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Developing an Organizational Resilience Measurement Tool

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ABSTRACT

Organizational resilience (OR) is rising in attention due to not just being a key solution for companies to cope with crises but also being closely tied to their long-term survival and growth. However, researchers acknowledge research gaps such as issues related to the comprehensiveness and accuracy of OR measuring tools, which also fail to specify the kind of crisis they cover. This study intended to develop a novel tool, considering both static (resource-based) and dynamic (capability-based) dimensions of OR, alongside all 4 strategic responses to crises to hedge expected and unexpected disruptions, aiming to enhance comprehensiveness, alongside eliminating redundancy among factors and assigning weight to improve accuracy. To this end, the structured focus group (FC) and best-worst method (BWM) were conducted with the participation of 6 experts to refine and augment as well as assign weight to the factors. The tool encompasses 8 factors distributed across three sets—direction with a weight of 0.222, execution with a weight of 0.317, and results with a weight of 0.460—collectively including 23 sub-factors and 86 indicators. The tool's validation was tested by assessing the resilience of five petrochemical companies and comparing it to the Altman-Z score calculated for each one. This tool enables decision-makers to precisely assess the resilience level of their organizations, identifying strengths and weaknesses more comprehensively and prioritizing areas for improvement.

KEYWORDS: Resilience; Organizational Resilience; Measurment; Crisis Management; Fucos Group; Best-Worst Method; Petrochemical Industry

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1. Introduction

Business disruptions have found more intense and frequent forms in recent years, revealing firms' vulnerabilities. Disruptions originating from unexpected natural crises, industrial accidents, political conflicts, etc., alongside the dynamic and uncertain business environment itself, pose a serious threat to businesses' ability to preserve their existence and profitability(Renán Teodoro & Bañuls, 2025; Xi et al., 2024). As an illustration, over 760 million people have been infected by the COVID-19 virus, leading to 6.9 million recorded deaths worldwide (World Health Organization, 2023). Apart from the health tragedy caused by the pandemic, industries globally have witnessed chaos and impacts, which can be contrasted with World War II(Matthews et al., 2022); adverse effects such as suppressed consumption, lower demand, restricted movement leading to a shortage of labor and shipping, declaring bankruptcy, job and economic losses due to temporary or permanent closure, and delay in investment(Neise et al., 2021; Shabankareh et al., 2023; Xu et al., 2022). Correspondingly, organizations prioritize survival and growth in a dynamic atmosphere(R. Chen et al., 2021a), refocusing their efforts from making large profits to developing resilience to cover these challenges(Xi et al., 2024), where regardless of their origin and nature, crises bring similar destructive effects(Abufardeh & Albloush, 2025).

Deliberating at the organizational level, resilience can be defined as "the measurable combination of characteristics, abilities, capacities, or capabilities that allow an organization to withstand known and unknown disturbances and survive”(Bravo & Hernandez, 2021, p. 2). Such a combination can be managed and developed. Indeed, studying, exploring, and improving this amalgam of indicators to promote organizational resilience (OR) is a rising approach to coping with crises(Somers, 2009) which has received attention to such an extent that, to manage operation and respond more effectively to adversity, resilience must be incorporated into all day-to-day activities(Ewertowski & Butlewski, 2021) and its elements should be integrated into the entire firm development process(G. Chen et al., 2023). Resilient organizations are not only better prepared to handle crises but can also stay competitive (Annarelli et al., 2020; Lee et al., 2013).

As unanticipated shocks and disruptions in the global economy are increasing along with changes in the business environment, it is more crucial than ever to have precise methods for assessing OR, garnering significant attention from academics and practitioners(Ilseven & Puranam, 2021).The definition and assessment of OR, however, are still in the developing phases of investigation. Given the varied approaches and results of to date, it is challenging to offer suggestions for handling crises more accurately and unambiguously(Annarelli & Nonino, 2016; Ignatowicz et al., 2023). Despite increased efforts in the measuring context during the previous five years (Hillmann, 2021), further clarification and attention remain required in this field(Hillmann & Guenther, 2021; Z. Ma et al., 2018).

There are several methods for measuring OR. One of the most prevalent approaches involves exploring and developing effective factors, along with their related indicators, based on the capabilities, features, and characteristics of resilient organizations(Darijani et al., 2019; Lee et al., 2013; Mallak, 1998; McManus et al., 2008; Sari et al., 2023). We identified three axes as more attention-needed issues based on a review of OR literature related to this approach. First, stemming from a review of large attempts conducted to study resilience as well as critics' opinions, Hillmann (Hillmann, 2021) and Z. Ma et al. (Z. Ma et al., 2018) distinguished a fractured and disjointed

development in the literature. In addition, there are few in-depth evaluations of the OR dimensions (R. Chen et al., 2021a) and fewer works in the measuring field(Akpinar & Özer-Çaylan, 2022; Ruiz-Martin et al., 2018). Likewise, it is noted that there is disagreement over what factors and fundamentals improve OR and how to measure it(Ruiz-Martin et al., 2018; Serfilippi & Ramnath, 2018; Sevilla et al., 2023). Due to this absence of unified opinion, quantitative and qualitative research have not grown at the same rate, consequently there is no widely accepted standard in this area (R. Chen et al., 2021a). Serfilippi & Ramnath (Serfilippi & Ramnath, 2018) attribute this dispersion in literature to the failure of most research to concurrently address both static and dynamic dimensions of resilience. Furthermore, the majority of authors do not specify which types of challenging situations resilient organizations are prepared to face. Some consider disruption or change to be turbulent. Others believe that resilience encompasses both expected and unexpected circumstances(Ruiz-Martin et al., 2018).
Second, unsurprisingly, in such fragmented literature, redundancy might exist among indicators. The study by Kazemi and Andalib(Kazemi & Andalib, 2017) indicated that indicators overlap and can measure multiple factors of OR simultaneously. This issue is relatively common among indicator-based tools due to the potential correlation between effective factors, which can lead to an overestimation of results(Corrente et al., 2023).
Third, while scholars and practitioners need to have insight into each feature and indicator's priority during measuring OR(Ignatowicz et al., 2023), few of the studies exploring and developing indicators have considered weighting them(Arsovski et al., 2015; Haghighat et al., 2024; Macuzic et al., 2016; Tadic et al., 2014). However, assigning relative weights to criteria under a specific intention (measuring OR more accurately) reflects their relative importance and might be changed in cases of necessity, according to circumstances(Sinha et al., 2009). Meanwhile, it facilitates decision-making by taking into account stakeholders' preferences(Kalbar & Das, 2020) and also significantly improves measurement tools(Lee et al., 2013). Involving stakeholders' preferences in OR assessment leads to not only gaining additional insights into the field but also more effective improvement plans(Cradock-Henry & Fountain, 2019).

To fill these gaps, the current study conducts hybrid methods that include qualitative and quantitative approaches, as follows:

focus group discussions for expert-informed refinement and augmentation of OR factors with the aim of in-depth investigating them to have more clear, comprehensive, and non-overlapping indicators encompassing both static and dynamic dimensions of OR, as well as all four strategic responses to crisis to address both expected and unexpected disruptions.
Best-worst method to assign weight to each factor with the aim of measuring OR more accurately.

Finally, to validate the findings of the research, 5 Iranian petrochemical companies are selected as case studies, and their resilience is measured using the tool developed in the research. Then, the results obtained from this assessment are compared with the calculated values of the Altman Z-score for predicting bankruptcy, which is based on several financial ratios.
Thus, the current study is intended to develop a tool for measuring OR more comprehensively and accurately that sheds light on weaknesses and strengths of businesses, providing decision-makers insights to be more prepared for and effectively cope with crises, and also grow in the long term. To achieve this, the tool is supposed to cover both static and dynamic dimensions of resilience, as well as encompass all four strategic responses to crisis. Additionally, its accuracy is enhanced by

eliminating redundancy among indicators and assigning weight to each factor. It is expected that measuring companies' OR with this tool will be converged with results from calculating the Altman Z-score of each one. This score has been widely accepted by researchers and stakeholders with regard to assessing the health of companies and predicting potential bankruptcy over the last two decades; recent empirical studies confirm its utility as a reliable measure for OR.
The remainder of this paper is organized into the following sections. Section 2 provides the theoretical background, in which we attempt to examine a brief definition of OR and four common strategic responses to crises, as well as collect various categories of OR measurement methods and approaches. This review resulted in the proposal of a novel classification of OR measurements, serving as one of the contributions of this study and guiding its continuation. In Section 3, the methodology is presented, which features a hybrid of qualitative and quantitative methods. Afterward, Section 4 shows our results, which include a set of weighted factors (along with related sub-factors and indicators) as a measurement tool and a case study validation. Section 5 further discusses the dynamics of OR measurement and improvement from this study's perspective. Finally, Section 6 offers practical and theoretical implications followed by limitations and future research avenues.

2. Theoretical background

Definition and static & dynamic dimensions of resilience

The global business climate involves various complex challenges that compromise company survival. The concept of OR emerges as a crucial solution, providing a comprehensive philosophy(Akpinar & Özer-Çaylan, 2022). OR helps to escape a difficult situation and, moreover, emphasizes a company's ability to grow throughout a crisis(R. Chen et al., 2021b), seize the opportunity, and achieve success(Lotfi & Saghiri, 2017).

A resilient organization blends multiple competencies, tasks, and resources from all sides together(Li et al., 2022; Ruiz-Martin et al., 2018). In fact, this combination is what makes an organization resilient(Gibson & Tarrant, 2010). Serfilippi & Ramnath (Serfilippi & Ramnath, 2018) characterize this combination as static and dynamic dimensions. The static dimension, capital, refers to measurable snapshots of assets controlled by stakeholders, including human, social, financial, physical, and natural resources, at any given time. The dynamic dimension, capacity, refers to households' strategies for managing stressors and shocks. This encompasses their ability to adjust capital and leverage skills and connections for positive adaptation.

Strategic response to crisis

A crisis is perceived as a significant threat to a system's core structures, values, and norms, demanding urgent decision-making amid time pressure and uncertainty. Along with time constraints and limited information, existing structures might be found inapplicable(Alirani et al., 2025). Hence, managers often find it challenging to formulate a coherent response(Maggetti & Trein, 2022). Situations become more complicated when they face large-scale crises such as the Covid-19 pandemic, which require comprehensive policy responses that incorporate diverse objectives and tools(Ansell et al., 2021).

Wenzel et al. (Wenzel et al., 2021) classify strategic responses to crises into four categories:

- Retrenchment, the most common strategy, involves cutting costs, assets, production, and overhead to narrow the scope of activities due to the crisis. While effective in the short term, it is not a long-term solution.
- Persevering refers to maintaining a firm's status quo and mitigating crisis impacts by leveraging internal and external slack resources, including international diversification, core competencies, and debt financing. It saves the firm from too-early strategic redirection, which is effective in the medium term.
- Innovating refers to conducting strategic renewal in response to crisis. It includes exploring new alternatives, expanding firm activities toward other sectors, developing new business methods amid environmental uncertainties such as vertical integration, and engaging in R&D. It also relies on complementary assets and the manager's decision-making skill, providing a long-term solution to crisis.
- Exit refers to the cessation of a firm's business activities due to a crisis and may become necessary if other strategies fail. However, unlike bankruptcy, a business exit can also occur as a strategic decision at any time, releasing allocated resources and thereby facilitating the establishment of new ventures.

These strategic responses are complementary, each offering unique benefits and drawbacks(Klyver & Nielsen, 2021). Therefore, during a major crisis, a combination of them is essential to effectively manage the situation and minimize negative consequences. Such a strategic response can be reached through the holistic and objective cognition of alternatives, which necessitates enough time for assessment(Maggetti & Trein, 2022). Accordingly, establishing the foundation for such assessment and decision-making can be highly valuable and beneficial for managers and decision-makers.

Trend and classification of measurement methods and approaches

Along with paying attention to the concept of OR and the attempt to theorize it, various methods and tools were developed to measure it. As Gonçalves et al. (Gonçalves et al., 2019) pointed out, one of the first studies in this field was conducted by Mallak (Mallak, 1998) based on Weick's research. He developed a questionnaire with 6 factors that included goal-oriented solutions, critical understanding, access to resources, role dependence, source reliance, and avoidance. Planning and accreditation, decision-making structure and centralization, and connectivity were added to that questionnaire due to Sommer's study, which is known as the Potential Organizational Resilience scale. McManus et al. (McManus et al., 2008) argued that OR relies on situational awareness, keystone vulnerabilities management, and adaptive capacity. They proposed 15 measuring indicators by studying 10 firms in New Zealand, which were followed by Stephenson via qualitative research. Lee et al. (Lee et al., 2013) took those findings as a starting point and developed 53 indicators categorized by two factors: planning and adaptive capacity, through a random sample survey in organizations from Auckland, New Zealand. This study received more than 1100 citations based on the Google Scholar website, reflecting the high level of interest in this type of OR measurement among researchers and practitioners. Known as the Benchmark Resilience Tool (BRT-53), it aimed to assess organizational strengths and weaknesses but was criticized for its length. To address this, Whitman et al. (R. Whitman et al., 2013) introduced a shorter version (BRT-13B), which was validated by Sharma & Sharma (Sharma & Sharma, 2015)

and Gonçalves et al. (Gonçalves et al., 2019). Furthermore, some authors, like Azadeh et al. (Azadeh et al., 2014) and Shirali et al. (Shirali et al., 2016), utilized Resilience Engineering (RE) principles along with MADM methods aimed at evaluating a firm's resilience. Obviously, research did not stop here, and other ways of resilience measurement developed simultaneously. Authors such as Rose (Rose, 2007) and Pant et al. (Pant et al., 2014) suggested measuring resilience quantitatively by analyzing an organization's recovery from disruption, mainly regarding time and cost, which is applicable only after failures. Homayounfar et al. (Homayounfar et al., 2025) utilized system dynamics modeling to evaluate startups' resilience during the COVID-19 pandemic. Afonso-Fernandes et al. (Afonso-Fernandes et al., 2026) conducted a Delphi study to tailor the Resilience Assessment Grid (RAG) to the hospital context to assess and enhance their resilient performance.

Linnenluecke (Linnenluecke, 2017) review study represented a major development in literature, with over 2200 citations to date. Five research streams were identified from 339 articles and book chapters from 1977 to 2014, but none of them directly addressed resilience measurement. She proposed four avenues for future research, including the need for more detailed and practical insights about measurement in response to different crises.

Hosseini et al. (Hosseini et al., 2016) reviewed articles on resilience measurement, focusing on system resilience. They categorized measuring approaches as qualitative and quantitative, each of which has subcategories based on the methodologies and data used in the measurement tools. They concluded that despite the increasing popularity of the term resilience, further research is still needed aimed at measuring it more practically, which could include the interrelationships between resilience factors.

Ruiz-Martin et al. (Ruiz-Martin et al., 2018) conducted another review of the resilience literature, focusing on OR. They noted that there are few definitions of resilience at the organizational level and even fewer measurement studies. They identified three different streams of conceptualization of OR in their review of the literature: resilience as a feature of the organization, resilience as an outcome of organizational activities, and resilience as the degree of disruption that an organization can tolerate. They also used the same classification to categorize types of resilience measurements. They introduced two main dimensions of resilience measurement: an estimate of the organization's potential resilience and the organization's actual level of resilience after a crisis; they also suggested developing common indicators based on the feature view for measuring potential resilience.

Serfilippi & Ramnath (Serfilippi & Ramnath, 2018) evaluated resilience models employed by international development agencies, focusing on implementation and measurement. They highlighted that measurement tools must meet three criteria to be effective for programmed intervention assessments: a) encompass a time dimension, b) establish causal relationships among factors, and c) fulfill aggregation and analytical requirements. They emphasized the need for pragmatic, actionable indicators that reflect a common language of resilience, addressing both static and dynamic dimensions.

More recently, Ignatowicz et al. (Ignatowicz et al., 2023) conducted a systematic review of quantitative, qualitative, and modeling studies measuring OR in the healthcare sector, categorizing them by format, scope, and purpose based on thematic areas. They noted ongoing challenges in assessing resilience, including a lack of consensus on its context and practical challenges in developing indicators and establishing weights and priorities. They advocated for the development of more comprehensive, theory-based indicators grounded in shared understanding and recommended that researchers and practitioners consider the measurement's nature and objectives, as well as the availability and accuracy of data. The table below summarizes these reviews.

Ignatowicz et al. (Ignatowicz et al., 2023) argue that a tool can belong to multiple categories. Moreover, restricting categories to a single criterion, such as just quantitative or qualitative, may overlook the multidimensionality of resilience. This limitation could complicate the selection of measurement tools and stifle creativity and progress in future resilience research. Therefore, considering the classifications that researchers have made so far and the necessities they have recommended, this study proposes a novel multi-criteria classification with the aim of offering more transparency and common understanding among stakeholders utilizing those tools. However, stakeholders must also consider the data availability and quality, as well as the assessment-required time and cost. Table 1 delineates this novel classification and the present research status concerning the criteria intended to be addressed.

Table 1. New classification of resilience measurement approaches proposed by this study

Criteria	Sub-criteria
Assessment level	Individual/team
	Organization/firm
	Industry/ supply chain/ market
	Set of industries/markets
Organization Type	Infrastructure/first responder stations/etc.
	Non-profit/public
	For-profit
Resilience Origin	Static/resource view
	Dynamic capability view
Strategic response to crisis	Retrenchment
	Persevering
	Innovating
	Exit
Assessment Time	Pre-shock
	During shock
	Post-shock
Assessment Purpose	Formative/ diagnostic
	Summative
Assessment Observation	Prospective/ potential

	Retrospective/ actual
Assessment Approach	Qualitative
	Quantitative
	Modeling/ simulation
Assessment Scope	Quick/brief
	Comprehensive/ detailed
Data Format	Semi-quantitative indices(self-declarative or expert opinion)
	Rigid financial and non-financial ratios/KPIs
Indicator Template	Pre-defined/ commonly accepted
	Shock/sector specific
Analytical Aid	Weight/priority
	Mutual relationships
	Hierarchy level structure
	Industry-tailored indicator acceptable threshold
	Others

3. Methodology

Focus group discussions

Focus group discussions commonly serve as a qualitative method to gain a comprehensive understanding of a theory, concept, or product. The method seeks to gather data from a deliberately chosen group of individuals instead of a statistically representative sample of a larger population, capturing qualitative data through dynamic group interactions and discussions on a topic presented by a facilitator in a time-cost-efficient manner(O.Nyumba et al., 2018; Tortorelli & Arantes, 2024). Participants may be chosen from individuals possessing pertinent lived experience or specialists in the field. Discussions among experts regarding their opinions, perceptions, attitudes, and beliefs about complex concepts like organisational resilience—which necessitate interdisciplinary expertise and structured deliberation— enhance the information available on the concept and foster new, profound understandings (Kramar & Sternad, 2025; Tortorelli & Arantes, 2024). Concurrently, conventional methods, including surveys or Delphi, frequently lack interactive elements and do not offer the requisite depth for intricate policy deliberations. Modified FG improves exploration by enabling thematic categorisation and refining contextual factors; it addresses previous limitations(Kramar & Sternad, 2025). To put it simply, the core advantage lies in leveraging experts with unique knowledge to analyse intricate phenomena—an approach that provides richer insights than other research methods(Sutton & Arnold, 2013).

Furthermore, focus group discussion can be considered a desired technique within a multi-method research design, aimed at engaging stakeholders in business governance and handling organizational issues(O.Nyumba et al., 2018), as well as resolving concerns about the validity of research's findings(Sutton & Arnold, 2013). Due to these advantages and the complex, umbrella nature of the resilience concept, this method was selected as the focal part of the research design for the current multi-method study. The method involves the following key steps: 1) Establishing the objectives and selecting participants 2) Preparing for the session and facilitating the meeting 3) Analyzing and verifying data 4) Presenting the final findings to stakeholders(Morgan, 1997).

There are several recommendations regarding optimal group size based on various considerations: "6 to 12 participants for maximizing interaction and maximizing input"(Ho et al., 2021), "5 to 10 participants to ensure sufficient diversity, quality of interaction, group dynamics, moderator control, logistics, and cost" (Lim, 2024), and "4 to 12 carefully selected experts to ensure a variety of perspectives and experience while minimizing bias"(Tortorelli & Arantes, 2024).

Best Worst Method (BWM)

The Best Worst Method (BWM), one of the Multi-Criteria Decision Making (MCDM) approaches, employs ratios of the relative significance of criteria derived from pairwise comparisons supplied by a decision-maker (DM), utilizing two evaluation vectors: the Best criterion compared to the Other criteria and the Other criteria in relation to the Worst criterion. The weight of each criterion is obtained by solving a nonlinear model(Rezaei, 2015), which simply can be converted to a linear model(Rezaei, 2016). BWM brings some advantageous benefits, including relying on fewer pairwise comparisons than the well-known Analytic Hierarchy Process (AHP), but can still make more consistent comparisons, leading to more precise and trustworthy results(Cavallo & Ishizaka, 2025; Mi et al., 2019). BWM's simplicity and reliability have led to its widespread application in addressing various problems(Liang et al., 2020). The steps of this method are as follows:

Step One: The set of effective factors (evaluation criteria) related to the phenomenon or concept that are to be weighted is determined.

Step Two: A group of experts is appointed. Next, the questionnaires are distributed among them. Each expert is separately asked to first determine the best and worst factor (in terms of importance) among the factors.

Step three: The preference of the best factor over the others on a scale of 1 to 9 is determined by each expert, which is represented as a preference vector in the form $A_B = (a_{B1}, a_{B2}, \dots, a_{Bn})$. In the mentioned vector, a_{Bj} indicates the preference of the best factor B over factor j, and it is clear that $a_{BB} = 1$.

Step four: The preference of all factors relative to the worst option is determined by each expert on a scale from 1 to 9. The priority vector of other factors relative to the worst factor is represented as $A_W = (a_{1W}, a_{2W}, \dots, a_{nW})$. a_{jW} indicates the priority of index j relative to the worst index W, and it is clear that $a_{WW} = 1$.

Step five: After receiving the completed questionnaires, this step involves formulating and solving the model to obtain the optimal weight of the factor based on each questionnaire. The non-linear model is as follows:

$$\min \max_j \left\{ \left| \frac{w_B}{w_j} - a_{Bj} \right|, \left| \frac{w_j}{w_W} - a_{jW} \right| \right\} \qquad (1)$$

Subject to:

$$\sum_{j=1}^{n} w_j = 1, \quad w_j \geq 0, \quad \forall j \tag{2}$$

Which can be converted to linear model as: min ξ^*

Subject to:

$$\left|w_B - a_{Bj} w_j\right| \leq \xi, \quad \forall j \tag{3}$$

$$\left|w_j - a_{jW} w_W\right| \leq \xi, \quad \forall j \tag{4}$$

$$\sum_{j=1}^{n} w_j = 1, \quad w_j \geq 0, \quad \forall j \tag{5}$$

The optimal weights $w^* = (w_1^*, w_2^*, \ldots, w_n^*)$ and ξ^* are obtained from the unique answer to this minimizing problem.

Step Six: Since the questionnaires are distributed across a group of experts, it is essential to collect the obtained weights from each questionnaire and average them to determine the final weight of each factor.

Altman's Z-Score Model

The Altman Z-score, a model based on the multiple discriminant analysis (MDA), was developed aiming to predict bankruptcy and financial crisis. Since this coefficient provides an overview of the organization's perspective, strategies, and nature of response to critical events, whether proactive (preparedness or response) or recovery, it has been widely adopted by researchers and companies from various corporate stakeholders over the last two decades(Pal et al., 2011). Empirical studies, such as those conducted on the oil and gas sector during the price collapse, further confirm its utility as a suitable measure for measuring resilience(Bravo & Hernandez, 2021). This model has different formulas for listed and unlisted companies. The Altman model for general use is as follows(Pal et al., 2011):

$$Z'' = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \tag{5}$$

X_1: Working capital/Total assets

X_2: Retained earnings/Total assets

X_3: Earnings before interest and taxes/Total assets

X_4: Book value of equity/Total liabilities

A higher Z'' value indicates a more desirable situation and vice versa.

Introducing the case study

Petrochemicals compose a large share of Iran's non-oil exports; hence, this sector is crucial for lowering reliance on oil earnings, diversifying the economy, and generating jobs. However, this industry suffers from external challenges such as sanctions and currency fluctuations resulting from political tensions and internal challenges such as lack of investment and weakness in evaluation systems and technology(Hajiebrahimi Farashah et al., 2021; Najafpour et al., 2025; Sadeqi Mohammadi & Weaver, 2025). Therefore, assessing the resilience of companies active in this industry while contributing to their long-term growth provides a suitable basis for the development of OR literature.

Five petrochemical companies located in the Petrochemical Special Economic Zone, Khuzestan Province, southwestern Iran, were selected as the case studies. These companies were selected to be different from each other in terms of product diversity and production volume in order to study a wider spectrum of this industry. The companies' approval to conduct the study was obtained on the condition of remaining anonymous.

4. Results

A holistic amalgamation of past and newly developed indicators

Systematically aggregating and integrating previous findings

Recently, systematic reviews and meta-synthesis analyses have become popular in various fields. These methods allow researchers to investigate databases and articles to yield comprehensive, transparent, and reproducible results in relevant literature and facilitate addressing existing gaps and new issues(Vovk et al., 2025). Thus, recognizing the importance of measuring OR, particularly taking into account the accumulated knowledge and findings during the Corona pandemic, the authors of the current research decided to consider the meta-synthesis study conducted by Hamidavi Nasab et al. (Hamidavi Nasab et al., 2023) as an initial feed for FC discussions. This approach is an attempt to address the fragmentation of literature and focus on identified gaps instead of the "reinvention of the wheel," ultimately enhancing the inclusiveness and exclusiveness of the outcome as much as possible. That study utilized the seven-step methodology of Sandelowski and Barroso (2007) to systematically identify and combine qualitative findings in resilience factors. By searching the most reputable international databases (i.e., Google Scholar, Scopus, and Web of Science) from 2000 to 2022, they identified 98 relevant articles, yielding 14 factors, 44 sub-factors, and 112 indicators (Hamidavi Nasab et al., 2023), which, to our best knowledge, represent one of the most extensive collections of indicators in existing research.

Expert-informed refinement and augmentation

The study in this phase employed the structured expert focus group method to revise and update meta-synthesis findings to ultimately determine indicators measuring OR. It includes two objectives: a) to revise and eliminate redundancy from the meta-synthesis's indicators and b) to add new complementary indicators that were missed regarding criteria the current study is supposed to cover, ticked in Table 1.

The focus group session included six academic and industrial practitioners, an appropriate number of participants for both focus group methodology and ISM modeling, as discussed in section 3. They were comprised of heterogeneous experience experts—five PhDs and one master's graduate—with over 20 years of experience each in academic research, industrial consulting, and investment. Their expertise spanned economics (1), business management and marketing (2), industrial engineering (1), financial management (1), and accounting (1). Experts were selected for their proficiency and experience in handling a broad range of organizational issues along with deep familiarity with the resilience concept, ensuring a diversity of expertise to address the complexity and umbrella nature of OR. The focus group objectives, along with a summary of the literature framework, past categories of measurement tools alongside the new classification proposed by this study (Table 1), and the outcome of the meta-synthesis study (Appendix A) as an initial feed, were distributed to the participants one week in advance to improve their preparedness for the group discussionThe group, with the collaboration of two authors, M.A., who served as the facilitator, and Y.H., who served as the facilitator's assistant, conducted two sessions of four and three hours, respectively. The following is a description of each round.

The first round began with a concise overview of the FC's objectives for experts, provided by the facilitator after welcoming them and expressing gratitude for their participation. This was followed by a summary of relevant literature, historical context, and common classifications of resilience measurement tools. Subsequently, the proposed current research classification was explained in detail, highlighting the criteria such as multi-timeframe, multi-strategic responses, and for-profit firm design that are expected to be considered by experts. Next, the group, guided by the facilitator, reviewed and discussed the systematic literature review and meta synthesis findings, receiving clarifications as needed. Then, the experts were asked to revise the indicators, irrespective of the meta-synthesis categorization, to identify and eliminate redundancy among them as much as possible. In this regard, the experts recognized that some of the indicators are associated with and overlap each other in such a way that, by considering and implementing the broader ones, the others are effectively addressed and fulfilled. Thus, they compiled sets of overlapped indicators, preserved and modified the broadest one of each set to precisely represent all related indicators, and removed the superfluous ones. The process occurred through iterative discussions and feedback among experts, closely supervised by the facilitator to ensure the inclusion of all perspectives through regular summarization and clarification. Then experts took a break, while in another room, the facilitator and his assistant engaged in a peer debriefing meeting with the remaining authors, sharing and critically reviewing discussion details and results of this round, aiming to mitigate any bias and finalize the first round's draft. Subsequently, at the conclusion of this round, the participants received the final draft and validated it through a member check.

In the second round, experts were asked to augment the first round's findings by proposing new indicators of OR they deemed necessary to add, drawing from their expertise, knowledge, and experience. The facilitator reminded experts that proposed indicators must complement the first round's ones to ensure the final list collectively meets the supposed criteria ticked off in Table 1, including encompassing all four strategic crisis responses tailored for for-profit firms, considering both static and dynamic resilience, addressing pre-, during-, and post-crisis phases, functioning at the organizational level, and the rest of them. Following this justification and reemphasis, experts

identified and proposed missing indicators. Each indicator was added to the list after discussing and reaching consensus. The facilitator moderated this process by summarizing expert perspectives and seeking confirmation; encouraging experts to articulate any disagreements or alternative viewpoints regarding propositions to identify widely accepted ones; and obtaining verbal consent. Ultimately, a consensus among experts, influenced by the literature framework and the EFQM excellence model—recognized for its broad acceptance across various organizations—led to the reclassification of revised and newly added indicators into sub-factors, factors, and sets. This process resulted in the final resilience measurement tool, which consists of three sets, eight factors, twenty-three sub-factors, and eighty-eight indicators, as detailed in Appendix. The direction set encompasses two factors: "strategic approach" and "redundancy and resources." The execution set includes four factors: "employees and organizational culture," "modernization discourse," "planning and decision-making," and "control and preparation." Finally, the results set comprises two factors: "adaptability" and "resilient governance." Peer debriefing and member check were executed similarly to the previous round. Additionally, at the end of this phase of the study, the remaining authors acted as external evaluators to assess the entire focus group process. This evaluation encompassed the rationale for method selection, research objectives, participant recruitment, detailed discussions, and findings, all intended to substantiate its implementation as an audit inquiry.

Quantitative research primarily addresses numerical data, emphasizing reliability and validity through statistical measures, whereas qualitative research examines non-numerical data, requiring distinct criteria to ensure rigor. In fact, reliability and validity are paralleled by trustworthiness, whose components—credibility, dependability, confirmability, and transferability—demonstrate how qualitative researchers ensure the rigor of their work. Besides, notwithstanding its significant advantages, the focus group method possesses inherent limitations. Constraints include groupthink, inequitable participation, and the moderator effect.(Lim, 2024). To establish the rigidity of findings by embracing trustworthiness principles as well as mitigate the potential drawbacks of focus group methodology, this study implemented broad strategies recommended by (Creswell & Poth, 2024; Lim, 2024), which are detailed in Table 2.

Table 1 . Strategies applied to enhancing trustworthiness of FC qualitative findings

Strategy	**Description**	**Aim to**
Prolonged engagement	All authors have collaboratively participated in this research since 2019, following the prior experiences and research of Author M.A. and Author H.Z. in OR.	enhancing Credibility
Triangulation	This study utilized two qualitative research methods to determine OR's indicators—meta-synthesis followed by structured expert focus groups, which were participated in by both experienced scholars and practitioners.	enhancing Credibility/ Dependability/ Confirmability
Peer debriefing	The facilitator and his assistant held a peer debriefing meeting with the remaining authors, sharing and critically evaluating the discussions and results after each round prior to the member check.	enhancing Credibility/ Confirmability

Member checking	Subsequent to the peer debriefing meeting, at the conclusion of each round, the participants received the final draft and confirmed its accuracy through a member check.	enhancing Credibility/ Confirmability
Audit inquiry	The remaining authors, including H. Z., who has previously researched and practiced OR, served as external evaluators to assess the entire focus group process, encompassing the research objectives, rationale for method selection, participant recruitment, detailed discussions, and findings, ensuring that each decision is substantiated and transparent.	enhancing Dependability
Skilled moderation	The author, M. A., the research team leader who is most experienced and familiar with both the research objectives and focus group methodology, was selected as the facilitator, while author Y. H. N. assisted him in managing session dynamics and ensuring equitable participation.	mitigating the focus group drawbacks
Participant selection and group size limitation	This study carefully selected six heterogeneous, experienced scholars and practitioners as experts to ensure adequate diversity and quality of interaction, as well as to facilitate group dynamics and moderation control. Furthermore, this selection decision was an integral part of the triangulation strategy.	mitigating the focus group drawbacks
Structuring interviews	This study attempted to structure the focus group sessions by providing meta-synthesis findings from past studies as a starting point, reviewing previous categories of OR measurement, updating them by proposing a new category, and clearly defining the objectives in this phase of the study. In this regard, measures such as sharing a brief summary of the theoretical framework, past and proposed categories, and research objectives a week in advance with participants, as well as reviewing them at the beginning of each round and answering participants' questions, were included.	mitigating the focus group drawbacks

Weighting of factors using the BMW

Through expert FC, the set of factors affecting OR was determined, and then BMW questionnaires were distributed to the 6 experts. After receiving them back and solving the linear model for each of them via Excel software, the obtained answers were averaged to reach the final weight for each factor. We also applied this process for factors with more than two subfactors, assigning subfactor weight accordingly.

For factors with only two subfactors, the point allocation method was used. Sinha et al. (Sinha et al., 2009) refers to this method as one of the direct weighting methods, while Odu (Odu, 2019) categorizes it as a subjective weighting method. It is one of the simple-to-use and appropriate

techniques due to its yielding of a cardinal scale of importance instead of an ordinal one. This method asks the expert to allocate 100 points across the items (in this case, subfactors) under consideration based on relative importance. The total of all item weights should be 100. Next, the weights are normalized from 0 to 1. Table 3 provides the final weights of each factor and subfactor.

Table 3. Weight of each factor and subfactor obtained by BWM

Factor	Weight	Subfactor	Weight	Final subfactor weight
Strategic approach	0.167	Resilience policy	0.51	0.085
		Investment and financing	0.202	0.034
		Management	0.287	0.048
Employees and organizational culture	0.077	Engagement and consistency	0.177	0.014
		Competence and motivation	0.577	0.044
		Individual resilience	0.247	0.019
Redundancy and resources	0.055	Operational redundancy	0.483	0.027
		Resources and reserves	0.517	0.028
Planning and decision making	0.057	Transparency and participation	0.162	0.009
		Smart decision making	0.439	0.025
		Utilizing planning strategies	0.399	0.023
Control and preparation	0.063	Risk and performance management	0.54	0.034
		Monitoring and anticipating	0.361	0.023
		Vulnerability management	0.099	0.006
Modernization discourse	0.12	Utilizing new technologies	0.493	0.059
		Entrepreneurship and creativity	0.339	0.041
		Knowledge management and learning	0.168	0.02
Adaptability	0.216	Locational characteristics	0.124	0.027
		Marketing and sales	0.222	0.048
		Flexibility	0.268	0.058
		Robustness	0.386	0.083
Resilient governance	0.244	Appropriate circumstances preceding the crisis	0.575	0.14
		The ability to respond to a crisis	0.425	0.104

Factors Resilient governance, adaptability, strategic approach, and modernization discourse have the highest weights, respectively, and collectively account for nearly 75% of the total weight. The heterogeneous distribution of weights highlights a significant difference in the importance of each factor. This emphasizes the need to consider these weights for a more accurate measurement and raises the necessity of exploring the interrelationships and hierarchical structure of the factors. Such exploration can lead to a deeper understanding that supports the development of more efficient interventions for boosting resilience.

Given the pairwise comparisons conducted during the best-worst method, it is necessary to calculate the consistency ratio, a number ranging from zero to one, to ensure the reliability of the results. A ratio that approaches 0 signifies a higher level of reliability in the results, and vice versa(Bahrami et al., 2019). The following formula uses the consistency index and the error from the best-worst linear model to derive this ratio:$CR = \frac{\xi^*}{CI}$. Kheybari and Ishizaka (Kheybari &

Ishizaka, 2022) suggest the calculated ratio must be less than or equal to thresholds, which is related to the number of criteria and a_{bw}. The consistency ratio is calculated for main factors along with subfactors (except factors that have less than two subfactors) illustrated in Table 4. All ratios are less than the smallest threshold (0.1581), indicating the reliability of the results obtained.

Table 4. Consistency ratio

	Main Factors	Employees and organizational culture	Strategic approach	Planning and decision making	Control and preparation	Modernization discourse	Adaptability
Consistency Ratio	0.016	0.106	0.03	0.047	0.039	0.023	0.033

Case study validation

The tool developed in the research was prepared in the form of a questionnaire with a 5-point Likert scale and was given to each company during a face-to-face visit. The company's excellence manager completed the questionnaire on behalf of the CEO, as he is familiar with the concept of resilience and responsible for implementing management systems and obtaining international ISO certificates. Given that some of these companies were not listed on the Tehran stock market, the ratios required to calculate the Altman Z score were obtained from the financial manager. The information was entered into Excel software, and the resilience score of each company was calculated (by considering the weight of each factor and sub-factor) as well as the Z score; the companies were ranked based on these two scores separately. The results are shown in Table 5.

Table 5. case study validation result

Company	A	B	C	D	E
Strategic approach	0.276	0.402	0.419	0.305	0.443
Employees and organizational culture	0.173	0.259	0.259	0.238	0.259
Redundancy and resources	0.133	0.173	0.173	0.199	0.173
Planning and decision making	0.069	0.190	0.190	0.206	0.190
Control and preparation	0.113	0.181	0.181	0.204	0.193
Modernization discourse	0.213	0.425	0.425	0.441	0.425
Adaptability	0.605	0.694	0.736	0.517	0.736
Resilient governance	0.663	0.698	0.796	0.67	0.796
OR score	2.245	3.023	3.179	2.78	3.215
OR ranking	5	3	2	4	1
Altman Z score	8.174	8.582	9.493	8.425	10.239
Altman Z score ranking	5	3	2	4	1

The ranking of selected petrochemical companies, as determined by the OR measurement tool developed in this study, aligns with their ranking based on the Altman Z score for predicting

bankruptcy probability. This consistency illustrates that the tool effectively measures OR, demonstrating its validity.

Discussion

Comparing indicators from the structured focus group with initial ones derived from the literature review and meta-synthesis illustrates that experts have revised and introduced new indicators to enhance measurability (e.g., "Diminishing period of financial claims collection"), clarity (e.g., "Decision-making based on expert consensus"), operationality (e.g., "Conducting market research and analyzing customer behavior"), strategic alignment (e.g., focus on scenario planning, operational flexibility, and regular strategy updates), and proactiveness (e.g., "Maintaining/expanding market share by adapting to changing customer consumption patterns"). Integrating static and dynamic views of resilience, these contributions provide organizations with increased agility, operational continuity, and the ability to proactively navigate market disruptions and bend with them rather than becoming fragmented. This part of the research results aligns with the findings of the following recent studies: upgrading, access to financial resources (including loans), cooperation among competitors in crisis response, government support, and regulatory management (satpathy et al., 2025); revenue diversification (Choi, 2025); inventory and liquidity management (Roy et al., 2025); and digital, continuous transformation, stakeholder engagement, financial reserves, and adaptation to environmental changes in volatile, complex, and ambiguous times (VUCA) (Hiney et al., 2025). This alignment reinforces the importance of considering both static (resource base) and dynamic (capability base) dimensions of resilience highlighted by Serfilippi & Ramnath (Serfilippi & Ramnath, 2018), contributing to a greater consensus on how to measure and boost OR.

Furthermore, the inclusion of elements such as multiexpertise participatory decision-making and external knowledge sharing, compliance with legal and environmental requirements, principles of resilience engineering, and risk management uncovers the interdisciplinary characteristic of resilience and complements the umbrella nature highlighted in the literature, facilitating the transformation of the umbrella concept into a coherent construct(Hillmann, 2021). Such policy integration and generation of innovative, contextually related problem solutions bolster OR and lead to sustainability and long-term growth(Renán Teodoro & Bañuls, 2025). Thus, together, these elements create a more practical tool for measuring resilience in complex, dynamic environments.

Finally, this study developed indicators that represent all four strategic responses to crises in a novel way, which embed them throughout the organization so they can be assessed before, during, and after a crisis. Such an approach could maximize resilience due to the complementary nature of these responses (Klyver & Nielsen, 2021; Maggetti & Trein, 2022), as well as ensure that the organization has sufficient time, opportunities, and resources to prepare before a crisis occurs. This enables managers to implement an inclusive response more effectively and with less difficulty, which is valuable and crucial regarding various limitations and ambiguities during crises, as described before in Section 2.2.

Weights for bridging to the real world

BWM findings reveal heterogeneity in the weights of the factors, providing significant insights as follows. "resilient governance" and "adaptability" receive the highest weight, while "redundancy

and resources" and "planning and decision-making" receive the lowest. Such distribution of weights shows that what's ultimately important is the outcome of the actions and efforts. Conducting the factors of direction and execution leads to improving resilience only when it enhances the results set. This highlights a shift from merely relying on surplus resources and redundancy or rigid planning to effectively leveraging these resources through dynamic capabilities, aimed at adapting to ongoing environmental changes and being more prepared for unexpected crises(Z. Ma et al., 2018; Xi et al., 2024).

Furthermore, findings of Brown et al.(Brown et al., 2017) showed that senior managers rated their organization 11% higher than other employees when assessing resilience. This phenomenon has been referred to in the management literature as overestimation, resulting from managers' overconfidence bias that may occur during self-assessment and performance feedback(Meier & O'Toole, 2013; Schumacher et al., 2020). This overestimation can also be due to overlap and redundancy between indicators, as mentioned before. Therefore, this study mitigates these two biases by minimizing redundancy among indicators and assigning greater weight to the results set as well. This modification enhances the accuracy of the measurement, aligning it more closely with the organization's real-world circumstances. It's worth mentioning that modernization discourse received the highest weight among execution set factors, highlighting the necessity of being aligned with the latest technological innovations and changes, such as AI and IoT, aimed at enhancing resilience(Anantrasirichai & Bull, 2022). Viewing modernization as discourse underlines the fact that its scope goes beyond adopting new technologies in production lines to engaging with every function of the organization, from customer service and demand forecasting to hiring, accounting, and strategic decision-making(ElMaraghy et al., 2021). This broader perspective underscores how modernization reshapes not only the tools and processes but also the very ways in which organizations think, operate, and exercise managerial control.

5. Conclusion

Decision-makers and researchers from various perspectives can utilize the findings of this study. First, by reviewing and combing various categories of OR measurement methods outlined in the literature, this study introduced a new classification that facilitates selecting the appropriate method for measuring OR based on different stakeholders' needs regarding organization type, assessment scope and purpose, time and cost constraints, data accessibility, and the crisis phase. This classification could also facilitate researchers scoping their study and identifying research gaps, considering potential stakeholders' requirements. Second, by considering both the static and dynamic dimensions of resilience, incorporating all four strategic responses to the crisis, gathering experiences and insights from a diverse range of experts in FC sessions, and using a meta-synthesis of past studies as the initial feed for these sessions, a comprehensive list of resilience indicators was developed. These indicators facilitate consensus among researchers and practitioners on how to measure OR when using this approach, as well as highlight the interdisciplinary nature of resilience. This issue could serve as a research stream for developing the concept of resilience, particularly within other disciplines such as economics, engineering, private and international law, HSE, and geopolitics. Third, decision-makers can utilize the weight-calibrated tool developed in this study to accurately measure the resilience level of their organizations, identifying strengths and weaknesses more comprehensively, as well as prioritizing areas for improvement.

Additionally, communicating its status according to various new classification criteria has increased the tool's practicality and overall usefulness.

This study aimed to develop a comprehensive measurement tool that covers both static and dynamic dimensions of OR as well as all four strategic responses to crises; it seeks to enhance accuracy by assigning weights to the factors and eliminating redundancy among indicators. However, certain limitations remain. The indicators require continuous updating for several reasons. First, despite the involvement of a diverse group of experts, the findings are still constrained by their perspectives and experiences. Second, resilience is an inherent organizational feature that varies based on the paths taken. Companies learn from past crises and innovate, but each new crisis presents unique challenges, necessitating fresh resources, capabilities, and skills. For instance, the COVID-19 crisis accelerated digital transformation, remote work, and localized supply chains essential for survival. Additionally, there is a lack of defined thresholds for each indicator, which can differ by industry; for instance, the speed of product development in the digital sector differs from that in the chemical industry. Based on the study's findings and limitations, the following avenues for future research are recommended. Future research is strongly recommended to continue to update resilience indicators based on the latest experiences and lessons learned from crises. Additionally, a minimum acceptable threshold for these indicators can be determined for each industry based on its specific characteristics. This makes the measurement tool more useful and illustrative. Collecting indicators and measuring resilience is of limited utility unless it can guide resilience implementation by understanding the interaction between influential factors(Hosseini et al., 2016; T. Ma et al., 2022). Thus, future studies are urged to explore and analyze these mutual relationships quantitatively and qualitatively. A short version of the indicators might be developed when a quick/brief assessment is needed or access to organizational information is limited. The implementation of these resilience factors will likely face limitations and obstacles, making research to identify and overcome them crucial. The research findings can be extended to the meso level (an industry) and macro level (through the value chain of a product or service), contributing to cooperation to cope with crises and market fluctuations. Also, various stakeholders can utilize those findings and insights to assess their associated businesses and play a more active role in enhancing resilience, thereby mitigating potential damages in the short term and gaining sustainable success in the long term.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.