American Journal of Business and Operations Research

♦ ISSN: 2692-2967 Vol: 14, No. 02, 2026 ♦ PP. 24–30

Article DOI: https://doi.org/10.54216/AJBOR.140204

FULL LENGTH ARTICLE

Business Data Analytics for GCC Travel and Tourism SMEs Under Geopolitical Disruption

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Received: December 26, 2025 Revised: March 01, 2026 Accepted: April 02, 2026 ⋆ Corresponding author

ABSTRACT

The paper creates the business data analytics vision of how small and medium-sized enterprises (SMEs) of GCC travel and tourism ecosystems can mitigate the commercial disruption as the perceived cost, uncertainty, or inconvenience of air travel increases due to geopolitical friction in the region. Since there is a lack of public GCC micro-level booking and itinerary data, the research paper relies on a similar public dataset: the travel mode-choice dataset published under the name of `statsmodels` and initially based on the intercity mode-choice literature. The benchmark is operationalized as an analogue of disruption-sensitive travel demand reallocation and poses a managerial question, not a simply transport question: in the event of a shock that increases generalized cost and waiting frictions on the most exposed mode what are the most likely demand reallocations and how should SMEs respond? Empirical design transforms the data in the long-format alternative-choice form into an analytical platform that is business-facing and integrates multinomial logit, random forest, gradient boosting, and scenario stress testing into a single analytical framework. The findings indicate that the random forest model provides the best out of sample predictive performance (accuracy 0.981; macro-F1 0.973), whereas the multinomial logit model is useful in translating scenarios that can be understood. Average predicted air share decreases by 28.0 to 16.1 percent with simulated air-travel disruption, and train-like substitutes acquire most of the share. The results suggest that GCC travel, hospitality, and mobility SMEs cannot afford to trust one open channel when a period of geopolitical escalation occurs, but rather they should develop substitution-ready packages, flexible repricing guidelines, and portfolios of partnering that encompass low-friction options. The article adds a unique business analytics template of demand reallocation sensitive to crisis through the use of repeatable public information and underlines practical resilience solutions as opposed to self-forecasting wars.

Keywords: Business data analytics ▪ SMEs ▪ GCC ▪ Tourism resilience ▪ Travel disruption ▪ Scenario stress testing ▪ Mode substitution

1. INTRODUCTION

The GCC expansion model is increasingly diversified and other economic sectors such as tourism, mobility, events, retail, and services activities have increasingly started to assume economic significance alongside the hydrocarbons. Meanwhile, the situation of regional business is also sensitive to the geopolitical spillovers, which may influence fuel prices, logistics confidence, booking habits, route availability, and traveler sentiment [1, 2, 3]. In the case of SMEs in travel

and tourism value chains, the commercial challenge is now urgent: a spell of geopolitical volatility does not have to kill demand directly to cause severe losses; it suffices that demand becomes less predictable, more price-sensitive, more delay-averse, or more prone to switching out of the channel that is most exposed.

This has been of particular concern to GCC companies, which rely on visitor flows, domestic movement, events, retail-related to airports, or travel intermediation. The outlook studies and reviews on crisis-governance consistently indicate that travel-associated SMEs are one of the most disruption-prone firms due to their tight capacity-window, inconsistent cancellations, and high reliance on trust, convenience and continuity [4, 5, 6]. The correct question to be asked by the managers, then, is not just whether an event of geopolitical event takes place, but how the customer choice shifts in the occurrence of perceived friction increase.

In this paper, the given business problem is discussed by constructing a public, reproducible analytical benchmark of disruption-sensitive substitution. GCC booking datasets that are publicly available with granular itinerary, pricing and choice information are not easily accessible. To ensure replicability, the research relies on the publicly recorded travel mode-choice data distributed in the `statsmodels` documentation and the `AER` package. The benchmark includes exposed-preference air, train, bus, and car intercity options, and generalized costs, in-vehicle time, terminal waiting time, income, and party size to the benchmark [7, 8, 9]. Although this is not the GCC firms observations, the dataset is quite appropriate as a similar case of the managerial mechanism under investigation: the redistribution of demand between the exposed and less exposed mobility choices in case of friction variations.

The paper makes four contributions. First, it reinstates a public mode-choice benchmark into a business continuity analytics issue, contextual to GCC SMEs. Second, it integrates predictive and interpretable methods, comparing performance to machine learning with economically significant stress-test translation. Third, it goes beyond a fixed accuracy to investigate the reallocation of demand in scenarios of simulated disruption to air travel. Fourth, it turns those empirical trends into practical measures to SMEs in the GCC travel, tourism and the nearby service industry.

The paper is deliberately designed not in the format of typical forecasting articles. Instead of having a traditional introduction-literature-method-results flow, it follows streams of evidence to translational logic, followed by baseline diagnostics, predictive evidence, scenario behavior, and managerial countermeasures. That architecture is more consistent with the problem applied and contributes to the paper being read as a business analytics crisis sensitive study, but not as a generic classification paper.

2. EVIDENCE STREAMS AND RESEARCH POSITIONING

2.1 Why GCC SMEs need disruption-sensitive analytics

The recent literature on the GCC makes two points that are highly relevant for SMEs. First, diversification has widened the commercial importance of tourism, hospitality, transportation, and consumer services. Second, geopolitical shocks now matter through indirect channels as much as through direct physical disruption. IMF and World Bank assessments emphasize geoeconomic fragmentation, supply-chain uncertainty, and commodity volatility as risks that can quickly alter private-sector operating conditions [1, 2]. GCC-Stat reporting similarly shows the region's financial and economic performance as increasingly connected to investor confidence and global conditions, not only to domestic output [3].

For SMEs, this means resilience depends on the ability to monitor not only top-line demand but also substitution behavior. A hotel, destination management company, shuttle operator, airport retailer, or digital travel intermediary can lose business when travelers switch channels, shorten stays, delay purchases, or prefer lower-friction routes. The operational challenge is therefore one of behavioral early warning: identifying how the booking portfolio will redistribute under uncertainty and what substitute packages should be activated.

2.2 What the crisis and tourism literature contributes

Crisis-management studies in tourism repeatedly show that resilience is shaped by flexibility, institutional coordination, information quality, pricing discipline, and adaptive service redesign [5, 4, 10, 6]. Yet many of these studies remain destination-level or policy-oriented. They often provide rich qualitative lessons on recovery, communication, and governance, but less guidance on operational micro-decisions such as which booking segments are most exposed, which substitute offerings should be emphasized, and how service portfolios should shift when one channel becomes unreliable.

A second stream of recent work focuses on booking-cancellation analytics and crisis-sensitive hospitality demand. Studies using hotel booking data show that cancellations, lead times, deposit conditions, and booking-channel characteristics can be predicted with useful accuracy and have direct revenue implications [11]. That literature is valuable because it demonstrates that business events traditionally treated as noise can instead become decision variables. However, cancellation studies do not necessarily capture intermodal substitution, which is the key mechanism relevant to GCC continuity planning when geopolitical stress affects one transport mode more than others.

2.3 What the mode-choice analytics literature contributes

Mode-choice modeling has undergone a clear methodological expansion. The classic discrete-choice tradition remains important because it offers interpretable elasticities and behavioral insights [9, 12]. Recent work has extended this space with interpretable machine learning, boosted models, and classifier comparisons that improve prediction and highlight variable relevance [13, 14, 15, 16, 17]. This literature is particularly useful for the present paper because it provides a public empirical environment in which switching between air and ground modes can be observed and modeled.

From a business analytics perspective, this literature offers two advantages. It captures the customer trade-off between time, money, and convenience, and it allows scenario experiments that mimic service friction. These attributes make it especially suitable for transferable managerial inference. If air travel becomes relatively more costly or inconvenient under geopolitical stress, what proportion of demand is likely

to migrate to train-like, car-like, or bus-like substitutes? What customer attributes condition that shift? And which business actions are implied by the resulting demand map?

2.4 Research gap and positioning

The gap addressed here lies at the intersection of tourism resilience, GCC business continuity, and applied customer-choice analytics. The tourism crisis literature explains why shocks matter. The GCC macro literature explains why re-gional spillovers require resilience. The booking and mode-choice literatures show that behavior can be predicted and interpreted. What remains underdeveloped is a business-facing analytical bridge connecting these streams to SME decision-making under regional disruption.

This paper therefore positions itself as a translational busi-ness analytics study. It does not claim to predict geopolitical events. Instead, it asks how a publicly observable, behav-iorally rich benchmark can be used to construct a decision sys-tem for GCC SMEs facing the possibility of conflict-related travel friction. The resulting contribution is not a region-specific demand forecast, but a replicable logic for stress testing substitution and redesigning offerings before losses concentrate.

3. ANALYTICAL EXPECTATIONS AND TRANSLATIONAL LOGIC

Instead of treating hypotheses as abstract statistical state-ments, this paper formulates them as analytic expectations tied to managerial logic.

H1. When generalized cost and waiting frictions rise for the most exposed travel mode, customers reallocate toward lower-friction alternatives in a systematic and predictable manner.

H2. Income and party size do not merely affect baseline choice; they alter the intensity and direction of substitution under disruption, creating identifiable vulnerability segments.

H3. A combined business analytics pipeline that includes both predictive machine learning and interpretable stress test-ing outperforms single-view monitoring for continuity plan-ning.

H4. The demand loss from the exposed mode concentrates disproportionately in commercially valuable customer groups, making proactive substitution design economically important for SMEs.

Figure 1 reorganizes the article around a continuity blueprint rather than a linear framework. The visual starts with three distinct pressure zones—regional shock, customer response, and firm response—then shows how the empirical benchmark is used to convert those zones into measurable decision mod-ules. This design makes the article look less like a transport-model workflow and more like a service-risk architecture for SMEs operating under disruption-sensitive conditions.

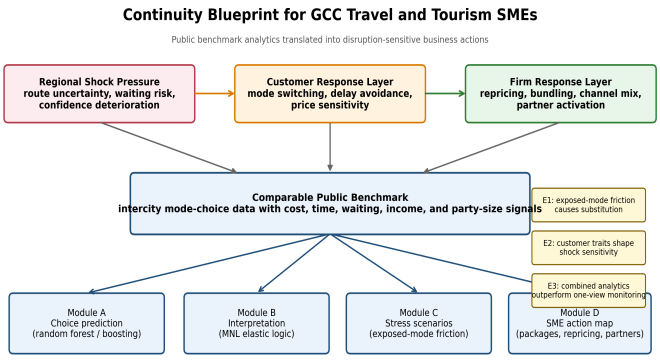

Figure 1. Continuity blueprint linking disruption pressures, analytical modules, and SME response levers

4. PUBLIC BENCHMARK DATA AND MODELING DESIGN

4.1 Data provenance and relevance

The empirical benchmark is the public travel mode-choice dataset distributed through `statsmodels` and documented in the `AER` package. The underlying data come from a 1987 intercity mode-choice study covering choices among air, train, bus, and car across 210 non-business trips, represented in long format as 840 alternative observations [7, 8]. The benchmark includes generalized cost, in-vehicle travel time, terminal waiting time, household income, and party size.

The benchmark is not a GCC micro-dataset, and this boundary is acknowledged throughout the paper. It is used because it captures the exact behavioral mechanism required for transferable crisis analytics: how customers redistribute across alternatives when one mode becomes less attractive. For travel and tourism SMEs in the GCC, that mechanism is directly relevant during periods of regional tension that raise the perceived friction of exposed channels.

4.2 Business-oriented feature engineering

To convert the dataset into a managerial analytics system, the long-format alternative data were transformed into one wide-format record per traveler. For each individual, the chosen mode becomes the target class, while the feature space includes mode-specific travel times, generalized costs, in-vehicle times, vehicle costs, and traveler attributes. This design allows the use of multiclass predictive models more familiar to business analytics practice.

The feature set contains four groups: (i) exposed-mode friction indicators (air travel time, air in-vehicle time, air generalized cost, air vehicle cost); (ii) substitute-mode friction indicators for train, bus, and car; (iii) customer resource characteristics represented by household income; and (iv) coordination characteristics represented by party size. This feature design is not arbitrary. It reflects the operating choices available to SMEs when an exposed service channel becomes less attractive: reduce friction, reprice, or redirect customers to substitutes.

4.3 Modeling workflow

Three predictive models were estimated on a stratified 75/25 train-test split: a multinomial logit model as the interpretable baseline, a random forest classifier as the flexible ensemble

Table 1. Evidence streams, transferable lessons, and unresolved operational needs

Evidence stream	Representative studies	What this stream already explains	What remains unresolved for the present article
Regional resilience: GCC macro resilience	[1], [2], [3]	Diversification, macro buffers, and the growing service role in GCC economies	Does not show how customer-facing SMEs should react when travel friction rises
Regional resilience: Geopolitical spillovers and oil-linked uncertainty	[18], [19]	Regional shocks affect volatility, pricing expectations, and confidence	Stops at financial or energy transmission rather than booking substitution logic
Tourism continuity: Crisis governance	[5], [4]	Tourism SMEs need agility, partnerships, and contingency routines	The governance discussion is broad and not linked to a predictive customer-choice engine
Tourism continuity: Recovery and resilience	[10], [6]	Adaptive capacity and recovery speed differ by destination conditions	Resilience is discussed more at destination level than at itinerary level
Tourism continuity: Booking risk analytics	[11]	Booking behavior can be modeled with data-driven tools	Existing hotel analytics emphasize cancellation rather than substitution under disruption
Choice analytics: Classical mode-choice modeling	[9], [12]	Time, cost, and waiting frictions explain transport choices in an interpretable way	Usually framed as a transport problem instead of an SME continuity problem
Choice analytics: Machine learning prediction	[13], [17], [14], [15], [16]	Flexible classifiers improve prediction and feature interpretation in travel choice settings	Their business value for crisis-sensitive service redesign is rarely made explicit
Gap addressed by this article	Public benchmark plus GCC-oriented translation	Connects disruption-sensitive choice behavior to SME revenue-preservation actions	Builds a bridge from comparable public demand data to GCC continuity decisions and substitution-ready service design

benchmark, and a gradient boosting classifier as an additional nonlinear comparator. Accuracy and macro-F1 were selected as evaluation metrics because the managerial problem requires not only overall correctness but balanced performance across alternatives.

A second analytical layer used the multinomial logit model for scenario translation. After baseline estimation, the study imposed two synthetic disruption scenarios on the exposed mode (air): a moderate disruption scenario that increases air generalized cost by 20%, air in-vehicle time by 30%, and terminal time by 25%; and a severe disruption scenario that increases the same attributes by 40%, 50%, and 40%, respectively. The purpose is not to claim exact causal magnitudes for a specific conflict episode, but to test how predicted mode shares redistribute when the exposed channel experiences plausible friction increases.

5. BASELINE PORTFOLIO DIAGNOSTICS

The benchmark already reveals a portfolio lesson relevant to SMEs. Observed mode shares are not dominated by a single option. Train accounts for 30.0% of chosen trips, car for 28.1%, air for 27.6%, and bus for 14.3%. This diversification matters because business resilience depends not only on total demand but also on the availability of substitute channels. A service ecosystem in which one option dominates overwhelmingly is much more fragile under sudden disruption.

The raw data also suggest that exposed-mode decisions are heavily conditioned by time and convenience. Air has the strongest performance advantage in travel-time variables, whereas ground alternatives frequently offer more stable generalized-cost profiles for certain travelers. From an SME perspective, this means that customers do not need to abandon travel entirely when friction rises; many can be retained if businesses pivot quickly enough toward acceptable substitutes.

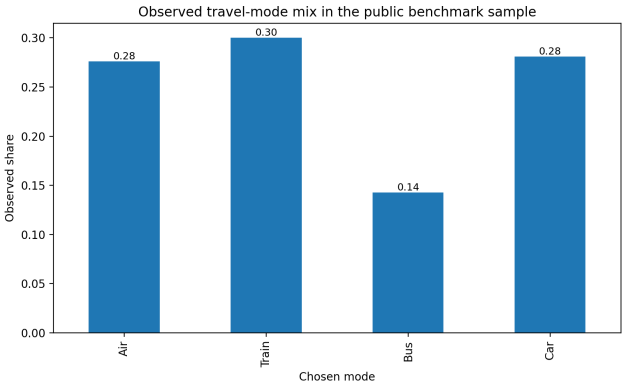

Figure 2. Observed travel-mode mix in the public benchmark sample

Table 2. Out-of-sample predictive performance

Model	Accuracy	Macro-F1
Multinomial logit	0.792	0.801
Random forest	0.981	0.973
Gradient boosting	0.962	0.957

6. PREDICTIVE EVIDENCE

6.1 Comparative model performance

The predictive results are presented in Table 2 and Figure 3. The random forest model delivers the strongest out-of-sample performance, reaching 0.981 accuracy and 0.973 macro-F1. Gradient boosting follows closely, while multinomial logit remains materially weaker in pure prediction but still respectable at 0.792 accuracy. This pattern supports H3: combined analytics are preferable to a single-model view. Ensemble methods excel at classification, while the multinomial logit model remains useful for interpretable scenario reasoning.

The confusion matrix for the random forest model shows that most alternatives are identified with high reliability. Only bus experiences one meaningful misclassification into car in

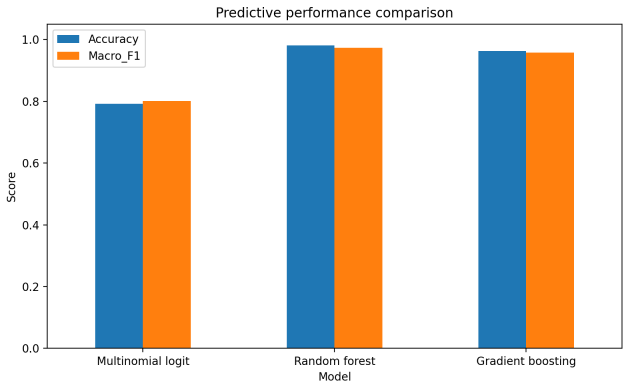

Figure 3. Predictive performance comparison

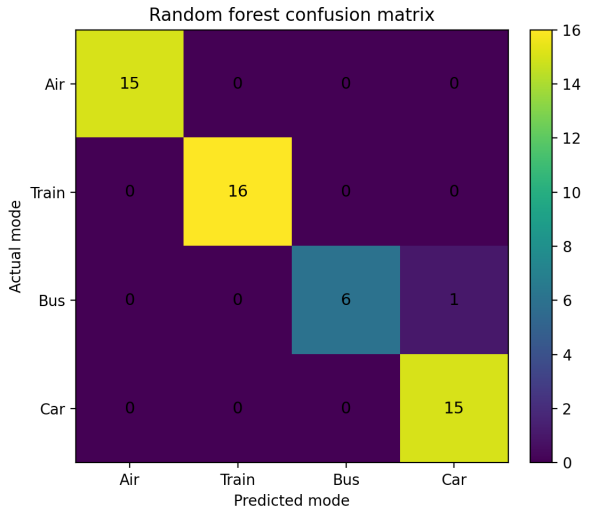

Figure 4. Random forest confusion matrix

the test set. For business applications, this suggests that an analytics layer can be sufficiently precise to support tactical routing, repricing, and redirection actions instead of being limited to descriptive reporting.

6.2 Which variables matter most

The random forest feature-importance profile identifies air travel time, train travel time, bus travel time, train in-vehicle time, and car in-vehicle time as the strongest predictors, fol-lowed by several cost variables. This ranking is strategically important. It indicates that travelers react primarily to friction and convenience before anything else, reinforcing H1. In a crisis-sensitive context, SMEs should therefore focus less on generic discounts and more on reducing booking frictions, transfer times, waiting uncertainty, and perceived hassle.

The explanatory pattern also supports H2. Customer attributes matter, but they matter through interaction with friction. In-come and party size influence which alternatives remain fea-sible when disruption rises. For managers, this means that segmentation should not be based solely on demographic value; it should be based on which customer groups are most likely to remain serviceable under stress.

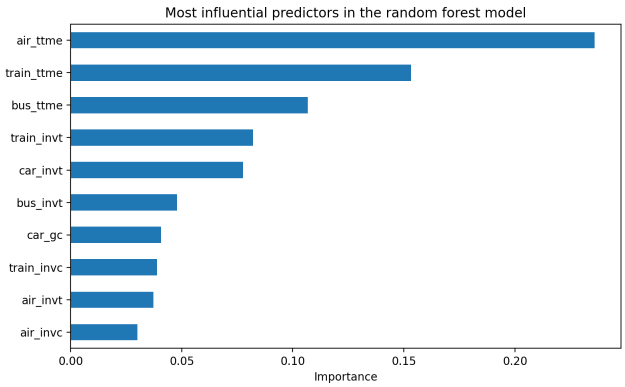

Figure 5. Most influential predictors in the random forest model

Table 3. Average predicted mode shares under disruption scenarios

Scenario	Air	Train	Bus	Car
Baseline	0.280	0.295	0.153	0.271
Moderate air disruption	0.188	0.379	0.177	0.256
Severe air disruption	0.161	0.434	0.187	0.219

7. SCENARIO STRESS TESTS AND REVENUE-PRESERVATION LOGIC

7.1 Demand redistribution under moderate and severe disruption

The scenario analysis uses the multinomial logit model to translate a friction shock into expected substitution. The baseline average predicted air share is 28.0%. Under moderate disruption, that falls to 18.8%; under severe disruption, it falls to 16.1%. The largest beneficiary is the train-like substitute, whose average predicted share rises from 29.5% to 43.4% under severe disruption. Bus also gains slightly, while car declines modestly in the severe scenario after an intermediate increase in the moderate scenario.

This result is economically meaningful even though the benchmark is not GCC-specific. It indicates that a sizeable share of exposed demand is not destroyed; it is reallocated. The managerial implication is direct: SMEs that can redirect customers quickly to lower-friction alternatives may preserve far more revenue than SMEs that wait for the original channel to normalize.

7.2 What the scenarios imply for commercially valuable customers

The severe scenario also reduces exposed-mode retention among higher-income air users. In the full sample, air remains one of the preferred modes for valuable customers under baseline conditions. Under severe disruption, however, the model indicates a pronounced migration toward train-like and car-like substitutes. That pattern supports H4 and matters for GCC businesses because premium or time-sensitive travelers often underpin event spending, destination packages, transfer services, and short-stay occupancy. Losing these customers entirely is much more damaging than losing low-yield discretionary traffic.

For this reason, the right resilience objective is not broad-based discounting. It is targeted preservation of commercially attractive customers through substitute itineraries, bun-

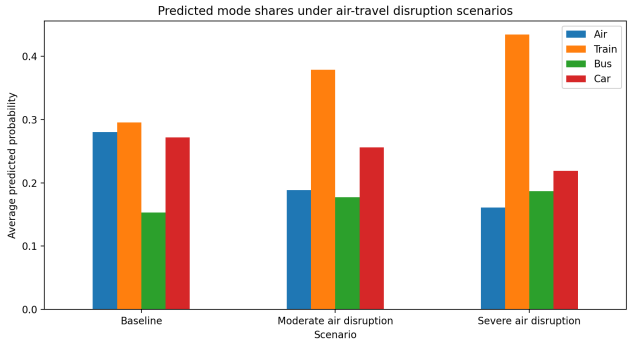

Figure 6. Predicted mode shares under air-travel disruption scenarios

dled transfers, flexible timing, and policy simplification. In business terms, the paper's central message is that continuity is a portfolio-redesign problem, not merely a marketing-communication problem.

8. COUNTERMEASURE PLAYBOOK FOR GCC SMES

The empirical evidence can be translated into a five-part playbook for GCC travel and tourism SMEs.

First, design substitute-ready offers before disruption occurs. If exposed air-linked demand begins to weaken, firms should already have rail-like, road-transfer, domestic-stay, or mixed-mode alternatives prepared. The scenario evidence suggests that lower-friction substitutes attract a meaningful share of the displaced portfolio.

Second, simplify the booking path during high-alert periods. Since friction variables dominate prediction, businesses should reduce decision complexity: fewer clicks, fewer approval steps, clearer cancellation rules, faster customer response, and more visible fallback options.

Third, segment customers by switchability rather than by value alone. High-income or group travelers may still convert if the alternative is packaged well. By contrast, some apparently valuable customers may be highly disruption-sensitive and difficult to retain. The implication is that SME dashboards should include a switchability layer in addition to classic customer-value metrics.

Fourth, use interpretable and predictive analytics together. The random forest model is excellent for identifying likely choices, but the multinomial logit model explains why scenario shares move. In practice, managers need both. A black-box alert without scenario translation is difficult to operationalize, while an interpretable model without strong classification may miss actionable signals.

Fifth, reposition the exposed mode as part of a resilient bundle rather than a stand-alone product. When one channel becomes unstable, firms can retain demand by bundling accommodation, flexible ground transfers, insurance, local experiences, or split-itinerary packages. This is especially relevant in GCC ecosystems where destination appeal can remain strong even when route confidence temporarily weakens.

9. DISTINCT CONTRIBUTION, BOUNDARIES, AND FUTURE WORK

The paper contributes in a deliberately different way from standard business forecasting articles. Its novelty does not lie in inventing a new algorithm. Instead, it lies in connecting public benchmark data, behavioral substitution analytics, and GCC-oriented SME continuity planning. The article demonstrates that even when region-specific microdata are unavailable, managers can still build meaningful stress-test logic from a comparable public dataset. That is a practical contribution for many emerging-market contexts in which proprietary data are scarce.

A second contribution is methodological translation. Much of the mode-choice literature is technical or planning-oriented; much of the tourism crisis literature is strategic or qualitative. This paper occupies the middle ground by using business data analysis to generate operational rules for service continuity. The outcome is not a transport policy conclusion but a portfolio-management conclusion: demand under disruption must be redirected, not simply awaited.

The study also has important boundaries. The benchmark comes from a comparable intercity case rather than GCC transactions, and the scenario magnitudes are synthetic rather than event-identified. As a result, the article should be read as a transferable business analytics template, not as a literal forecast of any specific geopolitical episode. Future work could improve on this foundation by integrating public GCC flight schedules, booking-platform data, hotel search intensity, or firm-level ticketing records as they become available. A second extension would connect substitution analytics to revenue management, allowing direct estimation of revenue-at-risk rather than mode share alone.

10. CONCLUSION

This paper has explored how GCC travel and tourism SMEs can be analytical in thinking about service continuity when regional disruption increases the friction of an exposed channel. The study demonstrated that reallocation of customers during disruption can be modeled to be predictive and managerially interpretable using a public and reproducible benchmark of travel mode-choice. The findings showed that ensemble models are very accurate in classification of the observed choices whereas multinomial logit is of particular use in translation of scenarios. On a drastic synthetic shock to air travel, the average forecasted air share decreased to 16.1 per cent, with the majority of the displaced demand shifting to train-like alternatives.

The management implication is simple. SMEs ought not to build resilience with the hope that the revealed demand would not fall in a crisis sensitive GCC environment. They need to be ready to divert it. Companies that establish substitute-ready bids, reduce the booking friction, classify consumers by switchability, and integrate predictive monitoring with interpretable stress testing will be in a better position to maintain their revenue during times of geopolitical uncertainty. In that regard, the paper provides a business analytics template of mitigating the commercial impacts of spillovers of regional conflict even in cases when the perfect local data are still unavailable.

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