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AUTOMATION IN SUPPLY CHAIN AND ITS IMPACT ON WORKFORCE RESILIENCE

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ABSTRACT

What happens to people when the machines get smarter? This is the important question behind this study. As supply chain operations move rapidly towards automation in India, IoT – enables tracking, robotic warehousing, AI driven forecasting etc., there are plenty of research on how it helps to improve efficiency. Where less attention goes towards the workforce navigating the changes every day.

The study examines the impact of automation in supply chain processes on workforce resilience among 280 employees across organizations in Bangalore. Automation and workforce resilience are positively linked. All the four hypotheses are supported. Automation has a significant positive relationship with employee adaptability, job security perception, learning and skill level. Training and organization support emerges as a critical factor, with the strongest correlation to employee adaptability. But the variance is not everything, workforce resilience is shaped by many factors such as personal motivation, organizational culture, life experience. The takeaway for organizations is to invest in people along with technology.

KEYWORDS: *Supply Chain Automation, Workforce Resilience, Employee Adaptability, Job Security, Industry 4.0, Bangalore*

INTRODUCTION

In the last five years, supply chain operations across India have changes faster than most people expected. E-commerce grew 25% annually, warehousing went from manual to semi-automated in many Bangalore facilities. Companies like Flipkart and Amazon built fulfilment centres where robots do a significant portion of the sorting. Yet walk into a mid-sized manufacturing company's logistics department, and it will still find people tracking shipments on Excel spreadsheets. Automation adoption in Indian supply chains is uneven, some organizations are ahead, many are catching up and a few have not started.

Due to growing globalization, technology improvements and regular disruptions like pandemics, geopolitical conflicts and climate related disasters, global supply chains have grown more complex and susceptible in recent years. Organizations are increasingly implementing supply chain process automation to improve responsiveness, efficiency and visibility in order to address these issues (Christopher & Peck 2004, Ivanov & Dolgui, 2020). Supply chain operations have been completely transformed by automation, which has progressed beyond simple mechanization to encompass cutting edge technology like artificial intelligence (AI), robotic process automation (RPA), the internet of things (IoT) and data analytics (Ghobakhloo et al. 2023)

The use of digital technologies to carry out and optimize tasks like demand forecasting, inventory management, procurement, logistics and distribution with little assistance from humans is known as supply chain automation. According to studies, automation increases supply chain network coordination, decreases errors, lowers operation expenses and improves accuracy (Telukdarie 2021, Kazancoglu et al 2023). Furthermore, real time data sharing and predictive decision making, both crucial for handling uncertainty and disruptions are made possible by automated systems (Ivanov & Dolgui, 2020)

Automation has well established operational benefits, but recent study has focused more on how it affects the human workforce. Within supply chain functions, automation dramatically changes job positions, skill requirements and work structures (Brougham & Haar, 2018). Employees are moving toward analytical, supervisory and decision-oriented roles as routine and repetitive tasks become more automated. But this shift also brings up issues with employee resistance to technological change, sill obsolescence and job instability (Sobczak, 2022).

In order to manage these changes, the idea of worker resilience has become crucial. The ability of workers to adjust, bounce back and maintain productivity in the face of organizational and environmental disturbances is known as workforce resilience (Lengnick Hall et al. 2011). A resilient workforce is crucial in supply chain settings for preserving continuity, handling unforeseen disturbances and making efficient use of automated technology (Ambrogio et al. 2022). According to research human adaptation are just as vital in ensuring resilience as technology (Romero & Stahre, 2021).
According to recent research, the implementation of automation can either increase or decrease workforce resiliency. Employee resistance, stress and fear of losing their jobs may all rise when automation is implemented without proper training and change

management (Brougham & Haar, 2018). On the other hand, automation can improve employee confidence, flexibility and long-term resilience when it is accompanied with reskilling programs, human centric design and participative leadership (Edum, 2024, Sobczak 2022)

Additionally, empirical data indicates that the effects of automation on the workforce differ among nations and industries. According to Al Bashar et al. (2024), labour costs, technological infrastructure and skill availability all have an impact on how automation is adopted and how it affects the workforce in industrialized and developing nations. Similarly, Odunukwe et al. (2025) discovered that when workers are given opportunities for skill development and training, automation does now always result in job redundancy. The growing industry 5.0 viewpoint highlights the necessity of human machine cooperation above complete automation. Dacre et al. (2025) and Shabur et al. (2025) believe that supply chains need to be balanced between advanced automation and worker well-being to become resilient and sustainable. In this human centred approach, it is important to highlight the necessity to align organizational support systems and employee resiliency with technology innovation.

Although the literature on supply chain automation and resilience is growing, it often considers the effectiveness of operations and technology performance without taking into account the resilience of workers. Empirical studies that investigate the process automation of supply chains and the implications it has on worker resilience are still lacking, particularly in the emerging economies (Kazancoglu et al. 2023, Ambrogio et al, 2022). To achieve operational excellence and long-term personnel development, organizations with the aim of achieving both require bridging this gap.

To help build a more holistic understanding of the impacts of technological revolution on human adaption in the supply chain environment, this research paper aims at exploring automation in supply chain.

OBJECTIVES

a) To investigate how automation affects workers job responsibilities and skill needs in supply chain operations
b) To investigate whether automation enhances workers flexibility and preparedness for change
c) To examine the impact of automation in supply chain processes on workforce resilience

REVIEW OF LITERATURE

One of the major change agents in supply chain is now automation. According to Christopher and Peck (2004), automation brings about improved coordination and minimises vulnerability in intra-company supply chains. Supply chain operations are expedited by technologies like automated warehousing systems, order processing, RPA and AI based forecasting make operations more accurate (Ivanov and Dolgui, 2020).

Telikdarie (2021) used simulation models to show how automation and digitalization greatly increase supply chain resilience by lowering operating costs and improving responsiveness. In a similar vein, Ghobakhloo et al. (2023) emphasized that Industry 4.0 technologies improve supply chain performance during disruptions by enabling real time data sharing and proactive risk management.

Job responsibilities and workforce structure are directly impacted by automation. Automation may eliminate some physical labour, but it also increases the need for new digital and analytical abilities, according to Brougham and Haar (2018). In their analysis of automated supply chain systems, Odunukwe et al. (2025) discovered that when workers are given the chance to retrain, automation does not always result in increased job redundancy.

Edum (2024) highlighted the importance of digital employee information systems in improving workforce resilience, emphasizing that employee's capacity to adjust to technological change is greatly impacted by system design and usability. These results imply that organizational support systems are just as important to workforce outcomes as automation itself.

Workforce resilience refers to the capacity of the workers to withstand, adjust and recover following an interruption. Lengn ick-Hall et al. (2011) define resilience in the workforce as a combination of psychological resilience, the capacity and flexibility to learn. The supply chain needs to be resilient due to the continuous disruption of the supply chain environments.

Ambrogio et al. (2022) introduced a concept of the human centric digital transformation and the Resilient Operator concept. In their work, it is stressed that technology is not aimed at replacing the human capabilities, but they are to be enhanced. Romero and Stahre (2021) built upon this idea and used the operator 5.0 framework to focus on the human machine cooperation to enhance resilience. Recent studies emphasize that the concept of automation and human factors needs to be introduced. According to Kazanoglu et al. (2023), new techs such as blockchain and artificial intelligence will help to build resilience only under the condition of informed and flexible personnel. Based on the empirical research done by Sobczak (2022) they discovered out that the organizations that had been strategic with RPA were more robust than the organizations which depended on automation to reduce costs.
Human centric automation is the next characteristic that is highlighted in Industry 5.0. According to Dacre et al. (2025), the supply chain should be resilient and sustainable in order to balance the new technologies and worker wellbeing. Similarly, Shabur et al.

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(2025) also mention that the long-term resilience and adaptation were also enhanced as a result of the cooperation with human-intelligent systems.

RESEARCH GAP

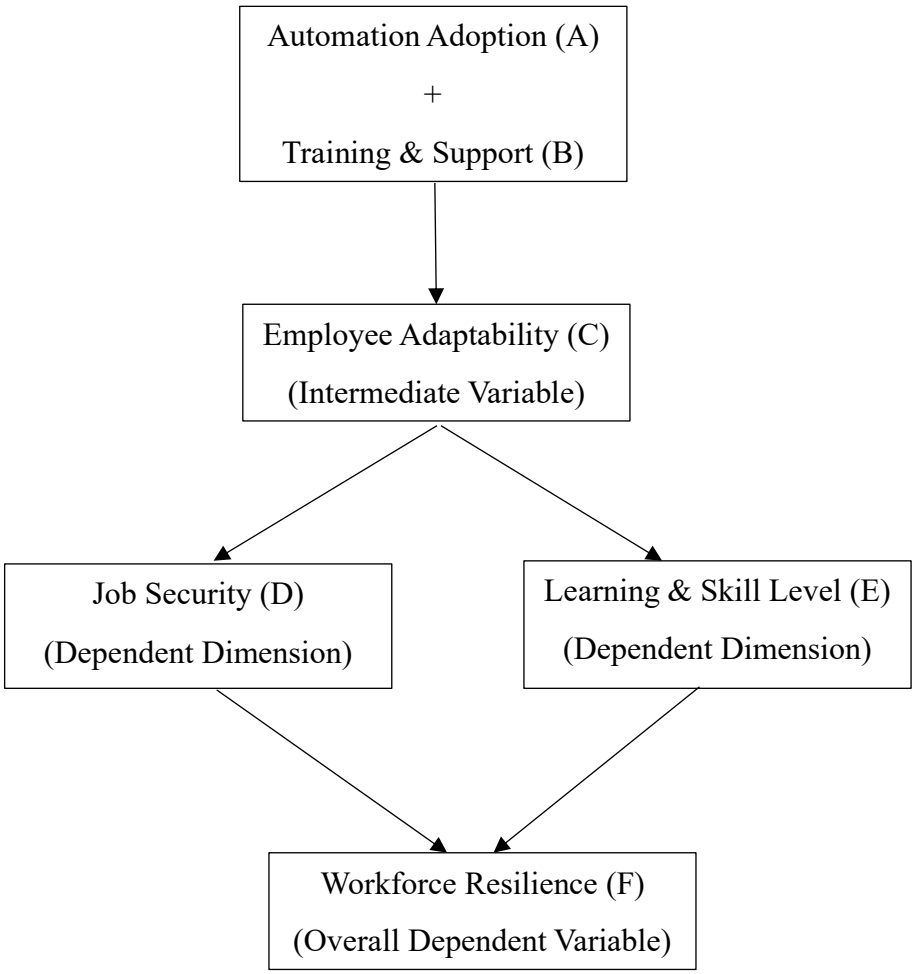
A comprehensive review of the literature on supply chain automation and worker resilience indicates that there are a number of significant research gaps that can support the current study.

Although much of the existing literature on automation in the supply chain focuses on cost reduction, most studies are grounded in optimisation and technological efficiency of the process (Christopher and Peck, 2004, Ivanov and Dolgui, 2020, Telukdarie, 2021). These studies are highly educative in regards to the knowledge of how to streamline the processes, though they do not cover all the consequences of automation to the human workforce specifically in the context of resilience, adaptability and long-term employability.

Workforce resilience tends to be considered as a supportive or supplementary concept, rather than a key variable of analysis. Though the significance of human adaptability has been highlighted, other studies like Lengnick-Hall et al. (2011), Ambrogio et al. (2022) and Romero and Stahre (2021) do not empirically correlate workforce resilience with particular automation solutions in the supply chain. This has led to a lack of relationship between human centred outcome and technology improvement.

The shortages evidently require the experimental examination of the phenomenon of automation in the supply chain and its effects on the worker resilience to be added to the academic literature and to the management practice.

Conceptual Framework



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RESEARCH METHODOLOGY

Research Design

Descriptive-analytical, cross sectional. The descriptive component profiles the current level of automation adoption and workforce resilience. The analytical tests for statistical relationships. Would a longitudinal design have been stronger for establishing causality? Yes

Sources of Data

Primary: A structured questionnaire of 5-point Likert scale for the research variables. Distributed to supply chain professionals in Bangalore through professional networks and workplace contacts.

Population and Sampling

Mid-level and lower-level employees in supply chain functions at Bangalore-based organizations that have implemented automation. Departments are warehousing, logistics, procurement, distribution, inventory management, packaging and supply chain operations

SAMPLE SIZE (Slovin's formula)

$$n = \frac{\mathrm{N}}{1 + \mathrm{N(e)\hat{}2}}$$

$$n = \frac{400}{1 + 400(0.0025)}$$

Final sample: 280 respondents. Random sampling method was used.

Hypotheses

Hypothesis H1

H0: There is no significant impact of automation in supply chain processes on workforce resilience
H1: There is a significant impact of automation in supply chain processes on workforce resilience

Hypothesis H2

H0: There is no significant relationship between automation and employee adaptability
H1: There is a significant relationship between automation and employee adaptability

Hypothesis H3

H0: There is no significant relationship between automation and employees learning and skill level
H1: There is a significant relationship between automation and employees learning and skill level

Hypothesis H4

H0: There is no significant relationship between automation and employees job security perception
H1: There is a significant relationship between automation and employees job security perception

Methodological Limitation

Random sampling withing accessible Bangalore organizations, so results may not generalise to other Indian cities. Self-reported data is always tricky, who is going to tick "Strongly Disagree" on "I adapt to change" when they know the survey is about adaptability? Cross-sectional, so it is association, no causation. The results may vary from Bangalore when compared with Chennai and Pune.

DATA ANALYSIS AND INTERPRETATION

The Demographic profile was 280 valid responses which was collected from the respondents. The following shows the breakdown of who were responded

GENDER	FREQUENCY	PERCENTAGE
Male	212	75.7%
Female	65	23.2%
Other	3	1.1%
Total	**280**	**100%**

The majority were male with 75.7%, as the gender representation in the supply chain and logistics jobs in India. The progress is being made, but slowly

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Descriptive Statistics
Section-level descriptive statistics:
Questionnaire Structure: A, B, C, D, E, F

VARIABLE	MEAN	STD.DEV.	INTERPRETATION
A: Automation Adoption	3.362	0.558	Moderate
B: Training & Support	3.479	0.570	Moderate-High
C: Employee Adaptability	3.629	0.563	Moderate-High
D: Job Security	3.389	0.545	Moderate
E: Learning & Skill Level	3.524	0.495	Moderate-High
F: Workforce Resilience	3.689	0.505	Moderate-High

Workforce Resilience (F) means 3.69 on average, Automation Adoption (A) means 3.36 on average. That 0.33-point difference is workers reacting to automation with Yes, automation is happening and yes we are in control. The average rating of Job Security (3.39) is a precondition but, people are getting used to it, yet they are not worried about the future anymore.

Reliability Analysis
Cronbach's Alpha
Questionnaire Structure: A, B, C, D, E, F

SECTION	ITEMS	CRONBACH'S ALPHA	RELIABILITY
A: Automation Adoption	5	0.775	Acceptable
B: Training & Support	5	0.783	Acceptable
C: Employee Adaptability	5	0.756	Acceptable
D: Job Security	5	0.769	Acceptable
E: Learning & Skill Level	5	0.700	Acceptable
F: Workforce Resilience	5	0.701	Acceptable

All above 0.70, so we are fine by Nunnally's (1978) standards. The range is 0.70-0.78, consistent and tight. The questions are measuring what they are supposed to measure.

Correlation Analysis
Questionnaire Structure: A, B, C, D, E, F

	A	B	C	D	E	F
A	1.000	0.589	0.457	0.430	0.406	0.388
B	0.589	1.000	0.569	0.473	0.550	0.484
C	0.457	0.569	1.000	0.502	0.550	0.508
D	0.430	0.473	0.502	1.000	0.366	0.419
E	0.406	0.550	0.550	0.366	1.000	0.518
F	0.388	0.484	0.508	0.419	0.518	1.000

The significance (p) of all correlations between Automation Adoption and Training & Support r=0.589 is significant ($p<0.001$). Organizations investing in automation are also likely to invest in training. It makes sense, and it is encouraging. The Training Adaptability correlation (r=0.569) is also high and this supports the fact that support is a factor that causes adaptability.

Learning & Skill Level (r=0.518) is the strongest predictor of Workforce Resilience among individual variables. When employees are proactive in the development of their skills irrespective of what the organization offers, they become more resilient. That is comforting and a bit chilling. It implies that individual initiative is equally important to organizational policy.

Regression Analysis

STATISTICS	VALUE
R	0.388
R-squared	0.150
Adjusted R-squared	0.147
F-statistics	49.119***
B (unstandardised)	0.350
β (standardised)	0.388
Standard Error	0.050

Regression Equation: Workforce Resilience = 2.510 + 0.350 x Automation Adoption

R-squared = 0.150. So, approximately 15% of the workforce resilience is explained by automation. One-unit change in the automation rating contributes 0.35 to the resilience score. Not bad. But not all either, the other 85 percent is organizational culture, individual motivation, the quality of training, life experience and other aspects that were not measured by this study. The standardised beta is 0.388, as this is a simple/bivariate regression, the standardised beta is the correlation coefficient.
The intermediate R-squared does make the results more realistic. The issue of workforce resilience is multi-faceted. Had 80 per cent of it been due to automation.

Findings
Automation matter ($r=0.388$, R-squared=0.15, $p<0.001$), but it is not the whole story. Training & the best connection is between Support and the others ($r=0.569$ with Adaptability). The is learning initiative.

Best single predictor of resilience ($r=0.518$). Each of the four hypotheses was correct. The data supports the opinion that automation and resilience complement, when organizations invest in their individuals and their technology.

FINDINGS, SUGGESTIONS & CONCLUSION
R-squared=0.15, automation makes a difference $r=0.388$. But 85 percent is of other origin. The cluster (Adaptability, Job Security, Learning) is the linking point between the adoption of automation and the general one.

Training and Support (B) is crucial in building resilience and the quality of that bridge.
One of the strongest correlations of the study is the Training-Adaptability ($r=0.569$). This aligns with these were highlighted by Edum (2024) and Lengnick-Hall et al. (2011) who pointed out that HRM systems and management. Support is essential in developing resilience. It also helps to confirm the finding of Sobczak (2022) that strategic. Not adoption but implementation is what makes organizations resilient.

The observation that the Learning & Skill Level is most strongly correlated with the Workforce Resilience ($r=0.518$) is particularly interesting. It implies that those employees who are initiative takers in helping develop their skills, whatever the organization offers, are likely to be stronger. This is in Favor of the Industry 5.0. Viewpoint suggested by Dacre et al. (2025) and Shabur et al. (2025), the need to balance technology development along with the development of manpower.
The average score of Job Security (3.39) is a reminder that there is still concern. Employees are adapting, but they are not to worry about. The difference between the I can handle change (Adaptability=3.63) and it is a real and worth listening to, thus, I feel secure (Job Security=3.39).

Suggestions and Recommendations
- Continuous training programmes**,** not just one-time onboarding sessions. Regular upskilling that keeps pace with technological changes. Hands-on workshops are more effective than PowerPoint presentations about automation
- Effective communication, employees will do well when they know what is coming and why. Open dialogue on automation reduces fear and establishes confidence. The vast majority of opposition to automation is fear of the unknown, rather than fear of the technology.
- Organizations should have proactive job security talks instead of waiting until the employees raise concerns about the effect of automation on their jobs. It is useful to demonstrate the instances of new positions that have been developed out of automation.
- Culture of learning**,** since learning initiative showed the strongest link to resilience, organizations should create environments that reward continuous skill development. Mentorship programmes, access to learning platforms, recognition of skill acquisition
- Human centric automation the aim is to supplement rather than to substitute human abilities. Employees should be involved in the automation planning and implementation to enhance acceptance and minimize resistance.

Scope for Future Research
A longitudinal pre- to post-automation study would resolve the causation issue. An analysis of Bangalore vs. Chennai vs. Pune would determine whether these results are local to a particular city or pan-Indian. The interview-based qualitative study would get what the survey questions fail to reach the lived experience of adjusting to automation. And the moderating variable of leadership style is far open to study.

CONCLUSION
The MBA educates you on models and frameworks. The facts give you modesty. This research has established what the literature expected, that automation and workforce resilience have a positive relationship but also demonstrated that the correlation is moderate, multifaceted and highly relies on organizational approaches to the transition.

With supply chain constantly changing, organizations that will be successful are those ones, which consider automation and workforce development as the two sides of the same coin. And speaking of the personal aspect, the work on this project altered my ideas about technology at the workplace. New tools and systems can be easily excited.

It is not just a matter of automation. The moderate scores of job security warn us that employees still have what is actually real and these must be dealt with. The best discovery of this research is that, it is equally crucial to invest in people, through training, communication and skill development opportunities as much as one invests in technology.

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