

Effects of Big Data, Mechanical System Flexibility, IOT and Digital Twin Adoption on Company Resilience and Operational Performance

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ABSTRACT

Purpose: The main purpose of this paper is to examine the effect of mechanical digital twin, mechanical system flexibility, IoT, and big data analytics on operational performance. The study also examined the mediating effect of organizational resilience in the proposed framework. **Design/ method/ approach:** The present research adopted a quantitative approach and survey methods to gather responses from respondents. The population of the study consisted of employees working in organizations. Convenience sampling was used for the collection of responses. A total of 202 responses were used for analysis purposes. AMOS was used for assessment of analysis. **Findings:** Results showed that organizational resilience has positive effect on operational performance. Moreover, IoT, Big data analytics capability, mechanical digital twin, and mechanical system flexibility have positive effect on operational performance. Findings also supported mediating effect of organizational resilience. **Originality:** Present study adds to the body of literature by exploring mediating role of organizational resilience.

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1. Introduction

The markets of the present digital age are characterized by personalization of products and shorter product life cycles. Global competition among organizations at the international level is mounting, which creates pressure on the resource efficiency of organizations to stay competitive and meet customer demand. To address these challenges, organizations need to adapt their strategies to improve their operational performance. In all sectors, operational performance is considered a widely accepted and recognized element of success (Fayyaz et al., 2025). Operational performance is the point at which different units of the organization work together to achieve certain goals. Organizations need to focus on development and adopt an innovative approach to improve operational performance (Buer et al., 2021). The element of operational performance is dependent on different factors like technological and mechanical factors.

In the present digital age, big data analytical capabilities are important to develop innovation and sustain competitive advantage for the long-term period. Data is considered as the lifeblood of organizations with the usage of technology in almost every industry. Organizations that are unable to use technology in their operations are unable to perform well in the competitive market. At the global level, big data analytical capability is one of the focus areas for managers at the global level, as a number of studies have mentioned the importance of big data in decision making. On the other hand, it is complex to understand the nexus between sustainable innovation and big data analytical capability. The combination of big data analytics with sustainability is viewed as important for economic prosperity with social well-being and environmental preservation. It is challenging for developing economies to adopt factors that are important for big data analytical capability (Novicka & Volkova, 2025). As a result of big data analytic capabilities, organizations are able to provide long-term solutions to customers that impact their overall performance.

Therefore, organizations across different industries are taking actions to incorporate big data analytics into their operations globally today (Arshad et al., 2024). On the other hand, big data also expands opportunities for the rise of different technologies in the market.

Factor of Internet of Things is also one of the factors that impact organizational operational performance. The Internet of things is network of different objects that communicate through internet between devices and person. Most organizations view internet of things as one of the big evolutions in technology. With the help of Internet of things, an individual can control and monitor different objects remotely. It is expected that business strategies and operations of the organizations are affected by internet of things and other related technologies. Internet of things get the attention of organizational decision makers as it is one of the important sources of strategic advantage. In other words, Internet of things is one of the important sources of competitive advantage of the organization. It has the ability to change future market and provide big business opportunities for organizations (Zein & Karimah, 2025). Therefore, it is important for organizations to align their strategies with the development of the Internet of Things. Organizations can make strategic decisions efficiently and effectively through this alignment. Organizations can identify problems and sustain competitive advantage as well through the integration of the Internet of Things (Vafaei-Zadeh et al., 2025).

There are different technologies that are employed by organizations for the completion of projects. It is also dependent upon the stage of the project that leads to the usage of mechanical digital twins in the project (Menegon & Isatto, 2023). Mechanical digital twin in the business has the ability to help at the design phase before beginning of physical part of the project. Mechanical Digital twin is used for the expansion and repair phase as well (Fan et al., 2025). Departments working on a project are connected with the mechanical digital twin, which helps managers to monitor the real-time situation of a project. Some studies have mentioned that the mechanical digital twin is important for enhancing the life cycle of the project, indicating its significance for project management.

Mechanical system flexibility shows the effectiveness and efficiency of machines when they perform multiple operations, respond to alterations in production mix and volume, and accommodate different designs for organizations (Wehrle et al., 2021). Flexibility enables the system to handle system requirements and manage variations in the project. Mechanical flexibility is an important factor that describes the level to which different equipment can execute tasks efficiently and economically. Every sector around the globe is becoming increasingly demanding and uncertain (Atli & Krystallis, 2025). Therefore, mechanical system flexibility is considered one of the important sources of competitive advantage. Flexible mechanical systems allow organizations to sustain operational performance, reduce downtime, and improve responsiveness under challenging circumstances.

In recent years, the factor of resilience has gained importance for organizations across different sectors. Resilience is one of the ways to survive in difficult situations and thrive through turbulence and adversity (Sethi et al., 2025). Resilience is linked to multi-ranged change phenomena, including general types of change, disruptive events, surprises, and unexpected events. Moreover, resilience is linked to different environmental characteristics, namely turbulent and uncertain environments, complex environments, and dynamic environments (Capoani et al., 2025). The factor of resilience is different in terms of every industry as it is mainly dependent on capabilities and resources of the organization that differ among organizations and industries also. The aim of this paper is to examine the effect organizational resilience, IoT, big data analytical capabilities, mechanical digital twins, and Mechanical System Flexibility on operational performance.

2. Review of Literature

2.1 Organizational Resilience (ORS) and Operational Performance

Operational performance is described in literature as measurable factor of processes of organizational outcomes including inventory turns, production cycle time and reliability (Okumu, 2022). Operational performance is the gauge regarding performance of business in its core and daily activities. operational performance at the optimum level guarantees the employee engagement, customer satisfaction and maximum profit. In other words, these three are aligned with the operational efficiency, and internal processes. Some of the authors have defined OR as organizational ability to anticipate, recover from, adapt to, and withstand from disruption while meeting performance targets and operational continuity (Manzini et al., 2025). In recent years, the concept of industry 4.0 is one of the factor that leads to performance improvement.

In present volatile business conditions including economic shocks, technological failures, and supply chain interruptions, resilient organizations are in better position to protect critical processes, minimize downtime, and sustain stable operations. ORS is developed through supportive organizational culture, adaptive decision making, flexible operational structures and proactive risk management that enables rapid recovery and response (Rashed et al., 2025). This stability has direct positive impact on operational performance by improving responsiveness, reliability and

efficiency. Therefore, resilient organizations mostly learn from different kinds of disruption. Therefore, they refine their operational routines that later strengthen their long-term productivity and innovation process. ORS enables them to absorb different shocks without significant losses in customer service, quality and output. Furthermore, resilience reduces chances of variability and operational risks. As a result, ORS play the role of strategic capability to safeguard operational continuity, improve delivery performance, flexibility, quality, cost control, and process effectiveness (Garrido-Moreno et al., 2024). The study by Werner et al. (2021) and Haddad and Hassan (2025) mentioned the positive effect of ORS on operational performance. Therefore, we hypothesize that

H1: ORS has positive effect on Operational performance.

2.2 Big Data Analytics capability (BDA) and Organizational Resilience (ORS)

BDA is based on talent capability, technology and management of big data analytics (Qaffas et al., 2023). Likewise, scholars proposed that big data analytical capability is based on talent abilities, technical abilities and management abilities. Studies has defined big data analytical capability as ability of the organization to deploy, integrate and assemble its resources of big data (Su et al., 2022). The dimensions of big data analytics include data driven decision culture, big data managerial skills, and technical skills (Lin et al., 2025). ORS is significantly effected by BDA through improvement of recovery from, respond to and anticipate to disruption. With the help of technical skills and analytical tools organizations are able to interpret, process and collect large volumes of environmental and operational data, speed, visibility, and increasing transparency of information flow. It enables managers to find out warning signals at early stage, understand complex independencies, monitor risks in real time and make organizations proactive (Kong & Feng, 2025).

The decision culture that is data driven also makes strong proactive reliance through integration of evidence-based reasoning into routines of organizations. When organizational and strategic decisions are dependent on data, organizations develop stronger foresight and awareness that allows them to anticipate different kinds of disruption. It also allows them to evaluate different alternatives in case of any problem. It provides support to the design of robust business and flexible strategies (Onesi-Ozigagun et al., 2024). Later, impact of different shocks in terms of operation and negative economic impacts are reduced. Organizational performance is also improved because of proactive resilience. By keeping operations during difficult situations, organizations are able to preserve market share, protect revenue streams, and minimize cost of downtime (Martín-Rojas et al., 2023). Additionally, resilient organizations mostly show superior decision making because managers are able to conduct assessment about risks, and planning of different scenarios that lead to higher quality and faster response in case of uncertainty. Overall, ORS is strengthened through BDA by timely decision making, informed decision making, supporting continuity planning, fostering proactive behavior and enhancing transparency (Lin et al., 2025). The study by Wided (2023) mentioned positive effect of big data analytical capability on OR. Thus, this research hypothesised that

H2: BDA has positive effect on ORS.

2.3 IOT and Organizational Resilience

Internet of Things (IoT) has the ability to improve our daily lives and revolutionary industries with increased convenience and efficiency for all kinds of enterprises. In literature, IoT is referred to as network of different devices that is used to connect different objects with software, connectivity and sensors allowing organizations to connect and exchange data with the help of internet (Vadivel et al., 2026). IoT devices can minimize uncertainty and improve operational efficiency as data is processed efficiently. With devices that are IoT enable productivity is improved, and processes are automated. IoT has significant effects on ORS by enhanced data driven decision making, operational flexibility, real-time visibility and technological capacity. IoT connected systems and enabled sensors provide continuous information about market conditions, supply chains and operations during situation of crisis (Idrissi et al., 2024). This monitoring on real time basis improves operational efficiency and situational awareness which is important factor of ORS.

For organizations, adoption of IoT provides support in adaptive resilience by improving their chance to handle environmental changes. Although adoption of technology mostly follows probable patterns. Therefore, organizational readiness provides benefits in terms of their operations (Morchid et al., 2024). Effective implementation of IoT equips organizations with different tools to adjust strategies and analyze operational data in response to volatility of market. Therefore, capacity to perform tasks is increased. By leveraging data insights and connectivity, organizations are able to develop new services and products, collaboration with partners and explore new markets to develop innovative solutions. Organizations having string IoT capability often develop competitive advantage by improving innovation, continuity and responsiveness (Babu et al., 2024). Therefore, IoT plays the strategic role to improve OR (Shoomal et al., 2024). The study by Ahmed (2025) mentioned in empirical study that IoT has positive influence on ORS.

H3: IoT has positive influence on ORS.

2.4 Mechanical Digital Twin and Organizational Resilience

Studies mentioned that digital twin technology is developed from tools of information monitoring with the help of internet connection, IoT deployment and digital simulation. Mechanical digital twins has the ability to address different issues related to construction sector to improve productivity (Xu et al., 2023). The construction process is improved with the help of mechanical digital twins. A mechanical digital twin has the ability to show asset behavior. Mechanical digital twin can enhance customers' experience as organizations try to minimize cost do they can remain competitive. Mechanical digital twin can better predict analytics by predicting future projections (Amer et al., 2026). Mechanical digital twin adoption improves ORS by proactive decision-making predictive analytics and real time monitoring in all types of industries. Mechanical digital twin develops a virtual duplicate of different physical assets that helps in maintenance of history and operational systems through data integration (Ebiloma et al., 2025).

Mechanical digital twin makes ORS string by providing support to response planning and risk anticipation. Through scenario analysis and simulation, mechanical digital system allows organizations to test alternatives, demand variability, supply interruptions and machine breakdowns by developing strategies in advance (Bongomin et al., 2025). Therefore, preparedness and adaptive capacity are improved as a response. Past empirical studies also support relationship between mechanical digital twin and ORS. Study by Bellavista et al. (2021) showed mechanical digital twin has positive influence on factories of industry 4.0. Additionally, Hasan and Crawford (2025) revealed that adoption of mechanical digital twin enhances recovery capability, adaptation and anticipation. In other words, mechanical digital twins have positive influence on ORS.

H4: Mechanical digital twins have positive effects on ORS.

2.5 Mechanical System Flexibility and Organizational Resilience

Mechanical system flexibility is the ability of a system to manage uncertainty and variability in grid, supply and demand in all timeframes. Scholars have defined mechanical system flexibility as ability of a system to cost effectively and reliably manage uncertainty and variability of supply and demand across all relevant times (Babatunde et al., 2020). Mechanical system flexibility plays very important role in improving ORS by enabling organizations to recover, absorb and adapt from disruption (Rahimazar et al., 2024). ORS is only an attribute of system but also shows the resilience of employees who manage, operate and design them. In industrial and mechanical settings, operational and managerial teams should show high resilience in important situations, because their responses impact systems remain functioning experience failure or under stress. In this scenario, flexibility is one of the defining factors of resilient in mechanical systems as it keeps internal mechanism to adapt to changing conditions whereas, keeping essential functions even of the operational performance of organization is declined. In case of external pressures including system failures, market volatility and technological change exceed capacity of systems resistance. In other words, rigid systems are highly likely to collapse (Settembre-Blundo et al., 2021).

From strategic point of view, ORS determines the capacity of organization to effectively respond to contextual feedback and environmental pressures. Therefore, mechanical system flexibility plays the role of important enabler regarding ORS by allowing organizations to efficiently respond rapidly to disruption and attain optimum performance. investment in innovative system and flexible technology has the ability to enhance reduce vulnerability and adaptive capacity to shocks. Organizations having complex infrastructure where flexibility can be embedded at the stage of planning ensures ORS. Research by Ghomi et al. (2023) empirically finds that system flexibility has positive effect on OR. Likewise the study of Rahimazar et al. (2024) and Shojaee et al. (2025) reported mechanical system flexibility have positive impact on organizational resilient. On the basis of above discussion, we assume that

H5: mechanical system flexibility has positive effect on ORS.

2.6 Mediation of Organizational Resilience

OR has the ability to act as mediator and develop link between BDA and operational performance by allowing organizations to convert analytical capabilities into recovery and adaptive oriented actions. As BDA enhances ability of organizations to generate actionable insights, anticipate operational disruptions and sense environmental changes. These capabilities do not translate into operational performance directly. Improvement in operational continuity, reliability, and efficiency are realized when data-based insights are integrated within organizational processes that help continuous learning, process stability, rapid response and support flexibility (Bhuiyan et al., 2025).

By providing strength to adaptive capacity and preparedness at the level of operation, ORS alters analytical intelligence into effective actions and decisions. Therefore, it ensures operational performance through ORS.

Mediating role of ORS is empirically discussed in literature. Study by Jangsiriwattana (2021); Malik and Garg (2020); Al-Mahrouqi et al. (2023) empirically mentioned mediating role of OR.

H6: Organizational Resilience is a significant mediator between Big Data Analytics and operational Performance.

Studies mentioned that ORS has the ability to mediate between IoT and operational performance by allowing organizations to change data driven and real time insights into responsive and adaptive capabilities. IoT technologies improve visibility of operation through regular monitoring of operations and helps in early findings of possible disruptions at the level of operations (Mashat et al., 2024). Whereas IoT technologies capability creates improvement in operational performance in situations when organizations develop routines and resilient structures that provide support to operational response rapidly, resource reconfiguration and continuous operations during unexpected shocks. By mechanisms of recovery, flexibility and learning, ORS converts IoT adoption into operational actions, thus ensuring sustainable operational performance. Studies by Malik and Garg (2020); Al-Mahrouqi et al. (2023) discussed mediating effect of ORS.

H7: Organizational Resilience is a significant mediator between IOT and Operational Performance.

ORS has the ability to bridge the gap between mechanical digital twin and operational performance. It is because ORS enables the organizations to convert real time monitoring and simulation-based insights into recovery and adaptive oriented operational actions. Mechanical digital twins enhance scenario analysis, system visibility and predictive maintenance that allows organizations to anticipate failure of equipment and disruptions of operations (Amer et al., 2026). Whereas mechanical digital twin improves operational performance when technology is embedded within operations of resilience supporting flexibility under stressful situations.

By recovery, learning and preparedness, ORS shape digital twins into sustainable operational performance, improved efficiency and operational stability un dynamic environment. Studies revealed mediating role of operational performance empirically. Research by Jangsiriwattana (2021); Malik and Garg (2020) mentioned mediating effect of ORS.

H8: organizational Resilience is a significant mediator between Mechanical Digital Twin and Operational Performance.

The link between mechanical system flexibility and operational performance (Silva & FERREIRA, 2017) can be potentially mediated by ORS as it converts technical adaptability into capabilities of operational response. Flexible mechanical systems help organizations in rapid alteration in operating conditions, process configuration and production volumes in response to unexpected disruption and demand variability.

Whereas operational performance improvement is achieved in case of integration between resilient operational routines that support recovery, learning, timely response and anticipation (Rashed et al., 2025). Through alignment of mechanical adaptability with decision making processes and resilient operational structures, ORS converts mechanical system flexibility into stable operational outcomes, operational reliability and sustained efficiency.

H9: Organizational Resilience as significant mediator between Mechanical System Flexibility and Operational Performance.

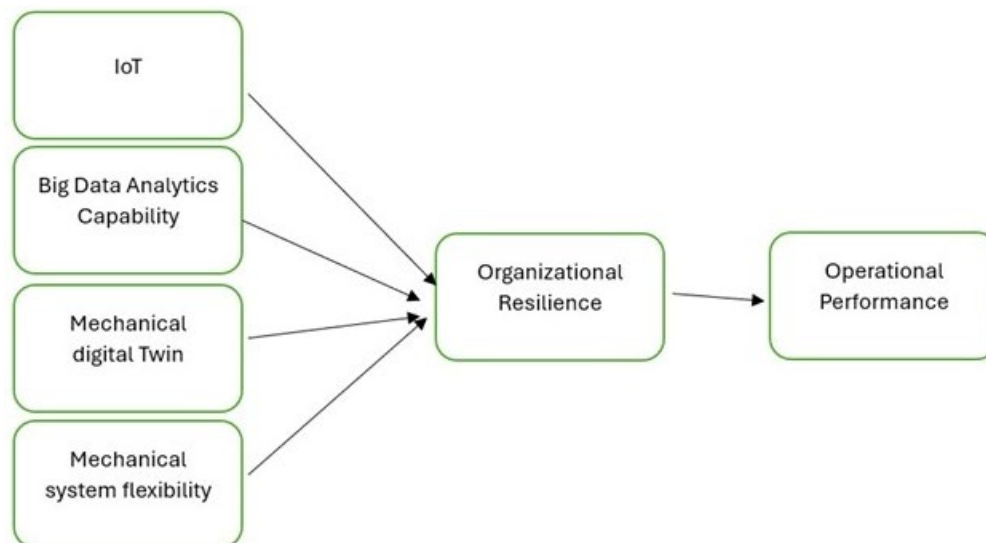


Figure 1: Framework

Based on above discussion, Figure 1 is developed showing framework of the study

3. Methodology

Quantitative research methodology was used for the current study. Additionally, for collection of data present research used survey instruments. Scale from the literature review was adopted to be used in survey. On the other hand, convenient sampling technique was used for collection of data. 265 questionnaires were distributed among the managers of construction organizations and 202 usable responses were received back. These responses were analyzed using AMOS.

3.1 Measurements

Researchers used quantitative research design and measured the latent variables with the well-developed scale adapted by previous researcher. Five points Likert scale was used *IoT* as the future use of IOT and measured with four items scale used by Rotsios et al. (2025), *Big data analytics capability* measured by 3 items scale used by Maroufkhani et al. (2020). *Digital twin* measured by 9 items scale used by Ebiloma et al. (2025). *Mechanical system flexibility* measured by 5 items scale used by Zhang et al. (2003). Operational Performance of organization measured by four items scale used by de Souza Miguel and Brito (2011). Organizational resilience measured by 9 items scale used by Kantur and Say (2015). All the measurements had good reliability and validity in the existing research.

3.2 Data Analysis

According to Table -1, 52.1% were male respondents and 47.9% were female, as regard to the age 28.6% were between 15 to 22, 27.2% were between 23 to 30, 31.3% were between 31 to 38 and 12.9% were above 39 years. 24.4% were having HSSC, 29.5% were BS, 17.9% were MS, and 28.1% were PhD respondents.

Table 1: Demographic Characteristics

Variant	Class	N	%
Gender	Male	113	52.1%
	Female	104	47.9%
Age	15–22 years	62	28.6%
	23– 30 years	59	27.2%
	31– 38 years	68	31.3%
	Above 39 years	28	12.9%
Education	HSSC	53	24.4%
	BS	64	29.5%
	MS	39	17.9%
	PhD	61	28.1%

Testing the demographic characteristics of the respondents leads to further data analysis strategies like testing of convergent and discriminant validity and reliability.

3.3 Reliability and Validity

Table -2 demonstrates the constructs' reliability and validity Matthews et al. (2018) to test the convergent reliability researcher evaluated the CR, for the construct to be convergent valid value of CR should be greater than or equal to 0.70 and for the validity testing value of AVE (average variance extracted) should be greater than 0.50 (Hair Jr et al., 2020). After performing CFA in AMOS researcher tested the convergent and discriminant validity and reliability with the help of factor loadings of the items with respect to their latent variables. From Table 2 it is evident that all the items have loadings greater than 0.60 and the reliability greater than 0.70 thus retained in the study for further analysis. We can see that the value of AVEs for all latent variables is greater than 0.50 (see figure 2).

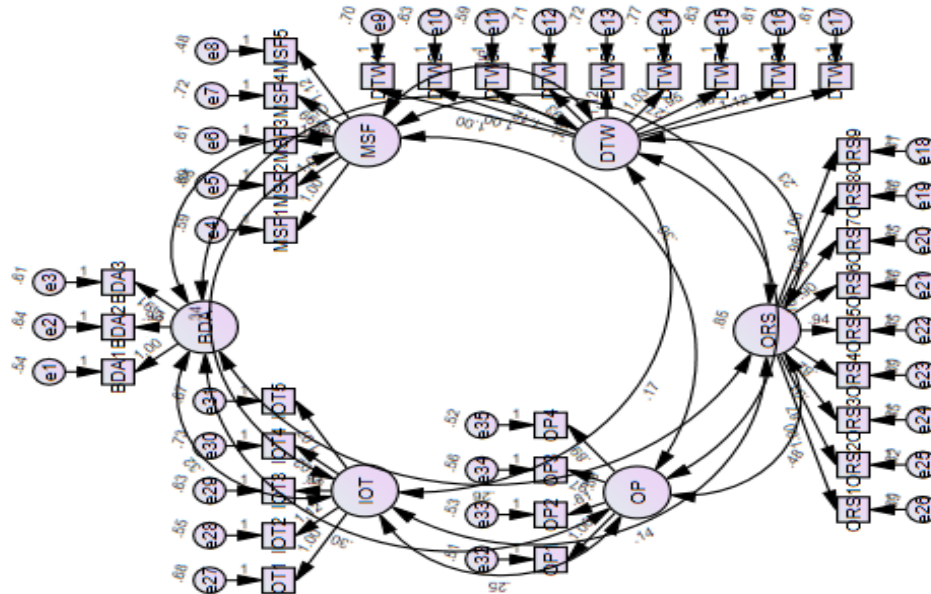


Figure 2: Confirmatory Factor Analysis

Table 2 (a): CFA, Factor Loading

Variable	Items	Loading	AVE	CR
IOT (IOT)			0.53	0.85
	IOT1	.870		
	IOT2	.746		
	IOT3	.634		
	IOT4	.665		
	IOT5	.697		
Big data Analytics Capability (BDA)			0.54	0.78
	BDA1	.717		
	BDA2	.792		
	BDA3	.699		
Mechanical Digital Twin (DTW)			0.55	0.91
	DTW1	.726		
	DTW2	.745		
	DTW3	.791		
	DTW4	.700		
	DTW5	.760		
	DTW6	.719		
	DTW7	.726		
	DTW8	.731		
	DTW9	.786		
Mechanical System Flexibility (MSF)			0.50	0.84
	MSF1	.691		
	MSF2	.682		
	MSF3	.730		
	MSF4	.751		
	MSF5	.691		
Organizational Resilience (ORS)			0.53	0.91
	ORS1	.743		
	ORS2	.690		
	ORS3	.744		
	ORS4	.733		

Table 2 (b): CFA, Factor Loading

Variable	Items	Loading	AVE	CR
Operational Performance (OP)	ORS5	.698	0.52	0.81
	ORS6	.721		
	ORS7	.711		
	ORS8	.767		
	ORS9	.743		
	OP1	.732		
	OP2	.747		
	OP3	.707		
	OP4	.685		

3.4 Discriminant Validity

For the validation of discriminant validity and reliability, researchers compared the values of AVEs for the related constructs with the correlation among variables. the values of AVEs taken at the diagonal and the values for the correlation given below diagonal (Fornell & Larcker, 1981). For the validation of discriminant validity, the values of AVEs compared with the values of correlation. The values at the diagonal should be greater than correlation. Table-3 demonstrates that the discriminant validity established for the given constructs.

Table 3: Discriminant Validity

	i.	ii.	iii.	iv.	v.	vi.	α
IOT	0.53						0.82
BDA	0.32	0.54					0.83
DTW	0.36	0.31	0.55				0.92
MSF	0.31	0.37	0.36	0.50			0.90
ORS	0.35	0.39	0.41	0.38	0.53		0.86
OP	0.28**	0.34	0.31	0.22	0.26	0.52	0.79

Table-3 shows that discriminant validity confirmed, all values at the diagonal are greater than 0.50 and moves from 0.50 to 0.55, are greater than the values of squared correlations. All the values of reliability are greater than 0.70 moves from 0.79 to 0.92 (Hair Jr et al., 2020).

3.5 Model Testing

Researcher tested the model using Structural equation modelling in AMOS.

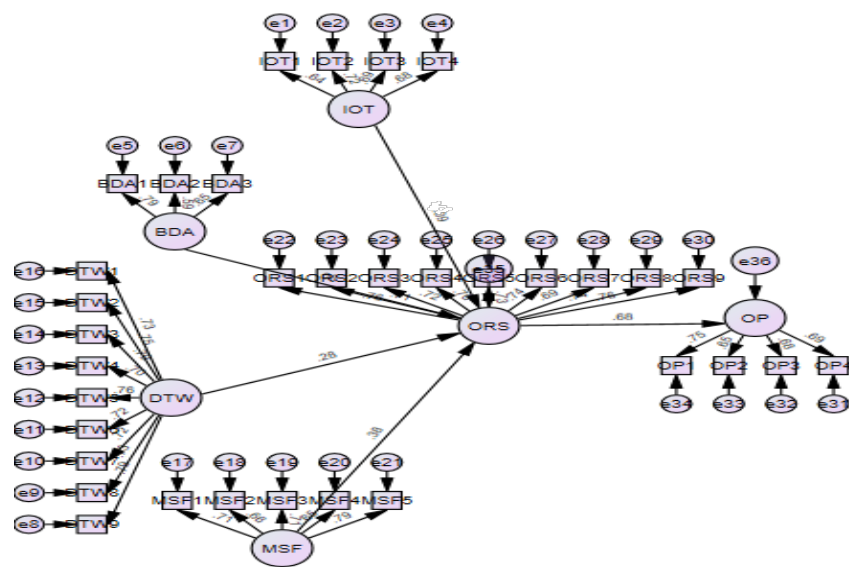
**Figure 3: Model Test**

Figure. 3 shows the testing of hypothesized models and standardized estimations. From Table 4 we can see that the tested model is good fit model having all the fitness indicators in good range. demonstrate the model testing and the values of standardized estimates, Values of GFI, TLI, CFI, NFI, greater than 0.80 demonstrating a good fit model (Anderson & Gerbing, 1988).

Table 4: Model Fitness

RMSEA	CFI	IFI	GFI	AGFI	TLI
0.023	0.86	0.91	0.87	0.85	0.97

In the below Table-5, given the estimates of direct and indirect effects of the hypothesised model.

Table 5: Direct and Indirect Effects

Independent Variable	Dependent Variable	Mediator	Effect
IOT	Organizational Resilience		0.39**
BDA			0.56**
DTW			0.28*
Mechanical System Flexibility			0.36**
Organizational Resilience	Operational Performance	Organizational Resilience	0.68**
IOT			0.265*
BDA			0.380*
DTW			0.190*
Mechanical System Flexibility			0.245*

Table-5 shows that IOT positively significantly affects organizational resilience with effect 0.39 and significant at 1%. big data adoption positively significantly effects the organizational resilience with effect 0.56 and significance at 1%. Mechanical Digital twin positively significantly effects the organizational resilience with effect 0.28 and significance at 5%. Mechanical system flexibility positively significantly affects the organizational resilience with effect 0.36 significant at 1%. Organizational resilience positively significantly affects the operational performance with effect 0.68 and significant at 1%.

Organizational resilience positively significantly mediates the link between IOT and the operational performance with effect 0.265 and 5% significant. Organizational resilience positively significantly mediates the link between big data adoption and the operational performance with effect 0.380 and 5% significant. Organizational resilience positively significantly mediates the link between digital twin and the operational performance with effect 0.190 and significance 5%. Organizational resilience positively significantly mediates the link between Mechanical system flexibility and the operational performance with effect 0.245 and significance 5%.

4. Discussion

This research examined effect of IoT, DTW, BDA and mechanical system flexibility on organizational resilience and operational performance. The results of the study shows that organizational resilience has positive effect on operational performance. organizations with higher organizational resilience often reflects more ability to enhance and maintain operational performance in situations of environmental change, disruption and uncertainty. Organizations are able to identify potential risks because of organizational resilience that later enables them to effectively respond to operational shocks. Moreover, organizations are able to adapt internal processes without having any major economic loss. Therefore, operational performance of organization improves because of better utilization of resources and reduced downtime.

Furthermore, recovery and learning mechanism is supported by organizational resilience that later provides strength to operational routines with the passage to time leading to long term improvement in operational performance. Resilient organizations are in better position to coordinate functional activities, realign operational priorities and reconfigure workflows that directly enhances operational performance in the form of service quality, reliability and efficiency. The findings of the study also suggests that organizational resilience plays the role of strategic capability that converts organizational responses into superior and stable operational performance. Thus, investment of firms in organizational resilience will lead to higher operational performance. These findings are supported by Haddad and Hassan (2025) from the literature.

The results of the findings support the hypothesis that IoT has positive influence on organizational resilience as revealed in the study of Ahmed (2025). The result of the study indicates that IoT technologies help firm to improve their organizational resilience by enabling then for rapid response, regular monitoring and real-time data collection at the stage of operational disruptions. With the help of IoT enabled system organizations often get improved visibility throughout the supply chains, and processes that strengthen organizational resilience by helping proactive risk management and timely decision making.

Furthermore, IoT integration improves organizational resilience by providing support to efficient resource coordination, early detection system failure, and predictive maintenance. Organizations are allowed through these capabilities to quickly adapt according to unexpected events and environmental conditions. The findings also reveals that IoT also contributes to recovery and learning mechanisms because gathering data through platforms of IoT helps in analysing disruption within organizations and develop strategies to respond. The results demonstrate that IoT plays an important technological role to enable organizational resilience. Through integration of IoT in strategic and operational processes, organizations have the ability to sustain operational performance.

The findings show that big data analytics capability has positive effect on organizational resilience Wided (2023). The possible reason for these findings can be the big data analytics capability strengthen organizational ability to respond unexpected situations and interpret complex data. Opposite to traditional information system, big data analytics capability allows organizations to handle unstructured and large volume of data, allowing deeper analysis into weak and emerging risk situations. By enhanced scenario analysis and forecasting, big data analytics capability provides support in terms of decision-making that later contributes directly to organizational resilience.

Moreover, organizational resilience is improved through big data analytics capability by providing facility in operational responses, strategic alignment and coordination. Data driven insights developed with the help of big data analytics capability allows organizations to adjust priorities, redesign processes and reallocated resources in real time. As a result of this dynamic responsiveness, organizational resilience is enhanced. Moreover, organizational is improved as well by reducing operational shocks and reaction time. Big data analytics capability also promotes learning within the organization that later effect the outcomes.

The results of this research revealed that mechanical digital twin has positive effect on organizational resilience as demonstrated by Hasan and Crawford (2025). The findings indicates that mechanical digital twin is strong predictor of organizational resilience by enhancing foresight, control and visibility in all systems. Mechanical digital twin system regularly shows the behavior and condition of all equipment that allows organizations to locate performance deviation in the beginning stage. This regular loop of feedback developed through mechanical digital twins provides strength to organizations resilience by minimizing chances of break down.

Moreover, mechanical digital twin allows organizations to handle stress scenarios, load variations and mechanical failures that improves adaptive capacity and preparedness. By regularly using mechanical digital twins, organizations mostly optimize mechanical configurations, refine maintenance schedule and evaluate response strategies. The insights developed through mechanical digital twins also have positive influence on organizational resilience by enhancing coordination among different operational units. Therefore, organizations relying on mechanical digital twins allowing organizations to respond to risks in proactive manner.

The results of the study demonstrate that mechanical system flexibility has positive effect on organizational resilience. Similar findings are also discussed in study of Shojaei et al. (2025) in past. The possible reasons for these findings can be that mechanical system flexibility enables firms to alter mechanical operations in case of changing environment. Higher mechanical system flexibility helps organizations to adapt mechanical processes, reconfigure equipments and modify production volumes without any delay. As a result of this adaptability, organizational resilience is strengthened without any vulnerability.

Also, mechanical system flexibility provide support to organizational resilience by ensuring fast response to variability of demand, process interruptions and equipment failures. When mechanical system flexibility is integrated with basic organizational operations, organizations are in better position to handle turbulent situations. These results suggests that mechanical system flexibility improves problem solving and learning because flexible systems allows mechanical configurations. With application of mechanical system flexibility in the organizational operations, organizations develop adaptive routines and capabilities to handle stressful situations. So, mechanical system flexibility has very important role to play in enhancement of organizational resilience.

The results also demonstrate mediating role of organizational resilience between IoT and operational performance. The results shows that IoT capabilities of the organization can lead to improved operational performance, but they have to go through organizational resilience. By providing support to organizational resilience, real time insights are created through IoT that later convert faster recover in case of disruption. This mediating finding highlights that organizational resilience is one of the important factor in the relationship between IoT and operational performance.

The results also shows that organizational resilience mediates between big data analytics capabilities and

operational performance. The findings reflect that organizational resilience is important to mediate between big data analytics capabilities and operational performance. As big data analytics capabilities develop valueable patterns and predictions, organizational resilience has the ability to control operations under pressure. With the help of resilient structure rapid adjustment in priorities and processes become possible. By using this pathway, operational performance is enhanced indirectly through big data analytics capabilities.

The findings of the study also support the mediating effect of organizational resilience between Mechanical Digital Twin and operational performance. The findings show that mechanical digital twin helps in providing predictive insights, simulation and advanced monitoring. Operational performance of organization is possible in case of resilient processes of organizations. With the help of organizational resilience, organizations are enabled to convert digital twins into recovery actions, decision making, and timely responses. By using this mediating relationship, operational performance is strengthened through mechanical digital twin through organizational capacity to absorb pressure leading to sustained operational performance.

The results also support mediating role of organizational resilience between mechanical system flexibility and operational performance. These findings explain the way technical adaptability is converted into outcomes linked to performance. Despite adjustment in processes and equipments is allowed by mechanical system flexibility, operational performance of organizations is improved in case of resilient priorities and coordination. It is ensured through organizational resilience that flexible mechanical response is implemented on regular basis minimizing variation in performance. This mediation result show that operational performance is strengthened through resilience rather than alone role of mechanical system flexibility. These mediating results are aligned with Rashed et al. (2025).

5. Limitations and Future Directions

Limitations and the way to handle mentioned limitations will be highlighted in the section. This research is showing relationships between four independent variables one dependent variable and one mediator. It is proposed to add one moderating variable in same framework upcoming studies. Moreover, present study has used two IT related variables namely IoT and big data analytics capability. It is proposed to use other variables like blockchain as IV in future.

This study used AMOS for the analysis of data collected from respondents. It is proposed to conduct analysis of the similar studies in future through Smart PLS 4 or Process MACROS. Additionally, this study used two mechanical variables like flexibility and digital twins. Future studies may add more variables related to mechanics in their studies. In the end, this research is quantitative by nature, it is proposed to use mixed methodology for more in-depth opinion collection of the respondents.

6. Theoretical and Managerial Contribution

This section discusses managerial and theoretical implications of present study. This research extend literature by discussing mechanical system flexibility, mechanical digital twin, big data analytics capability and IoT in a single framework. These results highlight the key role of organizational resilience to enhance operational performance. By discussing mediating effect of organizational resilience, this research enrich the literature of operations and information system in process to improve operational performance.

In terms of managerial implications, the research provides guidelines to the managers and decision makers to invest in mechanical systems and digital technologies to enhance operational performance. Managers of organizations should give priority to organizational resilience for the transformation of mechanical adaptability and technological factors into improved operational performance.

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