Visualising Disruption Management: Integrating EDM and Justice Theory for Airport Rail Link Services

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ABSTRACT

This study investigates how Airport Rail Link (ARL) users without prior experience of service disruption evaluate disruption management strategies during unexpected disruptions. While previous studies have focused on passengers who have encountered disruptions, little is known about the expectations and perceptions of users who have never faced such events. Integrating the Expectancy Disconfirmation Model (EDM) with Justice Theory, this study examines the roles of normative expectations, perceived fairness and performance in shaping disconfirmation judgments. To address methodological challenges in capturing expectations for hypothetical scenarios, a comic-strip-based questionnaire was developed. This visual approach depicted realistic disruption scenarios and response actions, enabling respondents to assess fairness across distributive, procedural and interactional dimensions before comparing perceived performance with initial expectations. The instrument was pretested and piloted to ensure its clarity and feasibility in terms of timing. Data were collected from 290 ARL users who confirmed they had never experienced a service disruption. Responses were analysed using Partial Least Squares Structural Equation Modelling to test hypothesized relationships and mediation effects. Results reveal that perceived fairness of response actions strongly influences disconfirmation and fully mediates the effect of expectations, highlighting the critical role of performance perception in shaping judgments. Importance-Performance Map Analysis further identified perceived fairness as the most influential construct. The findings underscore the importance of transparent communication and fairness-driven response actions in building trust among regular users who may hold idealized expectations. From a methodological perspective, the study demonstrates the value of visual stated preference instruments for eliciting meaningful responses in hypothetical contexts. Practical implications include designing proactive communication strategies and fairness-oriented response measures to enhance resilience and user confidence in the face of unexpected disruptions.

Keywords: Airport Rail Link Service; Disruption Management; Expectancy Disconfirmation Model; Justice Theory; Visual Stated Preference Method

INTRODUCTION

Disruption management refers to the process of minimizing the cascading effects of service interruptions while operating within existing resource constraints (Osman et al., 2016). A significant challenge arises when disruptions occur unexpectedly, as opposed to planned disruptions (Kaewunruen & Osman, 2023). Unexpected disruptions pose a significant challenge for operators, particularly in time-sensitive transport systems, such as Airport Rail Link (ARL) services that connect metropolitan areas to airports. When ARL services fail without warning, passengers risk missing flights due to delays in reaching the airport and completing boarding procedures (Malandri et al., 2017). Unlike general rail disruptions, ARL failures carry heightened operational and temporal constraints, making practical response actions critical.

Previous studies have primarily examined service users who have experienced disruptions, focusing on how prior encounters shape expectations and satisfaction (Auld et al., 2020; Currie & Muir, 2017; Hien et al., 2024; Lu et al., 2025). These users may have a baseline understanding of how operators typically manage such situations, which leads to specific expectations regarding their responses. However, a substantial gap exists in understanding ARL passengers who regularly use the service but have never faced a disruption. These passengers often form normative expectations based on idealized assumptions or experiences with other transport modes rather than firsthand knowledge of ARL recovery processes (Hjortskov, 2020). Such expectations may overlook operational realities, such as the time required to arrange shuttle buses or coordinate alternative transport (Rahimi et al., 2019; Wang et al., 2022). When disruptions occur, these passengers' evaluations of fairness and performance can significantly influence their trust and loyalty, which are key factors in sustaining ridership and reputation (Hien et al., 2024).

The evaluation of response actions during disruptions necessitates a multidimensional approach that considers for both cognitive and fairness-based judgments (Yim et al., 2003). To assess these evaluations, this study integrates the Expectancy Disconfirmation Model (EDM) and Justice Theory. EDM provides a cognitive lens, positing that satisfaction results from the comparison between perceived performance and prior expectations (Oliver, 1980). The results of this comparison can be classified into three possible outcomes: positive disconfirmation occurs when perceived performance exceeds initial expectations. In this case, the response action "over-delivered," resulting in a pleasant surprise; negative disconfirmation occurs when perceived performance falls short of initial expectations. Here, the response action is "under-delivered", leading to dissatisfaction, and a simple confirmation occurs when the perceived performance aligns perfectly with the initial expectations. Justice Theory complements EDM by introducing three dimensions of fairness: distributive, procedural and interactional. As stated by Liao et al., (2022), distributive justice refers to the fairness of outcomes, such as compensation or alternate transport; procedural justice focuses on the fairness and transparency of the processes used to handle disruptions; and interactional justice assesses the quality of interpersonal treatment, emphasizing respect and empathy during recovery interactions. Integrating EDM and Justice Theory offers a multidimensional lens for understanding how passengers without prior experience judge response actions (Chih et al., 2012; Hien et al., 2024).

Traditional EDM studies rely on survey-based evaluations, often in textual form, allowing respondents to answer at their convenience (Van Ryzin, 2005). Nevertheless, this approach may fail to capture abstract scenarios for respondents lacking prior exposure (Cherchi & Hensher, 2015). To address this, the present study employs a visual approach using comic-strip narratives embedded in questionnaires. This design immerses respondents in realistic disruption scenarios, enabling them to evaluate response actions across fairness dimensions before comparing them to their expectations (Schiebler et al., 2025).

Accordingly, the objectives of this study are to: i) evaluate the EDM for ARL disruption management through the lens of Justice Theory, ii) investigate whether standard planned response actions effectively disconfirm normative expectations among ARL passengers without prior disruption experience, and iii) offer practical implications for ARL operators to build trust and confidence among this passenger segment. By focusing on this overlooked group, the study contributes to the literature by extending research beyond disruption-experienced users to include regular passengers who have yet to encounter service failures.

LITERATURE REVIEW

Capturing public expectations for unpredictable events presents methodological challenges. Revealed Preference (RP) instruments cannot capture choices of non-users or new alternatives, prompting the use of Stated Preference (SP) designs to elicit choices under hypothetical scenarios. Traditionally, these scenarios are presented in written form. Nonetheless, text-based approaches often fail to convey abstract concepts effectively to non-users, potentially compromising response quality. To help respondents grasp abstract disruption scenarios, transport researchers increasingly embed visual elements into surveys. For instance, Auld et al., (2020) visually presented disruption response options such as waiting for service restoration or using a shuttle bus, within survey instruments. Similarly, Kalyanpad et al., (2020) integrated the Google Maps API into RP and SP experiments to provide interactive, map-based questionnaires. These innovations aim to improve accuracy, facilitate understanding and create a more engaging user experience.

Beyond methodological considerations, theoretical frameworks guide the evaluation of service satisfaction. The EDM provides a cognitive basis for assessing discrepancies between perceived performance and initial expectations. A 2025 meta-analysis confirms strong positive links among expectations, perceived performance and satisfaction, particularly for predictive expectations and services, underscoring the relevance of EDM in service contexts, such as transportation (Schiebler et al., 2025). In the context of service recovery, EDM explains how users, particularly existing ones, form expectations about reliability and the response actions taken. These expectations may include assumptions about response speed, clarity of communication and assistance provided during delays (McCollough et al., 2000). When disruptions occur, users evaluate whether the operator's actions align with or exceed these expectations. For instance, quickly deploying shuttle buses and proactively rebooking flights can build trust and loyalty (Matikiti et al., 2018; Migacz et al., 2018).

While EDM helps capture the expectation-performance gap, it does not fully address perceptions of fairness, which are crucial during service failures (Migacz et al., 2018). Justice Theory offers the evaluative basis for fairness across three dimensions: distributive (outcomes/compensation), procedural (processes/policies) and interactional (interpersonal treatment). Effective communication and compensation can mitigate negative disconfirmation (Wang et al., 2022). In contrast, poor transparency and delayed responses exacerbate dissatisfaction, eroding trust and loyalty (Naohiko et al., 2017). Emerging evidence also shows that service users compare their treatment to others, shaping perceived justice across dimensions in multi-stage recovery processes which is relevant for crowded, time-pressured ARL disruptions (Aguilar-Rojas et al., 2024).

METHODOLOGY

This study employed a mixed-method approach, combining visual survey design and structural equation modelling, to examine how normative expectations influence perceived fairness and disconfirmation of response actions among ARL users without prior disruption experience. The methodology consisted of four key components: research model development, instrument design, data collection and data analysis, as illustrated in Figure 1.

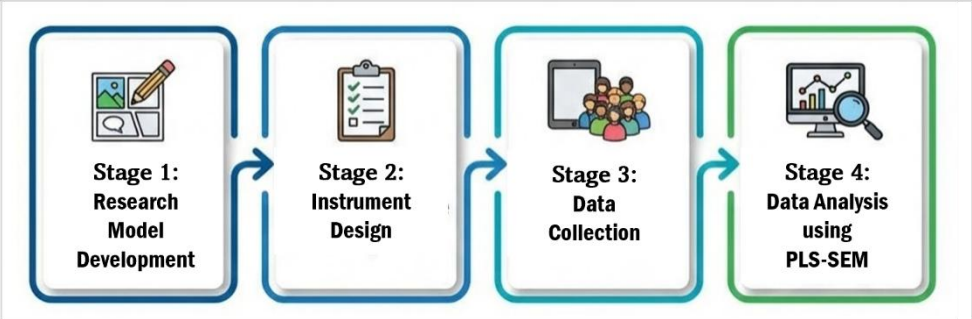

Figure 1: Sequential Stages of Research Methodology

Research Model

The conceptual model integrates the EDM with Justice Theory to capture both cognitive and fairness-based evaluations of response actions. Three primary constructs were operationalized:

i. Justice-based Expectations (EXP): Pre-formed beliefs about what constitutes a fair response during an unexpected disruption.
ii. Perceived Justice of Response Action (PCV): Evaluation of the fairness and appropriateness of the operator's actions as depicted in the scenario.
iii. Disconfirmation of Response Action (DSC): The extent to which PCV differs from initial EXP, indicating whether the response was better, worse or about the same as expected.

Based on these constructs, the following hypotheses were tested:

i. **H1**: EXP significantly influence DSC,
ii. **H2**: PCV positively affects DSC,
iii. **H3**: EXP positively influence PCV, and
iv. **H4**: PCV mediates the relationship between EXP and DSC.

Figure 2 illustrates how the EDM and Justice Theory jointly explain user disconfirmation during ARL service disruptions. EDM captures the expectation-performance gap, while Justice Theory addresses fairness across distributive, procedural and interactional dimensions, leading to disconfirmation.

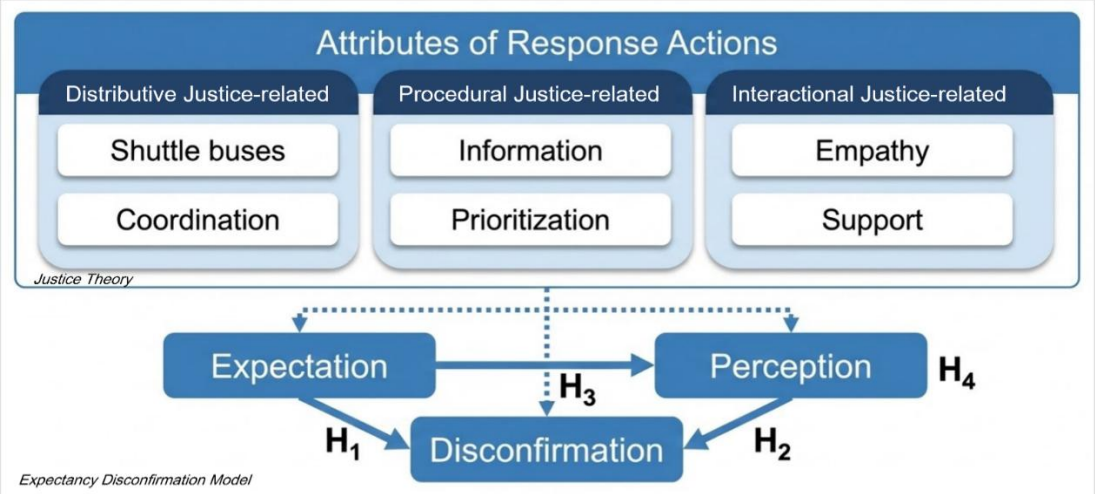

Figure 2: Conceptual Model Integrating Justice Theory Dimensions with the EDM To Explain How Response Actions Shape Expectations, Perceptions and Subsequent Disconfirmation.

Instrument Development

The creation of the comic strip narrative followed a structured framework adapted from Friesen et al. (2018), emphasizing the need for a detailed storyboard. The narrative was structured around three elements: transportation issue, people and information flow, following guidelines from Salomon and Singer (2011).

The story centres on Peter, a first-time user of the ARL service. He is initially scheduled to arrive at the airport with a comfortable 90-minute buffer before his flight's boarding time. Tension arises when a service suspension disrupts his plans. Peter's inexperience with the ARL operator's response procedures, combined with heavy rain outside the station, influences his critical decision. Rather than seeking alternative transportation, he decides to stay at the station. He is entirely reliant on the train operator's responses. This highlights user vulnerability during a service failure. The information flow element illustrates the crisis communication and response actions of the ARL operator, crafted using real-world procedures (Itani et al., 2019; Piner & Condry, 2017).

A hybrid workflow combining artificial intelligence with human illustration was employed to visually represent the narrative. Tools like StoryNest and StoryboardThat quickly generated visuals, which an illustrator then refined to enhance emotional depth and ensure contextual accuracy.

Finally, questionnaire items were anchored to specific points in the comic narrative to capture EXP, PCV and DSC sequentially. By anchoring the items to specific sequential points in the visual narrative, the instrument sought to capture immediate cognitive and emotional reactions rather than generalized post-hoc reflections. Questionnaire items were adapted from established service recovery literature (Chih et al., 2012; Matikiti et al., 2018; McCollough et al., 2000) and measured on a five-point Likert scale ranging from "*Strongly Disagree"* to "*Strongly Agree"*. The instrument was pretested by experts and piloted with 30 passengers to ensure clarity and the feasibility of timing. The comic-based questionnaire can be accessed at: https://forms.gle/e9soTHhmBBn9CPQKA

Data Collection

To mitigate potential response biases common in stated preference designs, several safeguards were implemented. First, the survey was distributed at major transit hubs in Kuala Lumpur to ensure respondents were in a 'commuter mindset'. Next, random distribution of QR codes allowed participants to complete the comic-based questionnaire at their convenience, reducing the likelihood of rushed or 'straightlined' responses. Finally, participants were required to indicate at the end of the questionnaire whether they had previously used a train to access the airport and confirm whether they had ever experienced a train service disruption.

Data Analysis

Data analysis utilized Partial Least Squares Structural Equation Modelling (PLS-SEM) to test hypothesized relationships among constructs and assess mediation effects. PLS-SEM was chosen for its ability to handle complex models that include latent variables, as well as its suitability for relatively small sample sizes. The implementation of PLS-SEM, facilitated by SmartPLS 4 software, follows a two-stage approach as recommended by Hair et al., (2017).

i. Measurement Model Assessment: The first stage evaluates the reliability and validity of the measurement model, encompassing assessments of indicator reliability, internal consistency reliability, convergent validity and discriminant validity.
ii. Structural Model Assessment: The second stage evaluates the structural model by examining the significance of the path coefficients (using bootstrapping), the coefficient of determination, and the model's predictive relevance.

After completing the model assessments, we conducted an Importance-Performance Map Analysis (IPMA). The primary objective of this analysis was to validate the relative importance and performance of EXP and PCV in influencing DSC among ARL users.

RESULTS

Out of the 650 invitation cards distributed, 557 individuals participated in the study, resulting in a participation rate of 86%. Among these participants, 290 individuals (approximately 53%) had no prior experience with ARL service disruption, which forms the relevant sample for this study. Importantly, the 290 participants provide sufficient statistical power for PLS-SEM analysis. The power analysis indicates that 90 participants are needed to achieve 80% statistical power at a 5% significance level for detecting R^2 values of 0.10. Thus, the structural model (as illustrated in Figure 3) can demonstrate adequate power to detect minimal effects and ensures reliable statistical outcomes.

Measurement Model Assessment

Before assessing the structural model, we evaluated the reliability and validity of the reflective measurement models for the three latent constructs: EXP, PCV and DSC. The results in Figure 4 show that all measurement constructs achieved high levels of internal consistency. The Cronbach's alpha values ranged from 0.788 to 0.858, while the Composite Reliability (CR) values fell between 0.875 and 0.894, both of which exceed the 0.70 threshold. The constructs demonstrated convergent validity, with Average Variance Extracted (AVE) values exceeding 0.50: 0.541 for EXP, 0.586 for PCV and 0.701 for DSC. This indicates that each construct accounts for over half of the variance in its indicators. Furthermore, the indicators displayed in Figure 3 show statistical significance with a *p*-value of less than 0.05, and most values exceed 0.7. The structural model still included indicators Exp1 and Exp2, despite their outer loadings being below 0.7, because their respective construct shows strong internal consistency and convergent validity.

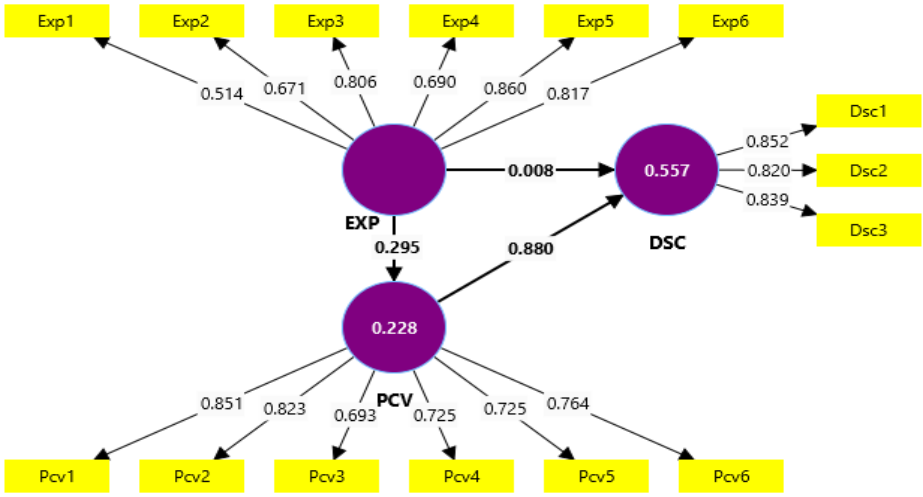

Figure 3: PLS-SEM Results Showing Indicator Outer Loadings, f^2 Effect Sizes on Paths and R^2 Values for Endogenous Constructs.

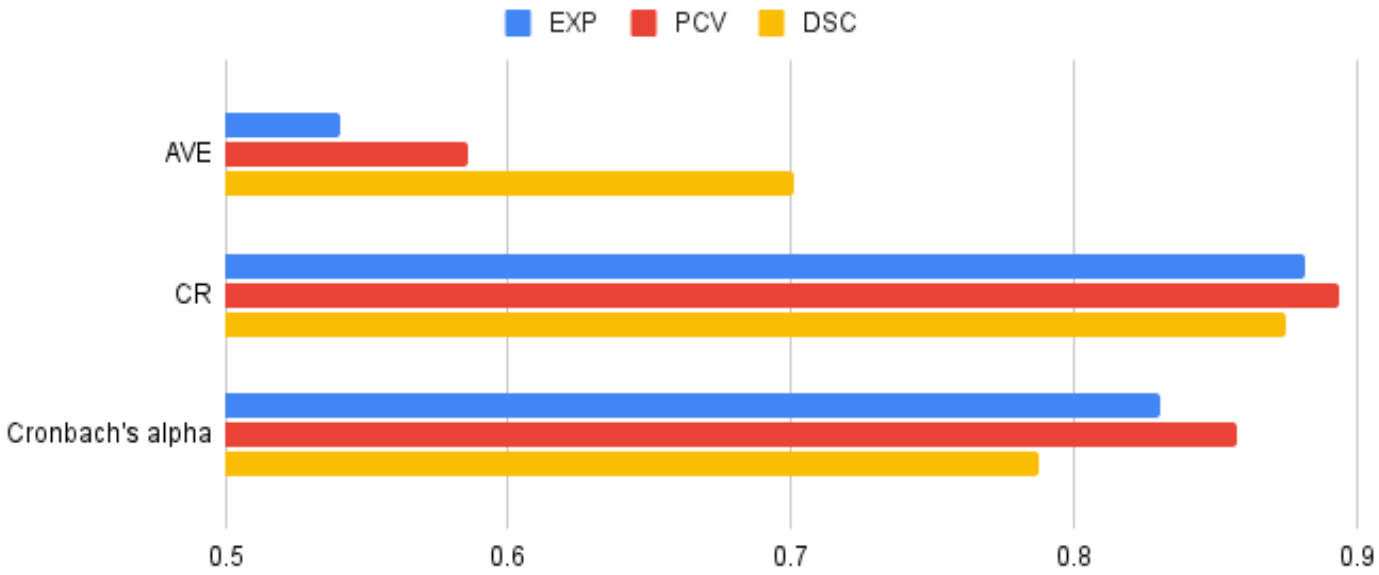

Figure 4: Reflective Measurement Model Results

Discriminant validity was confirmed using two approaches. First, the Fornell-Larcker criterion was satisfied, as the square root of each construct's AVE exceeded its correlations with other constructs (Table 1). Second, Heterotrait-Monotrait (HTMT) ratios (Table 2) were all below 0.90, confirming that the constructs are distinct.

Table 1: Discriminant Validity by Fornell-Larcker Criterion

Construct	**DSC**	**EXP**	**PCV**
DSC	0.837	-	-
EXP	0.409	0.736	-
PCV	0.744	0.477	0.766

Table 2: HTMT Ratio Results

Construct	**DSC**	**EXP**
EXP	0.443	-
PCV	0.884	0.510

Structural Model Assessment and Hypothesis Testing

The structural model was evaluated for multicollinearity, explanatory power and predictive relevance. VIF (Variance Inflation Factor) values (Figure 5) were well below the conservative threshold of 3.0, indicating no concerns about multicollinearity. The model explained 55.8% of the variance in DSC ($R^2 = 0.558$) and 22.8% of the variance in PCV ($R^2 = 0.228$). Stone-Geisser's Q^2 values for PCV (0.180) and DSC (0.358) exceeded 0.15, confirming predictive relevance.

Effect size analysis revealed that EXP had a negligible direct effect on DSC ($f^2 = 0.008$). At the same time, PCV exerted a powerful influence ($f^2 = 0.880$), surpassing Cohen's threshold for a significant effect (≥ 0.35). Bootstrapping results (Table 3) showed that the path from EXP to DSC was non-significant (*t*-value = 0.631, *p*-value = 0.528), so H1 was not supported. Conversely, PCV → DSC was positive and highly significant (*t*-value = 7.432, *p*-value < 0.001), providing support for H2. The path from EXP → PCV was also significant (*t*-value = 4.760, *p*-value < 0.001), supporting H3. Mediation analysis confirmed complete mediation. The indirect effect of EXP on DSC through PCV was significant (Indirect Effect = 0.339, *t*-value = 3.488, *p*-value < 0.01), with a 95% confidence interval [0.195, 0.560] that excluded zero. Therefore, H4 was supported.

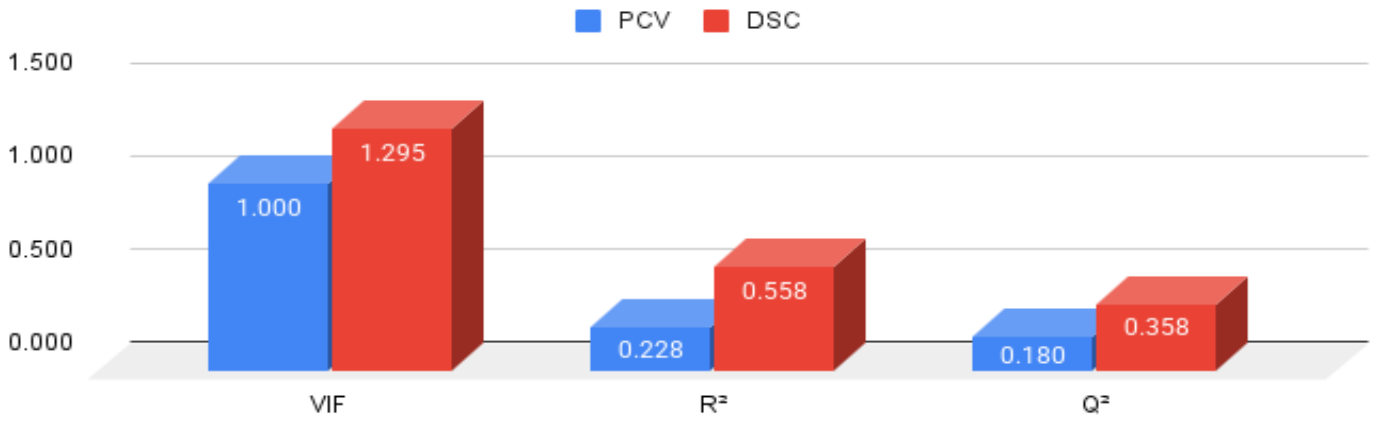

Figure 5: Endogenous Variable VIF, R^2 and Q^2

Table 3: Statistical Hypothesis Tests

Path	***β***	***t*-value**	***p*-value**	**Decision**
EXP → DSC	0.069	0.631	0.528	Not support H1
PCV → DSC	0.711	7.432	0.000	Support H2
EXP → PCV	0.447	4.760	0.000	Support H3
EXP → PCV→ DSC	0.339	3.488	0.001	Support H4

IPMA results (Table 4) validated the structural findings. PCV emerged as the most influential driver of DSC (importance score = 0.759), followed by EXP (importance score = 0.582). Performance scores were moderate and similar across constructs (PCV = 65.560; EXP = 68.698), indicating generally positive user perceptions.

Table 4: Importance and Performance Scores for Endogenous Variables

Construct	**Importance**	**Performance**
EXP	0.409	69.871
PCV	0.711	66.438

DISCUSSION AND MANAGERIAL IMPLICATIONS

The findings reveal that EXP did not have a direct influence on DSC (β = 0.069, *p*-value > 0.05). This finding diverges from prior research examining passengers who have experienced disruptions (Hien et al., 2024; Matikiti et al., 2018). A plausible explanation lies in the sample composition: respondents were train users who had never encountered a disruption. Their expectations were likely shaped by generalized assumptions or idealized service standards rather than firsthand experience with recovery processes. For example, the public may be unaware of the logistical constraints that ARL operators face, such as the limited time window for arranging shuttle buses during disruptions (Itani et al., 2019).

Interestingly, the total effect of EXP on DSC was fully mediated by PCV, as indicated by the significant indirect path (β = 0.339, *p*-value < 0.05). This suggests that passengers without disruption experience cannot accurately judge whether their expectations were met until they understand the operator's recovery measures. In this study, the comic-strip questionnaire played a pivotal role by visually depicting the disruption scenario and response actions through the lens of justice theory. This approach enabled respondents to evaluate performance across distributive, procedural and interactional dimensions before comparing it to their initial expectations.

The significant path from PCV to DSC (β = 0.711) underscores the critical role of performance perception in shaping disconfirmation judgments. IPMA further reinforces this finding, identifying PCV as the most influential

construct (importance score = 0.711), surpassing EXP (importance score = 0.409). These results align with established literature emphasizing the primacy of perceived performance in satisfaction and disconfirmation processes (McCollough et al., 2000).

From a managerial perspective, ARL operators should recognize that passengers who have never experienced disruptions may hold unrealistic expectations. Transparent communication strategies such as social media updates, website FAQs and visually engaging content, can help set realistic expectations and reduce uncertainty during disruptions. Specifically, tangible solutions such as shuttle buses (distributive justice), timely and accurate updates (procedural justice), and empathetic staff interactions (interactional justice) are essential for fostering positive perceptions. Failure to uphold these principles risks deterring regular users. In contrast, successful implementation can enhance the service's reputation and foster customer loyalty.

CONCLUSION

This study advances the understanding of disruption management in ARL services by focusing on passengers who have used the service but have never experienced a disruption; a group often overlooked in prior research. By integrating the EDM with Justice Theory, the findings reveal that justice-based expectations alone do not directly influence disconfirmation for this segment. These expectations, instead, can be disconfirmed when the service users are presented with clear and structured information about professional response actions, even under chaotic conditions.

From a practical perspective, ARL operators should prioritize proactive communication strategies and fairness-driven response actions to maintain trust among regular users who have never faced disruptions. Clear, timely updates and empathetic interactions can help manage normative expectations and foster confidence in the dace of unexpected service failures.

While this study provides foundational insights into Kuala Lumpur's transport infrastructure, the findings may reflect cultural and institutional norms specific to the Malaysian rail sector. Future studies should extend this framework to airport rail systems in diverse global contexts to account for variations in operational settings and passenger demographics, thereby enhancing external validity. Another promising avenue is to examine demographic differences, such as those between young university students and mature travellers, as these groups may exhibit distinct preferences for survey formats. Younger respondents might find visual narratives more engaging, whereas older travellers may favour traditional text-based questionnaires. Understanding these differences could inform the development of inclusive survey instruments and tailored communication strategies for disruption management.

Although this study did not directly compare comic-strip questionnaires with traditional text-based formats, the visual approach appears promising for immersing respondents in realistic disruption scenarios. By depicting both disruption events and response actions visually, the instrument enabled respondents to assess fairness across distributive, procedural and interactional dimensions before forming judgments. This suggests that visual survey designs may enhance stated preference research, particularly among respondents with limited prior exposure to service failures. A direct quantitative comparison between visual and text-based formats remains an important avenue for future research to isolate the effect size of visual elements. The current approach was adopted to mitigate cognitive barriers faced by non-users in complex disruption contexts.

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