

Research Article

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The Effects of Early Disruption Detection Capability and Resource Flexibility on Hospital Operational Resilience

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Abstract: Hospital operational resilience is essential for maintaining the continuity and quality of healthcare services when hospitals face unexpected disruptions. This study aims to examine the effects of early disruption detection capability and resource flexibility on hospital operational resilience. A quantitative research approach was employed, using a survey method to collect data from hospital respondents. The data were analyzed using multiple linear regression, supported by F-test, t-test, and coefficient of determination (R^2) analysis. The results of the F-test show that early disruption detection capability and resource flexibility simultaneously have a significant effect on hospital operational resilience, with an F-value of 10.684 and a significance value of 0.000. The partial test results indicate that early disruption detection capability has a positive and significant effect on hospital operational resilience, with a regression coefficient of 0.421, t-value of 2.763, and significance value of 0.010. Resource flexibility also has a positive and significant effect, with a regression coefficient of 0.356, t-value of 2.391, and significance value of 0.024. The coefficient of determination (R^2) of 0.442 indicates that the two independent variables explain 44.2% of the variation in hospital operational resilience, while the remaining 55.8% is explained by other factors outside the research model. These findings suggest that strengthening hospitals' ability to detect potential disruptions early and improving flexibility in managing resources can contribute to enhancing operational resilience and supporting the continuity of hospital operations.

Keywords: early disruption detection capability; resource flexibility; hospital operational resilience.

Introduction

Hospitals operate within an environment characterized by high uncertainty, interdependence, and the continuous demand for essential services. Unlike many other organizations, hospitals cannot simply suspend their operations when disruptions occur because interruptions in critical services may directly affect patient safety, treatment continuity, and access to care (Amalia & Putri, 2026). Disruptions may arise from a wide range of sources, including sudden increases in patient demand, shortages of healthcare personnel, failures of information systems, medical supply constraints, infrastructure problems, infectious disease outbreaks, and other external shocks. The increasing complexity of healthcare delivery therefore requires hospitals not only to maintain routine performance but also to develop the capacity to sustain essential operations when normal conditions are disrupted (Jasmin et al., 2025).

In this context, hospital operational resilience has become an important organizational capability. Operational resilience extends beyond the ability to recover after a disruption has occurred. It concerns the capacity of an organization to anticipate potential disturbances, absorb their effects, respond appropriately, adapt its operations, and restore or maintain critical functions under changing conditions. For hospitals, this capability is particularly important because operational failure may have consequences that extend beyond financial or organizational performance to patient outcomes and the continuity of essential healthcare services (Yualita, 2025). Consequently, resilience should not be viewed merely as a response mechanism but as a proactive and adaptive capability embedded in everyday hospital operations (Huda, 2023).

However, the ability of hospitals to remain resilient may depend on what happens before a disruption becomes a critical operational problem. One important capability in this regard is early disruption detection capability, namely the organizational ability to identify weak signals, deviations, emerging risks, and changes in operational conditions before they escalate into major disruptions (Kessi, 2026). In a hospital environment, early indications may emerge from changes in patient flows, staffing conditions, equipment performance, supply availability, information-system incidents, or other operational signals. The ability to recognize such signals provides management with an opportunity to intervene earlier and potentially limit the scale and consequences of disruption. Thus, operational resilience may be shaped not only by how quickly a hospital responds to a disruption, but also by how effectively it recognizes that a disruption is developing in the first place (Inaya et al., 2024).

Nevertheless, early detection alone does not guarantee operational resilience. Identifying a potential disruption has limited value if the organization lacks the capacity to reconfigure its resources in response to changing circumstances. This makes resource flexibility another critical dimension of hospital resilience. Resource flexibility refers to the ability to reallocate, adjust, combine, or redeploy available resources according to changing operational requirements. In hospitals, this may involve adjusting staff allocation, modifying service capacity, reallocating equipment, changing workflows, or mobilizing alternative resources when conventional arrangements become inadequate. Such flexibility allows hospitals to translate information about emerging disruptions into concrete operational adjustments rather than merely recognizing the existence of a problem (Rassi, 2022).

The relationship between these capabilities becomes particularly important because hospital disruptions are rarely isolated events with predictable consequences. A disruption detected at an early stage may still generate substantial operational pressure when the organization cannot rapidly adjust its resources. Conversely, highly flexible resources may not be utilized effectively when emerging threats are not recognized in sufficient time. This suggests that hospital operational resilience may emerge from the combination of anticipatory capability and adaptive capacity: the former enables organizations to recognize potential disruption before it escalates, while the latter enables them to modify their operations when existing arrangements are no longer appropriate (Anggarawati et al., 2025).

Despite the growing attention to organizational resilience in healthcare, an important research issue remains. Existing discussions of healthcare resilience have frequently emphasized preparedness, crisis response, recovery, or broader organizational capabilities, while the specific contribution of early disruption detection capability and resource flexibility to operational resilience requires further empirical examination. Moreover, these two capabilities represent different but potentially complementary mechanisms. Early detection addresses the question of *when and how an organization recognizes emerging disruption*, whereas resource flexibility addresses *how the organization can adjust its operational resources once changing conditions are identified*. Examining these capabilities simultaneously is therefore important for understanding whether hospital resilience is primarily associated with the ability to recognize disruption early, the ability to adapt resources, or both (Wangke et al., 2025).

This issue is particularly urgent because healthcare organizations face a fundamental operational constraint: they must remain functional while simultaneously managing uncertainty and changing demand. A hospital that detects disruption too late may have limited time to prevent cascading operational effects, while a hospital with rigid resource configurations may struggle to translate early warnings into effective action. The consequences are not limited to internal efficiency; prolonged operational disruption can affect service continuity, waiting times, workload distribution, resource availability, and ultimately the hospital's

ability to deliver safe and timely care. Strengthening resilience therefore requires a shift from a predominantly reactive perspective toward a capability-based perspective that considers both the anticipation of disruption and the flexibility to adapt operations (Sintesa et al., 2026).

Based on this perspective, this study examines the effects of early disruption detection capability and resource flexibility on hospital operational resilience. The study seeks to provide empirical evidence on whether the ability to detect emerging disruptions and the ability to flexibly manage operational resources contribute to hospitals' capacity to sustain and adapt their operations under uncertain conditions. Theoretically, this study contributes to the healthcare resilience literature by positioning operational resilience as an outcome of both anticipatory and adaptive organizational capabilities. Practically, the findings are expected to provide hospital managers with a more specific basis for strengthening resilience not only through crisis response and recovery mechanisms, but also through systematic early detection and flexible resource management embedded in routine operations.

Literature Review

Hospital Operational Resilience

Hospital operational resilience refers to the ability of hospitals to maintain the continuity of critical operations, respond to disruptions, and adapt operational processes to changing conditions. In healthcare settings, resilience is particularly important because disruptions in staffing, infrastructure, information systems, medical supplies, or patient demand can affect the continuity and quality of healthcare services. Therefore, operational resilience is not limited to the ability to recover after a disruption but also includes the capacity to anticipate and adapt to emerging operational challenges (Pentariputri et al., 2021).

Early Disruption Detection Capability

Early disruption detection capability refers to the ability of an organization to identify emerging disruptions, operational deviations, and early warning signals before they develop into more severe operational problems. In hospitals, this capability can be reflected in the ability to monitor changes in patient demand, staffing conditions, equipment performance, supply availability, and other operational indicators. Timely identification of potential disruptions provides hospital management with an opportunity to take preventive or corrective actions before the disruption significantly affects critical services (Hidayah, 2026).

Early disruption detection is therefore closely associated with operational resilience because the effectiveness of organizational response depends partly on how early a potential disruption is recognized. Hospitals that can identify emerging problems earlier are expected to have greater opportunities to prepare responses, allocate resources, and minimize the operational consequences of disruptions. Thus, the following hypothesis is proposed (Maryatun & Ningsih, 2019):

H1: Early disruption detection capability has a positive effect on hospital operational resilience.

Resource Flexibility

Resource flexibility refers to the ability of an organization to adjust, reallocate, and utilize its resources according to changing operational requirements. In hospitals, resource flexibility may involve the redistribution of healthcare personnel, adjustment of service capacity, utilization of alternative equipment, or reallocation of supplies when operational conditions change. Such flexibility enables hospitals to respond

to variations in demand and resource constraints without substantially interrupting critical services (Abdi et al., 2025).

Resource flexibility is relevant to operational resilience because hospitals require the ability to adapt their operational configurations when existing resources are insufficient or disrupted. Flexible resource allocation allows hospitals to respond more effectively to unexpected changes and maintain essential functions despite operational disturbances. Accordingly, hospitals with greater resource flexibility are expected to demonstrate stronger operational resilience (Purwadhi et al., 2025).

H2: Resource flexibility has a positive effect on hospital operational resilience.

Method

This study employed a quantitative cross-sectional design to examine the effects of early disruption detection capability and resource flexibility on hospital operational resilience. The study was conducted at Hospital X. The respondents consisted of 30 hospital employees who were directly involved in hospital operational and service activities. Respondents were selected using purposive sampling based on their involvement in daily hospital operations and their ability to assess operational conditions within the hospital.

Data were collected through a structured questionnaire consisting of statements measuring three variables: early disruption detection capability, resource flexibility, and hospital operational resilience. Each item was assessed using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire items were adapted from relevant literature and adjusted to the hospital context.

Data analysis was conducted using descriptive statistics and multiple linear regression. Validity and reliability tests were performed to assess the quality of the measurement instrument, followed by classical assumption tests before regression analysis. The regression analysis was used to examine the partial and simultaneous effects of early disruption detection capability and resource flexibility on hospital operational resilience. Statistical significance was evaluated at a 5% significance level.

Results and Discussion

Respondent Characteristics

Table 1. Characteristics of Medical Staff Respondents (n = 30)

Characteristics	Category	Frequency (n)	Percentage (%)
Gender	Male	9	30.0
	Female	21	70.0
Total		30	100.0
Age	< 30 years	12	40.0
	30–40 years	11	36.7
	> 40 years	7	23.3
Total		30	100.0
Education	Diploma	8	26.7
	Bachelor's degree	18	60.0
	Master's degree	4	13.3
Total		30	100.0
Length of Employment	< 5 years	13	43.3
	5–10 years	10	33.3

Characteristics	Category	Frequency (n)	Percentage (%)
	> 10 years	7	23.3
Total		30	100.0

The results indicate that the majority of respondents were female (70.0%), while male respondents accounted for 30.0%. In terms of age, most respondents were under 30 years old (40.0%), followed by those aged 30–40 years (36.7%) and above 40 years (23.3%). Regarding educational background, the majority of respondents held a bachelor's degree (60.0%). In terms of employment duration, 43.3% of respondents had worked for less than five years, while 33.3% had 5–10 years of experience and 23.3% had more than 10 years of experience. Overall, the respondent characteristics indicate that the participants had varied demographic and professional backgrounds. The inclusion of respondents with different levels of age, education, and work experience provides diverse perspectives in assessing early disruption detection capability, resource flexibility, and hospital operational resilience.

Validity Test

The validity test was conducted to determine whether each questionnaire item appropriately measured the intended research construct. The validity of the instrument was assessed using the Pearson Product-Moment correlation between each item score and the total score. With 30 respondents and a significance level of 5%, the critical value of the correlation coefficient (r-table) was 0.361. An item was considered valid when the r-count was greater than the r-table value.

Table 2. Validity Test Results

Variable	Item	r-count	r-table	Decision
Early Disruption Detection Capability	X1.1	0.684	0.361	Valid
	X1.2	0.721	0.361	Valid
	X1.3	0.756	0.361	Valid
	X1.4	0.693	0.361	Valid
Resource Flexibility	X2.1	0.718	0.361	Valid
	X2.2	0.782	0.361	Valid
	X2.3	0.741	0.361	Valid
	X2.4	0.695	0.361	Valid
Hospital Operational Resilience	Y1	0.763	0.361	Valid
	Y2	0.801	0.361	Valid
	Y3	0.746	0.361	Valid
	Y4	0.779	0.361	Valid

The validity test results show that all questionnaire items obtained r-count values greater than the r-table value of 0.361. Therefore, all items used to measure early disruption detection capability, resource flexibility, and hospital operational resilience were declared valid and suitable for further analysis.

Reliability Test

The reliability test was conducted to assess the internal consistency of the questionnaire items used to measure each research variable. Reliability was evaluated using Cronbach's Alpha, with a coefficient greater than 0.70 considered to indicate acceptable reliability.

Table 3. Reliability Test Results

Variable	Number of Items	Cronbach's Alpha	Decision
Early Disruption Detection Capability	4	0.842	Reliable
Resource Flexibility	4	0.876	Reliable
Hospital Operational Resilience	4	0.891	Reliable

The results indicate that all variables obtained Cronbach's Alpha coefficients above the minimum threshold of 0.70. Early disruption detection capability, resource flexibility, and hospital operational resilience therefore demonstrate satisfactory internal consistency. Accordingly, the questionnaire was considered reliable and suitable for subsequent statistical analysis.

Normality Test

The normality test was conducted using the One-Sample Kolmogorov-Smirnov test to determine whether the data were normally distributed. The data are considered normally distributed when the Asymp. Sig. (2-tailed) value is greater than 0.05.

Table 3. Normality Test

Parameter	Value
Number of Observations (N)	30
Mean	0.000
Standard Deviation	1.000
Test Statistic (D)	0.116
Asymp. Sig. (2-tailed)	0.200

The results show that the Kolmogorov-Smirnov test statistic was 0.116, with an Asymp. Sig. (2-tailed) value of 0.200. Since the significance value is greater than 0.05, the data are considered to be normally distributed. Therefore, the normality assumption is satisfied and the data can be used for further statistical analysis.

Multicollinearity Test

The multicollinearity test was performed to determine whether a high correlation existed among the independent variables in the regression model. Multicollinearity was assessed using the Tolerance and Variance Inflation Factor (VIF) values. A regression model is considered free from multicollinearity when the Tolerance value is greater than 0.10 and the VIF value is less than 10.

Table 4. Results of the Multicollinearity Test

Independent Variable	Tolerance	VIF
Early Disruption Detection Capability	0.681	1.469
Resource Flexibility	0.746	1.341

The results show that the Tolerance values for both independent variables were above 0.10, while the VIF values were below 10. These findings indicate that the regression model did not experience multicollinearity. Therefore, early disruption detection capability and resource flexibility can be analyzed simultaneously as independent variables in the regression model.

Heteroscedasticity Test

The heteroscedasticity test was conducted using the Glejser test to determine whether the regression model exhibited unequal variance of residuals. The model is considered free from heteroscedasticity when the significance value of each independent variable is greater than 0.05.

Table 5. Results of the Heteroscedasticity Test

Independent Variable	Sig.
Early Disruption Detection Capability	0.284
Resource Flexibility	0.417

The results show that the significance values of early disruption detection capability and resource flexibility were 0.284 and 0.417, respectively. Both values are greater than 0.05, indicating that the regression model does not exhibit heteroscedasticity. Therefore, the assumption of homoscedasticity is satisfied and the regression analysis can be continued.

Multiple Linear Regression Analysis

Multiple linear regression analysis was conducted to examine the effect of early disruption detection capability and resource flexibility on hospital operational resilience. The regression model was used to determine the direction and magnitude of the relationship between the independent variables and the dependent variable.

Table 7. Multiple Linear Regression Analysis

Variable	Coefficient (B)	t-value	Sig.
Constant	4.218	2.184	0.038
Early Disruption Detection Capability	0.421	2.763	0.010
Resource Flexibility	0.356	2.391	0.024

The regression results indicate that early disruption detection capability has a positive coefficient of 0.421 with a significance value of 0.010. This indicates that an improvement in early disruption detection capability is associated with an increase in hospital operational resilience. Resource flexibility also shows a positive coefficient of 0.356 with a significance value of 0.024, indicating that greater flexibility in managing organizational resources is associated with higher operational resilience.

Based on these results, the regression equation can be expressed as:

$$Y = 4.218 + 0.421X_1 + 0.356X_2$$

where Y represents hospital operational resilience, X_1 represents early disruption detection capability, and X_2 represents resource flexibility. The positive coefficients indicate that both independent variables have a positive relationship with hospital operational resilience. Among the two predictors, early disruption detection capability has a relatively larger regression coefficient, suggesting a stronger contribution to operational resilience within the observed sample.

Hypothesis Test

F-Test

The F-test was conducted to determine whether early disruption detection capability and resource flexibility simultaneously affect hospital operational resilience. The decision criterion was based on the

significance value, where a significance value below 0.05 indicates that the independent variables jointly have a significant effect on the dependent variable.

Table 7. F-Test Results

Model	F-value	Sig.
Regression	10.684	0.000

The results show that the regression model has an F-value of 10.684 with a significance value of 0.000. Since the significance value is less than 0.05, early disruption detection capability and resource flexibility simultaneously have a significant effect on hospital operational resilience. Thus, the regression model is statistically significant and both independent variables jointly contribute to explaining variations in hospital operational resilience.

T-Test

The t-test was conducted to determine the partial effect of each independent variable on hospital operational resilience. The decision criterion was based on a significance level of 5%. An independent variable is considered to have a significant partial effect when the significance value is less than 0.05.

Table 8. Results of the Partial Regression Coefficients (t-Test)

Independent Variable	Coefficient (B)	t-value	Sig.
Early Disruption Detection Capability	0.421	2.763	0.010
Resource Flexibility	0.356	2.391	0.024

The results indicate that early disruption detection capability has a t-value of 2.763 with a significance value of 0.010. Since the significance value is below 0.05, early disruption detection capability has a positive and significant partial effect on hospital operational resilience. Therefore, H1 is supported. Resource flexibility has a t-value of 2.391 with a significance value of 0.024. The significance value is also below 0.05, indicating that resource flexibility has a positive and significant partial effect on hospital operational resilience. Therefore, H2 is supported. Overall, the t-test results demonstrate that both early disruption detection capability and resource flexibility individually contribute significantly to hospital operational resilience.

Coefficient of Determination (R^2)

Table 7. Coefficient of Determination (R^2)

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
Regression Model	0.665	0.442	0.400	2.115

The results show that the regression model obtained an R^2 value of 0.442, indicating that early disruption detection capability and resource flexibility jointly explain 44.2% of the variation in hospital operational resilience. The remaining 55.8% is explained by other factors that are not included in the research model. The adjusted R^2 value of 0.400 indicates that after adjusting for the number of independent variables included in the model, the explanatory power of the model remains at 40.0%.

The R value of 0.665 indicates a moderate-to-strong relationship between early disruption detection capability, resource flexibility, and hospital operational resilience. Overall, the coefficient of determination indicates that the two independent variables provide a meaningful contribution to explaining hospital operational resilience.

Conclusion

Based on the results of the hypothesis testing, it can be concluded that early disruption detection capability and resource flexibility have an important role in strengthening hospital operational resilience. The F-test results show that both independent variables simultaneously have a significant effect on hospital operational resilience, as indicated by an F-value of 10.684 and a significance value of 0.000. This finding confirms that the regression model is statistically significant and that early disruption detection capability and resource flexibility jointly contribute to explaining variations in hospital operational resilience.

The partial hypothesis testing further demonstrates that both independent variables have positive and significant effects on hospital operational resilience. Early disruption detection capability has a positive effect, with a regression coefficient of 0.421 and a significance value of 0.010. Similarly, resource flexibility has a positive effect, with a regression coefficient of 0.356 and a significance value of 0.024. Therefore, H1 and H2 are supported. These findings indicate that hospitals with stronger capabilities to identify potential disruptions at an early stage and greater flexibility in managing and reallocating resources tend to demonstrate higher levels of operational resilience.

Furthermore, the coefficient of determination (R^2) of 0.442 indicates that early disruption detection capability and resource flexibility jointly explain 44.2% of the variation in hospital operational resilience, while the remaining 55.8% is attributable to other factors outside the research model. The adjusted R^2 of 0.400 indicates that the model retains an explanatory power of 40.0% after considering the number of independent variables included. Overall, the findings confirm that strengthening early disruption detection capability and resource flexibility can contribute significantly to improving hospital operational resilience.

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