be the coefficient of welfare of each supplier in each period.

Objective Function and Constraints

In a situation where the government intervenes in the supply chain through cash subsidies, employee insurance, and government currency provision, where the supplier's profit will be equal to the amount of the difference between the revenue from the sale of a product unit and the cost of the production unit in the total amount of demand met, to which must add government subsidies and from which distribution costs (packaging and delivery to distributor and distribution to customer) and cost of excess distribution capacity must be subtracted. Excess capacity cost means that the supplier has acquired some of the distributor's capacity under a contract with the distributor. However, a penalty must be paid for lack of use of the empty capacity. Therefore, the first model is as follows:

$$\pi 1_s = \sum_d \sum_s \sum_c \sum_t (p_s - rp_s) \times xs_{sdtc} - \sum_d \sum_s \sum_t bd_d \times xbd_{dst} - \sum_d \sum_s \sum_c \sum_t sd_{sd} \times xs_{sdtc} - \sum_d \sum_s \sum_c \sum_t dc_{sdc} \times xs_{sdtc} + \sum_s y1_s + \sum_d \sum_s \sum_c \sum_t (y2_s + y3_s) \times xs_{sdtc} \quad (1)$$

$$s.t: \quad \forall s,t,c \quad (2)$$

$$\sum_d xs_{sdtc} \leq de_{stc}$$

$$\sum_c xs_{sdtc} + xbd_{sdt} = md_{ds} \quad \forall s,d \quad (3)$$

$$b_s = \sum_d \sum_c \sum_t (y2_s + y3_s) \times xs_{sdtc} + y1_s \quad \forall s \quad (4)$$

$$\sum_d \sum_c xs_{sdtc} = \sum_c de_{stc} \times f_{st} \quad \forall s,t \quad (5)$$

$$\sum_s b_s \leq g \quad (6)$$

$$f_{st} \leq 1 \quad \forall s,t \quad (7)$$

$$xbd_{dst}, xs_{stc}, b_s, f_{st} \geq 0 \quad \forall s,t,c,d \quad (8)$$

In this model, Row 1 is the objective function, the details of which are described. Constraints 2 guarantee that the amount sent for each customer in each period for each supplier is less than or equal to the amount of customer demand. Constraints 3 show that the capacity placed by the distributor for the supplier is either used by sending to the customer or remains as excess capacity. Constraints 4 demonstrate the amount of subsidy of each supplier, which is equal to the amount of insurance subsidy of each supplier plus the total paper and cash subsidies, which is allocated to the total demand met by each supplier. In addition, Constraint 5 calculates the welfare coefficient related to each supplier in each period based on the total amount delivered by each supplier and the amount of demand. Constraints 6 ensure that the total subsidy allocated to suppliers must be less than the budget. Constraints 7 determine the maximum welfare coefficient value and Constraint 8 show the positivity of the variables.

The Second Model: Direct Interference of Government

As mentioned in the section of the statement of the problem, one of the defects of a supply chain is the lack of coordination of its members. In such situations, the government must establish supply chain coordination by entering the chain and developing integrators that are responsible for coordination among the members. In these situations, a supply chain is converted into a four-layer chain, where information of orders made by a customer is delivered to the supplier based on the required goods, and the information of all customer demands along with their address and data are given to the integrator. Suppliers deliver customer orders to the integrator, and each integrator packages and send the product to the distributor. Afterwards, the distributor deliveries the prepared package to customers (Figure1).

Methods of Subscription and Delivery of Journals

The subscription of publications in each period is independent of other periods and the customer can choose a publication from any group of products (newspapers, weekly magazines, etc.) and receive it until the end of that period. However, the two models of government intervention will have different delivery modes. In the first model, each publication is delivered to the customer with one delivery, whereas in the second model, the number of deliveries depends on the customer choosing or not choosing the newspaper. If the newspaper is selected, since the newspaper is delivered to the customer on a daily basis, other publications will be sent next to the newspaper as well if ordered.

However, if the newspaper is not selected, the number of deliveries will be equal to the total number of orders of the publications. Moreover, it is assumed in the research that a maximum of two publications are delivered to the customer in each delivery. The stated conditions are calculated outside the presented models and according to the customers' demand and are entered into the model as a demand parameter.

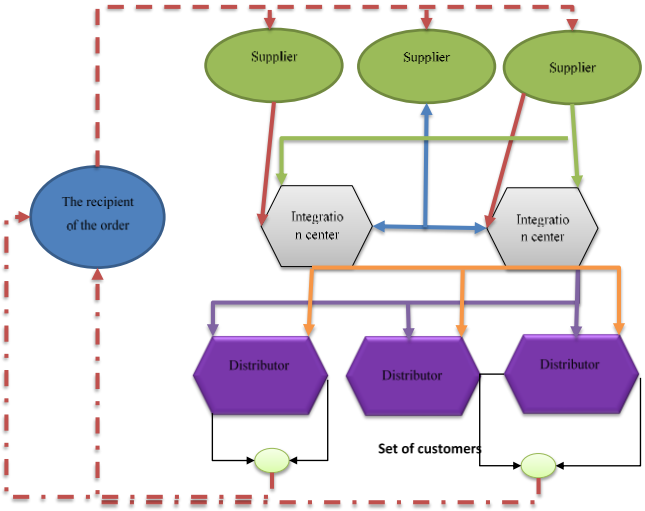

Figure 1. A schematic presentation of the supply chain network with direct interference of the government

Premises

1.Each customer is allocated to an integrator so that all of their information is given to one integrator.

2.The integrator decides based on the period of publication and delivery or accumulation of ordered products of the customer.

3.The government exploits the available facilities to create the integrator. As a result, the establishment cost is considered zero.

4.In this model, the government is responsible for packaging costs as subsidies.

5.Given the age of the publications, there is no inventory or warehouse in the model.

6.Since the government builds the integrators and these facilities are regarded as subsidies, the empty capacity cost is not calculated for the integrators. However, it is calculated for distributors similar to the first model.

7.Due to its long-term goals, the government allocates an amount as a budget for the subscription plan, and the total amount of subsidies in all periods is less than this amount.

8.If the amount of demand is more than the capacity of the facility, the model will face a shortage and its cost will be considered.

9. The number of merging facilities that must be established is announced by the government and among its candidates. The symbols used in the model are presented below based on the type of indices and sets of parameters and decision variables:

Indices and Sets

s = {1, 2,... ,S}:s Supplier index

o:{1,2,...,O} = o Integrator index

d = {1, 2,... ,D}:d Distributor index

c = {1,2,..., C}:c Customer index

t = {1,2,...,T}:t Time-related index

Parameters

hs_{so} :Shipping cost from supplier s to integrator o

ho_{od} :Shipping cost from integrator to distributor d

hd_{dc} :Shipping cost from distributor d to customer c

rp_s :The cost per unit of product s including production costs

nd_d :Distributor empty capacity costs

m :A desired large number

ed :Packaging unit cost

mo_o :The capacity of integrator o

md_d :The capacity of distributor d

de_{stc} :Customer demand C in period t of product s

α :Number of government integrator facilities to be established

g :Maximum government budget allocated

Decision Variables

xs_{sotc} :Amount sent from supplier s to integrator and in period t for customer c

xo_{odtc} :Amount sent from integrator o to distributor d in period t for customer c

xd_{dtc} :The amount sent from distributor d to customer c in period t

xb_{stc} :The amount of product shortage s for customer c in period t

xbo_{ot} :The amount of empty capacity of the integrator o in period t

xbd_{dt} :The amount of empty capacity of distributor d in period t;

$a1_{oc}$: 1, if integrator o is assigned to customer C; otherwise, 0.

z_o : 1, if integrator o is established; otherwise, 0.

f_{st} :Percentage sent by each supplier in each period, which will be the coefficient of welfare of each supplier in each period

v :The amount of subsidies allocated in the second model of government intervention.

Objective Function and Constraints

According to the definition of the problem and the components of the model that were stated, the objective function and constraints of the second model are as follows:

$$\max z = -\sum_{c}\sum_{t}\sum_{o}\sum_{s} hs_{so} \times xs_{sotc} \tag{9}$$

$$-\sum_{c}\sum_{t}\sum_{d}\sum_{o} (ho_{od} - ed) \times xo_{odtc} \tag{10}$$

$$-\sum_{c}\sum_{t}\sum_{d} hd_{dc} \times xd_{dtc} \quad (11)$$

$$+\sum_{c}\sum_{t}\sum_{o}\sum_{s}(p_s - rp_s) \times xs_{sotc} \quad (12)$$

$$-\sum_{d}\sum_{t} xbd_{dt} \times nd_d + \sum_{s} y1_s \quad (13)$$

$$s.t \qquad \forall o, t, c \quad (14)$$

$$\sum_{s} xs_{sotc} = \sum_{d} xo_{odtc}$$

$$xd_{dtc} = \sum_{o} xo_{odtc} \qquad \forall d, t, c \quad (15)$$

$$xs_{sotc} \leq m \times a1_{oc} \qquad \forall s, o, t, c \quad (16)$$

$$\sum_{o} a1_{oc} = 1 \qquad \forall c \quad (17)$$

$$\sum_{c}\sum_{s} xs_{sotc} \leq mo_o \times z_o \qquad \forall o, t \quad (18)$$

$$\sum_{c}\sum_{o} xo_{odtc} + xbd_{dt} = md_d \qquad \forall d, t \quad (19)$$

$$\sum_{o} z_o = \alpha \quad (20)$$

$$\sum_{o} xs_{sotc} \leq de_{stc} \qquad \forall s, t, c \quad (21)$$

$$\sum_{c}\sum_{o}(xs_{sotc}) = \sum_{c} de_{stc} \times f_{st} \qquad \forall s, t \quad (22)$$

$$v = \sum_{c}\sum_{t}\sum_{d}\sum_{o} ed * xo_{odtc} + \sum_{s} y1_s \quad (23)$$

$$f_{st} \leq 1 \qquad \forall s, t \quad (24)$$

$$v \leq g \quad (25)$$

$$a1_{oc}, z_o, \in \{0,1\} \qquad \forall o, c \quad (26)$$

$$xo_{odtc} xd_{dtc}, xb_{stc}, xbd_{dt}, xs_{sotc} \geq 0 \qquad \forall o, s, d, t, c \quad (27)$$

In this model, rows 9-13 are related to the objective function, and Row 9 is related to the cost of delivery from the supplier to the integrator. Row 10 is related to the costs of packaging and delivery to the distributor. In this regard, the packing cost must be subtracted from the chain costs due to government intervention. Row 11 shows the cost of delivery from distributor to customer and Row 12 shows the difference between sales revenue and production costs. Row 13 shows the excess distributor capacity costs and total insurance subsidies of each supplier (due to government intervention, the excess integrator cost is not added to the chain costs). Rows 14-17 show model constraints, where constraints 14 and 15 are related to the balance limitations of the delivered amount at each level, guaranteeing that the amount sent from one level is equal to the amount received at the lower level. Constraints 16 and 17 are allocation constraints, in which each customer is allocated to one of the integrators. In this model, the customer is merely assigned to an integrator, and other facilities may communicate with several facilities depending on the problem cost conditions.

Constraints 18 and 19 are facility capacity constraints. In Constraints 18, an integrator facility must be established, and Constraints 19 is considered equal in order to estimate the excess capacity of each facility and regard it as a cost in the objective function. Constraints 20 are related to the establishment of facilities among the candidate facilities, the number of which is announced by the government. Constraints 21 ensure that the amount sent for each customer in each period per supplier is less than the amount of customer demand. Constraints 22 calculate the welfare coefficient related to each supplier in each period based on the total amount delivered by each supplier and the amount of demand. Constraints 23 show the total chain subsidy amount, which is equal to the number of insurance subsidies allocated to each supplier and the total packaging cost of each product in all periods. Constraints 24 determine the maximum amount of welfare coefficient, and Constraints 25 ensure that the total subsidy allocated to suppliers is lower than the budget. Finally, Constraints 26 and 27 show the type and positivity of variables.

Case Study

In order to validate the models presented in the subscription plan, four journals are evaluated for 6,307 customers in East Asia. For four rounds, customers randomly order publications, and two distributors (east and west distributors) are responsible for the distribution of the publications. In both models, the cost of delivery from the distributor to the customer is assumed to be equal for the customers in one area, and the shipping cost is proportional to the distance dimension. The subsidies paid to suppliers are shown in Table 2.

Table 2. Subsidy amounts paid by product type in the second model

Product Type	Insurance Subsidies	Delivery Unit Paper Subsidies	Delivery Unit Cash Subsidies
Newspaper	26700	100	350
Weekly Journal	34800	80	460
Biweekly Journal	48000	120	540
Monthly Journal	75480	170	510

4. Results and Discussion

The presented models along with the data mentioned in the previous section are solved by GAMS and CPLEX per four random demands. According to the output of the second model, the east and west integrators must be established among the four candidate integrators. As observed in Table 3, the chain profit is higher in the first model, compared to the second model, which might be due to the profit of chain components (i.e., publications profit). However, considering the amount of subsidies paid to each publication in each model iteration, it is obvious that the paid subsidies are much higher than the profit of publications. For instance, the publication receives about 80 million subsidies for each model iteration, while its profit in each round is less than eight million. In other words, the newspaper has lost more than 72 million in each round. Meanwhile, the amount of loss is estimated at 55 million in the second model supply chain with a subsidy at a lower amount.

In this regard, the net profit of each chain is calculated without considering the subsidy, the results of which can be observed in the last row of Table (3), according to which the second supply chain has a profit of more than 33 million and has a more favorable performance. Another important point in Table 3 is the existence of approximate stability of the profit difference between the two models. It means that the profit difference in the output of each model implementation period is approximately 33 million due to the changes in the number of demands made each model implementation round. This is primarily due to similar changes in costs and profits of the two models. When the model is implemented with complete welfare, all changes in demand affect the profit of each chain. Given the equality of changes in demand and cost parameters in the two models, profit changes at the same level in both models, which stabilizes the difference between the two models. In Table 4, the two models are optimized regardless of social welfare. In this situation, as shown in the last row of Table 4, the second model has a better performance in terms of maximization of publisher profit. However, based on Diagram 1, the second model establishes less welfare in case of lack of attention to social welfare. A comparison of tables 2 and 3 reveals that the first model experiences a 38% increase in its profit by reducing about 20% of the number of subsidies received. Meanwhile, the second model increases profits by more than 60% with an 80% reduction in subsidies. According to the results, the second model less depends on the received subsides and is more sensitive to social welfare increase (Figure 2& 3).

Table 3. Solution of both models in similar and full welfare conditions in all regions and per various demand levels

Random demand set number		1	2	3	4
Demand	Total delivery number	382	382	399	399
	Total newspapers number	312	293	308	304
	Total weekly journals	47	48	49	46
	Total biweekly journals	210	220	295	356
	Total monthly journals	299	208	314	361
The first model (subsidy to the supplier)	Profit amount	235	355	300	353
	Newspaper profit	248	352	307	242
	Weekly journal profit	352	209	252	319
	Biweekly journal profit	279	240	320	337
	Monthly journal profit	331	351	197	254
	Total subsidies paid	343	311	260	368
	Newspaper subsidy	326	361	368	289
	Weekly journal subsidy	357	285	260	202
	Biweekly journal subsidy	261	218	316	265
	Monthly journal subsidy	315	186	360	237
The second model (integrator establishment)	Profit amount	328	371	302	344
	Total subsidies paid	258	273	331	299
Profit of supply chain without subsidies in the first model		360	210	220	202
Profit of supply chain without subsidies in the second model		270	197	359	199
Profit difference between the second model and the first model without subsidies		290	362	289	229

Table 4. Output solution of the two models per different welfares

Random demand set number		1	2	3	4
The first model (subsidy to the supplier)	Profit amount	17253	17242	17878	18132
	Total subsidies paid	88370	88968	93877	92219
The second model (integrator establishment)	Profit amount	2029	20476	19908	20318
	Total subsidies paid	3572	3973	3963	1933
Profit of supply chain without subsidies in the first model		72929	73958	71790	74000
Profit of supply chain without subsidies in the second model		23671	23751	24213	22
Profit difference between the second model and the first model without subsidies		47844	52134	48511	49144

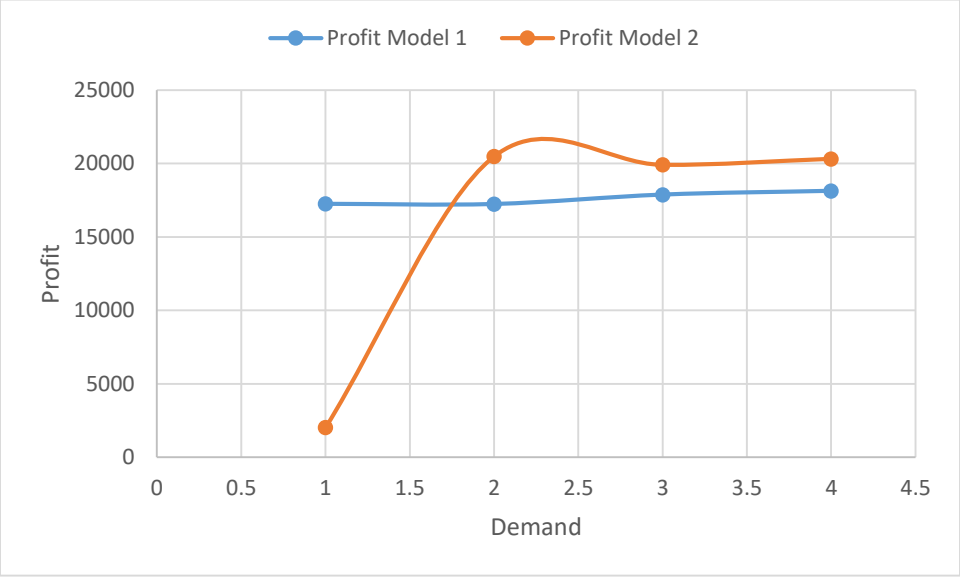

Figure 2. Comparison of profit amount in the two models

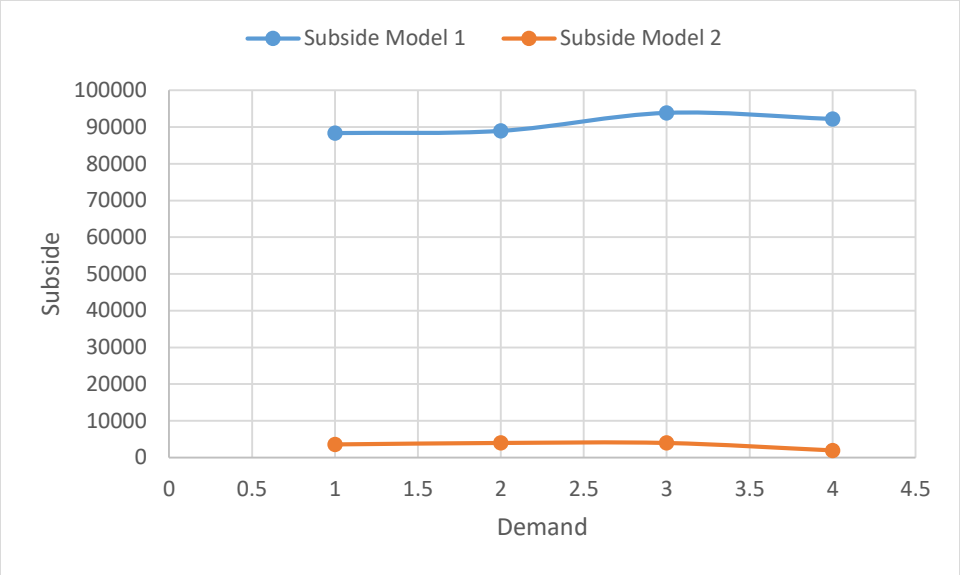

Figure 3. Comparison of subsidy amount in the two models

Sensitivity Analysis

In this section, the sensitivity of the model to changes in the price parameter of the journal is evaluated in order to examine the models in more detail. According to Table 5, the models are solved three times with an increase of zero, 200 and 300 units of the base price, respectively. Given the 100% welfare, the subsidies paid in both models are a fixed amount (not equal) and supplier profit increases with an increase in the price. According to the first-third columns of Table 5, the profit of the chain in the first model increases about 10 times by increasing 300 units in each price without increasing the amount of subsidy paid. However, this profit increase is different in each publication; newspaper profit increases more than 13 times with a 30% increase in the price, weekly journal profit increases more than 6.5 times with a 15% increase in the price, and biweekly and monthly journal profits increase more than 6 and 3.4 times, respectively. This increase in profit for the second model is more than doubled, showing that the second model is less sensitive to the price range, compared to the first model. In the fourth column of Table 5, both models are solved for different values of the price of each publication. As expected, the amount of profit of each supplier changes depending on the increase or decrease of price. For example, the amount of profit of newspapers decreases due to the decrease of newspaper price.

In the fifth column of Table 5, models are solved in the conditions of lack of subsidy payment such that welfare is extremely close to full. Prices are presented in such situations, according to which if, for example, the price of the newspaper is 1475, the newspaper establishes full welfare without receiving subsidy and based on its profit. The amount of subsidy for each newspaper is 250 units (the sum of two cash and foreign exchange subsidies), which, if deducted from 1475, gives the maximum price to which the subsidy must be allocated. In other words, the conditions of the third column of Table 5 must not occur for the newspaper since the price of 1300 price unit for the newspaper is higher than the maximum price (1225 units) which includes subsidy.

Table 5. Solution of the two models in equal and full welfare conditions in all regions per different prices and equal demand rates

Column Number		One	Two	Three	Four	Five
Price	Price of each newspaper	1000	1200	1300	900	1475
	Price of each weekly journal	2000	2200	2300	2300	2612
	Price of each biweekly journal	3000	3200	3300	3900	3662
	Price of each monthly journal	3000	300	3300	3600	3625
Demand	Total number of deliveries	406739				406739
	Total newspapers	318225				318225
	Total weekly journals	50444				50444
	Total biweekly journals	25298				25298
	Total monthly journals	12472				12472
The first model (subsidy to the supplier)	Profit amount	13600079	94887879	135531779	19678979	99552108
	Newspaper profit	7916625	71561625	103384125	-23905875	78517250
	Weekly journal profit	2689444	12778244	17822644	17822644	12883572
	Biweekly journal profit	1461676	6521276	9051076	24229876	5259952
	Monthly journal profit	1532334	4026734	5273934	15323334	2891334
	Total subsidies paid	120618850				0
	Newspaper subsidy	80556250				0
	Weekly journal subsidy	20677600				0
	Biweekly journal subsidy	12949000				0
	Monthly journal subsidy	6436000				0
	Profit amount	54880826	26406974	67050874	48801926	133601003
	Total subsidies paid	18089050				0
Profit of supply chain without subsidies in the first model		-107018771	-25730971	14912929	-100939871	99552108
Profit of supply chain without subsidies in the second model		-72969876	8317924	48961824	66890976	133601003

5. Conclusion

As mentioned, social welfare supply is one of the objectives of the upstream documents of the government, which is closely related to the use and type of government policies. In this regard, two policies are considered to support publications by the government. In the first model, three types of subsidies (cash, paper, and insurance) are provided for each supplier. In the second model, the government directly intervenes by entering the market and creating an integrator facility, which is responsible for packaging and coordination among facilities. By doing so, the packaging costs of supplier's decrease. In addition, the integration of publications reduces the number of deliveries, which leads to the support of the supply chain. Mathematical models were defined for each of the mentioned cases. In order to validate the models and compare their performance, a case study was conducted for 6307 customers and 119 districts of Tehran. According to the output of the models, the profit of each supplier including subsidies was more than the second model in the first model. However, the amount of subsidies paid in the first model is much higher than in the

second model. By considering this issue and eliminating subsidies from profit calculations of the two models, the second model showed a more favorable performance in equal and full welfare in all regions.

However, the first model had a better performance in conditions with different welfares in various regions. According to the results, in addition to subsidies, the government must enact laws that oblige publishers to complete welfare. Otherwise, suppliers optimize their profits in both models regardless of social welfare and the amount of welfare in the regions will not be the same. The first model must be used in situations where the government cannot fully supervise the operations of publishers to establish welfare. A third model must exist in case of the desire to pay a lower price with equal welfare; in this model, the government must determine the price such that the suppliers select the second model. However, the model seeks equal social welfare in all regions to maximize its profit. In such situations, the government will create equal welfare without subsidy payment, which will ultimately reduce social welfare due to decreased demand for the publications because of its increased price. In the present article, the number of deliveries of each journal per round was considered as a benchmark for social welfare.

FUTURE RESEARCH

The researchers recommend that variables such as customers and the method of receiving each publication be evaluated in future studies as an index of welfare. In addition, it is suggested that uncertainties related to transportation costs and prices or price-dependent demand be evaluated in further studies.

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AUTHOR'S CONTRIBUTION

Authors contributed equally for the article's elaboration. All authors worked together to develop the contextualization, definition of research design, analysis of the results, and conclusions.

CONFLICTS OF INTEREST

There is no conflict of interest in this article.

Data Availability

The data will be available upon request.

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References

Ali, S. S., Barman, H., Kaur, R., Tomaskova, H., & Roy, S. K. (2021). Multi-product multi echelon measurements of perishable supply chain: Fuzzy non-linear programming approach. *Mathematics, 9*(17), 1–27. https://doi.org/10.3390/math9172093

Allameh, G., Esmaeili, M., & Tajvidi, T. (2014). Developing several pricing models in green supply chain under risk by Game Theory Approach. *Industrial Management Journal, 6*(4), 767-789.

Al-waeli, A. J., Hanoon, R. N., Ageeb, H. A., & Idan, H. Z. (2020). Impact of Accounting Information System on Financial Performance with the Moderating Role of Internal Control in Iraqi Industrial Companies: An Analytical Study. *Jour of Adv Research in Dynamical & Control Systems, 12*(8), 246–261. https://doi.org/10.5373/JARDCS/V12I8/20202471

Al-Waeli, A., Ismail, Z., Hanoon, R., & Khalid, A. (2022). The impact of environmental costs dimensions on the financial performance of Iraqi industrial companies with the role of environmental disclosure as a mediator. *Eastern-European Journal of Enterprise Technologies, 5*(13 (119)), 43–51.

Barman, H., Pervin, M., & Roy, S. K. (2022). Impacts of green and preservation technology investments on a sustainable EPQ model during COVID-19 pandemic. *RAIRO - Operations Research*, *56*(4), 2245–2275. https://doi.org/10.1051/ro/2022102

Dai, Z., Aqlan, F., Zheng, X., & Gao, K. (2018). A location-inventory supply chain network model using two heuristic algorithms for perishable products with fuzzy constraints. *Computers & Industrial Engineering*, *119*, 338-352.

Dey, B. K., Yilmaz, I., & Seok, H. (2022). A Sustainable Supply Chain Integrated with Autonomated Inspection, Flexible Eco-Production, and Smart Transportation. *Processes*, *10*(9), 1–27. https://doi.org/10.3390/pr10091775

Esmaeili, M., & Zandi, S. (2018). Intervention of Government in the Competition between Green and Non-Green Supply Chains. *Industrial Management Journal*, *10*(2), 297-314.https://doi.org/10.22059/ij.2018.262181.1007464

Farahani, R. Z., Rezapour, S., Drezner, T., & Fallah, S. (2014). Competitive supply chain network design: An overview of classifications, models, solution techniques and applications. *Omega*, *45*, 92-118. https://doi.org/10.1016/J.OMEGA. 2013.08.006

Farooq, M. U., Hussain, A., Masood, T., & Habib, M. S. (2021). Supply chain operations management in pandemics: a state-of-the-art review inspired by COVID-19. *Sustainability*, *13*(5), 2504.

Ghavamifar, A. (2015). A Reliable Competitive Supply Chain Network Design under Risk of Disruption and Uncertainty Case Study: Isaco Company. MS's Thesis in Industrial Engineering, Industrial Engineering Department, Iran University of Science and Technology.

Govindan, K., Fattahi, M., & Keyvanshokooh, E. (2017). Supply chain network design under uncertainty: A comprehensive review and future research directions. *European Journal of Operational Research*, *263*(1), 108-141. https://doi.org/10.1016/j.ejor.2017.04.009

Hanoon, R. N., Khalid, A. A., Hanani, N. O. R., Rapani, A., Aljajawy, T. M., & Al-, A. J. (2021). The Impact of Internal Control Components on the Financial Performance, in the Iraqi Banking Sector. *Journal of Contemporary Issues in Business and Government*, *27*(3). https://doi.org/10.47750/cibg.2021.27.03.303

Hanoon, R. N., Rapani, N. H. A., & Khalid, A. A. (2020a). The Correlation between Internal Control Components and the Financial Performance of Iraqi Banks a Literature Review. *Jour of Adv Research in Dynamical & Control Systems*, *12*(4), 957–966. https://doi.org/10.5373/JARDCS/V12SP4/20201567

Hanoon, R. N., Rapani, N. H. A., & Khalid, A. A. (2020b). The Relationship Between Audit Committee And Financial Performance : Evidence From Iraq. *International Journal of Management (IJM)*, *11*(11), 564–585. https://doi.org/10.34218/IJM.11.11.2020.054

Heydari, J., Govindan, K., & Jafari, A. (2017). Reverse and closed loop supply chain coordination by considering government role. *Transportation Research Part D: Transport and Environment*, *52*, 379-398.https://doi.org/10.1016/j.trd.2017.03.008

Jana, C., Dobrodolac, M., Simic, V., Pal, M., Sarkar, B., & Stević, Ž. (2023). Evaluation of sustainable strategies for urban parcel delivery: Linguistic q-rung orthopair fuzzy Choquet integral approach. *Engineering Applications of Artificial Intelligence*, *126*(Part C), 106811. https://doi.org/https://doi.org/10.1016/j.engappai.

Luo, C., Leng, M., Huang, J., & Liang, L. (2014). Supply chain analysis under a price-discount incentive scheme for electric vehicles. *European Journal of Operational Research*, *235*(1), 329-333. https://doi.org/10.1016/j.ejor.2013.11.021

Madani, S. R., & Rasti-Barzoki, M. (2017). Sustainable supply chain management with pricing, greening and governmental tariffs determining strategies: A game-theoretic approach. *Computers & Industrial Engineering*, *105*, 287-298.

Mahmoudi, R., & Rasti-Barzoki, M. (2018). Sustainable supply chains under government intervention with a real-world case study: An evolutionary game theoretic approach. *Computers & Industrial Engineering*, *116*, 130-143. https://doi.org/10.1016/j.cie.2017.12.028.

Mehrjerdi, Y. Z., & Shafiee, M. (2021). A resilient and sustainable closed-loop supply chain using multiple sourcing and information sharing strategies. *Journal of Cleaner Production*, *289*, 125141.

Melo, M. T., Nickel, S., & Saldanha-Da-Gama, F. (2009). Facility location and supply chain management–A review. *European journal of operational research*, *196*(2), 401-412.https://doi.org/10.1016/j.ejor.2008.05.007.

Piraee, K., & Seif, B. (2011). The Impact of Self-Targeted Subsidies on Social Welfare in Iran. *Journal of Tax Research*, *18*(9), 61-82.

Rafeei, M., & Sayadi, M. (2018). Investigating the relation between government fiscal policy and social welfare with emphasis on Amartya Sen Index (Bound ARDL Testing Approach). *Quarterly Journal of Economic Growth and Development Research*, *8*(32), 168-151.

Rezaee, M. H. (2013). A Survey on Social Justice in the Programs of Development: A New Perspective. *Scientific Journal of Islamic Management*, *20*(2), 23-54.

Sabour, K. A., & Al-Waeli, A. (2023). the Effect of Blockchain Technology As a Moderator on the Relationship Between Big Data and the Risk of Financial Disclosure (Analytical Study in the Egyptian and Iraqi Stock Exchange). *Eastern-European Journal of Enterprise Technologies*, *1*(13(121)), 132–142. https://doi.org/10.15587/1729-4061.2023.274641

Sazvar, Z., Tafakkori, K., Oladzad, N., & Nayeri, S. (2021). A capacity planning *approach for sustainable-resilient supply chain network design under uncertainty: A case study of vaccine supply chain. Computers & Industrial Engineering*, *159*, 107406.

Wang, C. N., Nguyen, N. A. T., Dang, T. T., & Lu, C. M. (2021). A compromised decision-making approach to third-party logistics selection in sustainable supply chain using fuzzy AHP and fuzzy VIKOR methods. *Mathematics*, *9*(8), 886.

Wood, G., & Gough, I. (2006). A comparative welfare regime approach to global social policy. *World development*, *34*(10), 1696-1712.

Xie, L., & Ma, J. (2016). Study the complexity and control of the recycling-supply chain of China's color TVs market based on the government subsidy. *Communications in Nonlinear Science and Numerical Simulation*, *38*, 102-116. https://doi.org/10.1016/j.cnsns.2016.02.004.