

Volume 2 Issue 1 2022

ISSN (Print): 2767-6528

ISSN (Online): 2767-3316

# Management Science and Business Decisions

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Science Insight, Florida, U.S.A.

Email: manager@thescienceinsight.com

ISSN (Print): 2767-6528

ISSN (Online): 2767-3316

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ISSN (Print) 2767-6528  
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# Evaluation of Automotive Parts Suppliers through Ordinal Priority Approach and TOPSIS

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Received 16 December 2021; Revised 24 January 2022; Accepted 26 January 2022

**Abstract:** The problem of supplier selection is an important concern for all businesses. Also, as environmental concerns are mounting and socio-economic crises are increasing worldwide, the need for resilient and environment-friendly suppliers is aggravating. Companies are under tremendous pressure to redefine their business practices and operations to achieve sustainability goals while being resilient. The study aims to evaluate the Chinese automotive parts suppliers based on 'gresilience' (green and resilient) criteria. The suppliers are evaluated using the Ordinal Priority Approach (OPA) and TOPSIS models. Also, it is the first time the TOPSIS model has been executed on the OPA-based criteria weights. The results from the two methods were mostly consistent. However, the OPA is flexible and can produce ranking under different assumptions.

**Keywords:** Supplier selection; automobile industry; Ordinal Priority Approach; TOPSIS; multi-criteria decision analysis

## 1. Introduction

The global health crisis triggered by the novel coronavirus has generated much skepticism about the future of business operations. It has disrupted supply chains in many industries, challenging businesses across industries to make better decisions. Conventionally, decision-makers only pay attention to purchasing from suppliers that can provide them with materials and services at lower costs, better quality, and shorter delivery times without considering other performance factors such as adaptability, risk management capabilities, and sustainability practices (Kannan *et al.*, 2013). Since supplier selection is such an important part of every business today, increased studies are trying to build a resilient supply chain by incorporating resilience and green criteria into supplier selection using MCDM models. Selecting resilient suppliers has become one of the most important tasks for companies to avoid COVID -19 disruptions like these, as it can be a lever to mitigate such disruptions that eventually affect the long-term profitability of companies. On the other hand, green supplier selection is seen as a unique example of sustainability principles in modern society. The process of green supplier evaluation is a major step toward sustainable network systems. Incorporating environmental factors into traditional supplier evaluation procedures and methods is essential for a sustainable supply chain (Govindan *et al.*, 2015). As new insights into the interactions between business and the environment continue to develop, there is also increasing

consideration of how to integrate sustainable performance into business processes and an extended supply chain (Davis-Sramek *et al.*, 2020).

Now a new question arises: how to select suppliers from the perspective of long-term resilience while reducing negative environmental impacts? This study addresses this critical question by enabling managers to evaluate and select suppliers in the automotive supply industry from the 'gresilience' criteria (green and resilient) perspective. In this study, the Ordinal Priority Approach (OPA) (Ataei *et al.*, 2020) is used to evaluate suppliers in the automotive parts industry of China based on six criteria: speed of recovery, level of recovery, loss of performance during recovery, energy-saving, waste minimization, and green products. The evaluation of the suppliers is based on two different assumptions. In the first assumption, the resilience-based criteria are more important, while in the second assumption, all criteria (greenness and resilience) are considered equally important.

The remaining of the paper is organized as follows: Section 2 presents a comprehensive literature review on green, resilient and gresilient supplier selections. Section 3 presents research methodology, where data collected strategy and the detail about the OPA and TOPSIS is provided. Section 4 presents the results from the two methods. Section 6 concludes the paper and discusses the research limitations and scope of future work.

## 2. Literature review

### 2.1 Green supplier selection

Supplier selection is a mechanism that companies use to evaluate and select suppliers. The approach requires companies to evaluate and select their respective suppliers based on their sustainability goals and environmental commitments. Therefore, the selection of green suppliers appears to become one of the most important strategic concerns for companies. Considering this, industries must enhance existing practices that attempt to embrace sustainable initiatives and technologies to promote sustainable business activities (Konys, 2019). Nowadays, companies cannot neglect environmental concerns if they want to remain in business, thanks to the increased regulatory oversight and social awareness about sustainability practices (Lee *et al.*, 2008; Ullah *et al.*, 2022). Environmental sustainability involves the integration of environmental, financial, and social performance, and is a key issue for businesses in the twenty-first century (Ullah *et al.*, 2021; Verghese & Lewis, 2007).

Sustainable supply chain systems have emerged as a means for companies to achieve financial profitability while reducing their carbon footprint and improving environmental and social performance (van Hock & Erasmus, 2000). Environmentally conscious design and manufacturing, for example, is a core strategy that aims to minimize wastages, toxic emissions, and carbon emissions by restructuring the manufacturing and design operations and considering alternative resources (Zhang, 2004).

In the conventional supplier network practices, the criteria for supplier selection are limited to time, cost, delivery, and quality and have all been considered critical criteria. However, green supplier selection is considered a particular instance of sustainability practices in modern society. This view is like that of Ahi and Searcy (2013). Although there are numerous reports on supplier selection, there is not much on green supplier evaluation and selection that effectively addresses the actual ecological issues (Darnall *et al.*, 2008; Humphreys *et al.*, 2003). Using the Analytic Hierarchy Process (AHP), Noci (1997) developed an eco-friendly vendor-rating framework to assess a company's sustainability impact: green capabilities, current environmental efficiency, suppliers green image, and net life cycle cost.

Green supplier assessment requires monitoring the sustainability impacts of suppliers, asking them to address the environmental impact of their operations, and monitoring the impact of waste within their activities (Darnall *et al.*, 2008; Beamon, 1999). Even with the entire thrust of green distribution networks, some companies might be able to convert environmental investment capital



into economic and social benefits (Laari *et al.*, 2018). Scholars have reportedly developed several criteria and methods for supplier selection that consider underlying environmental threats.

Noci (1997) proposed that green products suppliers' selection consisted of the following three steps: (1) Identifying the green methods that businesses may adopt, (2) Developing a measurement technique to evaluate suppliers' environmental and social performance, and (3) Determining the most appropriate approach for selecting suppliers and ensuring that suppliers can meet the company's social and environmental objectives. Noci (1997) addressed a mechanism for selecting green suppliers. First, firms should evaluate suppliers' current environmental performance; second, firms should evaluate suppliers' sustainable capabilities; third, firms should examine suppliers' commitment to environmental concerns; and finally, firms should monitor the operating efficiency from an investment perspective. Humphreys *et al.* (2003) considered that conventional supplier selection focused solely on quality, flexibility, and other factors. However, as environmental pressures increased, various firms began to pay attention to environmental issues and evaluate suppliers' environmental and social performance. As a result, he argued for a decision-making tool to help companies incorporate environmental principles into the supplier selection process

## 2.2 Resilient supplier selection

Resilience is an important characteristic of reliable suppliers. Resilience allows a company to look beyond financial stability of their suppliers. A supplier that successfully went through a crisis provides a lot of information to its business partners that the supplier whose ability to cope with crises is unknown. Increasing supply chain resilience and selecting more resilient partners are both efficient approaches to minimize disruptions. Holling (1973) was the first to introduce the concept of resilience, emphasizing that it is the unique ability to absorb change. With time the resilient supply chain developed as a novel idea due to the application of resilience in the supply network (Hosseini & Khalid, 2019; Hosseini *et al.*, 2019). If price, quality, and speed are considered classical criteria for supply chain design, resilience could be one of the attributes for a dynamic supply chain configuration (Betti & Ni, 2020). Behzadi *et al.* (2020) have described resilience as the ability to recover rapidly and easily from supply chain chaos.

Selecting a potential supplier that can provide the most support in the face of disruptive events and reduce the overall risk of supply chain disruption is referred to as resilient supplier selection (Gan *et al.*, 2019; Sahu *et al.*, 2016; Sawik, 2013). For assorted reasons, selecting resilient suppliers is considered a more challenging task than normal selection problems. A supplier's resilience is multidimensional, and evaluating it only using quantitative measures is considered unrealistic. Since several qualitative factors engage in the evaluation process, subjective judgment is constantly present (Pramanik *et al.*, 2017; Hasan *et al.*, 2020).

Ponomarov and Holcomb (2009) describe resilience as the "adaptive capacity of the supply chain to prepare for unforeseen events, adapt to disturbances, and function." Another definition focuses on the ability of an organization to resume normal operations after a disruption (Brandon-Jones *et al.*, 2014; Ivanov & Sokolov, 2013). Currently, there are two ways to increase resilience: (1) strengthening the supply chain (e.g., by adding redundancies, increasing flexibility, and changing organizational culture) (Sheffi & Rice, 2005) and (2) selecting resilient suppliers (before, during, and after disruption) (Hosseini & Khalid, 2019; Hosseini *et al.*, 2019).

A deeper commitment to sustainability goals and developing resilient organizations has been identified as an essential component to help firms overcome future disruption (McKenzie, 2020). Sheffi and Rice (2005) defined supply chain resilience as "the inherent ability of a supply chain to maintain or restore its steady flow behavior so that it can resume regular operations after a disruption." Since vendor or supplier selection is a vital aspect of supply chain systems, many research publications attempt to build a more resilient supply chain by incorporating resilience into vendor or supplier selection using MCDM algorithms. With time, scholars found that resilience alone is not enough to express the performance of a supplier, especially as the negative affects of industrial activities on environment became more known. Thus, the concept of "gresilience" emerged.

### 2.3 Gresilient supplier selection

Today, a company's ability to redefine its existing distribution networks to go green while improving resilience to sudden disruptions is a key competitive advantage. The sophistication of strategic sourcing has grown and requires the development of novel approaches. Many scholars consider supplier selection's green and resilience aspects as separate perspectives, but merging the green aspect of strategic sourcing with the resilient aspect of strategic sourcing can result in lasting distribution networks (Fahimnia *et al.*, 2018). Resilient supplier selection aims to avoid or minimize predicted or unforeseen chaos, or at least reduce its negative influence on the environment. Consequently, resilience and greenness are the ultimate goals of healthy supply chain management (Mohammed *et al.*, 2021). Yavari and Zaker (2019) developed a two-layer network structure model to improve the resilient-green closed-loop supply chain for disrupting the power grid in the consumer goods supply chain, to achieve low cost and low carbon emission in the supply chain. However, the term "resilient-green" has been applied to supply chain design in various industries, while there is little relevant research for supplier selection. Ivanov *et al.* (2017) investigated the intersection of sustainability and resilience in supply networks to design a resilient supply chain while reducing uncertainty and improving sustainability. From the perspective of sustainability and resilience, Giannakis and Papadopoulos (2016) and Ivanov *et al.* (2017) argued that modeling and developing decision support systems can help enhance the development of environmentally sustainable and robust supply chains.

Supplier selection is a decision process that can significantly improve the supply chain surplus by preparing a firm future supply disruptions. Disruption would be detrimental to the goal of green development, so further studies on resilient-green supply chains are needed. Many studies have emphasized the importance of green and resilient suppliers for the long-term sustainability of companies. In addition, some recent attempts have merged them informally under the term "gresilience." The concept of gresilience is important for companies seeking a long-term relationship with their suppliers and environmentally friendly customers. Mohammed *et al.* (2021) proposed the concept of "gresilience" by describing the development of a unified green and resilient (Gresilient) supplier selection and contracting strategy that considers traditional, green, and resilient factors. Later, Mahmoudi *et al.* (2021a) proposed its first definition. They defined gresilience as the ability of an environmentally sustainable supply chain to recover from a disruption to its original or more desirable (improved) state in a timely and cost-effective manner (Mahmoudi *et al.*, 2021a). A keen supply selection is fundamental to the prosperity of any business; the global health crisis has proven that proper product outsourcing is critical for any organization. Resilience and environmental friendliness have already been associated with supply chain management.

Sustainable supply chain governance is affected by frequent unavoidable disruptions, so a robust supply chain framework is needed to address these dynamics. Considering sustainable development, Ivanov (2018) argued that key challenges include supply chain resilience and optimized distribution network structure following disruptions. Notwithstanding the need for proper integration of the elements of a gresilient framework into business operations, previous research does not adequately address some issues related to purchasing. Therefore, it is argued that integrating gresilience into the supplier selection framework can help managers deal with these constraints and other issues.

## 3. Research methodology

### 3.1 Sample and framework

Suppliers' data were collected from a procurement manager at a medium-sized Chinese company founded seven years ago that trades automotive parts not only to local companies but also to foreign companies, which account for two-thirds of its annual sales. The company is located in Nanjing, China. For the sake of convenience, the suppliers are defined as follows: first supplier (A1), second supplier (A2), third supplier (A3), and fourth supplier (A4). An expert from the

company's procurement department was asked to evaluate the suppliers based on the following six criteria: speed of recovery (C1), level of recovery (C2), performance loss during recovery (C3), energy-saving (C4), waste minimization (C5), and green products (C6). Thus, C1, C2, and C3 correspond to resilience and C4, C5, and C6 to greenness. The evaluation of the suppliers is based on two different assumptions. In the first assumption, resilience criteria are considered (1<sup>st</sup> priority), and green criteria are considered (2<sup>nd</sup> priority), while in the second assumption, both resilience and green criteria are considered equally important (1<sup>st</sup> priority). The supplier selection framework is shown in Figure 1. In the current study, the Ordinal Priority Approach (OPA) is used to evaluate the Chinese automotive suppliers based on resilience criteria. TOPSIS method is used for comparative analysis.

### 3.2 Ordinal Priority Approach

Multiple criteria decision-making (MCDM) is a critical problem in today's business world. Experts, criteria, and alternatives are the backbone of any decision-making process. In 2020, Amin Mahmoudi and colleagues (Ataei *et al.*, 2020) proposed the Ordinal Priority Approach (OPA), a linear programming-based model for multiple criteria decision-making. Later, it was extended to Grey OPA (Mahmoudi *et al.*, 2021b), Fuzzy OPA (Mahmoudi *et al.*, 2021a; Pamucar *et al.*, 2022), Robust OPA (Mahmoudi *et al.*, 2022), Neutrosophic OPA (Abdel-Basset *et al.*, 2022) and DEA-OPA (Mahmoudi *et al.*, 2021c). Shajedul (2021) used the OPA to evaluate sustainable technologies in the agricultural sector. Quartey-Papafio *et al.* (2021) used the OPA for supplier selection in the healthcare sector. Mahmoudi *et al.* (2020) used the OPA-based framework for project selection. Sadeghi *et al.* (2022) used the OPA to evaluate distributed ledger technologies for the construction industry. Mahmoudi and Javed (2021) used the OPA for weighing and ranking of sub-contractors in the construction industry. The literature identifies several benefits of the OPA. For instance, the OPA does not require a pairwise decision matrix. It uses a simple but powerful linear programming approach to solve MCDM problems without requiring normalization of the data and can work even when the data is incomplete. In the current study, the Ordinary Priority Approach (OPA) is used to determine the weights for suppliers and criteria. Eq. (1) shows the model OPA, which can be solved using appropriate software. In the current study, the OPA Solver (v1.00) was used to run the model. The OPA model is shown below.

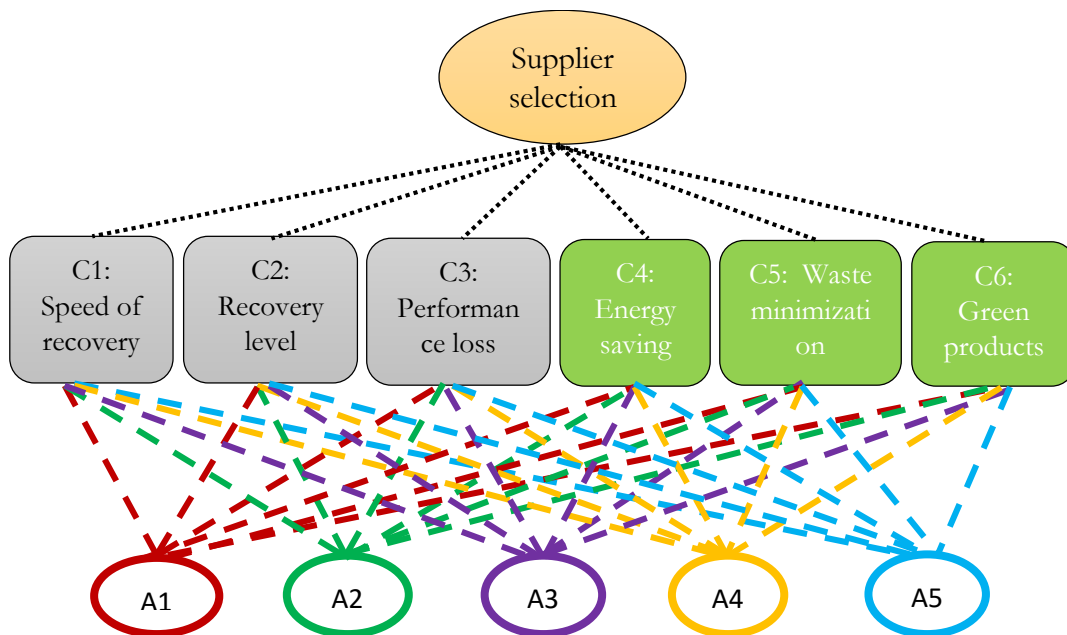


Figure 1. The supplier selection framework of five automotive parts suppliers against six criteria

$$\begin{aligned}
 & \text{Max } Z \\
 & \text{s. t.} \\
 & Z \leq j \left( r(W_{jk}^r - W_{jk}^{r+1}) \right) \quad \forall j, k \text{ and } r \\
 & Z \leq jmW_{jk}^m \quad \forall j \text{ and } k \\
 & \sum_{j=1}^n \sum_{k=1}^m W_{jk} = 1 \\
 & W_{jk} \geq 0 \quad \forall j \text{ and } k
 \end{aligned} \tag{1}$$

Equations (2) and (3) should be applied to determine weights for suppliers and criteria, respectively,

$$W_k = \sum_{j=1}^n W_{jk} \quad \forall k \tag{2}$$

$$W_j = \sum_{k=1}^m W_{jk} \quad \forall j \tag{3}$$

For the sake of completion, it is reported that  $j$  and  $k$  represent the indexes of the criteria and alternatives, respectively, whereas  $n$  and  $m$  represent the total number of criteria and alternatives.  $W_{jk}^r$  represent the weight(s) of  $k^{th}$  alternative based on  $j^{th}$  criterion and  $r^{th}$  rank, and  $j$  and  $k$  represent the rank of criterion and alternative (Quartey-Papafio *et al.*, 2021)

### 3.3 TOPSIS

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was proposed by Hwang and Yoon (1981). It is one of the most popular MCDM models. It has seen applications in various fields. For instance, Nazari *et al.* (2018) used it for photovoltaic power plant selection sites in Iran. Later, Liu *et al.* (2019) proposed the entropy-based TOPSIS model to measure the maturity of the carbon market in China. Mahmoudi *et al.* (2020) used it in their work on project selection. Ikram *et al.* (2020) used it in their study involving prioritization of barriers to integrated management system implementation. James *et al.* (2021) used the TOPSIS model to select the best bus chassis for bus fleet operators in India. Thio (2021) used TOPSIS to rank site selection criteria for marine cultivation in Indonesia. Kaul and Bhattacharjee (2022) used the Fuzzy TOPSIS model to evaluate the performance of lean green strategies in a healthcare products manufacturing company. Salookolaei and Nasab (2020) used the Fuzzy TOPSIS for evaluating projects. Zare *et al.* (2018) used the grey TOPSIS model for computerised management system selection. In the current study, the following steps (Hwang & Yoon, 1981) were used to run TOPSIS.

Step 1: The current approach assesses the decision matrix in Eq. (1), which consists of  $m$  alternatives and  $n$  criteria. If  $A_i$  represents the  $i^{th}$  supplier, and  $x_{ij}$  denotes the numerical result of the  $i^{th}$  supplier with respect to the  $j^{th}$  criterion, then the decision matrix  $D$  is,

$$D = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_j & \dots & C_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{matrix} & \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1j} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2j} & \dots & x_{2n} \\ \vdots & \vdots & \dots & \vdots & \dots & \dots \\ x_{i1} & x_{i2} & \dots & x_{ij} & \dots & x_{in} \\ \vdots & \vdots & \dots & \vdots & \dots & \vdots \\ x_{m1} & x_{m2} & \dots & x_{mj} & \dots & x_{mn} \end{bmatrix} \end{matrix} \tag{4}$$

Step 2: A normalized decision matrix is constructed in this step as expressed by Eq. (5).

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \tag{5}$$

Step 3: The criteria weights  $w$  obtained through the OPA model in Eq. (3) is applied at this step.

$$w = (w_1, w_2, \dots, w_j, \dots, w_n), \sum_{j=1}^n w_j = 1, \tag{6}$$

Step 4: The weighted normalized decision matrix  $V$  is formulated as shown in Eq. (7),

$$V = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \dots & w_j r_{1j} & \dots & w_n r_{1n} \\ \vdots & \vdots & & \vdots & & \vdots \\ w_1 r_{i1} & w_2 r_{i2} & \dots & w_j r_{ij} & \dots & w_n r_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \dots & w_j r_{mj} & \dots & w_n r_{mn} \end{bmatrix} \tag{7}$$

Step 5: The value of the positive ( $A^+$ ) and negative ideal vector ( $A^-$ ) is calculated in Eq. (8).

$$A^+ = \{v_1^+, v_2^+, \dots, v_j^+, \dots, v_n^+\}, \quad A^- = \{v_1^-, v_2^-, \dots, v_j^-, \dots, v_n^-\} \tag{8}$$

Step 6: The separation measure of each alternative from positive to negative ideal one is given by Eq. (9).

$$S_{i+} = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2}, \quad S_{i-} = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2}, \quad i = 1, 2, \dots, m \tag{9}$$

Step 7: The relative closeness to the ideal solution can be determined by Eq. (10). A higher value of  $C_{i+}$  implies, the supplier is better.

$$C_{i+} = \frac{S_{i-}}{S_{i+} + S_{i-}}, \quad 0 < C_{i*} < 1, \quad i = 1, 2, \dots, m \tag{10}$$

Step 8: Ranking of the alternatives (suppliers in the current study) is made at this step.

### 4. Results and discussion

The current research exposes a combination of the OPA-TOPSIS Approaches, which allows companies and managers to develop a decision-making tool to evaluate suppliers meritoriously. The current study sets a coherent substance for business managers to assess their decision process profoundly and eventually minimize the probability of a poor decision-making process.

The study used the data listed in Table 1 to run the Ordinal Priority Approach (OPA) model, as shown in Eq. (1). To determine the weights of the suppliers and the criteria, this research made use of Eqs. (2) - (3), respectively. Two assumptions were considered during the data analysis, one

**Table 1.** The decision matrix

Assumption 1 ( $H_1$ )	1	1	1	2	2	2
Assumption 2 ( $H_2$ )	1	1	1	1	1	1
	C1	C2	C3	C4	C5	C6
A1	1	1	4	1	2	3
A2	3	3	1	2	3	2
A3	2	1	3	2	2	1
A4	4	4	2	2	1	3
A5	1	2	3	2	1	2

where both the resilience and green criteria are unequally weighted (H1) and the latter where the resilience and green criteria are equally weighted (H2). In H1, the resilience criteria have the first priority (1), and the green criteria have the second priority (2), and in H2, both the resilience and green criteria have the first priority (1). Table 1 shows the decision matrix, and Table 2 shows the results, i.e., the weighting and ranking of the criteria and suppliers.

As can be seen in Figure 2, the third supplier (A3) turned out to be the best among all other suppliers, and A4 turned out to be the relatively worst supplier in both assumptions. Consequently, the procurement manager of the trading company is more likely to benefit from a close relationship with the supplier (A3) in case of future supply chain disruptions. Supplier (A4) should be considered as a last resort rather than a reliable supplier.

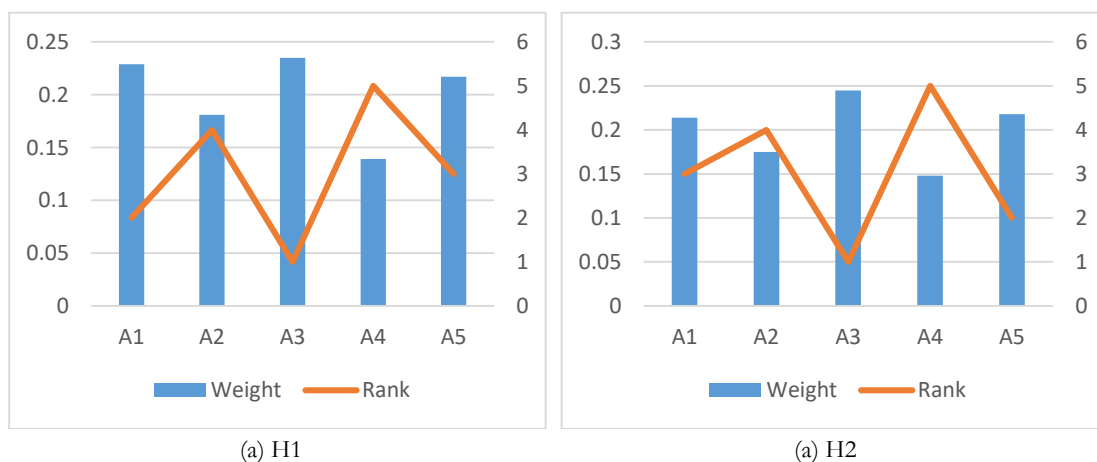
The results are considered reliable if multiple decision-making models produce comparable rankings. Therefore, after applying the OPA, TOPSIS was applied. Since TOPSIS can't estimate the weights of criteria, the weights earlier calculated through the OPA were used in both scenarios (H1 and H2). Table 3 shows the ranking and relative closeness of the ideal suppliers measured through the TOPSIS approach. Besides, the decision matrix in Table 1 contains the input data used to obtain the results in Table 3. However, it is worth mentioning that the criteria weigh vectors for the assumptions (H1 and H2) are extracted from the OPA model since the TOPSIS model cannot determine the weights of the criteria.

The TOPSIS approach indicates that suppliers A3, A5, and A1 have the most consistent performance in H1 relatively, with relative closeness values of 0.657, 0.635, and 0.579, respectively. Moreover, the results also indicate that in H2, suppliers A3, A5, and A1 remain the top-performing suppliers, with relative closeness values of 0.658, 0.625, and 0.524, respectively. Table 4 shows the comparative analysis of the rankings obtained through the two models. One can see from the table that the OPA and TOPSIS models present the respective ranking of the suppliers under the considered assumptions (H1 and H2). The comparative analysis shows that except for suppliers

**Table 2.** The evaluation of criteria and suppliers using the OPA

	C1	C2	C3	C4	C5	C6	A1	A2	A3	A4	A5
<b>Weight*</b>	0.223	0.223	0.175	0.108	0.12	0.151	0.229	0.181	0.235	0.139	0.217
<b>Rank*</b>	1	1	3	6	5	4	2	4	1	5	3
	C1	C2	C3	C4	C5	C6	A1	A2	A3	A4	A5
<b>Weight**</b>	0.162	0.162	0.127	0.157	0.175	0.218	0.214	0.175	0.245	0.148	0.218
<b>Rank**</b>	3	3	6	5	2	1	3	4	1	5	2

\*Assumption 1 (H1): Resilience criteria > Green criteria  
 \*\*Assumption 2 (H2): Resilience criteria = Green criteria



(a) H1

(a) H2

**Figure 2.** Weights and ranking of the suppliers in two scenarios



**Table 3.** Relative closeness and ranking of the suppliers through TOPSIS

	A1	A2	A3	A4	A5
<b>Separation Measure (Si+)*</b>	0.103	0.102	0.072	0.151	0.074
<b>Separation Measure (Si-)*</b>	0.141	0.104	0.132	0.068	0.129
<b>Relative Closeness (Ci+)*</b>	0.579	0.504	0.647	0.312	0.635
<b>Rank*</b>	3	4	1	5	2
<b>Separation Measure (Si+)**</b>	0.097	0.092	0.059	0.125	0.064
<b>Separation Measure (Si-)**</b>	0.106	0.081	0.114	0.065	0.106
<b>Relative Closeness (Ci+)**</b>	0.524	0.468	0.658	0.340	0.625
<b>Rank**</b>	3	4	1	5	2
*Assumption 1 (H1): Resilience criteria > Green criteria **Assumption 2 (H2): Resilience criteria = Green criteria					

**Table 4.** Comparative analyses of the rankings from the OPA and TOPSIS

Supplier	H1		H2	
	OPA	TOPSIS	OPA	TOPSIS
A1	2	3	3	3
A2	4	4	4	4
A3	1	1	1	1
A4	5	5	5	5
A5	3	2	2	2

A1 and A5 in the first assumption (H1) of both models, the OPA and TOPSIS methods have the same relative ranking of the suppliers. Thus, the comparative analyses indicate that the OPA and TOPSIS models are reliable tools for evaluating the suppliers as their results are comparable.

In recent years, organizations' environmental performance has gained extensive attention from governments, scholars, and environmentally conscious people. Therefore, resilient supply chain networks have become a growing concern for industry decision-makers as they become more conscious of potential chaos in the business environment. In this study, the evaluation and selection of suppliers were based on two different assumptions. First, the resilience and green criteria are unequally weighted (H1), and second, they are equally weighted (H2). Additionally, the research used the OPA and TOPSIS to evaluate supplier selection attributes in the automotive parts industry. TOPSIS is an established model, while the OPA is an innovative technology. The findings show that under both assumptions (H1 and H2) that suppliers A3, A5, and A1 are the top-performing suppliers relative to the others. Therefore, the local Chinese company managers should maintain a closer relationship with these suppliers. As the study proves, they are the most reliable suppliers that could overcome supply chain disruptions. However, the remaining suppliers are not as reliable as the top three performers. Thus, the manager should pay close attention to their business relationship and should consider asking them to improve their performance within a given timeframe or terminate their partnership.

Furthermore, the TOPSIS results in table 3 show that in either of the assumptions (H1 and H2), suppliers A3, A5, and A1 are the top-performing suppliers relative to the remaining suppliers. Therefore, confirming the earlier findings of the OPA model. Throughout the study, suppliers A3, A5, and A1 have demonstrated a consistent performance with relative closeness to the ideal suppliers higher than the remaining peers. Thus, the probability of better coping with uncertainties around today's changing business environment is relatively high.

Because of this study, the procurement manager at the Chinese trading company now understands the crucial importance of adopting a resilient supplier selection for the well-being of their future business operations. It gives the Chinese company and other companies within the same industry a comprehensive view of the most crucial factors to consider within the realm of the

unpredictable business environment. Thus, this study may greatly aid the less performing suppliers from this study to adapt to the changing market environment.

## 5. Conclusion

Supplier selection is an important process in automotive industries as it guarantees the quality of the material and services needed to produce automobiles and its components. Inadequate procurement of materials can jeopardize companies' economic performance and lead to a decline in sales and profitability. The current study argues that synthesizing green and resilient criteria into *gresilience* is a timely initiative, especially as the customers are becoming increasingly concerned about the environment and the businesses are becoming increasingly concerned about their partners' resilience. Primarily, after the COVID-19 pandemic, when supply chains were disrupted around the world, the focus on being green and resilient was much heard. The current study followed a unified framework of green and resilience (*gresilient*) criteria to execute the suppliers in a Chinese automotive parts industry using the OPA and TOPSIS models. The OPA approach was chosen because of its convenience in determining the weighting of suppliers and criteria since it does not require a pairwise decision matrix, or normalized decision matrix, and more importantly, it allows decision-makers to incorporate their own industry knowledge into the mathematical model. Also, the key rationale for using the TOPSIS approach in this study is its ability to evaluate the relative closeness to positive and negative ideal solutions. The rankings obtained from the two models were mostly consistent.

The study suggests to the trading companies, the procurement manager should establish exclusive stakeholder relationship strategies and management strategies to help manage their suppliers as business partners rather than just a supplier, which will not only reshape their business operations but also build resilient value chains to cope with the changing business environment. Furthermore, it is vital for companies to engage in addressing the looming environmental issues and evaluate suppliers' environmental and social performance. As society becomes more environmentally conscious, implementing a thorough green and resilient supplier selection criteria will pay exponential dividends in the future business environment. The current research will help scholars and industry leaders to solve real-world related complex decisions and promote sustainable practices.

In the future more extensive studies involving uncertainty, and advanced versions of the OPA, and TOPSIS can be undertaken. Also, more criteria can be included. Meanwhile, a more specific *gresilience*-based supplier selection framework for the automotive industry can be proposed. Time was a major constraint during the execution of this study; thus, group decision-making problem was not studied. In the future, group decision-making can also be involved by seeking input from multiple experts in the procurement department. Also, how the TOPSIS model runs on the OPA-based criteria weights may differ from the TOPSIS model run on the criteria weights estimated through other approaches is yet to be seen. Even though, in just a few years the OPA has emerged as a promising alternative decision-making model, as can be seen from the increasing number of publications involving the OPA, its validity will only be confirmed as it sees application in new and diverse problems. In the future, its validity should be confirmed through extensive comparative analyses with the established models like the Grey Relational Analysis and Analytic Hierarchy Process. Also, how the supplier passion (Nawaz *et al.*, 2021) can affect the supplier *gresilience*, or vice versa, is an interesting area of further research.

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# Factors Influencing Online Buying Behavior: A Case of Shopee Customers

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Received 12 November 2021; Revised 20 January 2022; Accepted 22 January 2022

**Abstract:** This research aims to gain an understanding into the factors influencing customer buying behavior on e-commerce platforms such as Shopee, particularly from a behavioral standpoint. The current study identified 23 factors influencing online buying behavior, and then evaluated the performance of Shopee on these factors using the Relative Importance Index (RII). The results revealed that quality of product (or service), customer knowledge of the product, price of product, and shop's reputation are most important factors. Relatively least important factors are impulsive buying behavior, perceived enjoyment, tagline, and mood. The study concludes with important implications for the electronic retailers.

**Keywords:** Consumer buying behavior; relative importance index; online shopping; e-commerce; Shopee

## 1. Introduction

The rapid growth of information technology such as internet has impacted various aspects of consumer life. Internet usage has evolved into a massive global marketplace for exchanging goods and services throughout the last few decades. Internet is utilized to disseminate information and is a medium for buying and selling or trading through an online marketplace environment in many developed countries. In 2021, the number of Indonesian internet users increased by 11 percent from the previous year, from 175.4 million to 202.6 million users (Agustini, 2021). The surge results from the advancement of internet technology, providing several new options in all aspects of people's lives. The ease of access to information, seeking enjoyment, and other activities have resulted in the creation of several new platforms involved in selling goods and services to customers over the internet, or commonly known as online retailers. Business actors have begun to innovate the marketing of their products and services by employing increasingly sophisticated media channels. This is done to keep up with the latest trends and provide convenience.

The most popular e-commerce marketplace in Indonesia is Shopee, an online shopping site that has been in the country since 2015. Shopee is the first digital platform in Southeast Asia (Indonesia, Singapore, Malaysia, Philippines, Vietnam, Taiwan, and Thailand) that allows free, enjoyable, and secure online buying and selling transactions. Shopee's products are geared primarily towards fashion and household goods. Shopee has become an e-commerce platform frequently explored and used by the community for online shopping in 2020 (Afrianto & Irwansyah, 2021). Shopee transactions in Indonesia are the largest in ASEAN, as evidenced by the fact that upon the Shopee



launch in the third quarter of 2015, activity sales in Indonesia made via smartphone reached 56 percent. In Indonesia, Shopee has an active listing of more than 55 million customers and downloads of 15 million. On a regional level, Shopee has a total transaction value of more than US\$3 billion with application downloads (Edward & Utami, 2020). The data, shown in Figure 1 (data from Databoks, 2021), can signify that e-commerce improves over time as the economy grows.

Shopee is a business-to-customer (B2C) e-commerce platform that sells products and services directly to customers. In B2C transactions, online stores and services are key sales channels. Shopee offers features that simplify buying and selling transactions between sellers and buyers by encouraging customers to purchase products through marketing, utilizing a simple payment mechanism, and requesting a low transaction fee. This affects buying behavior as customers usually seek information on a product before making a purchase decision. However, not everyone is interested in making online purchases. Several are still hesitant to purchase at an online shop for various reasons. A lack of trust in online purchasing is the primary factor affecting customer buying behavior. This is due to the emergence of competing companies that sell identical products of varying quality and cost (Hermawan, 2021). Other reasons are the difficulty of conducting transactions online, the fear of receiving goods that are not as ordered, and receiving a product whose quality does not match the price offered.

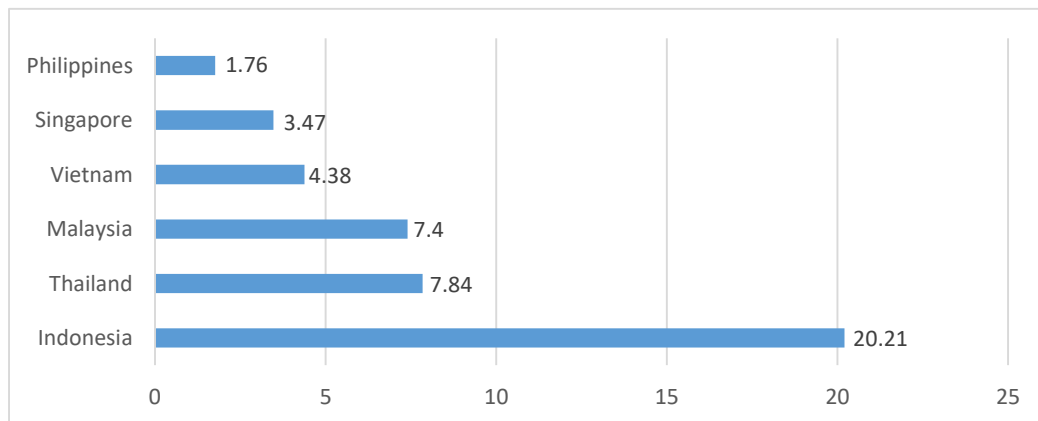
As a result, interest in completing online purchasing may decrease over time. This situation requires online business sellers to attract customers' interest in purchasing by paying attention to factors influencing customer decisions to shop on an online e-commerce platform. Hence, this study aimed to learn more about the antecedents that influence customer buying behavior and enhance readers' understanding of online buying behavior from a behavioral viewpoint.

To achieve the study's objectives, we first describe Shopee Indonesia's background as a B2C business model and introduce the problems and solutions regarding factors affecting customer buying behavior on an online e-commerce platform. The second section reviews the literature on online purchasing and the factors influencing customers' buying decisions. Following that, the author presents an outline of the methodological approach. Results and discussion will be covered in the fourth section. Finally, the study will conclude with essential suggestions and implications.

## 2. Literature review

### 2.1 Online commerce and Shopee

An e-commerce trading system is one platform that Indonesian people enjoy. The development of e-commerce has expanded worldwide, not just in Indonesia. E-commerce, often known as electronic commerce, is the buying and selling goods and services via an electronic system (Afrianto & Irwansyah, 2021). Huseynov and Yildirim (2016) discovered that understanding the motivations



Data source: databoks.katadata.co.id

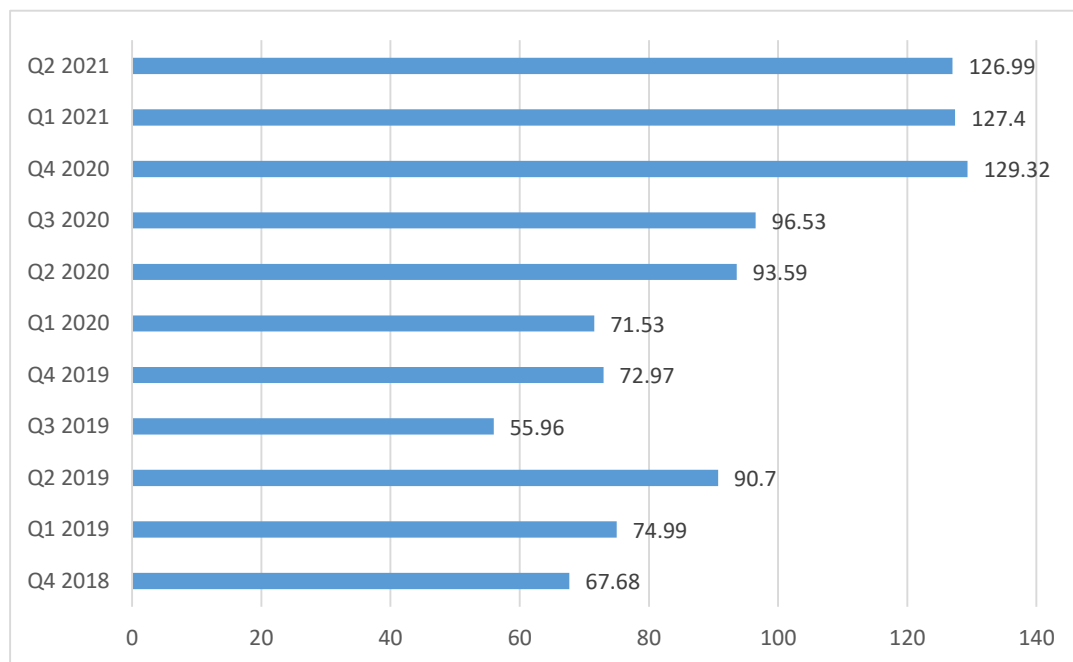
Figure 1. Projected E-commerce sales (in billion USD) in Southeast Asia in 2021

and elements that influence online shoppers contributes to an internet strategy's successful expansion and application. Anggrara and Santosa (2019) analyzed that e-commerce is utilized for financial transactions that use the internet as a medium for transactions and includes non-financial transactions such as information exchanges between the customer and the seller. E-commerce is an electronic business that focuses on business transactions, utilizing the internet as a medium for trading goods or services between two parties of institutions or organizations called business to business (B2B) and between institutions and customers called business to customer (B2C) model.

The growth of sales for e-commerce in Indonesia has reached US\$ 20.21 billion in 2021. This is much more than other countries in Southeast Asia, as shown in Figure 1. This is evidenced by the rise in internet users, representing a massive opportunity for e-commerce advertisers (Sumaa *et al.*, 2021). Shopee is Asia's most popular online shopping platform and one of Indonesia's most effective and successful e-commerce platforms. Customers can purchase from thousands of brands and sellers on Shopee, with over 500 local and international brands. This platform offers many products, including gadgets, apparel, automotive cosmetics, electronics, and many more. Shopee provides business opportunities and sells a wide range of products at a lower cost than a general store (Rizki, 2020). Ching *et al.* (2021) analyzed that due to the benefits and enjoyment that occurred, Shopee e-commerce has become increasingly popular among customers for shopping purposes compared to brick-and-mortar retail. Figure 2 shows Shopee's quarterly web visitors between 2018-2021 (data from iPrice, 2021).

2.2 Customer Buying Behavior and its antecedents

By definition (Kotler *et al.*, 2021; Sumarwan, 2021), a buyer is an individual, group, or organization that engages in activities such as the purchase, utilization, and disposal of goods, services, ideas, or experiences to fulfill their needs and desires. Depending on purchase choice, customer decision-making varies. In the purchase behavior process, buyers frequently go through three stages: promotional activities, buyer responses, and buyer behavior (Kotler *et al.*, 2021; Sumarwan, 2021). In the first stage, the company's marketing actions include providing stimuli that can influence customer impressions. The second stage is the analysis of all purchaser inputs based on analysis and decision-making of individual buying behavior, which changes based on activities and incentives in marketing activities. The last step involves making purchasing decisions,



Data source: iprice.co.id

Figure 2. Shopee’s quarterly web visitors (in million) between 2018-2021

influenced by the antecedents influencing customer buying behavior. Prior studies have revealed various antecedents (listed in Table 1) that affect customer buying behavior on an online e-commerce platform.

Maulana and Alisha (2020) identified product innovation as one factor influencing customer buying behavior. Buyers are more inclined to compare the product they purchase with similar products from other vendors. Globally, innovation has emerged as the most critical factor in maintaining competitiveness. It propels organizational growth, and future success and is a mechanism that allows businesses to stay afloat in the global economy (Husti & Mahyarni, 2019). According to Javadi *et al.* (2012) and Lim *et al.* (2016), suggestions from family, friends, and the media are essential. The more people recommend e-buying to one another, the more popular this purchasing method will become. Electronic word of mouth (e-WOM), according to Amrullah (2021), serves as a medium for disseminating information about reference groups and is utilized by other customers to determine behavior during the purchasing process. Like e-WOM, online customer review (OCR) was defined by Handayani and Usman (2021) as a type of word-of-mouth communication that can assist both merchants and buyers through its action. Sellers receive free product marketing, while customers get information about potential purchases without going to the vendor. This helps efficiency and effectiveness. Positive customer reviews can encourage customers to purchase products and boost their shop's reputation (Novitasari & Sari, 2019). Perceived benefits, ease of use, perceived web security, and perceived enjoyment as mutual influencing factors were investigated by Abd Aziz and Abd Wahid (2018), Yuliharsi *et al.* (2011), and Marza *et al.* (2019). Customers who have enjoyed the benefits of internet shopping prior to web experience may continue to do so in the future. It implies that the more customers feel the ease and benefits of making transactions, the more likely they will buy from e-commerce platforms (Abd Aziz & Abd Wahid, 2018; Yuliharsi *et al.*, 2011; Batubara *et al.*, 2021; Baubonienė & Gulevičiūtė, 2015). Mood also plays an important role that significantly affects perceived benefit and purchase intention (Zhang *et al.*, 2012).

In most cases, online purchasing is chosen for payment convenience; the ability to receive a required product or service without leaving home (Baubonienė & Gulevičiūtė, 2015), and the assurance of customer data security, which can encourage customers to shop in the marketplace (Novitasari & Sari, 2019). Quality, service quality, and website quality are essential considerations when running an online business. Customers are more likely to purchase if the quality is higher (Shahnaz and Wahyono, 2016; Luthfiana and Hadi, 2019; Novitasari and Sari, 2019). Trust that they will not be exposed to any dangers is reportedly another important factor influencing customer purchase behavior (Bhatti *et al.*, 2021). Customer purchase intention is positively associated with trust, impulsive purchase intention, the prior online purchasing experience, brand orientation (Ling *et al.*, 2010), and brand awareness (Adika & Subandrio, 2021).

Meanwhile, customers' knowledge of a product or service is equally crucial, as buyers can make purchasing decisions based on their understanding (Hertanto & Sulhaini, 2020). Promotions and discounts have a reciprocal influence on the price since they substantially impact customer purchasing behavior. The better the pricing and great deals, the more likely customers are to buy (Baubonienė & Gulevičiūtė, 2015; Wijaya & Teguh, 2012; Luthfiana & Hadi, 2019; Hertanto & Sulhaini, 2020; Pratama & Yoedtadi, 2021). Andrian (2019) discovered that the more products sellers could offer, the more likely people would buy. Batubara *et al.* (2021) believed that a memorable slogan would create a lasting impression on customers. Due to this perception, customers are expected to recognize the messages and information conveyed through the tagline.

### 3. Research methodology

#### 3.1 The research instrument and data collection

The study identified 23 factors influencing customer buying behavior on an online e-commerce platform (see Table 1). From these factors, a questionnaire was developed. The questions were like: "When I decide to buy a product (or service) at Shopee, it is mainly due to *product innovation*." Each

**Table 1.** Factors influencing customer buying behavior on online e-commerce platform

Code	Factors	Description	Literature
F1	Product innovation	Refers to the process of coming up with fresh ideas for a new product that may suit customers' needs.	Maulana and Alisha (2020)
F2	Suggestions by friends/family/relatives	Subjective factors such as family, friends, and the media can influence purchase intents.	Javadi <i>et al.</i> (2012); Lim <i>et al.</i> (2016)
F3	e-WOM and OCR	Electronic word of mouth (e-WOM) is a medium of transmitting information about a product. Online customer reviews (OCR) are written reviews in opinion, product assessment, and ratings by customers who have purchased a product online.	Amrullah (2021); Handayani and Usman (2021)
F4	Perceived benefits	Customers perceive some benefits from the products they intend to buy.	Abd Aziz and Abd Wahid (2018)
F5	Ease of use	Customers' perception about how simple or difficult it is to use the shopping system.	Li <i>et al.</i> (2020); Cho and Sagynov (2015)
F6	Perceived web security	While purchasing on the internet, customers may be assured of their safety and privacy.	Yulihastri <i>et al.</i> (2011)
F7	Payment convenience	Customers are attracted to convenient suppliers because they provide clear payment information and instructions, quick and straightforward product purchasing methods.	Baubonienė & Gulevičiūtė (2015); Novitasari and Sari (2019)
F8	Website quality	Perceived quality of a website, as seen by its look and information clarity.	Shahnaz and Wahyono (2016)
F9	Service quality	Capacity to meet customer wants, whether apparent or concealed, is demonstrated by the totality of the form attributes of services.	Luthfiana and Hadi (2019)
F10	Quality of the item	All product features and attributes must be met to meet customers' expectations.	Novitasari and Sari (2019)
F11	Trust	Perception that the customers would not be exploited or deceived.	Bhatti <i>et al.</i> (2021); Ling <i>et al.</i> (2010)
F12	Knowledge	Customers' information about a product, such as product features, accessibility, specs, and the advantages of utilizing the product.	Hertanto & Sulhaini (2020)
F13	Impulse purchase intention	Unexpected behavior occurs when shoppers feel compelled to buy things immediately due to specific stimulation.	Ling <i>et al.</i> (2010); Javed and Javed (2015)
F14	Brand orientation	Some customers identify product through brands and feel at ease when buying the brand they like.	Ling <i>et al.</i> (2010)
F15	Brand awareness	Capacity of a brand to attract potential customers by describing a company's identity by its looks, such as a logo, form, and color.	Adika and Subandrio (2021)
F16	Prior online purchase experience	Customers who have previously made an online purchase are more likely to do so again than those who have never done so.	Ling <i>et al.</i> (2010)
F17	Price	Price refers to a situation where customers give up a certain amount of money in return for a product.	Baubonienė & Gulevičiūtė (2015); Wijaya and Teguh (2012)
F18	Promotion and Discounts	A company's promotion strategy aims to spread information and solicit favorable comments from potential customers.	Wijaya and Teguh (2012); Luthfiana and Hadi (2019);

		Discounts are reduced fares offered to customers as a nominal appreciation for specific purchases.	Hertanto & Sulhaini (2020); Pratama and Yoedtadi (2021)
F19	Perceived enjoyment	When people are comfortable, happy, engaged, and thrilled while shopping, they shopping experience is improved.	Marza <i>et al.</i> (2019)
F20	Product variety	Product variety refers to a company strategy for gaining customers' interest by expanding the items supplied to achieve the intended market.	Andrian (2019)
F21	Tagline	A tagline's purpose is to leave a lasting impact on customers remembering the product's information and facts.	Batubara <i>et al.</i> (2021)
F22	Shop's reputation	Sellers' reputation helps make customer decision.	Novitasari and Sari (2019)
F23	Mood	Mood impacts perceived benefit and purchase intention.	Zhang <i>et al.</i> (2012)

respondent was provided with links to two questionnaires – one in English (ENG) and the other in Indonesian (IND) – and was asked to choose the language they were most comfortable with.

The questionnaire was prepared on Google Form and shared in the online groups containing the East Asians as the Shopee is popular among them. The primary data was collected from respondents who have experience purchasing goods or services on the Shopee e-commerce platform. Fifty-five respondents filled the questionnaire, but forty-nine of them accurately completed it; thus, the sample size was 49. Based on the language they chose, they were divided into Group ENG and Group IND (see Table 2). The 7-point Likert scale ranging from strongly disagree (1) to strongly agree (7) was used for recording observations. Respondents filled out one of the scales in each question to determine the most critical factors based on their previous experience with Shopee. Microsoft Excel was used for data analysis. A copy of the questionnaire can be obtained from the author at a reasonable request.

### 3.2 Data analysis techniques

In the current study the Relative Important Index was used to rank the 23 factors (see Table 1) based on the primary data while dispersion analysis was performed to identify the uncredible datasets, such as the cases where the respondent might had filled the questionnaire without even reading it and thus might have recorded same observation for all questions. These techniques are discussed below.

**3.2.1 Relative Importance Index:** The Relative Importance Index (RII) determines the relative relevance rankings of quality factors. RII is a convenient way to measure the relative importance of factors, usually based on primary data. Zhong *et al.* (2021) used RII to analyze the important factors influencing the decision-making procedure for building projects in Egypt. Sheikh *et al.* (2019) used RII to analyze 37 factors influencing the process quality throughout the construction phase of a structure life cycle in Pakistan. To define the importance level of each element, a five-point Likert scale ranging from 1 to 5 was used from (not at all important) to (extremely important). The formula for the RII is (Zhong *et al.*, 2021).

$$RII = \frac{\sum l_i r_i}{YZ} = \frac{1r_1 + 2r_2 + 3r_3 + 4r_4 + 5r_5 + 6r_6 + 7r_7}{7Z} \tag{1}$$

where  $l_i$  denotes the importance level  $i$  or the weighting given to each factor by the respondent, ranging from 1 to 7 on the Likert scale;  $r_i$  is the number of respondents who indicated importance level  $i$ ;  $Y$  represents the highest point, which is seven in the current study; and  $Z$  represents the total number of respondents, which is 49 in the current study.

**Table 2.** The grouping of the survey participants

Groups of respondents	Number of respondents	Percentage
Group ENG	32	65.3%
Group IND	17	34.7%
Overall	49	100%

The greater the value of the RII, the more important the factor is. RII scale runs from 0 to 1. The closer it is to 1, the more reliable the scale's internal consistency criteria are (Rooshdi *et al.*, 2018). In the current study, RII will be used to rank 23 factors.

**3.2.2 Dispersion analysis:** Coefficient variation measures the level of dispersion and helps in examining the distribution of data. It is calculated as (Zhong *et al.*, 2021)

$$CV = \frac{\sigma}{\bar{X}} \tag{2}$$

where,

$$\sigma = \sqrt{\frac{\sum_{i=1}^Z (x_i - \bar{X})^2}{Z}} \tag{3}$$

and

$$\bar{X} = \frac{\sum_{i=1}^Z x_i}{Z} \tag{4}$$

where CV represents the coefficient of variation,  $\sigma$  represents the standard deviation,  $x_i$  represents the  $i^{th}$  data scale,  $\bar{X}$  represents the mean value of all data scales, and Z represents the number of data scales. As a result, the greater the CV, the greater the dispersion degree, and vice versa.

#### 4. Results and discussion

In the previous sections, the factors were identified, and data was collected. In this section, the importance of the factors influencing buying behavior with the RII. Table 3 shows 23 potential factors influencing buying behavior (F: factors), including their RII and ranks for both groups and overall.

The lists of factors influencing customer buying behavior, Relative Importance Index (RII), and rankings are all shown in Table 3. Figure 3 illustrates the diagram for the ranking of factors. The results revealed the most and least important factors for both groups (Group ENG and IND) affecting customer buying behavior on an online e-commerce platform. The quality of product or service (F10) factor gets the highest rank as an essential factor for both groups. This is followed by the customer's knowledge of the product (F12), price of product or service (F17), and shop's reputation (F22). In Table 3, for aggregating the RII scores of the two groups, greater weight (0.6) was given to Group ENG because the data within it was more credible (as CV was high in most cases).

Quality of product or service (F10) tends to be the highest rank as this factor has a significant positive effect on the image of a product that affects customers' purchasing decisions. Luthfiana and Hadi (2019) showed that the better the quality is, the higher the interest in repurchasing at the e-commerce marketplace. In other words, product quality improvement will increase customers' buying behavior.

The second highest is the customer's product knowledge (F12). Customers' understanding of a product has varying levels because of their differences in the ability to receive information about products, which will affect their purchasing decisions (Hertanto & Sulhaini, 2020). Pucci *et al.* (2018) reported that knowledge positively impacts the relationships of a variable affecting the



**Table 3.** Relative Importance Index and ranking of the factors

Factors	RII			Rank		
	Group ENG	Group IND	Overall*	Group ENG	Group IND	Overall
F1	0.832	0.808	0.822	7	15	11
F2	0.739	0.763	0.749	15	20	17
F3	0.866	0.835	0.853	4	10	6
F4	0.807	0.884	0.838	11	3	9
F5	0.823	0.857	0.837	10	8	10
F6	0.723	0.804	0.755	16	16	16
F7	0.832	0.853	0.840	7	9	8
F8	0.714	0.795	0.746	18	17	18
F9	0.723	0.835	0.768	16	10	14
F10	0.882	0.888	0.885	1	1	1
F11	0.765	0.835	0.793	13	10	13
F12	0.874	0.888	0.880	2	1	2
F13	0.579	0.674	0.618	22	22	23
F14	0.681	0.812	0.733	19	14	19
F15	0.756	0.781	0.766	14	19	15
F16	0.857	0.862	0.859	6	6	5
F17	0.874	0.870	0.873	2	4	3
F18	0.832	0.862	0.844	7	6	7
F19	0.555	0.790	0.649	23	18	20
F20	0.789	0.826	0.804	12	13	12
F21	0.613	0.674	0.638	20	22	21
F22	0.865	0.866	0.866	4	5	4
F23	0.588	0.683	0.626	21	21	22

\*Overall score = Group ENG score\*0.6 + Group IND score\*0.4  
Note: CV (Group ENG) = [0.139, 0.538]; CV (Group IND) = [0.079, 0.371]

purchasing behavior. The study compared the effects of social media use on the purchase of online products. Therefore, the greater the customer's understanding of the product, the more likely they will purchase it.

Thirdly, the price of a product or service (F17) is essential in affecting customers' buying behavior. Price impacts customer purchasing decisions; the lower the price, the more likely a purchase will be made. Earlier, Baubonienė and Gulevičiūtė (2015) revealed that the lower the price, the more convenience provided for the customer. This will lead to an increase in purchasing.

Lastly, the shop's reputation (F22) is one of the most critical factors affecting customers' buying behavior. Sellers with a high-performance record, excellent reviews, and positive testimonials are expected to enhance customers' attitudes toward online purchases (Novitasari & Sari, 2019). The better the seller's reputation, the more confident the buyer will be in purchasing. Buyers believe that a good shop reputation means good quality products or services. Therefore, the shop's reputation is one of the most critical factors that impact buyers' buying behavior in online e-commerce platforms.

Meanwhile, the least important factors for both groups are depicted in Figure 3. These factors are impulsive buying behavior (F13), perceived enjoyment (F19), tagline (F21), and mood (F23).

Impulsive buying behavior (F13) is an unexpected behavior when a customer experiences an urge to purchase products or services. This behavior tends to be a sudden and unplanned reaction to individual physiological purchasing behavior. The internet may minimize customers' ability to

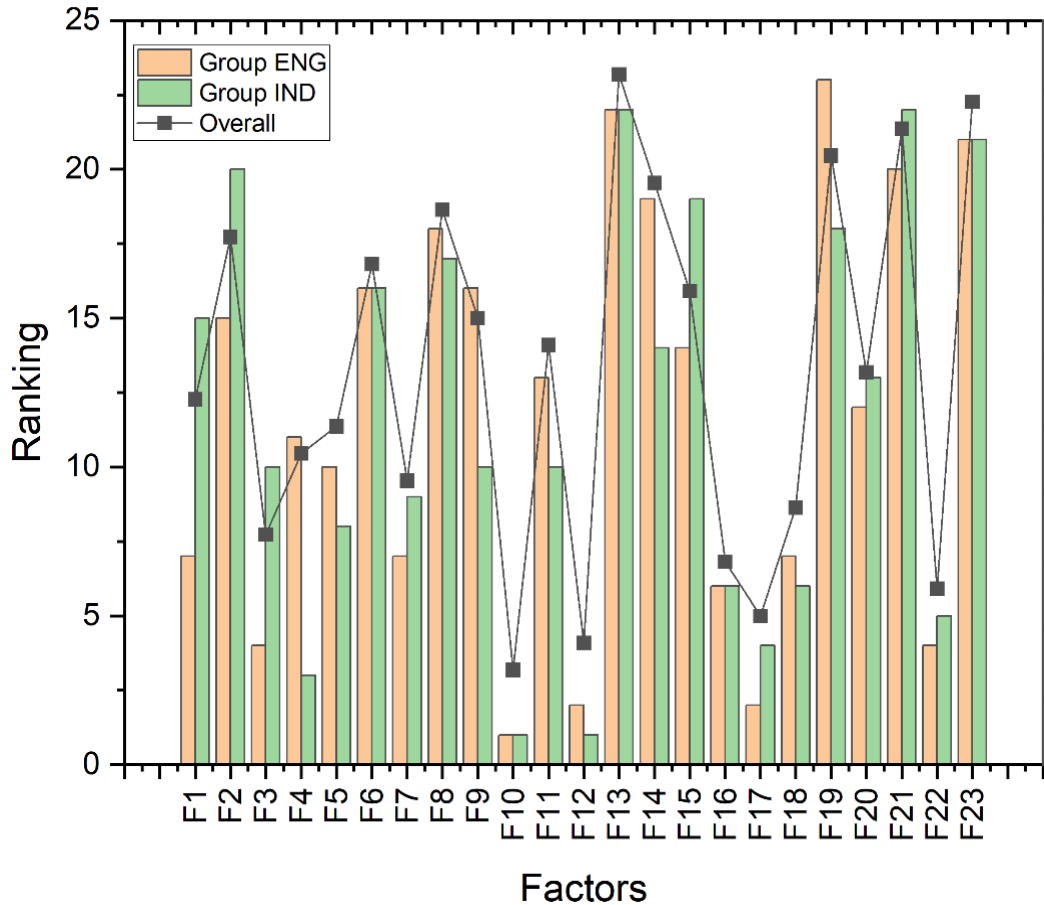


Figure 3. The ranking of 23 factors influencing online purchase intentions

control their impulsive buying behavior. On the other hand, the physical stores' environment and production of sensory experiences can lead to more impulsive purchases than online stores (Gupta, 2011). According to an analysis done by Kearney (2013), 40% of participants in a poll (3,000 customers of the United States and the United Kingdom were involved) spent more money than expected in physical stores. In contrast, only 25% did so in the online platform. Therefore, not all buyers make impulse purchases all the time. This behavior does not significantly affect customer buying behavior.

Perceived enjoyment (F19) is a form of individual behavior where buyers feel happy, comfortable, and excited while doing purchasing activities (Kim & Ammeter, 2018). The perceived enjoyment factor is considered the least important factor because most customers enjoy buying in physical stores more than online. Prior study has found that shoppers' satisfaction with physical in-store purchasing experiences significantly impacts their behavior (Pappas *et al.*, 2012). Perceived enjoyment can affect a variety of customer responses. Prior studies have examined various antecedents; nevertheless, many elements influence perceived enjoyment while shopping. Furthermore, there is a shortage of studies on perceived enjoyment in post-transitional economies that are still relatively underdeveloped.

Tagline (F21) is a company's phrase used as a marketing stimulus to attract customers. Depending on the phrase, a carefully designed tagline can change the willingness to acquire the promoted goods. Rybaczewska *et al.* (2020) revealed that the model approach to buying behavior refutes the notion that slogans or taglines have the most significant influence on customers during the period of Alternative Evaluation. Slogans or taglines give a reference point for young customers throughout the post-purchase to determine if they are content or dissatisfied with their purchase and information during the information search phase. This demonstrates that the tagline is not

considered a crucial factor affecting customers' intention when purchasing because the tagline does not explicitly influence customer buying behavior.

Lastly, customer emotions impacting behavior while purchasing are referred to as mood (F23). Mood tends to be positive and negative emotions in a particular situation, where mood does not significantly affect customers while purchasing products or services. Tulipa *et al.* (2014) discussed that positive emotion or mood mainly had no discernible effect on repurchase intent. Mood can turn a positive perception about products or services into a negative perception that affects customer buying behavior.

In light of the facts stated above, it can be argued that the crucial factors in customer buying behavior are quality of product or service (F10), customer's knowledge of product or service (F12), price of product or service (F17), and shop's reputation (F22). Customers are more likely to purchase when sellers have an outstanding quality of products or services, reasonable price, proven track record, outstanding evaluations, and positive comments. On the contrary, impulsive purchase behavior (F13), perceived enjoyment (F19), tagline (F21), and mood (F23) are not regarded as critical factors that may influence a customer's purchasing decision.

Based on the results above, it is suggested that buyers or decision-makers must pay attention to the quality of the product or service (F10) because quality plays a crucial role in determining customer buying behavior. Improvement of product or service quality will automatically enhance and affect other factors such as customer trust in product quality, shop reputation, and customer knowledge. These factors will undoubtedly influence customer buying behavior on an online e-commerce platform, mainly Shopee customers.

## 5. Conclusion

Internet usage is one of the most popular activities in Indonesia. Every year, the increasing number of internet users has led some parties to take advantage of this trend by opening online stores in electronic commerce systems or e-commerce. Shopee is one of the most well-known e-commerce sites in Indonesia. Shopee provides an effortless payment system, and various products or services with affordable prices that engage customer buying behavior. Unfortunately, many are concerned with purchasing using an e-commerce platform. A lack of trust in online purchases is one of the critical factors reducing the number of purchases.

The study applied the Relative Importance Index (RII) method to calculate the relative importance of the factors influencing the Shopee customers' buying behavior. Thus, the study reported the most and least important factors influencing buying behavior in the current study. It was found that the most significant factors are quality of product or service, customer knowledge of the product, price of product or service, and shop's reputation. Customers' willingness to purchase online is more likely to increase when merchants offer high-quality products and services at an affordable price, an impressive track record, and high ratings. Meanwhile, the least important factors are impulsive buying behavior, perceived enjoyment, tagline, and mood. Moreover, it is proposed that buyers or decision-makers focus on the quality of product or service factor as it's a key element in determining customer purchasing behavior. The Shopee and their competitors in the region should note down the importance of these factors and efforts should be made to use these factors in a way that encourages online shopping and thus sales. Special attention should be paid to the top factors.

As with any study, there are some limitations of this study. The study didn't collect in-depth demographic information about the respondents thus in the future demographic questions may also be added and their influence on customer buying behavior can be gauged. The sample size is small but all had experienced e-commerce. As a result, the analysis excludes those potential customers who have no prior experience with online transactions but intend to engage in such activities. The current study used the popular Relative Importance Index primarily because of its simplicity and ease of computation, however in future other alternatives, such as the Relative Performance Index (Mahmoudi & Javed, 2022), may also be tried. Hence, further scholars can extend this research by providing additional variables and extensively studying factors influencing

customer buying behavior. Furthermore, researchers are encouraged to include more information regarding factors influencing online purchasing behavior.

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# Evaluation of Barriers to Gilgit Baltistan's Travel & Tourism Industry: Pakistani Youth's Perception

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Received 28 February 2022; Revised 29 March 2022; Accepted 29 March 2022

**Abstract:** Thousands of local and foreign tourists visit Gilgit-Baltistan (GB) which has huge tourist potential due to its unique beauty, but for being countryside area and new province, this region is facing different type of challenges and barriers towards its travel & tourism development. The current study intends to identifying and evaluate multiple varriers barriers to the development of GB's travel & tourism industry. Primary data was collected from Pakistani youth. The opinion of both men and women were sought. Later, the Grey Rational Analysis (GRA) model was used to analyse data and rank the barriers. The results showed that, absence of tourist information centres, limited and expensive flights and inability to regulate tourism & lack of effective tourism policy are key barriers hindering the development of GB. The results are important for GB's cultural & tourism department and for policy makers. Also, the results are important for the tour operators and the general public who want to visit GB.

**Keywords:** Gilgit Baltistan; Pakistan; travel and tourism; barriers; grey relational analysis

## 1. Introduction

Tourism is a social, cultural, and monetary factor that offers many benefits, including small businesses, economic benefits for attracting visitors from different places, and providing jobs for people working in the transport and hotel industry (Angela & Angelina, 2021). Further, tourism can lead to better the relation between countries or businesses by cultural exchange and improve the value of currency, for tourist it provides happiness, refreshment, knowledge, etc (Laksito & Yudiarta, 2021). Pakistan has potential in the tourism industry, having its variety of cultures, highest and snowy mountain ranges, beautiful lakes, rivers, cold and hot deserts and has especially Gilgit Baltistan (GB) which can satisfy the needs of domestic and overseas tourist (Arshad *et al.*, 2018). Gilgit Baltistan has its own beauty and rank as concerning national and international level, however its tourism industry not so developed yet because of some challenges and difficulties on the way of tourism and hospitality growth which are mainly highlighted in this study.

Even though GB has huge tourism potential, the tourist still faces different types of problems like lack of communication services, absence of tourist information centres, unavailability of relaxing benches, and lack of resting areas on scenic points (Nation, 2020). In the extreme north of Pakistan, the beautiful Skardu valley is located which path to some the highest mountain in the world including K2, K3 and Gasherbrum. These towering mountains attract lots of climbers,

visitors from different countries (Bukhari, 2019) if we talk from tourism perspective in Pakistan, Gilgit Baltistan is one of the most attractive parts of the country. But there are not many facilities, the hospitality of the people is amazing (Qureshi, 2013). Hussain (2021a) concluded that the beauty and serenity of this region being collapsed due to unregulated, unplanned and irresponsible tourism policy, which also the decrease flow of decent and nature loving tourists in Gilgit Baltistan. This study predicted that Gilgit-Baltistan is losing its advantage in the exchange of tourism and is becoming a centre of illegal and unfair business activities like other border areas of the country (Hussain, 2021a).

In some recent studies about tourism industry in GB Pakistan, it is seen that some criteria such as geographical, historical reviews and cultural traits of this region has been discussed (Hussain *et al.*, 2017). Most of the previous researches presented the potential for tourism, sustainable development and a list of leading challenges to the way of GB's travel & tourism growth by sharing their self-traveling experience and collecting local's opinions mainly including transportation problems, lack of hoteling, natural risk, lack of connectivity between valleys, lack of tourism planning, lack of medical facilities (Nation, 2020; Hussain, 2021a; Qureshi, 2013). Saqib *et al.* (2019) explored the impact of tourism on GB, through interviews and personal observation of local residents and tourists.

Many studies identified the challenges that the GB's tourism industry is facing. Some studies (Nabi *et al.*, 2019; Hussain, 2021a; Khan, 2021) highlighted natural risks and challenges towards tourism whereas others (Baig, 2017; Qureshi, 2013; Bukhari, 2019; Jabri, 2021; Khursid, 2003) highlighted the inability and lack of functional policy from the government side. Issues concerning social media marketing, safety and security issues have also been studied (Khan, 2021; Arshad *et al.*, 2018). It is obvious from the literature that there are many risks and challenges that the tourism industry of Pakistan, in general, and GB, in particular, is facing, however rarely efforts have been made to identify all important factors and issues followed by their scientific evaluation. Considering this gap in the literature, the current study identified the key challenges currently being faced by the Pakistani tourism industry from the online literature and then evaluates them against the GB tourism sector using the Grey Relational Analysis (GRA) method in light of the opinions collected from the Pakistani youth.

The rest of the study is organized as follows. The second section is on literature review. Here the important risks and challenges being faced by GB's tourism sector are identified. The third section is on research methodology where data collection strategy and data analysis technique (Grey Relational Analysis) are reported. The fourth section presents the results and their discussion while the last section presents conclusion and recommendations.

## 2. Literature review

Gilgit-Baltistan (GB) is Pakistan's fifth province, located in the north of Pakistan. Gilgit Baltistan is famous for its own cultural tourism and graceful views. Tourists visit Gilgit Baltistan to explore the beautiful plains (Astora Valley), the highest mountains (K2), and high-altitude plains (Deosai Plain). In 2019, according to statistics posted by PTDC-Pakistani Tourism Development Company, this area was visited by 1.72 million tourists, in fact, which is 3 times the number of tourists visited last year, and in 2021 the number of regional and foreign tourists is equal to 700,000 people. Tourists contributed up to 300 million rupees to the regional economy, and tourism accounts for 2.8% of the joint state GDP (Tabarak, 2019).

In 2021's summer season close to 700,000 local and foreign tourists and travellers visited GB (BR, 2021). The flow of foreign tourists decreased during the last years while the domestic tourist increased compared to previous years. The declining number of overseas tourists was seen due to the terrorism events, the poor security issue that damaged the tourism industry. Such uncertain situations in Pakistan have prevented the flow of overseas tourists towards northern-areas especially GB. The highest number of domestic visitors record in 2015 which shows a great change in people's perceptions about security. The promotion of domestic tourism was due to the new publishing reports, sharing scenic pictures on social media and print media.as statistical report by

Pakistan Association of Tourism, before the 9/11 terrorist attacks on the US in September 2001, more than 20,000 foreign tourists used to visit Gilgit-Baltistan each year. The number of visitors decreased more than fivefold in 2002 following the 9/11 terrorist attack event in USA (Saqib *et al.*, 2019).

The tourism and hospitality industry in GB is growing day by day because of the new well security plan and tourists from different places want to visit this place of Pakistan. Pakistan is also a safe sound country in the world. Lots of local and foreign tourists want to explore the beauties of the different places of Pakistan. The amiable residents, heavenly scenery and charming waterfalls make this province a favourite destination for tourists from all over the world, the simplicity and harmony of the province are the enjoyment of the heart and soul. Hussain (2017) composed a list of top 7 key tourist places in GB in accordance to the tourist preferences. These are Hunza Valley, Skardu Valley, Nagar Valley, Khaplu valley, Shigar Valley, Gupis Valley, and Astore Valley. The map of GB is shown in Figure 1.

### 3. Research methodology

#### 3.1 The research instrument

Based on the nineteen factors extracted from the literature (Table 1), a questionnaire was designed. The questionnaire had two parts; the first part aimed to collect the demographic information of the respondents and the second part contained key questions. The questions were like this: "I believe \_\_\_\_\_ is/are key barriers to the growth of Gilgit Baltistan's Travel & Tourism industry." Data was collected on 5-point Likert scale.

#### 3.2 Data collection

In this study, Pakistani citizens and GB's residents were selected to evaluate the top-ranking risk and challenges towards travel and tourism in GB. Data was collected through an online questionnaire on 5-point Likert scale where 5 implies strongly agree and 1 implied strongly disagree. 36 respondents participated in the survey, however only 31 filled the questionnaire properly and thus the sample size was thirty-one. 21 of them were male and 10 were female. Most of the respondents were young people of Pakistan and GB with bachelor degree and work experience of

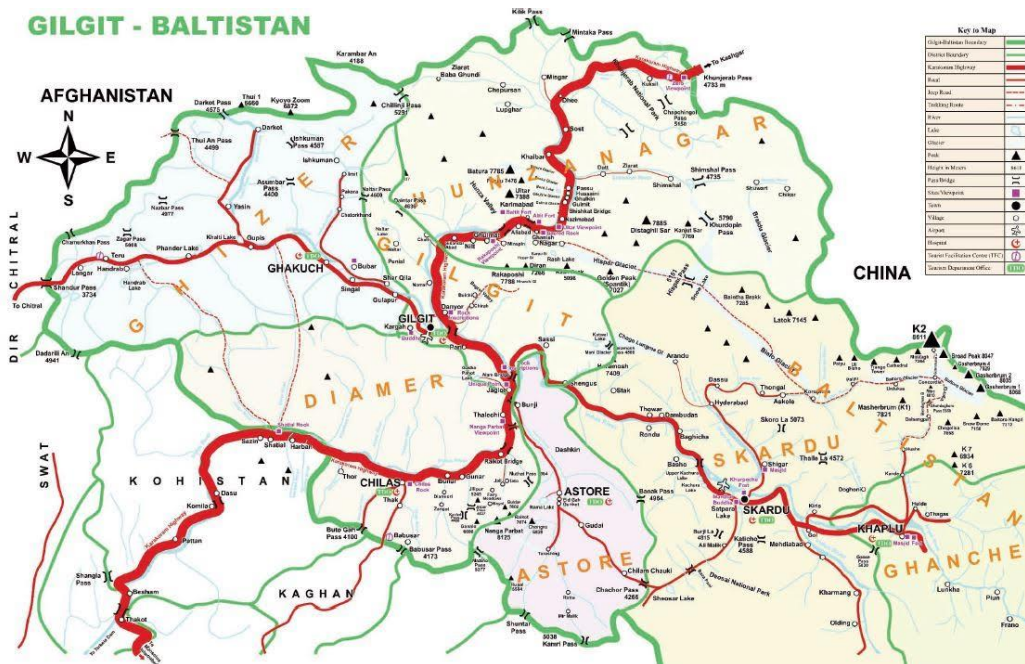


Figure 1. Map of Gilgit-Baltistan (Source: AP, 2015)

**Table 1.** Key challenges currently being faced by Pakistani tourism sector

Code	Factors	Literature
F1	Absence of tourist information centres	Sheikh (2020); Arshad et al., (2018)
F2	Harassment and misbehaviour with tourists	Iqbal (2020); Shahid (2019)
F3	Inability to regulate tourism & lack of effective tourism policy	Hussain (2021a); Hussain (2021b); Arshad et al., (2018)
F4	Lack of lactation rooms & child care facilities	Soomro (2015)
F5	Lack of hotels	Baig (2017); Qureshi (2013)
F6	Lack of variety in food	Hussain (2021b)
F7	Lack of sports & entertainment facilities	Baig (2017) ; Qureshi (2013)
F8	Land sliding	Nabi et al., (2019); Dawn (2021)
F9	Limited & expensive flights	Sheikh (2020); Jabri (2021)
F10	Overpricing or overcharging for tourists	Iqbal (2020); PK (2022)
F11	Poor communication infrastructure (Wi-Fi/internet)	APP (2018); Abbas (2021)
F12	Poor transportation infrastructure	Sheikh (2020); Hussain et al. (2017); Qureshi (2013)
F13	Increasing water & land pollution	Javaid (2018); Khan (2021)
F14	Poor governance & weak rule of law	Hussain (2021a); Jabri (2021)
F15	Shortage of electricity	Hussain (2021a)
F16	Shortage of clean drinking water	Hussain (2021a); Hussain (2021b)
F17	Safety & security concerns	Bukhari (2019); Jabri (2021); Khursid (2003)
F18	Unavailability of public toilets	Sheikh (2020)
F19	Weak tourism marketing	Khan (2021); Arshad et al. (2018); Ullah et al. (2021); Haq et al. (2008)

less than one year. Data was analysed using Deng's Grey Relational Analysis (GRA) model at MS Excel. Demographic features of respondents are given in Table 2.

### 3.3 Grey Relational Analysis model

Grey System Theory was proposed by Deng Julong in the 1980s (Deng, 1982). Grey System Theory classifies all systems of the world into three groups; black, white and grey. Black and white systems are the systems whose information is unknown and know respectively while grey is the system whose information is partially known (Javed & Cudjoe, 2021). Such systems can be found in every field. That's why the theory has seen applications in various fields e.g., aviation industry (Delcea *et al.*, 2021), energy sector (Wu *et al.*, 2019; Xie *et al.*, 2021), construction sector (Mahmoudi *et al.*, 2021a), healthcare sector (Delcea & Bradea, 2017; Javed & Liu, 2018), supply chain management (Mahmoudi *et al.*, 2021b), tourism sector (Javed *et al.*, 2020), among others. Grey Relational Analysis is an important part of Grey System Theory and is primarily used for ranking of factors. It can quantify the correlation between multiple independent and dependent variables in the studied field. For the comparison process it shows some degree of similarity to the referencing model and determine the best one. The GRA model is defined by its Grey Relational Grade, which is given by (Mahmoudi *et al.*, 2020):

$$\gamma(x_0x_i) = \frac{1}{n} \sum_{k=1}^n \gamma(x_0(k), x_i(k)) \tag{1}$$

where,

$$\gamma(x_0(k), x_i(k)) = \frac{\min_k \min_i |x_0(k) - x_i(k)| + \xi \max_k \max_i |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \xi \max_k \max_i |x_0(k) - x_i(k)|} \tag{2}$$

**Table 2.** The demographic profile of the respondents

Variable	Category	No.	%
Gender	Male	21	68
	Female	10	32
Education	Diploma	1	3
	Bachelor	20	65
	Master	5	16
	PhD	5	16
Experience	<1 year	18	58
	1 ~ 3 year	6	19
	4 ~ 6 year	2	6
	>6 year	5	16
Age	Less than 25	21	68
	25 ~ 30	3	10
	30 ~ 35	6	19
	35 ~ 40	1	3

Here  $\gamma(x_0x_i)$  shows the degree of influence of the sequence  $x_i$  on reference sequence  $x_0$ . The reference sequence can collect useful information about the variation of data points from other similar sequences. In the current study,  $\xi = 0.5$ . Analysing Grey Relational Grades and associated ranks allow us to understand which factors are more or less important than others.

**4. Results and discussion**

In the current section, the key challenges currently being faced by GB will be evaluated in light of the opinions of Pakistani youth. To the best of our knowledge, it's the first time Deng's GRA model has been used for the evaluation and ranking of this factors. The analyses were performed on MS Excel and the results are shown in Table 3 for both males and females.

As can be seen in the table, the factors are different in values for both male & female, that's we can see they all have different potential. According to GRA model, the absence of Tourist Information Centres (F1) gets the highest relative weight and got first rank in both among both male and female.it followed by Limited & Expensive Flights (F9) among male respondents, whether Overpricing or Overcharging for Tourists (F10) from female. The Poor Transportation Infrastructure (F12) among male respondents with most critical expectation, while the Inability to Regulate Tourism & Lack of Functional Tourism Policy (F3) from female got 3<sup>rd</sup> rank. Lack of Variety in Foods (F6), Lack of Sports & Entertainment Facilities (F7), Increasing Water & Land Pollution (F13), Poor Governance & Weak Rule of Law (F14), Shortage of Clean Drinking Water (F16), Safety & Security Concerns(F17) was ranked 18<sup>th</sup>, 10<sup>th</sup>, 16<sup>th</sup>, 11<sup>th</sup>, 14<sup>th</sup>, 17<sup>th</sup> respectively these factors got same rank among both male and female group respectively. Overall, the results are realistic and convincing. Details can be seen from Figures 2 and 3 as well.

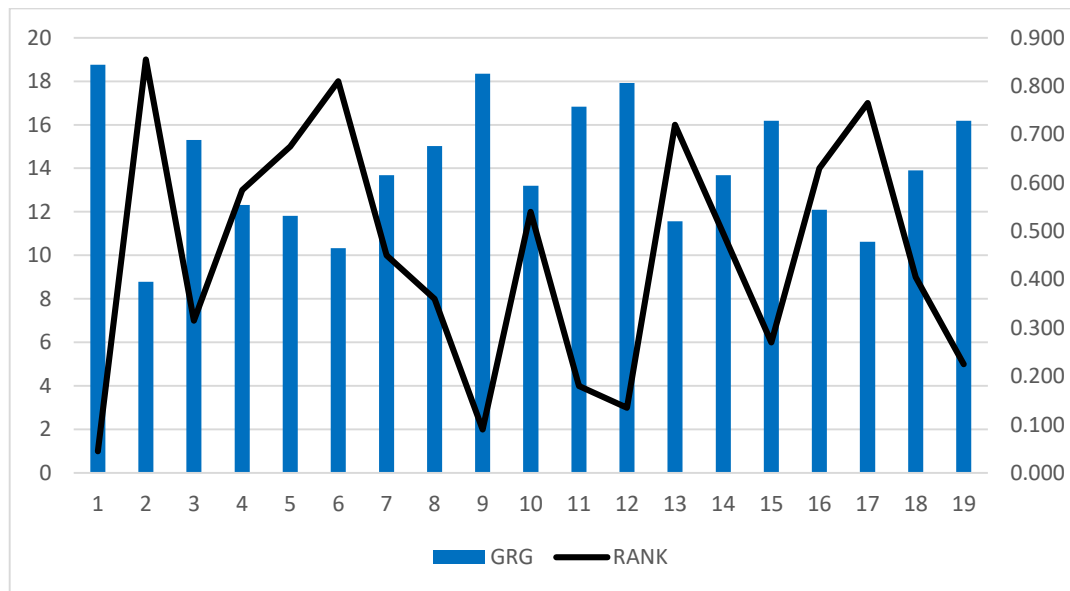
As in the previous literature presenting most of the challenges and barriers towards GB's tourism industry, which means these mentioned barriers in our study have certainly negative impacts on its tourism industry. These facts also seem to relate to our findings in which our respondents including local residents and domestic tourists has agreed and support to top ranked factors as they are really most important for attracting more tourist and other factors got least rank as the government and civil society took notice on them and some are in process to completion.

**5. Conclusion**

This project has shown the perception of GB's residents about Identification and Ranking of Barriers to Gilgit Baltistan's Travel & Tourism Industry. Apart from local people, different

**Table 3.** Grey relational grades and ranking of the woes of Gilgit-Baltistan's tourism sector

	Male		Female	
	GRG	Rank	GRG	Rank
F1	0.844	1	0.850	1
F2	0.395	19	0.707	8
F3	0.689	7	0.773	3
F4	0.554	13	0.667	12
F5	0.532	15	0.757	4
F6	0.465	18	0.570	18
F7	0.616	10	0.697	10
F8	0.676	8	0.733	5
F9	0.825	2	0.723	7
F10	0.594	12	0.817	2
F11	0.757	4	0.617	15
F12	0.806	3	0.707	8
F13	0.521	16	0.607	16
F14	0.616	11	0.683	11
F15	0.729	6	0.733	5
F16	0.544	14	0.623	14
F17	0.478	17	0.573	17
F18	0.625	9	0.547	19
F19	0.729	5	0.647	13



**Figure 2.** Grey relational evaluation of the factors (among male respondents)

respondents from all over the Pakistan were included in the questionnaire survey. Most of the respondents rated the basic and famous key factors impacting the growth of GB's travel and tourism industry. More over by this study we can concluded the mix behaviour and perception of local and domestic tourists in ranking the of top key barriers towards growth of GB's travel and tourism industry using the Grey Relational Analysis (GRA) method, a user-friendly multi-attribute

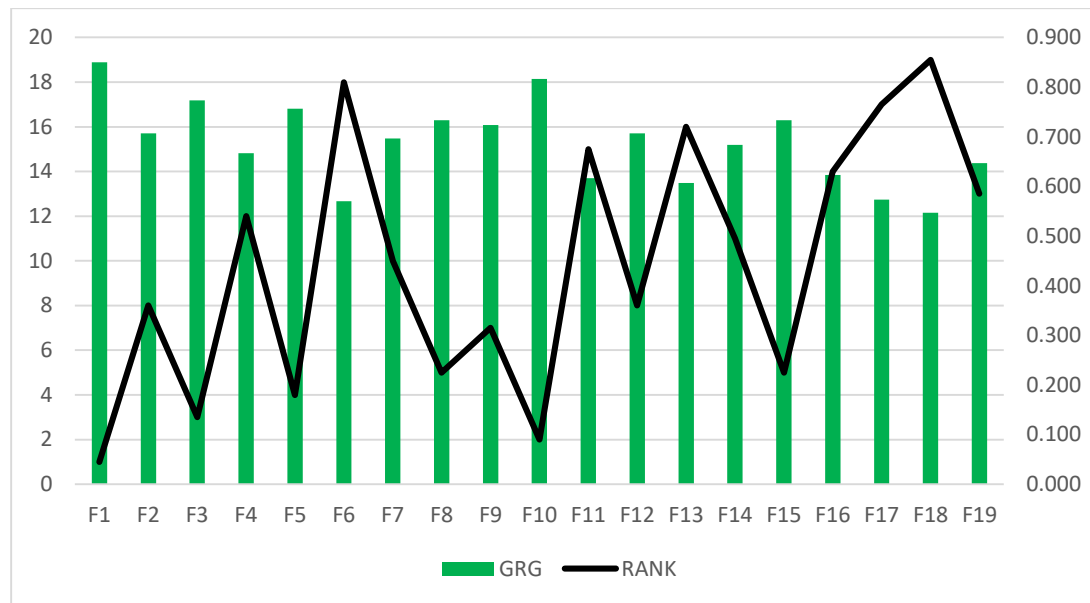


Figure 3. Grey relational evaluation of the factors (among female respondents)

decision-making technique, that helped in identifying most possible top expected ranked key factors or barriers for GB's tourism. These analyses discovered that there are many beautiful hotspot and potential tourist places for local and oversea tourists in GB, but because of lack of facilities and factors or criteria under discuss in this study are the most famous reason keeping tourist away from GB. By this study we can concluded that to improve the travel & tourism in GB is important to build tourist information centres. The tourism marketing strategies and communication (Wi-Fi/internet) system need to be updated to accommodate the awareness of this region to world tourist market. The study also emphasizes the need to increase efficiency of government regulated functional tourism policy, improving the hospitality industry, concerning safety, security and transportation system and GB provincial government and policy makers should improvise tourism policy by providing most needed facilities which meet the requirement of Gilgit Baltistan. On the basis of respondents opinion we concluded that the 19 factors based on most reasonable criteria has negative impact on the tourism industry.

The current study has certain limitations, on which future scholars may work. For instance, most of the respondents were young, thusn mature and expereined people can be considered in the future. Sample size can also be increased. Local people can be optimistic, thus in the future opinions of actual tourists, especially foreigners, should be considered before generalizing the findings of the current study.

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# Evaluation of Risks to Russian Food Supply Chains during the COVID-19

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Received 11 January 2022; Revised 16 March 2022; Accepted 16 March 2022

**Abstract:** The COVID-19 pandemic has demonstrated the vulnerability of global supply chains - the failure of one link in the supply chain can lead to numerous supply disruptions. The current study examines the main supply chain problems associated with the spread of the coronavirus and their ranking based on the perceived importance among the Russian shop owners. The study found the key factors of risks and uncertainty that might have disrupted the food supply chains in Russia during the COVID-19 pandemic and are source of food insecurity if not managed properly. These factors were identified through the literature, and later, based on the primary data collected from the grocery and catering shop owners in Russia, they were ranked using the Grey Relational Analysis model. The study found that traceability and logistical issues are perceived to be the most critical factors that have disrupted the food supply chain in the country.

**Keywords:** Food security; supply chain; COVID-19; Russian food retailers; grey relational analysis

## 1. Introduction

The COVID-19 crisis has impacted supply chain systems around the world. A necessary function is to ensure the secure movement of food products in the supply chain. This is considered desirable to support consumer confidence in food safety, particularly during a pandemic. Food security is a public health priority, although the coronavirus is not spread through food. But this has had a significant impact on food security. Although in Russia, the impact of the pandemic on the food supply chain was not so critical, the pandemic has again drawn people's attention to issues related to food safety.

The actual food supply chains were hit hardest during the pandemic. According to expert estimates, losses the Russian transportation sector incurred at the beginning of May 2020 amounted to 230 billion rubles, most of which fell on the aviation segment, which practically stopped logistics operations (Kuleshova & Kuskov, 2020). Along with this, storage facilities for food and drinks were also damaged. Likewise, rising labor costs due to labor shortages put upward pressure on operating costs. Given the duration of the pandemic, personnel management is of the utmost importance in areas that will require additional work from the outbreak onset to several weeks when contractors can make a significant contribution. The scale of the outbreak may also vary, and so far, the infection has been localized with some degree of global impact (Luckstead *et al.*, 2021). The pandemic has provided an opportunity for the people to make such changes to our food

systems so that the future disruptions can be avoided. Now consumers have become very serious about food safety and the technology that provides it.

The globalization of supply chains has greatly complicated food systems and created information asymmetries between food producers and consumers. As a result, there is a growing need for greater transparency of food origin, cultivation, collection and production methods, and working and impact on the environment (Kulikova & Suvorova, 2021). The structure of incomes of the subjects of the world agri-food market is characterized by the share participation of its individual participants in the chain in the formation of the aggregate volume of proceeds from the main types of agricultural products consumed by the population. Specific weights differ by sales channels, number, and subject composition of participants in the food supply chain in the agri-food market (Kuleshova & Kuskov, 2020). The conducted studies made it possible to detect discrepancies in the profitability of market elements in the context of implementing the functional task of providing information on volumes and nomenclature. Subject to the freedom to choose the channel for the sale of agricultural products, their quality, and delivery time, taking into account market conditions. Therefore, the current study argues that what are the key factors influencing the food security in Russian during the pandemic? How different factors differ from each other in terms of their impact on the food supply chain as per the shopkeepers, who are an integral bridge between the food consumers and producers.

The rest of the article is organized as follows: the next section is devoted to a brief overview of the relevant research. Section 3 talks about the method of collecting information and processing it. Section 4 discusses the data and results. Finally, Section 5 concludes the study.

## 2. Background

Due to the impact of COVID-19, the global logistics system is faced with a crisis, the scale of which is a threat to the entire Russian economy. Improved border inspections and customs procedures increased delays, reduced delivery performance, and created severe logistics challenges (Verbitskaya, 2021). With globalization and the complexity of the supply chain, food hygiene risks are on the rise, and with infectious diseases and health hazards from food occurring all over the world today, food safety is becoming one of the major sustainability challenges the world must address (Kopteva *et al.*, 2020). In the food chain, at least in the short term, the main challenges relate more to supply and logistics than production. Due to the uncertainty in this process, countries prioritize the sustainability of their food systems and impose significant restrictions on agricultural and food exports. Cross-border restrictions at the country and/or city level also pose logistical problems. While food logistics is given flexibility, delays caused by restrictions can lead to food degradation, waste, and higher prices (Voronetsky, 2021). Ensuring food security is not aimed at the productive activities of organizations and agro-industrial complexes but primarily at increasing the level of vital life sustenance of the population and raising the level of the general welfare of the Russian economy. Thus, food security is considered one of the essential links in the national security system of Russia.

The COVID-19 pandemic has changed the ways and methods for monitoring food safety, now, inspections are carried out remotely, so companies need to find ways to improve technological resources for food auditing (Rejeb *et al.*, 2020). Post-pandemic travel restrictions and isolation procedures have limited the ability of food certification bodies to conduct on-site regulatory audits and issue certifications to participants in the food supply chain. Food inspectors are responsible for regulating and identifying contamination that can lead to food loss, high prices, and food insecurity. If appropriate food management processes are not developed, all supply chain stages may suffer as a result. And in connection with the pandemic, many companies were forced to switch to remote auditing, but it was also found that many grocery stores and restaurant owners do not believe that remote auditing can fully verify the quality of food products.

In the current situation, it is difficult to maintain routine activities without interruption, such as inspection of food business operations, export certification, control of food imports, monitoring and supervision of the safety of the food supply chain, etc. Traceability will help improve control

of the food supply chain to ensure the quality, taste, and safety of all products sold (Kulikova & Suvorova, 2021). Monitoring every step of the food chain is essential for grocery shops and catering to achieve these goals. One way to ensure that inventory is poorly tracked in stores and warehouses and that food is not wasted is to track current inventory throughout the supply chain. Guided by the literature review, some challenges and issues faced by the food supply chain during COVID-19 are listed in Table 1.

### 3. Research methodology

#### 3.1 Data collection

Several owners of the grocery stores and catering businesses in the Republic of Sakha (Yakutia), Kobyaysky District, Russia, were approached. From all those who expressed interest, forty-four of actively participating in the survey. Most of the respondents were female (52.3%) and rest (47.7%) were males. Most of the respondents were grocery store owners (61.4%) and rest were the public catering owners (38.6%). Most of the respondents were adults of age ranging from 40 to 49. Most of them (52.3%) were in the business for 4 to 6 years. A link to an online questionnaire in the Russian language was sent to them electronically with a request to fill it. The questionnaire had two parts, the first one contained four demographic questions, and the second involved seven core questions. The core questions were built from the factors reported in Table 1. The core questions were like this: "Do you think the increase in customs clearance time during the pandemic affects

**Table 1.** Challenges and issues being faced by food supply chain during COVID-19

Code	Challenges	Description	Reference
F1	International customs clearance issues	*The pandemic has had a major impact on the work of customs authorities and has generally changed the conditions for international customs cooperation. *Parties to foreign economic activity should develop special conditions, namely clauses on the risks of a pandemic spread	Verbitskaya (2021)
F2	Transportation and logistical issues	*There are difficulties such as increased transport costs caused by changes in lead times, extended shipment times and additional prevention and control measures. *Participants in the food supply chain are forced to comply with regulations to prevent C19 contamination and incur additional transportation costs.	Kuleshova and Kuskov (2020)
F3	New requirements for food suppliers	*Daily disinfection of vehicles before entering the "clean area", regular testing of drivers for COVID, full equipment of staff. *A separate checklist was also developed aimed at monitoring control points for the prevention of coronavirus COVID-19.	Kopteva <i>et al.</i> (2020)
F4	Visibility and traceability	*Currently, there is no company that could independently organize a completely transparent supply chain. This requires the establishment of cooperation between partners using common standards and databases, thereby accelerating capacity development, smoothing out uncertainty in decision-making in joint work	Kulikova and Suvorova (2021)
F5	Food audits	*Post-pandemic travel restrictions and isolation procedures have limited the ability of food certification bodies to conduct on-site regulatory audits and issue certifications to participants in the food supply chain.	Rejeb <i>et al.</i> (2020)
F6	Air transportation	*Violation of air transportation affects perishable expensive products, primarily fruits and vegetables.	Voronetsky (2021)
F7	Post-crisis trends	*Redistribution of companies in the transport market. *Developed provision of consolidated cargo services. *Development of transport services focused on domestic transport. *Redistribution of freight traffic to rail transport. *Application of new transport technologies in the provision of transport services.	Kuleshova and Kuskov (2020)

food safety in the supply chain?". Data was collected on 7-point Likert scale, where 7 = strongly agree and 1 = strongly disagree. The complete questionnaire can be obtained from the author at a reasonable request. Table 2 presents the demographic information of survey participants.

### 3.2 Grey Relational Analysis

Grey System Theory was proposed in 1982 by the Chinese scientist Deng Julong (Deng, 1982; 1989). The theory is particularly useful to handle problems containing partially known and partially unknown information, small samples, and when data does not follow any particular distribution (Javed & Cudjoe, 2022; Javed *et al.*, 2020). Grey Forecasting (Tian *et al.*, 2021; Laksito & Yudiarta, 2021), Grey Numbers (Shajedul, 2021; Mahmoudi *et al.*, 2021), and Grey Relational Analysis (GRA) form the core of Grey System Theory. Angela and Angelina (2021) used the GRA to evaluate the hospitality sector's supplier selection criteria. Fahim *et al.* (2021) used the GRA to evaluate barriers affecting university enrollment. Mahmoudi *et al.* (2020) and Sheikh *et al.* (2021) used the GRA in project management. Abifarin *et al.* (2021), Obara *et al.* (2021), and Abifarin (2021) used the Taguchi-based GRA for the engineering optimizations. Peng *et al.* (2021) used the GRA to rank China's healthcare resource factors. Rao *et al.* (2021a) used the GRA for the assessment of energy poverty. Shahzad *et al.* (2020) used the GRA to find the relationships of environmental sustainability to green innovation, and corporate social responsibility. Thio (2021) used a GRA-based approach for site selection in Indonesia. Ikram *et al.* (2020) used the GRA for the assessment of the CO<sub>2</sub> emissions in the selected countries. Irfan *et al.* (2021) used the GRA to analyze the relationship between temperature and COVID-19 transmissibility in Pakistan. Han *et al.* (2019) applied the GRA to build a risk assessment model for quality and safety in the food industry. Grey Relational Analysis is a model for quantifying related factors that affect a target sequence.

Let the ideal sequence is  $y_0 = (y_0(1), y_0(2), \dots, y_0(n))$ , and the reference sequence is  $y_i = (y_i(1), y_i(2), \dots, y_i(n))$ ,  $i = 1, 2, \dots, m$ , where in the current study  $m = 7$ , the total number of risks identified through the literature. The grey relational grade (GRG) is the average of the grey relational coefficients (GRC) and is given by (Mahmoudi *et al.*, 2020):

$$GRG_{0i} = \frac{1}{n} \sum_{k=1}^n GRC_{0i}(k) \tag{1}$$

where,

$$GRC_{0i}(k) = \frac{\min_0 \min_i |y_0(k) - y_i(k)| + \xi \max_0 \max_i |y_0(k) - y_i(k)|}{|y_0(k) - y_i(k)| + \xi \max_0 \max_i |y_0(k) - y_i(k)|} \tag{2}$$

**Table 2.** The demographic profile of the respondents (N = 44).

		No.	%
<b>Gender</b>	Female	23	52.3
	Male	21	47.7
<b>Age</b>	20-29	2	4.5
	30-39	5	11.4
	40-49	31	70.5
	>50	6	13.6
<b>Work experience</b>	<1 year	3	6.8
	1-3 years	8	18.2
	4-6 years	23	52.3
	6 above	10	22.7
<b>Industry</b>	Grocery shop	27	61.4
	Public catering	17	38.6

In the current study,  $\xi = 0.5$ . Later, the risk factors can be ranked in an order based on the value of GRG, whereas a higher value of GRG implies a more important risk factor, and a lower value of GRG indicates a less important risk factor.

#### 4. Results

This study's practical significance is identifying the main factors affecting food safety in the supply chain, followed by its grey relational evaluation. Thanks to the data obtained during the survey, it can be concluded that COVID-19 made its own changes and affected the supply chain only because the world was not ready for such a radical change. The main conclusions that can be reached during the study of this topic and the results are that the impact of COVID-19 has led to a change in the supply chain and new high-risk trends. And the importance of this study is that food safety is a public health priority. In addition, efficient transportation reduces or prevents wasted time and materials by helping supply chain participants get their products to the right place on time. Delayed shipment can affect the next stages of the supply chain, cause food waste, increase costs and damage the company's reputation. COVID-19 has mainly caused delays in the supply chain, and delays in shipment and handling of products can affect the supply chain, cause food waste, increase costs and damage a company's reputation.

Table 3 and Figure 1 show the results. Many respondents noted that the increase in customs clearance times during the pandemic and the increase in delivery times led to additional transportation costs (F1; F2; F7). It was also found by a majority vote that new requirements for suppliers (daily disinfection of vehicles and regular testing of drivers for COVID-19) may well affect food safety (F3). It is true that no one company currently can organize a completely transparent supply chain. It was clear from the data collected through the questionnaire that the respondents believed that the traceability of goods had become a serious problem in the food supply chain during the COVID-19 pandemic (F4). In addition, many problems that need to be addressed by coexisting with the coronavirus, such as a shortage of truck drivers, long working hours, and the narrowing that some consumer markets are overcrowded. Drivers and other personnel who deliver to food facilities should not leave their vehicles when delivering food. Drivers must be provided with alcoholic hand sanitizer and wipes. Based on the collected data, it was found that the lack of labor can also affect food safety in the supply chain (F5). Russian air transportation suffered the most. Violation of air transportation affects expensive perishable products, primarily vegetables and fruits (F6). As a result, F2 and F5 are the most important, so you will find that most of the respondents feel that remote audits cannot fully test the quality of food. In addition, it was found that transport and logistics problems caused by the COVID-19 pandemic pose a more significant threat to the food supply chain. These are the factors that deserve special attention by the food policymakers and effective handling of them is of paramount importance for the food security in Russia. Also, if one looks at these top ranking factors one can see that these are the risks that are hard to be resolved automatically by the market forces and hence strong support from the government is necessary.

**Table 3.** The grey relational grades and ranks of the seven risk factors in three categories

Code	Grocery Shop		Catering		Overall	
	GRG	Rank	GRG	Rank	GRG	Rank
<b>F1</b>	0.729	4	0.859	1	0.779	1
<b>F2</b>	0.625	7	0.654	7	0.636	7
<b>F3</b>	0.683	5	0.825	2	0.738	5
<b>F4</b>	0.780	2	0.761	3	0.773	3
<b>F5</b>	0.608	8	0.643	8	0.622	8
<b>F6</b>	0.812	1	0.711	5	0.773	2
<b>F7</b>	0.761	3	0.745	4	0.755	4

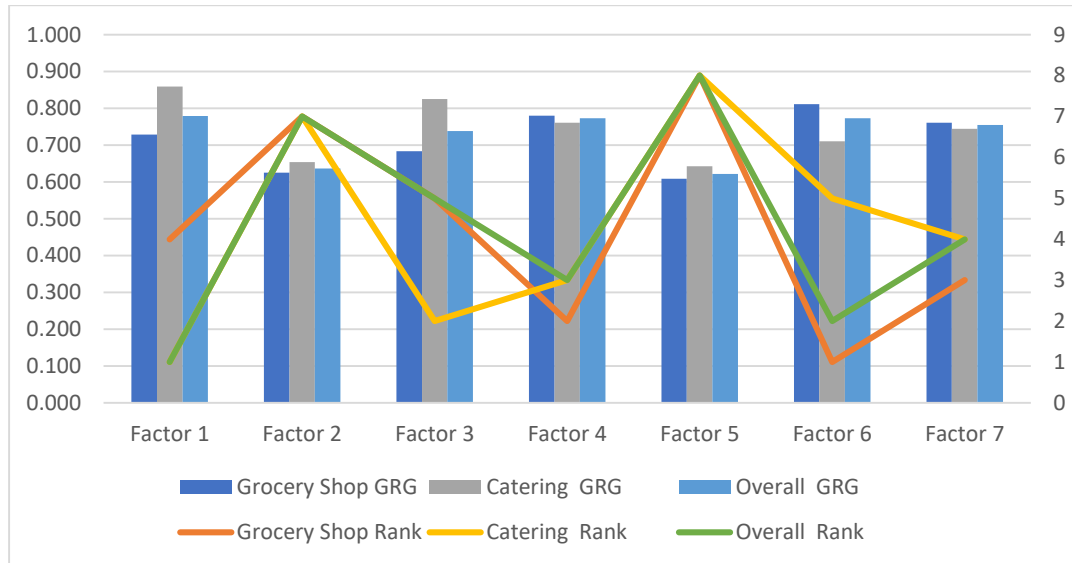


Figure 1. Grey relational grades and ranking of the factors

### 5. Conclusion

As companies grapple with the impact of the COVID-19 suspension around the world, governments are implementing a variety of comprehensive pandemic containment measures that further disruptions in supply, forcing companies to adapt to new conditions on the fly. Against the backdrop of the pandemic, it became obvious that to maintain business continuity, companies urgently need to maintain comprehensive strategic planning, taking into account all kinds of natural disasters, including pandemics. The food supply chain is the most basic infrastructure needed to keep it running smoothly even in times of crisis. Providing flexible sales channels from normal times can mitigate changes in consumption patterns.

Food loss and waste can reduce food market accessibility, resulting in higher prices and reduced access to low-income materials. In addition, if the food quality is inferior to the point that the food is sold at a lower price or disposed of, this could affect the well-being and livelihoods of farmers and producers. Among the challenges facing the food supply chain, especially those stemming from the COVID-19 crisis, are concerns about clustering at logistics bases such as wholesale markets. And it must be recognized that concerns about clustering in the food market are a sufficient threat. In particular, if food distribution centers such as the wholesale market are closed, the impact on a stable food supply will be enormous.

Food and food safety requirements a risk-based approach to meeting the world's food needs. Coordinated efforts to ensure food safety and reduce the socio-economic impact of a pandemic can facilitate and accelerate trade in food and agricultural products. The pandemic has provided an opportunity to improve quality, focus on the safety of employees and partners, and work regularly and well with suppliers. The past year has been a year of responses and short-term solutions. Many companies have found that their operations and supply chains are not ready to handle unpredictable peaks, and their supplier pools are not diversified enough. Manual processes in logistics also did not show the flexibility and the required speed of the result; it was difficult to make quick decisions necessary for the safety of the business, customers, and employees.

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# Nord Stream 2: The Expectations of Russian Citizens from Increasing Gas Exports to Europe

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Received 23 December 2021; Revised 25 January 2022; Accepted 26 January 2022

**Abstract:** Natural gas is one of the key exports of Russia. The country exports gas via pipelines and liquefied natural gas (LNG) via ships. In 2018, the construction of the Nord Stream 2 (NS2) project began and finished in early September 2021, despite all challenges. The purpose of the NS2 is to supply affordable natural gas to European markets while helping them improve energy security, especially for land-locked countries that are ill-suited to receive LNG. The current study aims to gauge the expectations of Russians from the increase in Russian gas exports to Europe resulting from the completion of the NS2. From the literature, some important factors were identified. Primary data was collected from the Russian citizens, and the Grey Relational Analysis model was used to analyze data and rank the key expectations of Russians from the increasing gas supply to the European consumers. The results are interesting and can help the policy-makers know the expectations of the Russian taxpayers.

**Keywords:** Natural gas exports; Nord Stream 2; European energy security; Russia; grey relational analysis

## 1. Introduction

The gas industry is strategically important to the Russian economy and largely determines its international specialization. Increased competition in the global gas market, the need for technological modernization of the Russian oil and gas industry, the aggravation of the investment problem, actualize the development of gas exports from Russia to Europe. Russia is a major supplier of natural gas to Europe, primarily Germany. The main supplies are carried out via pipeline gas transmission systems (GTS). Russia, through the GTS, supplied 168 billion cubic meters (bcm) of gas to European countries, including 56.3 bcm to Germany, which amounted to 55.2% of its total pipeline gas imports (Belov, 2021).

The post-Soviet technological breakthrough of the GTS required its significant modernization and renovation to ensure stable exports to Europe - the main Russian gas sales market (Belov, 2018). One of the most important projects became "The Nord Stream" (Alenga, 2021), when experts substantiated the technical feasibility of constructing several parallel pipelines along the bottom of the Baltic Sea. In December 2000, the European Commission recognized it as a part of the trans-European energy network under the TEN-E directive. Scheduled in September 2006, the pipeline received the status of "Project for the Benefit of Europe" (Belov, 2021). Therefore, from the point of view of Brussels, it was initially of key importance for ensuring sustainable

development and energy security of the European Union (Bogaert, 2019). The flawless construction process for "Nord Stream 1" (length 1,224 km, annual capacity 55 bcm), the world's largest offshore export gas pipeline, its successful launch, as well as the continued high demand for gas in Europe motivated the shareholders of Nord Stream AG to make the decision to build the third and fourth lines, which were purchased the status of The Nord Stream 2 project (the feasibility study was prepared in 2011). It was operated by another company, also located in the Swiss Zug - Nord Stream 2 AG, which began construction work in September 2018 and completed it by 2021 (Statista, 2021a).

Following the completion of the NS2 project, Hungary signed a new contract with Gazprom in September 2021 for a 4.5 bcm gas supply that bypasses Ukraine for 15 years. This agreement came into effect on October 1. It will be possible to change, supplement or extend the contract in ten years (Gazprom, 2021a). Against the backdrop of the contract between Budapest and Gazprom, Kiev allowed a complete stop of gas transit to Hungary through Ukraine (Krasnolutska *et al.*, 2021). In July, 2021, the cost of gas futures on London's ICE Exchange exceeded \$500 per 1,000 cubic meters amid growing demand, insufficient supply of LNG and refusal to increase pumped volume through Ukraine by Gazprom. The contract pegged to the gas price of the EU's largest hub TTF reached \$501 per 1,000 cubic meters (€40.87 per 1,000 kWh), up 3% per day and 10% from the beginning of the week. EU gas prices are up 150% compared to January and nearly quadrupled compared to last summer's lows. A new round of gas rally started in August 2021, and Gazprom ignored further offers to pass Ukraine again. Currently, the company is pumping 109 million cubic meters (mcm) per day through Ukraine's gas transport system (under long-term contracts) and 15 mcm for unexpected armor. Since the spring 2021, Kiev has been holding auctions regularly, offering to order Gazprom with a transport capacity of more than 60 mcm per day. However, they encountered rejection several times (Udafkovich, 2021).

In the light of the above records, the study makes a pioneering attempt to determine possible risks and benefits of the completed NS2 project for Russian Federation. Therefore, using a multiple attribute decision making approach, Grey Relational Analysis (GRA) Model was used to evaluate the criteria, which are in line with the learning theme, namely Russians' expectations from the increased pipeline gas exports to Europe.

The study organized as follows: after introduction part, section two describes the literature review. The main attention was drawn to the Russian exports through the Nord Stream 2 gas pipeline. Section three describes research methodology, followed by results and discussion section. In the last section, key findings and recommendations for energy markets of Russia are concluded.

## 2. Background

### 2.1 Gas network of Russia

Over the past decade, natural gas production in the world has increased by almost 21%, or 640 bcm. At the same time, the world trade of gas increased by 46% and reached 1 trillion 134 bcm (Looney, 2020). Today, the export of gas and oil products through the pipeline is considered the most convenient and economical way of transportation. Pipeline transportation plays an important role in Russia's foreign trade by supplying oil and gas to Western Europe, Turkey, and the countries of Southeast Asia.

Oil and gas exploration in the Soviet/Russian Arctic region began as early as the 1930s, and, at the time, no other Arctic country was exploring hydrocarbons in the area (Kontorovich, 2015). Today, Russia ranks second in the world after the United States in terms of the length of pipelines (GEM, 2021). The length of Russian main gas pipelines is 92,831km (57,683 miles), oil pipelines - 38,419km (23,872 miles). The most important gas pipelines in Russia are Yamal-Europe, Nord Stream 2, and Turkish Stream (Ponomareva *et al.*, 2017). Yamal-Europe Gas Pipeline (1,660 km length with capacity of 90 mcm per day) transports gas from Russia's Yamal Peninsula to European consumers across Russia, Belarus, Poland, and Germany. The Turkish Stream gas pipeline is paved from Russia to Turkey through the Black Sea. The first of the two lines of the gas pipeline is

intended for gas supplies to Turkish consumers, the second - for gas supply to the countries of Southern and Southeastern Europe. The total capacity of the Turkish Stream is 31.5 bcm (15.75 bcm each line). The recently completed NS2 gas pipeline (1,230 km length or 764 miles) is set to run from Ust-Luga in Russia to Greifswald, Germany, and carry 151 mcm of natural gas per day. The pipeline plans to start operations in 2022 (Mohammed, 2021).

## 2.2 Gas trade between Russia and Europe

In recent five years, the Russian export of natural gas to Western Europe has grown by 40% (Trellevik, 2020). The total consumption of natural gas by European countries in August-September 2021 continued to grow due to increased demand, in particular in Europe, in the context of the onset of the heating season at historically low Underground Gas Storage (UGS) filling levels for the season. The Title Transfer Facility (TTF) index in August 2021 increased by 21.2% versus July 2021 (after + 22.5% in July versus June 2021), the National Balancing Point (NBP) index - by 20.3% (+ 23.7% in July by June 2021). On average, European indices (NBP and TTF) in August were at the level of \$ 538.4-545.8 / thousand cubic meters (tcm). Asian LNG prices show similar dynamics of European indicators: in August, the Northeast Asia LNG index increased by 20.4% versus July 2021 (+ 17.5% in July versus June 2021). In the middle of the month, the indices briefly dropped below the \$500 tcm due to the false announcement of the launch of NS2, but already on August 31, prices exceeded the \$600 tcm, and further growth of quotations did not stop. Prices continue to break historical records: on September 10, the price on the Dutch TTF hub exceeded \$700 tcm, on September 14 - \$800 tcm. On September 28-29, prices exceeded the mark of \$1,000 tcm, and on September 30 they approached \$1200 tcm (Perild, 2021). Table 1 shows the Russian gas production statistics.

In September 2021, the growth rate of gas production in Russia accelerated, reaching 11.7% Year-over-year (YoY) (+ 7.4% YoY in August 2021). Due to economic recovery in annual terms internal demand increases (+ 12.0% YoY in August, + 21.5% YoY in September 2021). Moreover, in August 2021, the export of pipeline gas from Russia in physical terms decreased (- 2.4% YoY) for the first time since December 2020, but in value terms increased 3.3 times. Export to non-CIS countries is stable (+ 0.4% YoY), the main consumers - Germany and Turkey - continue to significantly increase imports of Russian gas (+ 32.9% YoY and + 102.8% YoY respectively) (Fedorenko *et al.*, 2021a).

## 2.3 Key aspects of the Russian gas market

Currently, gas prices in Europe have risen due to Russia's reluctance to increase transit through Ukraine. Russia is determined to switch flows to NS2 as soon as possible and avoids using more expensive routes through Ukraine and Poland (Sziklai *et al.*, 2020). This pushes prices up as demand rises and vaults are emptied. As of June 26, Europe's UGS facilities had 50 bcm of gas, which is 35 billion less than last year and 15 billion less than the average for the last five years. The situation is aggravated by unplanned supply disruptions from the Norwegian "Troll" - a key source of alternative gas for Europe (Carter, 2021). Liquefied gas imports to Europe remain 20% lower than last year, as all free volume is taken by Asia, where quotations are even higher: on the spot market they reach \$539 per tcm, while futures for February 2022 are traded at almost \$600 (Udafkovich, 2021).

**2.3.1 Gas exports from Russia:** Russian gas supplies to Gazprom's key customers in the first quarter of 2021 set a 3-year record (Gazprom, 2021b). In three months, Gazprom pumped 52.7 bcm on

**Table 1.** Gas production in Russia (bcm)

	Sep 2021	% versus Sep 2020	Jan - Sep 2021	% versus Jan - Sep 2020
Production	62.5	11.7	563.7	12.5

*Source of data:* Fedorenko *et al.* (2021a)

westward, which is 12.4 billion (30%) more than a year earlier (Gazprom Export, 2021). The export volume fell just slightly below the absolute maximum shown in 2018 - 54.25 bcm (Gazprom, 2018). Germany increased purchases of Russian gas by a third, to 15.54 bcm. Supplies to Turkey soared 106% to 7.76 bcm. Poland has increased imports by 18.5% to 2.45 bcm. Exports to Finland were 67% more than in the first quarter of 2020, to Romania by 90%, Bulgaria by 52%, and Greece by 23%. The main factor that influenced the large-scale withdrawals from UGS facilities this winter was the weather, or rather, the abnormal frosts that hit Europe. Experts from the Skolkovo Energy Center noted that on some days in January and February, over 1 bcm of gas per day were taken from the UGS facility, and on January 15, the fourth daily rate of withdrawal from UGS facilities in Europe was recorded in the history of observations since 2011. In addition, there was a noticeable drop in LNG imports, which poured into Asia, where prices at the moment were rising above \$1,000 per tcm. In March, the EU was supplied with 8 bcm of LNG - 20% less than a year earlier and in February. By April, the storage facilities of Europe came up a little more than a quarter full. This means that in the summer, it will be necessary to pump 65-70 bcm of gas (European Commission, 2021). Table 2 shows the export of pipeline gas from Russia from main directions.

In July 2021, pipeline gas exports from Russia (in value terms) increased 3.2 times due to the active growth of global gas prices. The growth rate of pipeline gas exports (in bcm) from Russia accelerated (+ 6.4% YoY in June 2021, + 11.8% YoY in July 2021). The increase in supplies was due to non-CIS countries (+14.8 YoY), especially Turkey (+ 543.2% YoY) and Germany (+ 136.4% YoY). Supplies to Europe continue to reorient from Ukrainian transit (-22.2% YoY) to Nord Stream (+ 7.5% YoY, despite the planned pipeline maintenance from 13 to 23 July), the Yamal-Europe gas pipeline (+ 29.3% YoY), Turkish Stream (+ 46.7% YoY) and Blue Stream (Gazprom, 2021b). In the direction of the near abroad, exports, on the other hand, are slightly decreasing (-1.7% YoY), but the main trading partners within the EAEU - Belarus and Kazakhstan - have maintained a positive trend in gas purchases (Fedorenko *et al.*, 2021b)

*2.3.2 Russian gas sales:* In 2020, 638.5 bcm of natural gas was produced by Russia, as shown in Figure 1. The volume decreased by approximately 40.5 bcm compared to the previous year. As a result, it was ranked as the world's second-leading producer of natural gas (Statista, 2021b). Gas sales in 2020 brought Russia \$ 25.1 billion - at least since 2004 (Milkin, 2021). At the end of 2020, Gazprom pumped 179.3 bcm of gas to non-CIS countries - the minimum volume over the past five years. In physical terms, exports fell by 10%, and in monetary terms - by 40% due to a sharp decline in prices in Europe, which in the spring went below the profitability point of Gazprom (about \$ 100 per tcm). At the end of 2020, Russia, for the first time, overtook the United States in the supply of LNG to Europe. It was said that LNG supplies to Europe in 2020 amounted to about 84 million tons, of which 22 million tons were in Russia and 20 million tons in the United States. The export of LNG from Russia in 2020 increased by 4.5% annually to 68.3 mcm. Revenues from its sale amounted to \$ 6.75 billion, which is 15% lower than in the same period in 2019. The largest LNG producer in Russia - Yamal LNG - exported 18.3 million tons (40.8 mcm) in 2020 (Yermakov, 2021). "Gazprom" exported 7 million tons of LNG in 2020 and plans to more than double this figure by 2025 (Sokolov, 2021).

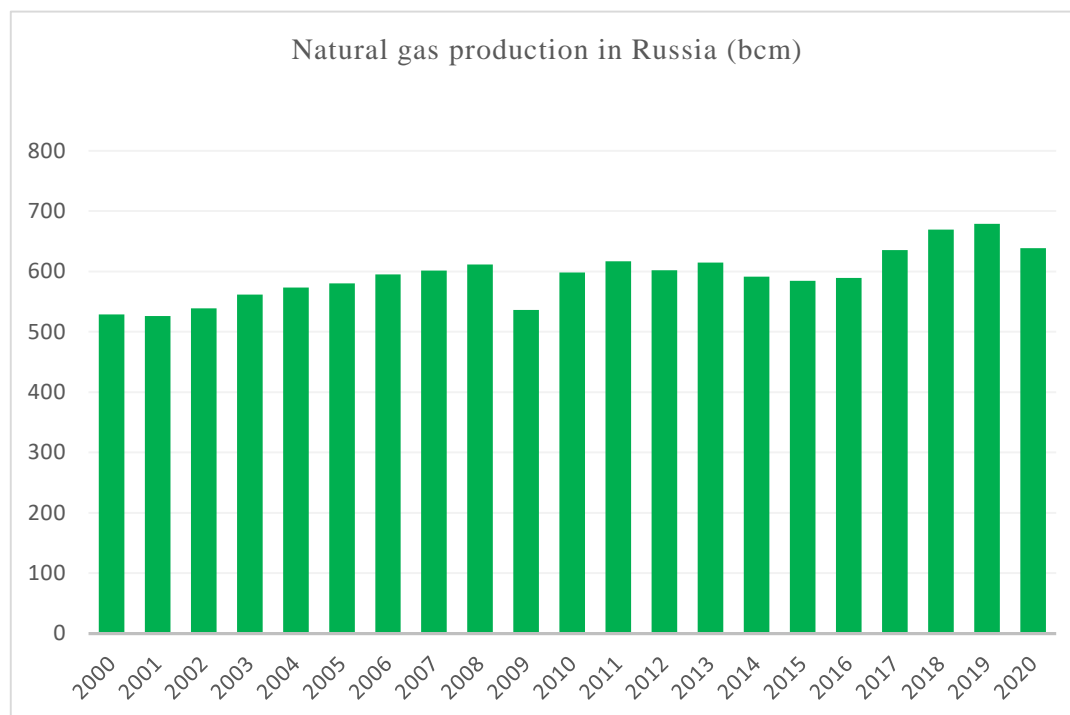
#### *2.4 Assessment of Russian gas export potential*

Production dynamics are not the same across companies. Independent producers (e.g., NOVATEK, oil companies, etc.) may gradually oust Gazprom from the internal market (e.g., by lowering gas prices). One of the reasons for the stability of these dynamics is that Gazprom pays more attention to maintaining gas exports, while independent producers are unable to export the gas they produce and are forced to operate only on the domestic market. Undoubtedly, the isolation of gas producers independent from foreign markets, with their growing influence on the domestic market, will create pressure on the state to give independent producers the right to export their gas to foreign markets (Evseeva, 2018).

**Table 2.** Export of pipeline gas from Russia by main directions (bcm)

	Jul 2021	% versus Jul 2020	Jan - Jul 2021	% versus Jan - Jul 2020
Total	14.2	+11.8	118.9	+11.4
Far-abroad countries	12	+14.8	98.5	+13.3
Commonwealth of Independent States (CIS)	2.3	-1.7	20.4	+3.0

Source of data: Fedorenko et al. (2021b)

**Figure 1.** Natural gas production in Russia from 2000 to 2020 (bcm) (Source of data: Statista, 2021b)

The entry of independent producers into foreign markets will increase the export potential of Russian gas. However, it will only be realized if suitable markets are found. With the growing difficulties in selling Russian gas in foreign markets, both Gazprom and independent gas producers will have to look for new opportunities for gas sales in the domestic markets of Russia. One of them is to increase the gasification of agents operating in Russia. The level of gasification is about 60% (Evseeva, 2018). It can be increased because of the cold climate of Russia. As for the directions of export, experts consider three main directions: the near abroad, the European market (far abroad), and the Asian direction. Demand in the near abroad is decreasing, primarily due to Ukraine (previously, Ukraine consumed 54% of exported Russian gas) (Stepanyan *et al.*, 2021). Ukraine can do without Russian gas, since they will use reverse supplies from Poland, Hungary, Croatia. The question is, are they a sign of a decline in demand for Russian gas as a result of Poland, Hungary and Croatia re-exporting Russian gas to Ukraine? Or will these countries receive gas from non-Russian gas fields? It remains unclear, since this issue was not covered in any reports. For the short term, a decrease in Russian gas exports to the near-abroad countries is quite likely, since a lot of gas has been accumulated in the gas storage facilities of Ukraine. Therefore, the Ukrainian market will not take gas in the same volumes (Krutikhin, 2016). And the main consumer of exported Russian gas has been and remains the European market (Goldthau, 2016). Thus, a system of gas pipelines (e.g., Nord Stream 2) has been built from the main regions of gas production in Russia to serve this market. Long-term contracts have been signed with participants in this market (Herrera & Cunha, 2021).

### 3. Research methodology

#### 3.1 The research instrument

In terms of the recently completed NS2 project, ten possible factors/criteria (C) were identified from the literature. These factors and their description is reported in Table 3. The questionnaire had two parts – the first was demographic, and the second was about the perception of the respondents about these factors. The questions were like this, "Do you think the completion of Nord Stream 2 will improve the resilience of the Russian Economy?". The complete questionnaire can be obtained from the corresponding author at a reasonable request.

**Table 3.** The factors

Code	Criteria/factors	Description	Literature
C <sub>1</sub>	Increase of "GDP per capita" in Russia	-The outstripping growth of exports (106.3%) over imports (103.8%). -Increase in the share of net exports of goods and services in the structure of GDP compared to 2017.	RIA News (2020)
C <sub>2</sub>	Improvement in bilateral relationships between Russia and the Western Europe	-Extension of the gas supply contract with the Austrian gas company OMV until 2040 -Italy is negotiating diversification supplies of Russian gas. "Gazprom" and "Edison S.p.A." signed an agreement on cooperation within the southern route of Russian gas supplies to Europe.	Schmidt-Felzmann (2018)
C <sub>3</sub>	Improvement of living standard in Russia	-The average household net-adjusted disposable income per capita in the second quarter of 2021 increased by 6.8%. -The development of relations with European countries will have a beneficial effect on tourism for Russians.	Gazprom (2021c)
C <sub>4</sub>	Stabilization of the gas prices in Russian market	-Gas prices have remained relatively stable throughout 2021. By early July 2021, the price has risen by 3%.	Rambler (2021)
C <sub>5</sub>	Improvement of the resilience of Russian Economy	- "The Nord Stream 2" will improve the position of Russian business. - "Gazprom" makes profits, creates jobs and pays taxes on an increased scale.	Lebedev (2020)
C <sub>6</sub>	Increase of the gas production in Russia	- Gas production in Russia increased by more than 11% in 10 months of 2021.	AK&M (2021)
C <sub>7</sub>	Increase in demand for Russian gas in Europe	-Export of pipeline gas from Russia (in value terms) increased by 3.2 times. -The launch of "The Nord Stream 2", even with a large supply of LNG on the EU market, will help reduce gas prices for European consumers by 13%	RIA News (2021)
C <sub>8</sub>	Increase of the market share of Russian gas in Europe	-The share of Russian gas in the EU market has grown by several percentage points to about 45%. - "Gazprom's" share in the EU market reached 36.7%	Interfax (2019)
C <sub>9</sub>	Increase of the economic burden on Russian citizens (e.g., through the increment in the Value Added Tax (VAT))	-The measure is aimed to attract additional funds to the budget for the implementation of the May decrees.	TACC (2018)
C <sub>10</sub>	Increase of Russia's political influence in Europe	-The completion of "The Nord Stream 2" project provides new opportunities for the development of economic relations between Russia and the EU.	Soldatkin et al. (2021)

3.2 Data collection

This study collected data through an online questionnaire, which was designed on *QuestionPro*. The target sample was Russian residents who were asked to evaluate possible benefits and risks from increased exports of Russian natural gas to Europe due to the completed NS2 project. 44 people were approached, and 18 properly filled questionnaires were obtained. Hence, the sample size was 18. Most of the respondents were aged 25 to 54, with more than one year of experience. Data were collected on a 7-point Likert scale, where "7" represents high priority ("strongly agree") and "1" represents low priority ("strongly disagree"). The questions were designed in a way that all questions (factors) had higher the better characteristic. Thus, to run the GRA model, an ideal data sequence would be of the form {7, 7, ..., 7}. Microsoft Excel was utilized for data analysis through the GRA model, which will be discussed in the subsequent section. The demographic profile of the respondents is presented in Table 4.

3.3 Grey Relational Analysis model

The Chinese professor Julong Deng proposed the Grey System Theory in the 1980s (Julong, 1989). Since then, it has seen application in various fields, such as Supply Chain Management (Diba & Xie, 2019; Bai & Sarkis, 2018), Sustainable Development (Ikram *et al.*, 2019; 2020), Project Management (Mahmoudi *et al.*, 2021a; 2021b), Energy and Emissions (Javed *et al.*, 2020; Javed & Cudjoe, 2022). Grey system theory concerns a system whose information is partially known and partially unknown, in other words, with an incomplete description. Grey Relational Analysis is an important part of the grey system theory. It captures the relationship between the main factor and other auxiliary factors. In the comparison process, the reference sequence is related to the sequences being compared, which show some degree of similarity to the reference model and thus determine the best one. The GRA model can be executed as follows (Mahmoudi *et al.*, 2020; Liu *et al.*, 2017).

**Table 4.** Demographic information of the respondents

Characteristic	Demographic Characteristics	Number	%
Latest Education	High school	6	33
	Diploma	4	22
	Bachelor	4	22
	Master	1	6
	Doctoral degree	2	11
	N/A	1	6
Work Experience	< 1 year	4	22
	1-2 years	2	11
	3-5 years	3	17
	6-7 years	4	22
	>7 years	5	28
Age	18-24	3	17
	25-34	5	28
	35-44	4	22
	45-54	5	28
	>54	1	6
Gender	Male	8	44
	Female	4	22
	Not mentioned	6	33



Let the ideal sequence is  $x_0 = \{x_0(1), x_0(2), \dots, x_0(n)\}$ , and the reference sequence is  $x_i = \{x_i(1), x_i(2), \dots, x_i(n)\}, i = 1, 2, \dots, m$ , where  $m$  is the total number of factor being evaluated. The GRA model is recognized through its Grey Relational Grade, given by:

$$\gamma(x_0, x_i) = \frac{1}{n} \sum_{k=1}^n \gamma(x_0(k), x_i(k)) \tag{1}$$

where,

$$\gamma(x_0(k), x_i(k)) = \frac{\min_0 \min_i |x_0(k) - x_i(k)| + \xi \max_0 \max_i |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \xi \max_0 \max_i |x_0(k) - x_i(k)|} \tag{2}$$

and  $\xi \in (0, 1]$  is the distinguishing coefficient. Scholars frequently assume its value to be 0.5. Here,  $\gamma(x_0(k), x_i(k))$  is called the Grey Relational Coefficient (GRC) at point  $k$ , and GRG shows the closeness between  $x_0$  and  $x_i$ . GRA allows us to understand which factors are critical in the system. For further details on GRA, Kuo *et al.* (2008) and Mahmoudi *et al.* (2020) can be referred.

### 4. Results and discussion

After collecting data, the analysis was performed using Deng's GRA model as it is a convenient tool to evaluate factors even when the sample size is small. The raw data obtained from eighteen respondents about the ten factors is shown in Table 5. The Grey Relational Coefficients and Grey Relational Grades are shown in Tables 6 and 7, respectively. In the tables, "C" deputizes criteria/factors, and "A" deputizes respondents. Figure 2 illustrates the GRG and Ranks of the criteria.

After analyzing respondents' opinions, results showed that all expectations have some potential. However, the current study discovered that among all determined alternatives Improvement in bilateral relationships between Russia and Western Europe (C2) gets the highest order relative weight, means selected to be the most critical expectation from the increase in Russian gas exports to Europe by the completion of the NS2 project, while the increase of the economic burden on Russian citizens (e.g., through the increment in the Value Added Tax (VAT)) (C9) gets the lowest. It is followed by Increase of the market share of Russian gas in Europe (C8), Improvement in living standard in Russia (C3), Increase in demand for Russian gas in Europe (C7), Increase in the gas production in Russia (C6), Increase of Russia's political influence in Europe (C10), Increase of "GDP per capita" in Russia (C1), Stabilization of the gas prices in the Russian market (C4), Improvement of the resilience of Russian Economy, (C5).

Most of the respondents believe that the completion of NS2 will improve bilateral relationships between Russia and Western Europe (C2). Now, NS2 is not just a Russian-German project, but a Russian-European project, since Germany is becoming the main transit country for Europe,

**Table 5.** The response sheet containing original data

	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>4</sub>	A <sub>5</sub>	A <sub>6</sub>	A <sub>7</sub>	A <sub>8</sub>	A <sub>9</sub>	A <sub>10</sub>	A <sub>11</sub>	A <sub>12</sub>	A <sub>13</sub>	A <sub>14</sub>	A <sub>15</sub>	A <sub>16</sub>	A <sub>17</sub>	A <sub>18</sub>
C <sub>1</sub>	2	4	6	2	3	3	4	5	3	5	7	2	2	2	7	1	5	7
C <sub>2</sub>	3	3	7	3	3	3	3	6	6	2	5	4	6	6	7	4	3	6
C <sub>3</sub>	7	7	4	2	5	1	5	1	6	5	5	3	7	6	4	3	6	1
C <sub>4</sub>	1	1	4	3	7	2	6	3	3	3	6	4	2	7	3	4	4	4
C <sub>5</sub>	1	4	1	2	5	2	3	2	3	7	6	1	7	6	4	1	5	1
C <sub>6</sub>	2	5	4	2	6	2	3	4	5	7	3	5	2	6	3	1	7	4
C <sub>7</sub>	3	5	4	1	2	5	1	7	6	4	2	4	3	7	7	6	1	5
C <sub>8</sub>	3	4	2	3	2	4	7	6	3	7	7	2	7	4	1	6	6	2
C <sub>9</sub>	2	5	1	4	4	5	1	4	3	5	1	2	2	3	7	3	1	2
C <sub>10</sub>	7	4	7	2	1	2	3	1	1	5	6	5	1	5	6	3	2	6

**Table 6.** Grey Relational Coefficients

	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>4</sub>	A <sub>5</sub>	A <sub>6</sub>	A <sub>7</sub>	A <sub>8</sub>	A <sub>9</sub>	A <sub>10</sub>	A <sub>11</sub>	A <sub>12</sub>	A <sub>13</sub>	A <sub>14</sub>	A <sub>15</sub>	A <sub>16</sub>	A <sub>17</sub>	A <sub>18</sub>
<b>C<sub>1</sub></b>	0.44	0.57	0.80	0.66	0.49	0.66	0.57	0.66	0.57	0.66	1.00	0.57	0.44	0.44	1.00	0.44	0.66	1.00
<b>C<sub>2</sub></b>	0.49	0.49	1.00	0.80	0.49	0.66	0.49	0.80	1.00	0.44	0.66	0.80	0.80	0.80	1.00	0.66	0.49	0.80
<b>C<sub>3</sub></b>	1.00	1.00	0.57	0.66	0.66	0.49	0.66	0.39	1.00	0.66	0.66	0.66	1.00	0.80	0.57	0.57	0.80	0.39
<b>C<sub>4</sub></b>	0.39	0.39	0.57	0.80	1.00	0.57	0.80	0.49	0.57	0.49	0.80	0.80	0.44	1.00	0.49	0.66	0.57	0.57
<b>C<sub>5</sub></b>	0.39	0.57	0.39	0.66	0.66	0.57	0.49	0.44	0.57	1.00	0.80	0.49	1.00	0.80	0.57	0.44	0.66	0.39
<b>C<sub>6</sub></b>	0.44	0.66	0.57	0.66	0.80	0.57	0.49	0.57	0.80	1.00	0.49	1.00	0.44	0.80	0.49	0.44	1.00	0.57
<b>C<sub>7</sub></b>	0.49	0.66	0.57	0.57	0.44	1.00	0.39	1.00	1.00	0.57	0.44	0.80	0.49	1.00	1.00	1.00	0.39	0.66
<b>C<sub>8</sub></b>	0.49	0.57	0.44	0.80	0.44	0.80	1.00	0.80	0.57	1.00	1.00	0.57	1.00	0.57	0.39	1.00	0.80	0.44
<b>C<sub>9</sub></b>	0.44	0.66	0.39	1.00	0.57	1.00	0.39	0.57	0.57	0.66	0.39	0.57	0.44	0.49	1.00	0.57	0.39	0.44
<b>C<sub>10</sub></b>	1.00	0.57	1.00	0.66	0.39	0.57	0.49	0.39	0.44	0.66	0.80	1.00	0.39	0.66	0.80	0.57	0.44	0.80

**Table 7.** Grey Relational Grades and ranks

Code	Criteria	GRG	Rank
<b>C<sub>2</sub></b>	Improvement in bilateral relationships between Russia and Western Europe	0.7036	1
<b>C<sub>8</sub></b>	Increase of the market share of Russian gas in Europe	0.7026	2
<b>C<sub>3</sub></b>	Improvement in living standard in Russia	0.6964	3
<b>C<sub>7</sub></b>	Increase in demand for Russian gas in Europe	0.6925	4
<b>C<sub>6</sub></b>	Increase of the gas production in Russia	0.6537	5
<b>C<sub>10</sub></b>	Increase of Russia's political influence in Europe	0.6455	6
<b>C<sub>1</sub></b>	Increase of GDP per capita in Russia	0.6449	7
<b>C<sub>4</sub></b>	Stabilization of the gas prices in Russian market	0.6321	8
<b>C<sub>5</sub></b>	Improvement of the resilience of Russian Economy	0.6045	9
<b>C<sub>9</sub></b>	Increase of the economic burden on Russian citizens (e.g., through the increment in the Value Added Tax)	0.5851	10

through which other countries (e.g., Italy, France, Finland, etc.) will begin to receive gas. As long as Russia is the main European gas supplier, Russian natural gas and LNG exports have grown significantly, thereby increasing the share of Russian gas in the EU market. This explains why the increase of the market share of Russian gas in Europe (C8) was ranked second most practicable expectation. In addition, the export of natural resources is the main source of Russian income. Part of the income is spent on pensions, social benefits, and subsidies. Plus, the construction of schools, hospitals, and roads is also funded by the state budget. For this reason, the respondents could define improving living standards in Russia (C3) as the third eventual expectation. The study also revealed that the increase in Russian gas exports to Europe would have the least impact on the increase of the economic burden on Russian citizens (e.g., through the increment in the VAT) (C9). However, with the launch of NS2, export gas prices at European hubs might begin to fall, and it will become less profitable to export gas on external markets, which can economically encumber Russian citizens. Overall, the results are realistic and convincing.

**5. Conclusion**

The Nord Stream 2 pipeline, just like the existing one (Nord Stream 1), is likely to establish a direct connection between Gazprom and European consumers while warranting high reliability of Russian gas supplies to Europe. This is particularly significant, especially if one notes the falling gas production in Europe and increasing demand for its imports. Furthermore, the NS2 is pivotal for Russia as its launch would improve the stature of Russian businesses and the nation. The



Figure 2. Grey Relational Grades based ranking for the ten expectations.

current study employs the Grey Relational Analysis model to identify the key expectations of Russians from the increased supplies of Russian natural gas to Europe following the completion of the NS2. Based on the results and discussion, the increase in Russian gas exports to Europe shows that the most critical expectation is improving bilateral relationships between Russia and Western Europe. The results will likely benefit Russian public and parties involved in projecting the NS2 gas pipeline. Besides, the results are valuable for economic and energy policy-makers while helping them know the viewpoint of the masses.

Prospects for further gas cooperation between Russia and European countries will depend on the formation of a favorable investment climate, technological interaction between the parties, as well as the diversification of routes delivery of natural gas to European countries. The priority task is to develop full-fledged cooperation with all importing countries of Russian gas and, of course, with the European Union as Russia's most important strategic partner. In addition, Gazprom should flexibly adapt to the new pricing system to maintain current export volumes. In the case of low demand and oversupply, it is inevitable price wars. However, it is possible to maintain its market share in Europe only by offering lower prices. For new markets, some discounts can be offered. When the market is oversaturated, many companies are ready to sell gas at prices that cover current rather than long-term costs. Also, because of the opposition of the United States, the world's third-largest LNG exporter, the NS2 project is as much about energy as geopolitics and competition. Thus, lessons should be learned from China's Belt and Road Initiative, so the project achieves targets despite all frictions.

The study involved a small sample size. Thus, findings should be generalized with caution. A larger sample size encompassing greater diversity can be considered in the future. Also, new factors can be added to the framework. Meanwhile, to what extent the government and its policy-makers would meet the expectations of the Russian citizens and what value the project would add to the relationship between Russia and Europe is yet to be seen.

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