Enablers of post-COVID-19 customer demand resilience: Evidence from fast-fashion MSMEs

Abstract

Purpose: This study aims to analyse the resilience of customer demand management in post-coronavirus disease (COVID) 2019, using fast fashion as an example. The paper provides insights for potential applications to micro, small, and medium enterprises (MSMEs).

Design/methodology/approach: Based on the qualitative analysis and an integrated PDCA-DEMATEL-fuzzy technique for order of preference by similarity to the ideal solution (TOPSIS) methodology of fuzzy multi-criteria decision-making, we explored and prioritised the enablers of resilience management for fast-fashion MSMEs.

Findings: The results reveal that the highest priority enabler is maintaining customer loyalty. Other enablers are associated with e-commerce endorsement, a customer-focused assortment of items, and flexible store operations.

Research/implications: The study findings will enable fast-fashion MSMEs to develop effective actions and priorities in operations efforts to promote post-pandemic recovery.

Originality/value: Despite the importance of the resilience project and the changing fast-fashion customer patterns, only a handful of studies have explored how resilience can be managed in this field. Thus, the findings can contribute to closing this gap in the context of operations resilience research as well as MSME operations.

Keywords: COVID-19, customer demand resilience, fuzzy TOPSIS, fast-fashion MSMEs.

Article classification: Research paper

1. Introduction

Amid the Coronavirus disease 2019 (COVID-19) pandemic, retail operations experienced a challenging period (Fares and Lloret, 2022). Unexpected disruptions led to the shutdown of several factories and businesses, sparking a recession in the commerce and industry sectors (Donthu and Gustafsson, 2020) and a significant bullwhip effect (Zighan,2022). Approximately75% of companies faced disruption in their supply chains within the U.S. (Fernandes, 2020). In China, retail sales and industrial output fell by 20% and 13.5%, respectively (Fernandes, 2020). In addition to the economic aspect, the pandemic had a social impact on several lifestyle features (Abu-Rayash and Dincer, 2020). A study conducted across 30 countries showed that the median gross domestic product (GDP) decreased by 2.8%, and

pandemic costs decreased from 2.5% of the global GDP to 3% for every additional outbreak month (Fernandes, 2020). This impacted brand investments and consumer expenditure (Belhadi *et al.*, 2021; Kumar and Managi, 2020). A recent study exploring the impact of the COVID-19 pandemic on micro, small, and medium enterprises (MSMEs) globally showed that the pandemic has resulted in an economic downturn and bankruptcies (Affandi *et al.,* 2020; Susan, 2020). This has been echoed by Sarmah *et al.* (2021), which highlight how MSMEs contribute significantly to economic development and promote employment generation. Therefore, exploring the COVID-19 challenges faced by MSMEs and the resilience strategies being adopted for survival is essential.

Post-COVID-19 resilience is an important topic for research because of the critical impact of the pandemic on consumer behaviour and purchase patterns (Remko,2020). Therefore, it is necessary to conceptualise operational policies to foster an understanding of customer demand resilience. Furthermore, understanding the volatile COVID-19 environment and customer demand patterns can help MSMEs better manage crises, especially in rapidly changing markets such as fast fashion.

This study focuses on fast-fashion firms because of the market's quick responsiveness (Fares et al., 2018a) and their continuous adaptation during the COVID-19 lockdown when they resorted to intensive online channel sales. This emerged as a new customer expenditure, and demand-altered patterns affected the sales of fast-fashion retail brands such as Zara (Shabir and AlBishri, 2021). Other sectors are beyond the scope of this study, as the operations resilience patterns differ among consumption goods. Based on the associated literature, we assessed the resilience aspects through five axes: elasticity, amplitude, hysteresis, malleability, and damping (Ponomarov and Holcomb,2009).

This study contributes to the previous research on resilience management (Butt, 2021; Jain *et al.*, 2021; Sreenivasan *et al.*, 2022). Recent studies show the importance of resilience during the post-COVID-19 period for supply chain management (Golan *et al.*, 2020; Ivanov, 2020; Ivanov and Dolgui, 2020; Remko, 2020). However, they fail to provide a decision-making system for resilience drivers in line with the five aspects mentioned above. Hence our main research questions (R.Q.s) for this study are:

- What are the enablers of resilience customer demand management for fast-fashion retailers post-COVID-19?

- How are the relative priorities of these drivers determined?

We used a PDCA-DEMATEL-Fuzzy technique for order of preference by similarity to the ideal solution (TOPSIS) method to answer these R.Q.s. Quality management is the link between the three perspectives—the PDCA model, post-COVID-19 fast fashion, and resilience. It has been argued that a quality perspective of organisational resilience is effective in investigating how firms can improve resilience (Madani and Parast, 2021). Furthermore, according to Alibašić (2018), the PDCA enables organisations to measure progress using a sustainability or resilience plan. In the literature, several researchers used PDCA for resilience analysis. For example, Hussain *et al.* (2022) used PDCA to investigate the resilience of disaster relief operations in terms of their responsiveness.

Therefore, this study builds on the resilience PDCA cycle of Madani and Parast(2021) while integrating it with decision-making tools. Among the multiple-criteria decision-making (MCDM) methods, the decision-making trial and evaluation laboratory (DEMATEL) is suitable because it helps assess the impact and influence of the alternatives through comparison by measuring the cause-effect relationships. Hence, we used it for cause-effect analysis between the PDCA elements. However, the input data of assessments have been obtained from experts. Therefore, the judgement of a group may be vague, and thus, to ensure a robust decision system, we combined it with the fuzzy TOPSIS to rank the resilience factors.

Our first contribution is formulating 24 drivers of customer demand resilience for fast-fashion retail MSMEs through experts and the existing body of knowledge in line with the five dimensions of resilience. Our second contribution is using an integrated PDCA FMCD methodology to rank driver priorities. Our findings can help fast-fashion MSMEs retailers to build continuous improvement policies for resilient operations. From a theoretical perspective, we contribute to the integrated models of fuzzy decision-making systems while adding insights into post-pandemic resilience management for fast-fashion retail.

The remainder of the paper is organised as follows. Section 2 presents the theoretical background and literature review, Section3 describes the steps of our research methodology, and Section 4 outlines the case study. The results are presented and discussed in Section 5, while Section 6 discusses the managerial implications and concludes.

2. Theoretical background and literature review

This section draws a connection between the existing context and studies, followed by deeper insights from the relevant literature. We did not use the bibliometric analysis method, as it has a quantitative approach and does not adequately capture authors' context and intention when referring to other works (Vogel and Güttel, 2013). Instead, we adopted a content analysis method by comparing the features of some recent studies with ours.

2.1 Theoretical background

During the COVID-19 pandemic, the global supply and operations network has been facing several challenges, such as questioning global sourcing decisions (Koerber and Schiele, 2022), sustainable partner sourcing risks for collaborated network organisations (Badulescu *et al*., 2022), and startup sourcing risks (Sreenivasan and Suresh, 2022). Due to reduced economic growth, stakeholders are focused more on saving capital than investing (Donthu and Gustafsson, 2020). For MSMEs, this means working on improving operations management processes rather than seeking new openings. As a result, a huge demand-supply gap in goods distribution has been observed (Kumar *et al*., 2020). The situation is even more challenging for fast-fashion retail due to its varied customer profiles (Fares *et al*., 2018b) and supply chain complexities (Fares and Lebbar, 2019). Western countries were around two months behind the outbreak in China before the worldwide spread due to globalisation and trading (Fernandes, 2020). As a result, operations management stakeholders were in a severe

crisis management stage, making strategic financial decisions to catch up. We believe that the pandemic circumstances have influenced different supply chain aspects (Hajiagha *et al.*, 2021), stimulating unprecedented research openings in new operations challenges, especially in resilience management.

2.2 *Resilience management following the COVID-19 pandemic*

Customer demand resilience has been a key success factor following the COVID-19 pandemic. Siagian *et al.* (2021) argued that customer demand satisfaction positively correlates with the firm's ability to quickly cope with sudden customer changes, including volume fluctuation, product variety, and time constraints. Therefore, the authors confirmed that supply chain resilience affects business performance.

In the literature, several studies have recently explored resilience management following the pandemic. Ozdemir *et al.* (2022) investigated how existing solutions helped enhance supply chain resilience in the U.K. perishable goods market. Their findings show that the pandemic outbreak has impacted resilience-building activities. In addition, they found that larger companies have been more efficiently applying supply chain risk management. However, this study provides limited insights regarding consumer's and customers' behaviour.

Kursan Milaković (2021) explored the relevance of consumer resilience and other behaviour features within the purchase experience during the COVID-19 pandemic. The author found that resilience and vulnerability indirectly impact repurchase motivation and directly impact purchase satisfaction. Similarly, Guthrie *et al.* (2021) investigated online consumer resilience during a pandemic by investigating the e-commerce behaviour before, during, and after the COVID-19 lockdown. They found that online consumers participate in both emotion-oriented and problem-oriented coping behaviours. Nevertheless, both studies do not provide insights into fashion consumer behaviours.

With a focus on the textile industry, Appel and Hardaker (2021) found that aiming for a "bounce back" to a pre-crisis state and re-organising existing practices are among the resilience strategies. Nurcahyanie *et al.* (2022) found that for Muslim fashion in Indonesia, features or customer requirements from online product reviews would enable designers to develop fashion products in the post-pandemic new normal. Similarly, Ali *et al.* (2021) found a set of factors to improve resilience capability against vulnerability in readymade garments. However, their study is based on a particular industry in Bangladesh. Despite fashion-oriented inputs, the three studies above fail to develop a fuzzy decision-making system for stakeholders.

2.3 *Research gap*

Table I provides a comparative analysis of some associated studies. It has been observed that there is limited development of fuzzy decision-making systems for customer resilience in the fast-fashion field. The uncertainty of post-pandemic resilience compels the need for the use of fuzzy decision-making systems. It has been argued that a major asset of fuzzy set theory is its capability to represent vague data (Burmaoglu *et al.*, 2012). Therefore, to fill this

literature gap, we built on the current literature on the five resilience aspects (Ponomarov and Holcomb,2009) to formulate the enablers of customer demand resilience for fast-fashion retail MSMEs on a PDCA model based on Madani and Parast (2021). We then ranked the enablers with an integrated FDMC.

[Insert Table I here]

3. Methodology

Figure 1 outlines the methodology used in this study. The PDCA method was first introduced by Walter A. Shewhart and later developed by Deming (Silva *et al*., 2017). The method articulates four steps: plan, do, act and check. It was first used as a quality tool and after that, used as an organisational processes development tool, including for resilience. The PDCA cycle used in our study adapted from Madani and Parast (2021) is shown in Figure 2. We next describe the DEMATEL and Fussy-TOPSIS techniques that are combined with PDCA in the integrated approach of this study.

[Insert Figure 1 here]

[Insert Figure 2 here]

3.1 DEMATEL

Introduced by the Geneva Research Centre of the Battelle Memorial institute in 1971, DEMATEL is the multi-criteria decision-making method that visualises the causal relationships between different variables in the system (Zhao *et al*., 2021). Its calculations steps are described as follows

Step 1: Calculating the average matrix of criteria as the direct-relation n*n matrix, where a_{ij} is the degree to which criterion i affects the criterion j as outlined in Equation (1):

$$A = [a_{ij}]i, j = 1, \ldots, n \tag{1}$$

Step 2: Calculating the normalised relationship matrix D by using Equations (2) and (3). We defined k as $k = \dfrac{1}{\max\limits_{1 \leq i \leq n} \sum_{j=1}^{n} a_{ij}}$ (2)

Then, $D = k*A$ (3)

Step 3: Calculating the influencing matrix T, by using Equation (4), where I is the identity matrix

$$T = [t_{ij}] = D * (I - D)^{-I} (4)$$

Step 4: Calculating causal parameters D and R by using Equations (5) and (6)

$$D = [\sum_{j=1}^{n} t_{ij}]_{n*1} \tag{5}$$

$$R = [\sum_{i=1}^{n} t_{ij}]_{n*1} \tag{6}$$

5

Step 5: Drawing the cause–effect after calculating:

- Prominence (D+R), which reflects the importance of the criterion;
- Relation (D-R); if positive, the factor belongs to the cause group, and if negative, it belongs to the effect group.

For causal mapping, we considered the average of the matrix values as the threshold value.

3.2 Fuzzy TOPSIS

TOPSIS was introduced by Hwang and Yoon (1981) and later extended by Chen (2000) with triangular fuzzy numbers (Nădăban *et al*., 2016). The fuzzy TOPSIS method has been used to identify and prioritise the enablers of the PDCA cycle that can contribute to customer demand resilience management after COVID-19. The choice of this method is justified by the dominant uncertainty post-COVID-19, inducing decision-making uncertainty, necessitating the use of a fuzzy method. It is combined with TOPSIS for ranking (Samaie *et al*., 2020). Fuzzy TOPSIS has been widely used in FMCDM systems (Ertuğrul and Karakaşoğlu, 2008).Recent applications of TOPSIS for COVID-19research include those in Husain *et al*. (2021) for circular economy implementation, Majumder *et al*. (2020) for risk factors for COVID-19 death, Naeem *et al*. (2020) for assessing cures of COVID-19, and Albahri *et al*. (2021) for multi-laboratory characteristics analysis. The steps are outlined as follows.

Step 1: Define the decision-making committee formed by K experts.

Step 2: Identify the PDCA resilience enablers.

Step 3: Get the criteria (PDCA steps) and alternatives (enablers) weighted by the experts with the defined linguistic variables and aggregate the fuzzy weighting.

We consider a problem with n alternatives A and m decision criteria. $i \in (1, ..., n) ; j \in (1, ..., m)$

We nominate the fuzzy weights of the kth decision-maker (expert) as:

$$\tilde{x}_{ijk} = (a_{ijk}, b_{ijk}, c_{ijk}) \tag{7}$$

$$\widetilde{w}_{ijk} = (w_{ijk1}, w_{ijk2}, w_{ijk3}), \tag{8}$$

While$\tilde{x}_{ij}$: aggregate fuzzy weighting of each alternative

$\widetilde{w}_j$: Aggregate fuzzy weighting of each criterion

Then,$\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ $\tag{9}$

Knowing that$a_{ij} = \min_{k}\{a_{ijk}\}$ $\tag{10}$

$b_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ijk}$ $\tag{11}$

$$c_{ij} = \max_k \{c_{ijk}\} \tag{12}$$

Additionally, $\widetilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$ (13)

Knowing that $w_{j1} = \min_k \{w_{jk1}\}$ (14)

$$w_{j2} = \frac{1}{K} \sum_{k=1}^{K} w_{jk2} \tag{15}$$

$$w_{j3} = \max_k \{w_{jk3}\} \tag{16}$$

Then, the decision matrix is defined as $\widetilde{D} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & \cdots & \tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} & \cdots & \tilde{x}_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \cdots & \tilde{x}_{mn} \end{bmatrix}$ (17)

and the weights vector is defined as $\widetilde{W} = [\widetilde{w}_1, \widetilde{w}_2, \dots, \widetilde{w}_n]$ (18)

Step 4: Normalise the decision matrix $\tilde{R} = [\tilde{r}_{ij}]_{mxn}$, (19)

where $\tilde{r}_{ij} = (\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*})$ (20)

and $c_j^* = \max_j c_{ij}$ (21)

As in our case, we consider all criteria as benefit criteria.

The weighted normalised decision matrix is: $\tilde{V} = [\tilde{v}_{ij}]_{mxn}$, (22)

where: $\tilde{v}_{ij} = \tilde{r}_{ij}(.)\widetilde{w}_j.$ (23)

Step 5: Calculate the Fuzzy Positive Ideal Solution (FPIS: A^*) and Fuzzy Negative Ideal Solution (FNIS: A^-)

$A^* = (\tilde{v}_1^*, \tilde{v}_2^*, \dots, \tilde{v}_n^*)$ (24)

$A^- = (\tilde{v}_1^-, \tilde{v}_2^-, \dots, \tilde{v}_n^-),$ (25)

where: $v_j^* = \max_i v_{ij3}.$ (26)

$v_j^- = \min_i v_{ij1}$ (27)

Step 6: Calculate the distances of each alternative from FPIS and FNIS:

$d_i^* = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^*)$ (28)

$d_i^- = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^-),$ (29)

where d_v is the distance measurement between two fuzzy numbers (Ertuğrul and Karakaşoğlu, 2007),

and calculate the closeness coefficient: $CC_i = \frac{d_i^-}{d_i^* + d_i^-}$ (30)

Thus, the ranking of alternatives is found and determined depending on the associated closeness to the ideal solution. The higher the CC_i value, the better the alternative A. The

alternative with the maximum closeness to the ideal solution is the best. We synthesise the equations used for calculations during each step in a flow chart diagram (Figure 3). The equations not cited in this flow chart are used for mathematical definition purposes and not for calculations.

To avoid the complicated aggregation of fuzzy numbers, the normalised weighted ratings are de-fuzzified into crisp values (Chu, 2002) for criteria weight by using the formula by Kim *et al.* (2011) as follows.

$$P(\tilde{X}) = \frac{a_{ijk} + 4\,b_{ijk} + c_{ijk}}{6}, (31)$$

Whereas the distances have been calculated by using Equation (32) between two fuzzy numbers $\tilde{A} = (a_1; a_2; a_3)$ and $\tilde{B} = (b_1; b_2; b_3)$ (Walczak and Rutkowska, 2017):

$$d(\tilde{A};\tilde{B}) = \sqrt{\frac{(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2}{3}} (32)$$

If $\tilde{A}$ and $\tilde{B}$ are real numbers, then the distance measurement is proportional to the Euclidean distance (Chu, 2002).

For our case, we use this formula to calculate the distance between the real numbers (A* and A-) and the fuzzy values of the weighted normalised decision matrix.

[**Insert Figure 3 here**]

4. Fast-fashion MSMEs

This study focuses on fast-fashion MSMEs operating in Morocco. MSMEs represent 73% of jobs in Morocco, and the textile and clothing industry is one of the largest employers, providing more than 200,000 jobs and playing a major role in popularising multinational fashion brands. However, the pandemic has severely impacted the textile value chain, and the sector needs to revise current production practices to stimulate economic recovery while embracing opportunities for rebuilding its supply chains and prioritising innovation.

The data for this study were collected from senior managers working in different fast-fashion retailers' brands in Morocco to address their recommendations for fast-fashion MSMEs. Both qualitative and quantitative data were collected; the qualitative analysis is associated with the enablers' identifications, while the qualitative analysis is linked to their ranking. Table II shows the interviewees' experience in years. They have experience in different retail brands, including international brands. Therefore, we aligned their input with the literature to get managerial insights for MSMEs. Most of these experts work in the fast-

fashion retailers' operations departments, and some are from the sales and textile departments. The interviewed positions are as follows:

- Store managers

- Textile buyers

- Hypermarket directors

- Section manager

- Retail manager

- Textile department head

First, we identified the main criteria of enablers and the resilience aspects in the literature. Then, to manage customer demand resilience post-pandemic, we aligned the five phases of the PDCA model to the five aspects of resilience. Finally, we adapted the components of resilience to customer demand management. We restricted this study to only matching each PDCA step and resilience aspects. Hence, we formulated the experts' open questions (Table III), listed in a structured interview and surveys. The qualitative data questions are outlined in Questionnaire 1 (Appendix 1), while the quantitative ones are in Questionnaire 2 (Appendix 2).

[**Insert Tables II and III here**]

5. Results and discussions

First, outlining the study results, we describe the enablers identified. Second, we present the ranking of PDCA enablers found with DEMATEL. Third, we depict the ranking of resilience enablers using fuzzy TOPSIS. Each result is supported and validated with relevant literature. Finally, we test the results' robustness with sensitivity analysis.

5.1 Resilience enablers

With the support of the literature and experts' opinions, we formalised the enablers presented in Table IV. A total of 24 enablers were identified. These enablers were not comprehensive, as we did not examine them in general but only for the post-COVID-19 period. The supporting literature provided arguments about consumer behaviours and perceptions to validate the formalised enablers.

[**Insert Table IV here**]

5.2 Ranking of PDCA steps

The DEMATEL results are listed in Table V and presented in Figures 3 and 4. The calculation results of prominence levels and cause-effect using Equations (4), (5), and (6) are shown in Table V. In Figure 4; we visualise the causal distribution of the PDCA steps. Thereafter, in Figure 5, we demonstrate the cause-effect relationship diagram according to the influencing PDCA enablers captured. The P2, C, and A steps are classified as cause phases and the P1and D as effect phases for post-COVID-19 resilience. Steps are ranked based on the prominence $D_i + R_i$ (global) score as follows: A is ranked as the most prioritised, followed by P2, D, P1, and C.

[Insert Table V here]

[Insert Figures 4 and 5 here]

The P1 step is ranked fourth, or the fourth-highest priority for managing the post-pandemic period, with a Di+Ri score value of 6,664. Studying resilience during the early COVID-19 period, Rosenberg (2020) classified resilience resources into three elements: individual, community, and existential. Marshall et al. (2021) supported the first two points. They highlighted the need for quick decisions in practice, such as relieving the panic of employees who are losing their jobs following the economic crisis. The third point emphasises, in addition to social support, the post-pandemic impact at individual and organisational levels. This includes collecting holistic and reliable data (Trump and Linkov, 2020) and enabling decision-makers to perform efficient analyses and draw conclusions on resilience policies.

The P2 step of resilience is ranked second, with a Di+Ri score value of 7,128, while C is ranked 5th with a Di+Ri value of 6,311. A step is ranked 1stwith a Di+Ri score value of 7,727. Crisis periods such as the COVID-19 pandemic are uncertain, and their impact patterns can vary. Therefore, the design of operational systems for resilience is crucial. This supports the statements of Linkov *et al.* (2021), enhancing the importance of resilience through design strategies, such as endorsing modular system engineering and ecosystem diversity. Such diversity strengthens the pillars of the global market network, with partners serving as backups in case of flow disruptions with other partners. For instance, in New Zealand, Fath *et al.* (2021) revealed that SME exporters with strong international-market operating relationships maintained their resilience during the pandemic. Gölgeci *et al.* (2020) also elucidated the maintenance of global value chain resilience, arguing that social and relational capital can maintain tacit knowledge and contribute to a socially cohesive global value chain network.

The D step is ranked third, prioritised with a Di+Ri score value of 6,704. The new normal post the pandemic was leveraged by reviving the economy and jumpstarting industrial sectors (Berawi,2020). This transition triggered the implementation of operational adaptations led by market changes. The change in customer demand motivated researchers to develop methods to measure supply chain resilience. Moosavi and Hosseini (2021) developed a simulation-based method by prepositioning backup suppliers and extra inventory. Their study recommends policies, such as securing back stock for essential products and setting backup suppliers for less important items. Such policies may foster the implementation of resilience in the post-pandemic period.

5.3 Ranking of enablers

After identifying the PDCA resilience enablers, fuzzy TOPSIS was used for ranking. The decision committee's involvement defined the importance of the criteria (the PDCA steps) and alternatives (or enablers). This ranking was performed using the linguistic variables and triangular fuzzy numbers shown in Table VI. After each expert weighed the criteria and alternatives, we formalised the decision matrix defined in Equation (11) and normalised it using Equations (14) and (15).

[Insert Table VI here]

We present the results of the decision matrix in Table VII. For the weight of non-cross functional factors, for instance, P1.1–P1.6, according to non-requirement criteria, we consider the lowest value of the scale as weight (1;1;3); it is the same for the remaining enablers. After obtaining the fuzzy positive and negative ideal solutions, we calculate the distance (d*) of each alternative from FPIS (A*) using Equation (22). Thereafter, the closeness of the 24 enablers (or alternatives) is calculated using Equation (24), as indicated in Table VIII. Once the closeness coefficients are obtained, the next step is to rank these coefficients to obtain the prioritised ranking of the enablers. The results of this ranking are shown in Figure 6.

[Insert Tables VII and VIII, and Figure6]

The investigation of enabler rankings reveals the prioritisation of actions to be taken by fast-fashion MSMEs. Thus, we discuss and validate relevant findings in the literature. The P2.4 enabler is ranked as the most significant enabler for resilience post-COVID-19. It is aligned with the purchase of only basic products, as consumer purchasing power has been impacted due to the economic crisis caused by the pandemic. This conforms to previous findings that, under certain conditions, e-payments can provide a lower selling price than cash payments (Roggeveen and Sethuraman, 2020; Xu *et al.,* 2020). Fast-fashion MSMEs are advised to reduce the assortment of accessories (e.g. bags, belts, etc.) for men and women, as customers will be more rational in their purchases and tend to buy only necessary clothing. It is also advised that easy payment facilities be provided in physical stores, such as payment in instalments, for shopping convenience during this recovery period. This crisis period should be leveraged to create a positive impact on the brand's image and increase customer loyalty.

The second-most important enabler is A2, associated with customer loyalty. In accordance with the literature, Mason *et al.* (2020) found that customer satisfaction levels decreased during the pandemic. Hence, fast-fashion MSMEs are advised to manage customer loyalty resilience by adopting a suitable assortment of items for different customer groups (such as for men, women, and children), per the circumstances of each group, under the new normal. For instance, as men are more responsible for their families, they sacrifice their own purchases to prioritise those of their kids. Therefore, fast-fashion MSMEs could reduce the stocking of men's products in quantity and range. In addition, as most schools adopt hybrid or distance learning modes, fast-fashion MSMEs could reduce back-to-school products, depending on the school education status of the relevant city or country.

The third most important enabler is D2, associated with assortment decisions. The phenomenon of impulse buying developed during the pandemic (Thakur *et al*., 2020). Furthermore, consumers have been making mobile purchases during the pandemic, which stimulates emotional change that boosts impulsive buying (Zhang *et al*., 2020). Pantano *et al*. (2020) emphasise that customers can substitute their regular retailers with competitors that provide a better assortment during the emergency period. To maintain a balance between impulse purchases and economic crises, fast-fashion MSMEs are advised to deliver more mid-season products. These items could be used in autumn-winter and spring-summer periods, providing more profitability and use than only winter or summer clothing items do.

The fourth-ranked enabler is C3, related to local market analysis for effective forecasting. Enhancing the importance of product pricing and market analysis is crucial. This supports the findings of Eger *et al*. (2021) that during the pandemic, consumers' retail brand choice was determined based on convenience of purchase, quality, and availability. Zhang *et al*. (2020) underlined that cost and trust are among the factors that stimulate purchase intentions during a pandemic. For instance, kids' product sets that include multiple clothing items as one outfit that can be worn in various combinations are not advised during this period, as consumers are more selective in their purchase of only the items that they need.

The fifth-ranked enabler is P1.1, corresponding to online marketing. Sheth (2020) emphasised that the lockdown and pandemic period will generate new purchasing habits oriented toward information technology channels; hence, fast-fashion MSMEs are advised to enhance e-commerce platforms.

The sixth-ranked enabler is P1.6, related to P2.4 about purchasing basic products, followed by D3, ranked seventh, related to developing materials unfavourable to the virus. These findings are supported in the literature, which says that store hygiene is one of the biggest challenges caused by COVID-19 (Kohli *et al*., 2020). In addition to store hygiene, fast-fashion MSMEs are advised to focus on newborn clothing items in hazardous-chemical-free fibres and colours, as consumer childcare health awareness has increased during the pandemic and is more demanding than before.

The eighth-ranked enabler is A3, or maintaining the new normal. This corresponds to extant studies (Pantano *et al*., 2020; Tarki *et al*., 2020) that emphasise maintaining and attracting new customers during the COVID-19 crisis period as being more complex than regular times. Fast-fashion MSMEs are advised to reinforce their assortment with long-lasting products, such as denim for men and women. In addition, as social events are restricted by social distancing, they should minimise party wear and special events clothing in favour of a more casual range.

The remaining enablers are also important and must be managed efficiently. Most of them are associated with product implementation, sales staff flexibility, and customer-focused actions. As consumers have developed new habits (Sheth, 2020), fast-fashion MSMEs should involve all operations teams to pursue customer behaviour changes. Finally, as all sectors faced pandemic challenges, this study's findings would benefit other sectors. Replicability can be achieved in different sectors, as researchers may use the same methodology to answer the R.Q.s in other application fields. However, the applicability in other contexts is not certain as it was not tested.

5.4 Sensitivity analysis

To test the validity of the results, we performed a sensitivity analysis. FMCDM inputs were changed to observe output variations by changing the weights in the weighted decision matrix and checking the enabler ranking changes. The ranking of each experiment is outlined in Table IX. For case 1, P1.1, P2.4, A2, D2, C3, P1.4, P1.2, and P2.1 ranks change. For case 2, P1.1, P2.4, A2, D2, C3, A3 and D3 ranks change. For case 3, P1.1, P2.4, A2, D2 and C3 ranks change. We observe that P1.1, P2.4, A2, D2 and C3 are sensitive to variation, as they

change the rank for each experiment done. This means that the factors associated with enhancing digital marketing and the operational aspects associated with assortment choices, local market forecast, and customer loyalty are highly influenced by the prioritisation of P1, D, and A factors.

[Insert Table IX here]

6. Conclusions and implications

Following COVID-19-induced consumer panic-buying (Islam *et al.*, 2021), adaptation to market changes has become crucial for retailers. Suppliers and retailers should be in line with new consumers' needs and implement customer-focused changes (Eger *et al.*, 2021). According to the first research question, this study identifies 24 enablers of resilience in line with the PDCA resilience cycle. Regarding the second research question, we found that P2, C and A steps are cause factors, while P1 and D are effect factors.

To answer the third research question, a fuzzy TOPSIS approach was used to prioritise the post-COVID-19 resilience enablers in fast-fashion MSMEs. The findings reveal that maintaining customer loyalty is the top prioritised enabler for customer demand resilience management. In addition, most enablers deal with strong e-commerce, suitable assortments, and pricing offers in the new normal.

6.1 Practical implications

Our study has several practical implications. The findings support fast-fashion MSMEs with ways to manage post-pandemic customer demand resilience, which is crucial in the current operations environment. The study also adds to our knowledge of the various enablers for customer demand management, whose prioritisation would help fast-fashion stakeholders to take effective action plans to address changing consumer behaviours. Resilience management should be designed considering consumer demand.

Specifically, fast-fashion retailers are recommended to adapt their assortments to meet the new normal. Remote work has impacted purchasing decisions, as we seek more casual and less formal products. In addition, the economic situation has impacted purchasing power; hence, customers are more rational in shopping decisions and are more likely to purchase basic products. This flexibility in managing fast-fashion retail today requires processing enablers from design to maintenance to ensure a consistent customer loyalty level.

6.2 Theoretical implications

The study has several theoretical implications. By elucidating the PDCA cycle resilience approach in customer demand resilience, researchers can be stimulated to investigate more continuous improvement approaches for resilience management. This study contributes to the literature on the FMCDM continuous improvement applications. Our findings extend those of previous studies, such as Butt (2021), who discussed resilience in the retail supply chain and lessons learned from COVID-19. Researchers who seek causal relationships analysis can build on our DEMATEL analysis results to examine the influence metrics deeply.

6.3 Limitations and future scope

This study has some limitations. As stated in Section 4.1, it is restricted to one PDCA resilience matching. Future research can investigate other enablers with another matching, such as the planning of resilience aspects: amplitude, malleability, and damping. Second, the experts in this study are Moroccan; hence, the findings cannot be generalised, as the perspective of MSMEs in other countries may differ. Third, future research could also replicate the analysis for other countries. Fourth, we considered only 12 experts; future researchers can consult more experts and analyse the potential variations in their opinions. Finally, a promising future research area can investigate other FMCDM methods and compare the relevant findings.

References

Abu-Rayash, A. and Dincer, I. (2020), "Analysis of the electricity demand trends amidst the COVID-19 coronavirus pandemic", *Energy Research and Social Science*, Vol. 68, p. 101682. DOI: 10.1016/j.erss.2020.101682.

Affandi, A., Sarwani, A.S., Erlangga, H., Siagian, A.O., Purwanto, A., Effendy, A.A., and Juhaeri, G. (2020), "Optimisation of MSMEs empowerment in facing competition in the global market during the COVID-19 pandemic time", *Systematic Reviews in Pharmacy*, Vol. 11 No. 11, pp. 1506–1515.

Ahmed, R.R., Streimikiene, D., Rolle, J.A., and Duc, P.A. (2020), "The COVID-19 pandemic and the antecedents for the impulse buying behavior of U.S. citizens", *Journal of Competitiveness*, Vol. 12 No. 3, pp. 5–27. DOI: 10.7441/joc.2020.03.01.

Albahri, A.S., Hamid, R.A., Albahri, O.S., and Zaidan, A.A. (2021), "Detection-based prioritisation: framework of multi-laboratory characteristics for asymptomatic COVID-19 carriers based on integrated entropy–TOPSIS methods", *Artificial Intelligence in Medicine,* Vol. 111, p. 101983. DOI: 10.1016/j.artmed.2020.101983.

Alexa, L., Apetrei, A., and Sapena, J. (2021), "The COVID-19 lockdown effect on the intention to purchase sustainable brands", *Sustainability*, Vol. 13 No. 6, p. 3241. DOI: 10.3390/su13063241.

Ali, M., Rahman, S.M., and Frederico, G.F. (2021), "Capability components of supply chain resilience for readymade garments (RMG) sector in Bangladesh during COVID-19", *Modern Supply Chain Research and Applications*, Vol. 3 No. 2, pp. 127–144. DOI: 10.1108/MSCRA-06-2020-0015.

Alibašić, H. (2018), "Mapping out the sustainability and resilience process for organisations and communities", *Sustainable Development Goals Series*, Springer, Cham, pp. 17–32. DOI: 10.1007/978-3-319-72568-0_2.

Appel, A. and Hardaker, S. (2021), "Strategies in times of pandemic crisis—retailers and regional resilience in Würzburg, Germany", *Sustainability*, Vol. 13No. 5, p. 2643.DOI: 10.3390/su13052643.

Arora, N., Charm, T., Grimmelt, A., Ortega, M., Robinson, K., Sexauer, C., and Yamakawa, N. (2020), "A global view of how consumer behavior is changing amid COVID-19", Available at: https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/Marketing%20and%20Sales/Our%20Insights/A%20global%20view%20of%20how%20consumer%20behavior%20is%20changing%20amid%20COVID%2019/20200707/covid-19-global-consumer-sentiment-20200707.pdf(Accessed 29 September 2021), McKinsey and Company.

Badulescu, Y., Hameri, A.-P., and Cheikhrouhou, N. (2022), "Sustainable partner selection for collaborative networked organisations with risk consideration in the context of COVID-19", *Journal of Global Operations and Strategic Sourcing*, Vol. 15 No. 2, 197–218. DOI: 10.1108/JGOSS-11-2020-0069.

Beesoon, S., Behary, N., and Perwuelz, A. (2020), "Universal masking during COVID-19 pandemic: can textile engineering help public health? Narrative review of the evidence", *Preventive Medicine*, Vol. 139, p. 106236. DOI: 10.1016/j.ypmed.2020.106236.

Belhadi, A., Kamble, S., Jabbour, C.J.C., Gunasekaran, A., Ndubisi, N.O., and Venkatesh, M. (2021), "Manufacturing and service supply chain resilience to the COVID-19 outbreak: lessons learned from the automobile and airline industries", *Technological Forecasting and Social Change,* Vol. 163, p. 120447. DOI: 10.1016/j.techfore.2020.120447.

Belling, S. (2020), *Succeeding with Agile Hybrids*, Springer.

Berawi, M.A. (2020), "Empowering healthcare, economic, and social resilience during global pandemic COVID-19", *International Journal of Technology,* Vol. 11 No. 3, pp. 436–439. DOI: 10.14716/ijtech.v11i3.4200.

Blay, K.B. (2017), "Resilience in projects: definition, dimensions, antecedents and consequences", Doctoral dissertation, Loughborough University.

Burmaoglu, S. and Kazancoglu, Y. (2012), "E-government website evaluation with hybrid MCDM method in fuzzy environment", *International Journal of Applied Decision Sciences*, Vol. 5 No.2, pp. 163–181. DOI: 10.1504/IJADS.2012.046504.

Butt, A.S. (2021), "Building resilience in retail supply chains: lessons learned from COVID-19 and future pathways", *Benchmarking: an International Journal*, Vol. ahead-of-print No. ahead-of-print. DOI: 10.1108/BIJ-09-2021-0514.

Chen, C.T. (2000), "Extensions of the TOPSIS for group decision-making under fuzzy environment", *Fuzzy Sets and Systems*, Vol. 114 No. 1, pp. 1–9. DOI: 10.1016/S0165-0114(97)00377-1.

Chen, Y., Xiong, H., and Chen, Y. (2021), "Should traditional retailers function as pre-warehouses of online retailers?", *International Journal of Production Research,* Vol. 59 No. 5*,* pp. 1476–1495. DOI: 10.1080/00207543.2020.1825864.

Chu, T.-C. (2002), "Selecting plant location via a fuzzy TOPSIS approach", *The International Journal of Advanced Manufacturing Technology*, Vol. 20 No. 11, pp. 859–864. DOI: 10.1007/s001700200227.

Clapham, W.B. (1971), *Natural Ecosystems*, MacMillan, New York, NY.

Donthu, N.and Gustafsson, A. (2020), "Effects of COVID-19 on business and research", *Journal of Business Research*, Vol. 117, pp. 284–289. DOI: 10.1016/j.jbusres.2020.06.008.

Dovers, S.R. and Handmer, J.W. (1992), "Uncertainty, sustainability and change", *Global Environmental Change*, Vol. 2 No. 4, pp. 262–276. DOI: 10.1016/0959-3780(92)90044-8.

Eger, L., Komárková, L., Egerová, D., and Mičík, M. (2021), "The effect of COVID-19 on consumer shopping behaviour: generational cohort perspective", *Journal of Retailing and Consumer Services*, Vol. 61, p. 102542. DOI: 10.1016/j.jretconser.2021.102542.

Ertuğrul, Í. and Karakaşoğlu, N. (2007), "Fuzzy TOPSIS method for academic member selection in engineering faculty", *Innovations in E-learning, Instruction Technology, Assessment, and Engineering Education*, Springer, Dordrecht, pp. 151–156.

Ertuğrul, İ. and Karakaşoğlu, N. (2008), "Comparison of fuzzy AHP and fuzzy TOPSIS methods for facility location selection", *International Journal of Advanced Manufacturing Technology,* Vol. 39 No. 7–8, pp. 783–795. DOI: 10.1007/s00170-007-1249-8.

Fares, N. and Lebbar, M. (2019), "Optimisation of fast fashion retail supply chain processes: overall literature review and future research challenges", *International Journal of Engineering Research in Africa*, Vol. 45, pp. 205–220. DOI: 10.4028/www.scientific.net/JERA.45.205.

Fares, N., Lebbar, M., and Sbihi, N. (2018a, April), "Quick response in fast fashion retail: an optimisation supply chain responsiveness model", Vol. 2018 4th International Conference on Optimisation and Applications (ICOA), IEEE Publications, pp. 1–5.

Fares, N., Lebbar, M., and Sbihi, N. (2018b, July), *A CustomerProfiling*' machine learning approach, for in-store sales in fast fashion" International Conference on Advanced Intelligent Systems for Sustainable Development, Springer, Cham, pp. 586–591.

Fares, N. and Lloret, J. (2022), "An integrated SWOT-AHP-fuzzy TOPSIS approach for maturity management following the COVID-19 outbreak: lessons learned from fast fashion", *Journal of Global Operations and Strategic Sourcing*, Vol. ahead-of-print No. ahead-of-print. DOI: 10.1108/JGOSS-09-2021-0072.

Fath, B., Fiedler, A., Sinkovics, N., Sinkovics, R.R., and Sullivan-Taylor, B. (2021), "International relationships and resilience of New Zealand SME exporters during COVID-19", *Critical Perspectives on International Business,* Vol. 17 No. 2, pp. 359–379. DOI: 10.1108/cpoib-05-2020-0061.

Fernandes, N. (2020), "Economic effects of coronavirus outbreak (COVID-19) on the world economy", *SSRN Electronic Journal*. DOI: 10.2139/ssrn.3557504.

Golan, M.S., Jernegan, L.H., and Linkov, I. (2020), "Trends and applications of resilience analytics in supply chain modeling: systematic literature review in the context of the COVID-19 pandemic", *Environment Systems and Decisions*, Vol. 40 No. 2, pp. 222–243. DOI: 10.1007/s10669-020-09777-w.

Gölgeci, I., Yildiz, H.E., and Andersson, U.R. (2020), "The rising tensions between efficiency and resilience in global value chains in the post-COVID-19 world", *Transnational Corporations*, Vol. 27 No. 2, pp. 127–141. DOI: 10.18356/99b1410f-en.

Guthrie, C., Fosso-Wamba, S., and Arnaud, J.B. (2021), "Online consumer resilience during a pandemic: an exploratory study of e-commerce behavior before, during and after a COVID-19 lockdown", *Journal of Retailing and Consumer Services*, Vol. 61, p. 102570. DOI: 10.1016/j.jretconser.2021.102570.

Hashem, T.N. (2020), "Examining the influence of COVID-19 pandemic in changing customers' orientation towards e-shopping", *Modern Applied Science*, Vol. 14 No. 8, pp. 59–76. DOI: 10.5539/mas. v14n8p59.

Hollenbeck, J.R., DeRue, D.S., and Guzzo, R. (2004), " 'Bridging the gap between I/O research and H.R. practice: improving team composition, team training, and team task design': published in Cooperation with the School of Business Administration, The University of Michigan and in alliance with the Society of Human Resources Management", *Human Resource Management*, Vol. 43 No. 4, pp. 353–366. DOI: 10.1002/hrm.20029.

Husain, Z., Maqbool, A., Haleem, A., Pathak, R.D., and Samson, D. (2021), "Analysing the business models for circular economy implementation: a fuzzy TOPSIS approach", *Operations Management Research*, Vol. 14 No. 3–4, pp. 256–271. DOI: 10.1007/s12063-021-00197-w.

Hussain, A., Masood, T., Munir, H., Habib, M.S., and Farooq, M.U. (2022), "Developing resilience in disaster relief operations management through lean transformation", *Production Planning and Control*, pp. 1–22. DOI: 10.1080/09537287.2022.2026671.

Hwang, C.-L. and Yoon, K. (1981), *Multiple Attribute Decision Making – Methods and Applications: A State-of-the-Art Survey*, SpringerVerlag, Berlin and Heidelberg.

Islam, T., Pitafi, A.H., Arya, V., Wang, Y., Akhtar, N., Mubarik, S., and Xiaobei, L. (2021), "Panic buying in the COVID-19 pandemic: a multi-country examination", *Journal of Retailing and Consumer Services*, Vol. 59, p. 102357. DOI: 10.1016/j.jretconser.2020.102357.

Ivanov, D. (2020), "Viable supply chain model: integrating agility, resilience and sustainability perspectives-lessons from and thinking beyond the COVID-19 pandemic", *Annals of Operations Research,* pp. 1–21. DOI: 10.1007/s10479-020-03640-6.

Ivanov, D. and Dolgui, A. (2020), "Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability.A position paper motivated by COVID-19 outbreak", *International Journal of Production Research*, Vol. 58 No. 10, pp. 2904–2915. DOI: 10.1080/00207543.2020.1750727.

Jain, A., Shanker, S., and Barve, A. (2021), " 'Resilience against the COVID-19 pandemic: is the hotel and tourism supply chain on the right path?", *Benchmarking: an International Journal,* Vol. ahead-of-print No. ahead-of-print. DOI: 10.1108/BIJ-05-2021-0249.

Joung, H.M. (2014), "Fast-fashion consumers' post-purchase behaviours", *International Journal of Retail and Distribution Management*, Vol. 42 No. 8, pp. 688–697. DOI: 10.1108/IJRDM-03-2013-0055.

Jüttner, U., Christopher, M., and Baker, S. (2007), "Demand chain management-integrating marketing and supply chain management", *Industrial Marketing Management*, Vol. 36 No. 3, pp. 377–392. DOI: 10.1016/j.indmarman.2005.10.003.

Kim, S., Lee, K., Cho, J.K., and Kim, C.O. (2011), "Agent-based diffusion model for an automobile market with fuzzy TOPSIS-based product adoption process", *Expert Systems with Applications*, Vol. 38 No. 6, pp. 7270–7276. DOI: 10.1016/j.eswa.2010.12.024.

Koçak, O., Koçak, Ö.E., and Younis, M.Z. (2021), "The psychological consequences of Covid-19 fear and the moderator effects of individuals' underlying illness and witnessing infected friends and family", *International Journal of Environmental Research and Public Health*, Vol. 18 No. 4, p. 1836. DOI: 10.3390/ijerph18041836.

Koerber, T. and Schiele, H. (2022), "Is COVID-19 a turning point in stopping global sourcing? Differentiating between declining continental and increasing transcontinental sourcing", *Journal of Global Operations and Strategic Sourcing*, Vol. 15 No. 2, pp. 219–234. DOI: 10.1108/JGOSS-02-2021-0018.

Kohli, S., Timelin, B., Fabius, V., and Veranen, S.M. (2020), "How COVID-19 is changing consumer behavior–now and forever", Available at: https://www.mckinsey.com/industries/retail/our-insights/how-covid-19-is-changing-consumer-behavior-now-and-forever(Accessed 29 September 2021).

Kumar, A., Luthra, S., Mangla, S.K., and Kazançoğlu, Y. (2020), "COVID-19 impact on sustainable production and operations management", *Sustainable Operations and Computers*, Vol. 1, pp. 1–7. DOI: 10.1016/j.susoc.2020.06.001.

Kumar, S. and Managi, S. (2020), "Does stringency of lockdown affect air quality? Evidence from Indian cities", *Economics of Disasters and Climate Change*, Vol. 4 No. 3, pp. 481–502. DOI: 10.1007/s41885-020-00072-1.

Kursan Milaković, I. (2021), "Purchase experience during the COVID-19 pandemic and social cognitive theory: the relevance of consumer vulnerability, resilience, and adaptability for purchase satisfaction and repurchase", *International Journal of ConsumerStudies*, Vol. 45 No. 6, pp. 1425–1442. DOI: 10.1111/ijcs.12672.

Lee, S.M. and Trimi, S. (2021), "Convergence innovation in the digital age and in the Covid-19 pandemic crisis", *Journal of Business Research,* Vol. 123, pp. 14–22. DOI: 10.1016/j.jbusres.2020.09.041.

Linkov, I., Trump, B.D., Golan, M., and Keisler, J.M. (2021), "Enhancing resilience in post-COVID societies: by design or by intervention?", *Environmental Science and Technology,* Vol. 55 No. 8, pp. 4202–4204. DOI: 10.1021/acs.est.1c00444.

Lloret, J., Garcia-Sabater, J.P., and Marin-Garcia, J.A. (2009, September), "'Cooperative supply chain rescheduling: the case of an engine supply chain', in"*, Lecture Notes in Computer ScienceInternational Conference on Cooperative Design,* Springer, Berlin, Heidelberg, pp. 376–383. DOI: 10.1007/978-3-642-04265-2_57.

Madani, F. and Parast, M.M. (2021), "An integrated approach to organisational resilience: a quality perspective", *International Journal of Quality and Reliability Management*, Vol. ahead-of-print No. ahead-of-print.DOI:10.1108/IJQRM-07-2020-0229.

Majumder, P., Biswas, P., and Majumder, S. (2020), "Application of new TOPSIS approach to identify the most significant risk factor and continuous monitoring of death of COVID-19", *Electronic Journal of General Medicine*, Vol. 17 No. 6. DOI: 10.29333/ejgm/7904.

Marshall, F., Gordon, A., Gladman, J.R.F., and Bishop, S. (2021), "Care homes, their communities, and resilience in the face of the COVID-19 pandemic: interim findings from a qualitative study", *BMC Geriatrics*, Vol. 21 No. 1, p. 102. DOI: 10.1186/s12877-021-02053-9.

Mason, A., Narcum, J., and Mason, K. (2020), "Changes in consumer decision-making resulting from the COVID-19 pandemic", *Journal of Customer Behaviour*, Vol. 19 No. 4, pp. 299–321. DOI: 10.1362/147539220X16003502334181.

Masten, A.S. and Motti-Stefanidi, F. (2020),"Multisystem resilience for children and youth in disaster: reflections in the context of COVID-19", *Adversity and Resilience Science*, Vol. 1 No.2, pp. 95–106. DOI: 10.1007/s42844-020-00010-w.

Moosavi, J.and Hosseini, S. (2021), "Simulation-based assessment of supply chain resilience with consideration of recovery strategies in the COVID-19 pandemic context", *Computers and Industrial Engineering*, Vol. 160, p. 107593. DOI: 10.1016/j.cie.2021.107593.

Nădăban, S., Dzitac, S., and Dzitac, I. (2016), "Fuzzy TOPSIS: a general view", *Procedia Computer Science*, Vol. 91, pp. 823–831. DOI: 10.1016/j.procs.2016.07.088.

Naderpajouh, N., Matinheikki, J., Keeys, L.A., Aldrich, D.P., and Linkov, I. (2020), "Resilience and projects: an interdisciplinary crossroad", *Project Leadership and Society*, Vol. 1, p. 100001. DOI: 10.1016/j.plas.2020.100001.

Naeem, K., Riaz, M., Peng, X., and Afzal, D. (2020), "Pythagorean m-polar fuzzy topology with TOPSIS approach in exploring most effectual method for curing from COVID-19", *International Journal of Biomathematics,* Vol. 13 No. 8, p. 2050075. DOI: 10.1142/S1793524520500758.

Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., and Gwilt, A. (2020), "The environmental price of fast fashion", *Nature Reviews Earth and Environment,* Vol. 1 No. 4, pp. 189–200. DOI: 10.1038/s43017-020-0039-9.

Nurcahyanie, Y.D., Singgih, M.L., and Dewi, D.S. (2022), "Implementing online product reviews and Muslim fashion innovation for resilience during the new normal in Indonesia", *Sustainability*, Vol. 14No. 4, p. 2073. DOI: 10.3390/su14042073.

Ozdemir, D., Sharma, M., Dhir, A., and Daim, T. (2022), "Supply chain resilience during COVID 19 pandemic", *Technology in Society*, Vol. 68, 101847. DOI: 10.1016/j.techsoc.2021.101847.

Pantano, E., Pizzi, G., Scarpi, D., and Dennis, C. (2020), "Competing during a pandemic? Retailers' ups and downs during the COVID-19 outbreak", *Journal of Business Research*, Vol. 116, pp. 209–213. DOI: 10.1016/j.jbusres.2020.05.036.

Ponomarov, S.Y. and Holcomb, M.C. (2009), "Understanding the concept of supply chain resilience", *The International Journal of Logistics Management,* Vol. 20 No. 1, pp. 124–143. DOI: 10.1108/09574090910954873.

Raj, A., Mukherjee, A.A., de Sousa Jabbour, A.B.L., and Srivastava, S.K. (2022), "Supply chain management during and post-COVID-19 pandemic: mitigation strategies and practical lessons learned", *Journal of Business Research*, Vol. 142, pp. 1125–1139. DOI: 10.1016/j.jbusres.2022.01.037.

Remko, vH. (2020), "Research opportunities for a more resilient post-Covid-19 supply chain – closing the gap between research findings and industry practice", *International Journal of Operations and Production Management*, Vol. 40 No. 4, pp. 341–355. DOI: 10.1108/IJOPM-03-2020-0165.

Roggeveen, A.L. and Sethuraman, R. (2020), "How the COVID-19 pandemic may change the world of retailing", *Journal of Retailing,* Vol. 96 No. 2, pp. 169–171. DOI: 10.1016/j.jretai.2020.04.002.

Rosenberg, A.R. (2020), "Cultivating deliberate resilience during the coronavirus disease 2019 pandemic", *JAMA Pediatrics*, Vol. 174 No. 9, pp. 817–818. DOI: 10.1001/jamapediatrics.2020.1436.

Royce, W.W. (1987, March), "Managing the development of large software systems: concepts and techniques", Proceedings of the 9th International Conference on Software Engineering, pp. 328–338.

Samaie, F., Meyar-Naimi, H., Javadi, S., and Feshki-Farahani, H. (2020), "Comparison of sustainability models in development of electric vehicles in Tehran using fuzzy TOPSIS method", *Sustainable Cities and Society*, Vol. 53, p. 101912. DOI: 10.1016/j.scs.2019.101912.

Sanyala, S. and Hisamb, M.W. (2019, November), "Factors affecting customer satisfaction with e-commerce websites: an Omani perspective", *The 2019 International Conference on Digitization (ICD)", IEEE Publications,* pp. 232–236.

Sarmah, A., Saikia, B., and Tripathi, D. (2021), "Can unemployment be answered by Micro Small and Medium Enterprises? Evidences from Assam", *Indian Growth and Development Review*, Vol. 14 No. 2, pp. 199–222. DOI: 10.1108/IGDR-09-2020-0140.

Shabir, S. and AlBishri, N.A. (2021), "Sustainable retailing performance of Zara during COVID-19 pandemic", *Open Journal of Business and Management*, Vol. 09 No. 3, pp. 1013–1029. DOI: 10.4236/ojbm.2021.93054.

Shamim, K., Ahmad, S., and Alam, M.A. (2021), "COVID-19 health safety practices: influence on grocery shopping behavior", *Journal of Public Affairs*, Vol., p. e2624. DOI: 10.1002/pa.2624.

Sheth, J. (2020), "Impact of COVID-19 on consumer behavior: will the old habits return or die?", *Journal of Business Research*, Vol. 117, pp. 280–283. DOI: 10.1016/j.jbusres.2020.05.059.

Shishodia, A., Verma, P., and Dixit, V. (2019), "Supplier evaluation for resilient project driven supply chain", *Computers and Industrial Engineering*, Vol. 129, pp. 465–478. DOI: 10.1016/j.cie.2019.02.006.

Siagian, H., Tarigan, Z.J.H., and Jie, F. (2021), "Supply chain integration enables resilience, flexibility, and innovation to improve business performance in COVID-19 era", *Sustainability*, Vol. 13No.9, p. 4669. DOI:10.3390/su13094669.

Silva, A.S., Medeiros, C.F., and Vieira, R.K. (2017), "Cleaner Production and PDCA cycle: practical application for reducing the Cans Loss Index in a beverage company", *Journal of Cleaner Production*, Vol. 150, pp. 324–338. DOI: 10.1016/j.jclepro.2017.03.033.

Sreenivasan, A. and Suresh, M. (2022), "Modeling the enablers of sourcing risks faced by startups in COVID-19 era", *Journal of Global Operations and Strategic Sourcing*, Vol. 15 No. 2, pp. 151–171. DOI: 10.1108/JGOSS-12-2020-0070.

Sreenivasan, A., Suresh, M., and Tuesta Panduro, J.A. (2022), "Modelling the resilience of startups during COVID-19 pandemic", *Benchmarking: an International Journal*, Vol. ahead-of-print No. ahead-of-print. DOI: 10.1108/BIJ-09-2021-0530.

Stiglitz, J.E. (2020), *"Priorities for the Covid-19 economy", Project Syndicate*, Vol. 1, Available at: https://www.project-syndicate.org/commentary/covid-2020-recession-how-to-respond-by-joseph-e-stiglitz-2020-06(Accessed 29 September 2021).

Susan, M. (2020), "Financial literacy and growth of micro, small, and medium enterprises in west Java, Indonesia", *International Symposia in Economic Theory and Econometrics*, Barnett, W.A. and Sergi, B.S. (Eds.), Emerald Publishing Limited, Bingley, Vol. 27, pp. 39–48. DOI: 10.1108/S1571-038620200000027004.

Talwar, M., Talwar, S., Kaur, P., Tripathy, N., and Dhir, A. (2021), "Has financial attitude impacted the trading activity of retail investors during the COVID-19 pandemic?", *Journal of Retailing and Consumer Services*, Vol. 58, p. 102341. DOI: 10.1016/j.jretconser.2020.102341.

Tarki, A., Levy, P., and Weiss, J. (2020), "The coronavirus crisis doesn't have to lead to layoffs", *Harvard Business Review, Digital Press,* Available at: https://hbr.org/2020/03/the-coronavirus-crisis-doesn't-have-to-lead-to-layoffs (Accessed 4 April 2020).

Thakur, C., Diwekar, A., Reddy, B.J., and Gajjala, N. (2020), "A study of the online impulse buying behaviour during COVID-19 pandemic", *International Journal of Research in Engineering, Science and Management*, Vol. 3 No. 9, pp. 86–90. DOI: 10.47607/ijresm.2020.294.

Trump, B.D. and Linkov, I. (2020), "Risk and resilience in the time of the COVID-19 crisis", *Environment Systems and Decisions*, Vol.40, pp. 1–3. DOI: 10.1007/s10669-020-09781-0.

Vogel, R. and Güttel, W.H. (2013), "The dynamic capability view in strategic management: a bibliometric review", *International Journal of Management Reviews*, Vol. 15 No. 4, pp. 426–446.DOI: 10.1111/ijmr.12000.

Walczak, D. and Rutkowska, A. (2017), "Project rankings for participatory budget based on the fuzzy TOPSIS method", *European Journal of Operational Research*, Vol. 260 No. 2, pp. 706–714. DOI: 10.1016/j.ejor.2016.12.044.

Westman, W.E. (1986), "Resilience: concepts and measures", Dell, B., Hopkins, A.J.M., and Lamont, B.B. (Eds.), *Resilience in Mediterranean-type Ecosystems. Tasks for Vegetation Science,* Springer, Dordrecht, pp. 5–19. DOI: 10.1007/978-94-009-4822-8_2.

Xu, X., Chen, R., and Jiang, L. (2020), "The influence of payment mechanisms on pricing: when mental imagery stimulates desire for money", *Journal of Retailing*, Vol. 96 No. 2, pp. 178–188. DOI: 10.1016/j.jretai.2019.08.002.

Zhang, W., Leng, X., and Liu, S. (2020), "Research on mobile impulse purchase intention in the perspective of system users during COVID-19", *Personal and Ubiquitous Computing*, Vol. 12, pp. 1–9. DOI: 10.1007/s00779-020-01460-w.

Zhao, G., Irfan Ahmed, R.I., Ahmad, N., Yan, C., and Usmani, M.S. (2021), "Prioritising critical success factors for sustainable energy sector in China: a DEMATEL approach", *Energy Strategy Reviews,* Vol. 35, p. 100635. DOI: 10.1016/j.esr.2021.100635.

Zighan, S. (2022), "Managing the great bullwhip effects caused by COVID-19", *Journal of Global Operations and Strategic Sourcing*, Vol. 15 No. 1, pp. 28–47. DOI: 10.1108/JGOSS-02-2021-0017.

Zobel, C.W., MacKenzie, C.A., Baghersad, M., and Li, Y. (2021), "Establishing a frame of reference for measuring disaster resilience", *Decision Support Systems,* Vol. 140, p. 113406. DOI: 10.1016/j.dss.2020.113406.

.

Appendix 1. Survey Questionnaire 1

Part 1

Presentation of the research background

Part 2: Expert profile

Please fill in the following

- Total number of years of experience

- Country

- Position

Part 3: Qualitative questions

- Please cite two main requirements to be implemented for retail stores to return to the stable state of purchase and consumers' desire to buy as before COVID-19.

- Please suggest two actions to design 'back to the retail store after COVID-19' initiatives from the consumers' perspective.

- Consumer preferences in terms of fashion models and purchase behaviours may change after COVID-19. Please suggest two proposals to implement actions in the retail store to manage this eventual change.

- How can we test for and verify differences in consumers' purchase quantities after COVID-19? Please state two proposals.

- How can we maintain a new normal in retail store sales after COVID-19? Please state two proposals.

Appendix 2. Survey Questionnaire 2

Quantitative questions

In this part, we seek to analyse the management of a resilient post-pandemic era in fast-fashion retail. Here, we examine the relationships between:

REQUIREMENTS for retail stores to return to the stable state of purchase and consumers' desire to buy as before COVID-19

DESIGN of 'back to the retail store after COVID-19' initiatives from the consumers' perspective

IMPLEMENTATION of actions in the retail store to manage this eventual change, as consumer preferences in terms of fashion models and purchase behaviours may change after COVID-19

VERIFICATION and testing of differences in consumers' purchase quantities after COVID-19

MAINTENANCE of the new normal in retail stores sales after COVID-19

Part 4.1

Each of the following is a multiple-choice question. Please choose:

0: if there is no influence

1: if there is a low influence

2: if there is a medium influence

3: if there is a high influence

4: if there is a very high influence

- How do the requirements influence the design?

- How do the requirements influence the implementation?

- How do the requirements influence the verification?

- How do the requirements influence the maintenance?

- How does the design influence the requirements?

- How does the design influence the implementation?

- How does the design influence the verification?

-How does the design influence the maintenance?

- How does the implementation influence the requirements?

- How does the implementation influence the design?

- How does the implementation influence the maintenance?

- How does the verification influence requirements?

- How does the verification influence the design?

- How does the verification influence the implementation?

- How does the verification influence the maintenance?

- How does maintenance influence the requirements?

- How does maintenance influence the design?

- How does maintenance influence the implementation?

- How does maintenance influence the verification?

Part 4.2

Each of the following is a multiple-choice question. Please choose:

(Very low) OR (Low) OR (Average) OR (High) OR (Very high)

- How do you rank the importance/criticality of the REQUIREMENTS?

- How do you rank the importance/criticality of the DESIGN?

- How do you rank the importance/criticality of the IMPLEMENTATION?

- How do you rank the importance/criticality of the VERIFICATION?

- How do you rank the importance/criticality of the MAINTENANCE?

Part 4.3

For the post-COVID period, how do you rank the importance of these factors (from the retailer's perspective)on the resilience of the fast-fashion business?

For each of the following factors, please choose:

(Very low) OR (Low) OR (Average) OR (High) OR (Very high)

- Reinforcing online advertising and marketing

- Providing customers opportunities to use payment options such as instalments for an affordable shopping experience

- Addressing customers' price sensitivity and the high price elasticity in fast-fashion by providing the best market prices

- Exploring impulse selling as a compensatory mechanism

- Adopting hygiene standards and health security aspects, such as using sanitisers

- Adapting the assortment to the new economic and social situation: less trendy items, more basics

- Establishing a close relationship with customers and listening to their suggestions; providing them with the right support for the new normal post COVID-19

- Integrating sustainable aspects into retailer's offerings, such as 'environmentally friendly' labels, to consolidate brand image

- Avoiding overcrowding in stores (closing the doors when the store is full, proposing promotions during mornings and when there are no rush hours) to enhance customers' comfort

- Realising that after this pandemic, many customers will be more rational than ever, which means they will buy only necessary and basic products

- Attracting a new range of customers by trying to acquire their market share (For instance, customers who would earlier opt for high-range fashion may become potential consumers if fast-fashion retailers adapt their offers.)

- Reinforcing team training to manage the new normal

- Improving the assortment to contain more basics and avoiding very trendy items, as a large part of the customers will either buy fewer fashionable items or choose long-lasting items

- Developing materials that are unfavourable to the virus

- Sterilising products returned to the store to satisfy the customers

- Implementing fast-fashion products with extended lifetime

- Analysing macroeconomic figures, such as unemployment and inflation rates, to get a clear idea of how the business will develop after the pandemic

- Performing a global market analysis

- Performing local market analysis for effective forecasting of post-pandemic market changes

- Benchmarking using other business figures by analysing customers' behaviour in similar fast-fashion sectors

- Developing business on web stores owing to the upsurge in online purchases

- Promoting customers' loyalty by providing gift cards and similar offers (after COVID-19, customers are likely to be less loyal)

- Ensuring flexible management to maintain the new normal in retail stores in terms of human resources and logistics management to adapt to any unexpected crisis

- Working with resellers during times of crisis

Figures

```
┌─────────────────────────────────────────────────────┐
│                                                     │
│        Experts' opinions and literature analysis     │
│                                                     │
└─────────────────────────────────────────────────────┘
                          │
┌─────────────────────────────────────────────────────┐
│                                                     │
│   Enablers of resilience for customer demand         │
│   management in fast fashion                         │
│                                                     │
└─────────────────────────────────────────────────────┘
                          │
┌─────────────────────────────────────────────────────┐
│                                                     │
│         Ranking of PDCA steps with DEMATEL           │
│                                                     │
└─────────────────────────────────────────────────────┘
                          │
┌─────────────────────────────────────────────────────┐
│                                                     │
│      Ranking of resilience enablers with Fuzzy TOPSIS │
│                                                     │
└─────────────────────────────────────────────────────┘
                          │
┌─────────────────────────────────────────────────────┐
│                                                     │
│              Implications for practitioners          │
│                                                     │
└─────────────────────────────────────────────────────┘
```
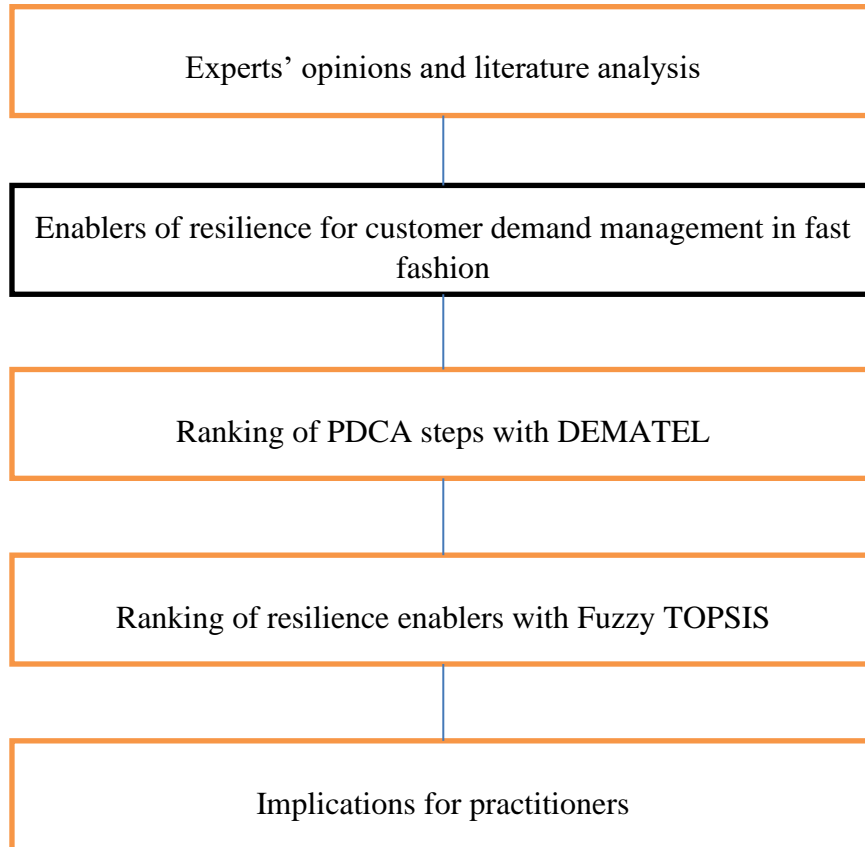
Figure 1: Methodology
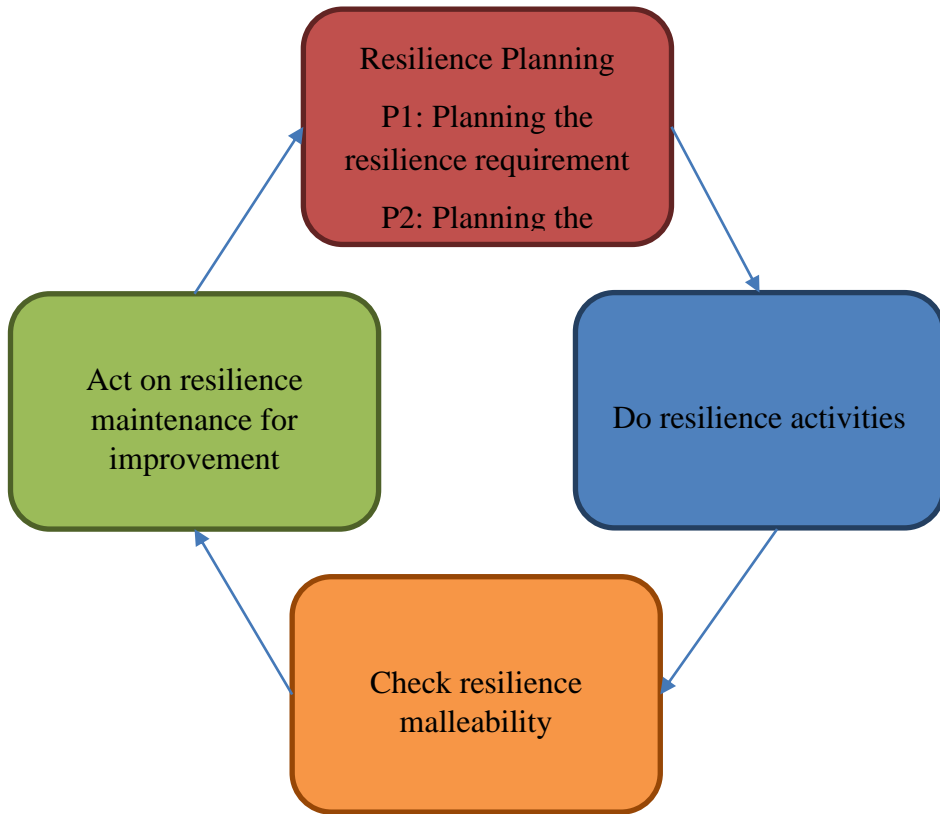
Figure 2 : Resilience Cycle
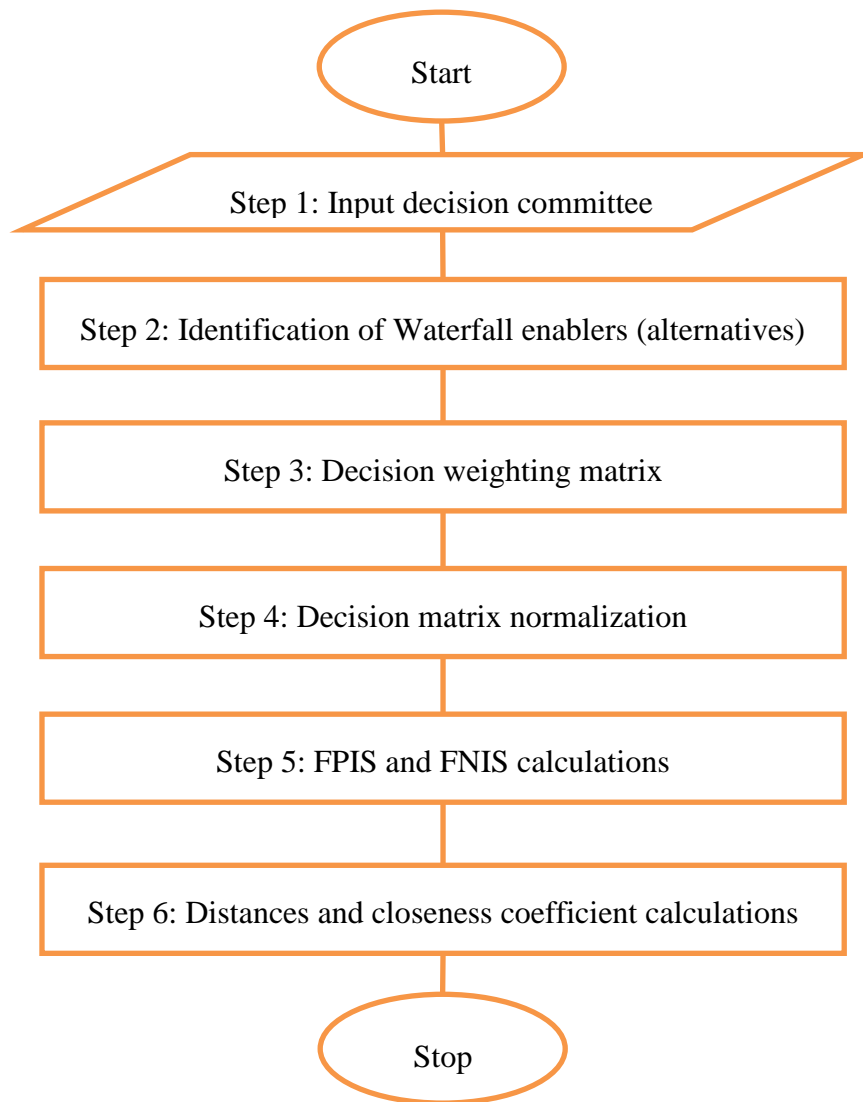
Figure 3. Flow chart of the steps and equations used for calculations
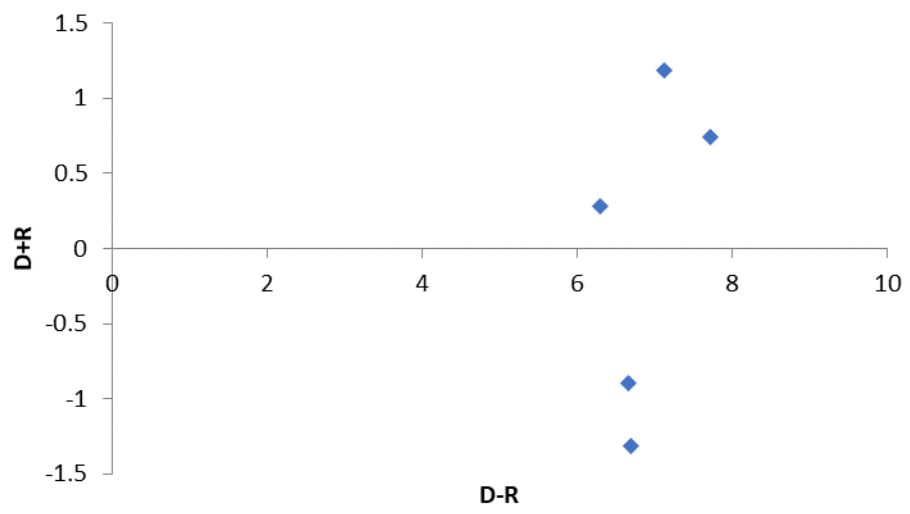
Figure 4 : Causal Diagram
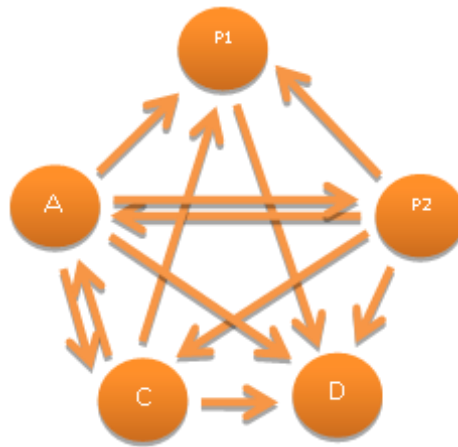
Figure 5 : Casse-effect relationship diagram
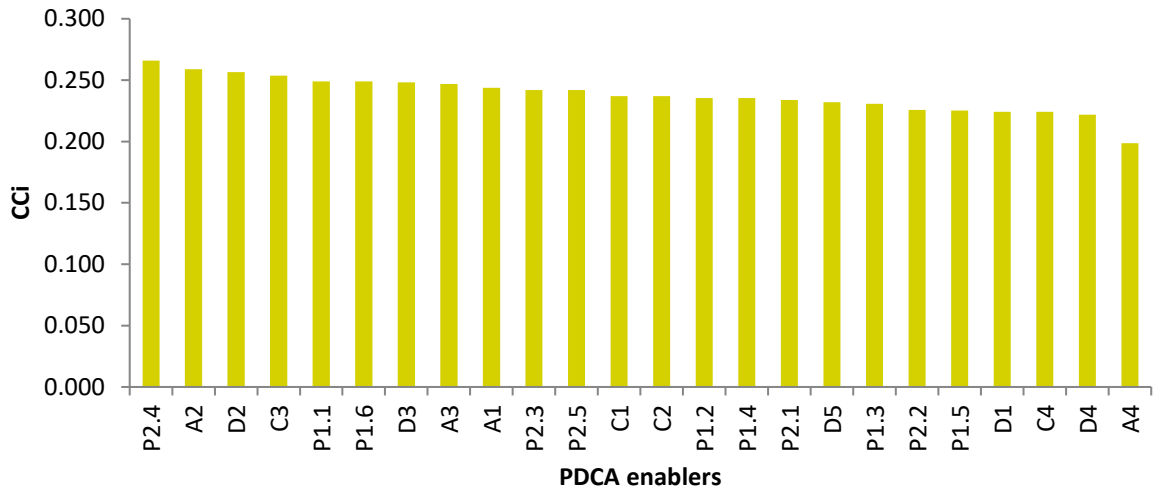
Figure 6: Ranking of Enablers

Tables

Table I. Review of research stream on resilience following the COVID-19 pandemic

Paper	Purpose	Scope	Methodology
Nurcahyanie *et al*. 2022	Demonstrate the benefits of online product reviews in the development of new Muslim fashion products	Muslim fashion innovation in Indonesia	Data mining and descriptive analysis
Ozdemir *et al.* (2022)	How existing solutions helped enhancing supply chain resilience	UK perishable goods market	literature and covariance-based structural equation modeling
Kursan Milaković (2021)	Analyze the impacts of the personal processes of consumer resilience, vulnerability, and adaptability on the behavioral processes of purchase satisfaction and repurchase	Purchase experience during the COVID-19 pandemic	social cognitive theory
Guthrie *et al.* (2021)	Explore how consumers use e-commerce to behave, encounter and adapt to periods of environmentally imposed constraints	French healthcare	descriptive single-case research design

Appel and Hardaker, (2021)	Investigate how individual retailers deal with COVID-19 and the relevant resilience strategies applied	Textile retailers in Germany	contextual analysis of primary (experts interview) and secondary data
Ali *et al*. (2021)	Explore the vulnerability and capability factors of ready-made garments	Bangladesh	qualitative research

Table II. Experts' contributions

Expert	Total years of experience	Contribution
1	18	Questionnaires 1 and 2
2	14	Questionnaire 1
3	14	Questionnaire 1
4	20	Questionnaire 1
5	25	Questionnaire 1
6	15	Questionnaires 1 and 2
7	15	Questionnaires 1 and 2
8	10	Questionnaire 1
9	14	Questionnaire 1
10	20	Questionnaire 1
11	13	Questionnaire 2
12	5	Questionnaire 2

Table III. Questions for experts

PDCA	Resilience aspects of customer demand	Open questions
P1	Elasticity: quickness of restitution of customer demand to a stable state after a crisis	Q1
P2	Amplitude: impact area from which customer demand operations will return to a normal state	Q2
Do	Hysteresis: extent of differences between degradation and recovery of customer demand	Q3
Check	Malleability: difference between the original state of customer demand before disruption and the state reached after recovery	Q4
Act	Damping: the way customer demand restitution is adapted by any circumstance that changes normal restitution	Q5

Table IV. Enablers and supporting literature

PDCA steps	Enabler	Description	Supporting literature	Reference
P1	P1.1	Reinforce online advertising and marketing	During the COVID-19 period, new demographic customer groups, such as older and less digitally savvy consumers, have started using e-commerce.	Eger *et al.*,2021
	P1.2	Provide customers with various payment options, such as instalments, for an affordable shopping experience.	Several payment options enhance customer satisfaction with online shopping.	Sanyala and Hisam, 2019
	P1.3	Because of the economic situation, customers will be very sensitive to prices. Since price elasticity in fast	One of the features influencing customers' choice of fast-fashion products is affordable prices.	Joung,2014

			fashion is very high, retailers should provide the best prices in the market.		
		P1.4	Impulse selling will help to cover for losses	Due to the fear ofCOVID-19, impulse purchase behaviour among consumers has grown.	Ahmed *et al.*,2020; Eger *et al.*,2021
		P1.5	Continue implementing hygiene standards and health security aspects, like using sanitizers, ventilating the stores, reducing the exposed quantity of textiles, enlarging the passages to allow a smooth passing for customers, and avoiding overcrowded stores.	Proper hygiene at the store must be adopted by grocery stores to deliver a clear message that customer safety is a priority.	Shamim *et al.*,2021
		P1.6	Adapt the assortment of items to the emerging economic and social situation: less trendy, more basics.	Owing to the economic impact of COVID-19, customer purchases have been focused on meeting basic needs.	Eger *et al.*,2021
P2		P2.1	Remain close to customers and listen to their suggestions, by providing them with the right support post-COVID19.	The new operating system induced by COVID-19 will generate collaborative relationships.	Lee and Trimi, 2021
		P2.2	Integrate sustainable aspects into retailers' offerings, for example by using labels that indicate environment friendly, to consolidate the image of the brand.	During the lockdown, customers have shown an increased intention to purchase sustainable products.	Alexa *et al.*,2021
		P2.3	Retailers should avoid the crowding of stores (closing the doors when the store is full, proposing promotions during the morning would help to make customers more comfortable.	Customers need visible signs and barriers when shopping in the stores after COVID-19.	Arora *et al.*,2020

		P2.4	Post pandemic, many customers will be more rational than ever, which means they will buy only necessary and basic products.	People will re-evaluate what is important and their prioritization after the pandemic experience.	Lee and Trimi,2021
		P2.5	Attract a new range of customers by trying to get a new market share is important. For instance, customers who used to look for high-range fashion might become a potential for fast-fashion retailers.	Customer satisfaction levels and purchase behaviour have been influenced by the pandemic.	Mason *et al.*,2020
D		D1	Reinforce team training to manage the new normal.	Continuous training of staff is crucial for consistency in organizational development for competitive advantage.	Hollenbek *et al.*,2004
		D2	The assortment should contain more basics and retailers should avoid very trendy items since a large portion of the customers will either buy less fast fashion items or choose long-lasting ones.	Customer shopping interests have been focused on basic products due to theCOVID-19-related economic crisis.	Eger *et al.*, 2021
		D3	Develop material unfavourable to the virus.	Proper fabrics derived from textile filtration science and the pandemic research must be manufactured.	Beesoon*et al.*,2020
		D4	Sterilize products returned to the store to satisfy the customers.	The fear and distress caused by COVID-19 will change individual lifestyles after the pandemic.	Koçak*et al.*,2021
		D5	Implement fast-fashion products with extended life.	Due to the ecological negative impact of fashion products, the environmental need to extend such products' life and ensure that customers do not need to make frequent purchases has increased.	Niinimäki*e t al.*,2020
C		C1	Retailers should analyse	The macro-economy shows that	Stiglitz,

		macroeconomic figures, such as unemployment and inflation rates, to get a clear idea of how the business will fare after the pandemic.	spending will decrease.	2020
	C2	Global market analysis	Understanding the uncertainties associated with the pandemic global impact will enable effective prediction of restoration post COVID-19.	Song and Zhou,2020
	C3	Local market analysis for effective forecasting for post-pandemic market changes	The microeconomics reveals that the pandemic will impact production and consumption patterns.	Stiglitz, 2020
	C4	Benchmark with other businesses, by analysing customer behaviour in similar sectors of fast fashion.	The pandemic will be a catalyst for the economies impacting customer behaviours.	Mason *et al.*,2020
A	A1	Develop the business on the web since online purchases are increasingly popular.	Online shopping has been crucial for customers.	Hashem, 2020
	A2	Work on gaining customer loyalty, by providing gift cards and similar incentives, because customers would be less loyal after COVID-19.	Until the new post-COVID-19normal is reached, and even later, retailers should choose to focus on customers' wellbeing and satisfaction.	Pantano*et al.*,2020
	A3	Retailers should practice flexible management to adapt to the new normal in retail stores in terms of human resources and logistics management to be able to adapt to any sudden crisis.	New habits among customers will appear, mainly for technology use.	Sheth, 2020
	A4	Retailers can work with resellers during crises.	Online retailers as resellers can be better as pure marketplaces.	Chen *et al.*,2020

Table V. Relation and influence matrix

	P1	P2	D	C	A	Di	Ri	Di+Ri	Di-Ri	Cause/Effect
P1	0,512	0,509	0,724	0,511	0,629	2,885	3,778	6,664	-0,893	Effect
P2	0,927	0,581	0,982	0,788	0,881	4,159	2,969	7,128	1,190	Cause
D	0,627	0,503	0,509	0,476	0,579	2,694	4,010	6,704	-1,317	Effect
C	0,754	0,587	0,780	0,465	0,708	3,294	3,017	6,311	0,277	Cause
A	0,959	0,789	1,016	0,777	0,695	4,235	3,492	7,727	0,743	Cause

Table VI. Linguistic variables

Linguistic variables	Triangular fuzzy numbers
Very low	(1 ; 1; 3)
Low	(1 ; 3 ; 5)
Average	(3 ; 5 ; 7)
High	(5; 7 ; 9)
Very high	(7 ; 9 ; 9)

Table VII. Decision matrix

	P1			P2			D			C			A		
P1.1	5	7,8	9	1	1	3	1	1	3	1	1	3	1	1	3
P1.2	3	7,4	9	1	1	3	1	1	3	1	1	3	1	1	3
P1.3	1	7,8	9	1	1	3	1	1	3	1	1	3	1	1	3
P1.4	3	7,4	9	1	1	3	1	1	3	1	1	3	1	1	3
P1.5	3	5,8	9	1	1	3	1	1	3	1	1	3	1	1	3
P1.6	5	7,8	9	1	1	3	1	1	3	1	1	3	1	1	3
P2.1	1	1	3	1	6,6	9	1	1	3	1	1	3	1	1	3
P2.2	1	1	3	1	5,4	9	1	1	3	1	1	3	1	1	3
P2.3	1	1	3	3	6,6	9	1	1	3	1	1	3	1	1	3
P2.4	1	1	3	5	8,2	9	1	1	3	1	1	3	1	1	3
P2.5	1	1	3	3	6,6	9	1	1	3	1	1	3	1	1	3
D1	1	1	3	1	1	3	1	6,2	9	1	1	3	1	1	3
D2	1	1	3	1	1	3	5	8,2	9	1	1	3	1	1	3
D3	1	1	3	1	1	3	5	7	9	1	1	3	1	1	3
D4	1	1	3	1	1	3	1	5,8	9	1	1	3	1	1	3
D5	1	1	3	1	1	3	1	7,4	9	1	1	3	1	1	3
C1	1	1	3	1	1	3	1	1	3	3	7	9	1	1	3
C2	1	1	3	1	1	3	1	1	3	3	7	9	1	1	3
C3	1	1	3	1	1	3	1	1	3	5	7,8	9	1	1	3
C4	1	1	3	1	1	3	1	1	3	1	6,2	9	1	1	3
A1	1	1	3	1	1	3	1	1	3	1	1	3	1	7,4	9
A2	1	1	3	1	1	3	1	1	3	1	1	3	3	8,2	9
A3	1	1	3	1	1	3	1	1	3	1	1	3	3	6,6	9
A4	1	1	3	1	1	3	1	1	3	1	1	3	1	3,8	7

Table VIII.COVID-19Fuzzy TOPSIS results

	d*	d-	CCi
P1.1	24,772	8,214	0,249
P1.2	25,607	7,887	0,235
P1.3	26,379	7,912	0,231
P1.4	25,607	7,887	0,235
P1.5	25,849	7,518	0,225
P1.6	24,772	8,214	0,249
P2.1	26,258	8,009	0,234
P2.2	26,452	7,715	0,226
P2.3	25,385	8,102	0,242
P2.4	24,284	8,802	0,266
P2.5	25,385	8,102	0,242
D1	26,463	7,647	0,224
D2	24,583	8,477	0,256
D3	24,751	8,173	0,248
D4	26,523	7,557	0,222
D5	26,327	7,948	0,232
C1	25,543	7,928	0,237
C2	25,543	7,928	0,237
C3	24,624	8,372	0,254
C4	26,463	7,647	0,224
A1	26,069	8,407	0,244
A2	25,052	8,746	0,259
A3	25,249	8,273	0,247
A4	26,838	6,655	0,199

Table IX. Sensitivity analysis results

Experiment number	Definition of the variation in the weighted decision matrix	Initial weight in the weighted normalized matrix	Experiment weight	Ranking
1	Weight of P1.1 for P1 criterion	(3,556; 5,547; 6,4)	(3,400; 5,547;6,400)	P1.1>P2.4>A2>D2> C3>P1.6>D3>A3>A1 >P2.3>P2.5>C1>C2> P1.4>P2.1>P1.2>D5> P1.3>P2.2>P1.5>D1> C4>D4>A4
	Weight of P1.2 for P1 criterion	(2,133; 5,262; 6,4)	(2,133; 5,262;6,200)	
	Weight of P1.3 for P1 criterion	(0,711; 5,547; 6,4)	(0,711; 5,600;6,400)	
2	Weight of D2 for D criterion	(3,704; 6,074;6,667)	(3,600; 6,074;6,667)	P1.1>P2.4>A2> D2>C3>P1.6>A3 >D3>A1>P2.3> P2.5>C1>C2 >P1.2>P1.4>P2.1 >D5>P1.3>P2.2 >P1.5>D1>C4> D4>A4
	Weight of D3 for D criterion	(3,704; 5,185;6,667)	(3,704; 5,185;6,400)	
	Weight of D4 for Dcriterion	(0,741; 4,296;6,667)	(0,741; 4,400;6,667)	
3	Weight of A2 for A criterion	(2,511; 6,864; 7,533)	(2,400; 6,864;7,533)	P1.1>P2.4>A2> D2>C3>P1.6> D3>A3>A1> P2.3>P2.5>C1> C2>P1.2>P1.4> P2.1>D5>P1.3> P2.2>P1.5>D1>C4> D4>A4
	Weight of A3 for A criterion	(2,511; 5,524; 7,533)	(2,511; 5,524;7,300)	
	Weight of A4 for A criterion	(0,837; 3,181; 5,859)	(0,837; 3,300;5,859)	