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How is Automation Reshaping Worker Well-Being in United States Supply Chains?

by

Priyanka Madhavan

Thesis Advisor: Professor Debjit Roy

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Abstract
As automation is reshaping the U.S. automotive and manufacturing industries, there are rising concerns about the impact on jobs and employees' well-being. Previous research has looked at the general perception of automation within single nodes of the supply chain and has not considered the firsthand accounts of employees' experiences in the automotive and manufacturing industries specifically. This study investigates the effects of workplace automation on job satisfaction, productivity, and safety in automated environments, as well as employee concerns about the future implementation of automation technologies in non-automated environments. Results show that automation improves these outcomes, more significantly when paired with upskilling and adequate training. However, more experienced employees reported weaker positive effects. In non-automated companies, employees expressed concerns, primarily around job loss and the cost of capital. Overall, findings suggest a positive trajectory for automation in manufacturing and automotive industries, with growing acceptance expected as the workforce evolves.

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Introduction

Will automation replace human jobs? This sentiment in the media is widespread and has been exacerbated in the last year. Portrayals in movies like "Terminator" and "I, Robot," have fostered fears of a "robot uprising," where automation will fundamentally replace the ways humans are valued in the global workforce. One form of automation, Artificial Intelligence, has been popularized by ChatGPT's introduction in November 2022. This has put generative AI at the forefront and has made automation more accessible and powerful. Nearly 70% of companies plan on automating tasks within the next year and specifically implementing AI technologies to do so (McKinsey, 2023). There are mixed opinions on the costs and benefits of the rise of automation in the workforce, which will be observed in this paper. This paper will explore the overarching question: *How is Automation Reshaping Worker Well-Being in United States Supply Chains?*

This study will focus on automation technologies in general, but will also analyze Robotics Process Automation (RPA) more specifically. RPA is any technology that uses robots for repetitive and defined tasks. These can include software that tracks and completes tasks that mimic human movements or physical robots that work in tandem with human workers. RPA is different from AI, which starts with a large, unstructured dataset and is trained to learn and improve over time. Unlike RPA, which follows pre-structured rules, AI can analyze data, make decisions, and evolve based on experience. RPA and AI are commonly used interchangeably, so discussions in the news on automation may be RPA tasks but are referred to as AI.

Automation for manufacturing and automotive supply chains will be analyzed in this paper. Automotive supply chains are a subset of manufacturing, consisting of designers, manufacturers, material suppliers, and distributors of cars. Ford, Volkswagen, and Tesla are some

examples. Car manufacturers have implemented automation in their manufacturing and supply chain operations since 1913 and have used these technologies for mass production for the last 65 years. This has made automotive companies frontrunners in implementing innovative automation technologies for their operations. The manufacturing practices in the automotive industry are consistent with those of general manufacturing, so the industries will be categorized together for this research.

Preliminary interviews with industry professionals in the automotive industry were conducted to gain a holistic understanding of the real-world applications of automation, and the insights guided the survey creation. The theoretical framework of this study is centered around the Technology Acceptance model, which states that an individual's perceived usefulness and ease of use of a technology will result in the successful implementation of automation. The Sociotechnical Systems also guided research to understand that technological and social optimization must be considered before the mass application of automation practices to ensure success.

200 U.S. manufacturing employees were surveyed and separated based on their company's use of automation. If the employee's company used automation, they were asked Likert scale questions on their perceived changes in job satisfaction, productivity, and safety. If their company did not use automation, they were asked open-ended questions about their future concerns and why they don't think it has been implemented yet.

After a quantitative and qualitative analysis was conducted for these two groups, the results indicated that job satisfaction, productivity, and safety all increased on average. There were moderately strong correlations between job satisfaction and productivity. These also had more substantial effects if employees were allowed to learn new skills or given adequate training

on automation. Supervisors saw the most substantial upskilling effects, especially for job satisfaction. These results also varied for years of industry experience, with a less strong positive reception for higher years of experience. 70.61% of employees expressed concerns about automation. The primary concerns expressed by employees involved job loss and the cost of capital for their company.

These findings suggest that companies planning on implementing automation will receive the most positive employee reception if they provide training and then subsequently offer opportunities for upskilling. Organizations that consider the sociotechnical systems that integrate automation will help mitigate common job-loss-related anxieties among employees. C-suite executives, managers, industry professionals, labor organizations, and policymakers can use this research to guide automation rollouts within their companies.

Literature Review

This literature review examines public perceptions of robots, the historical evolution of automation, the implementation of these technologies across various supply chain nodes, the documented organizational benefits of automation, and the psychological impact on employees. While existing research highlights the widespread adoption of automation within manufacturing and assembly nodes, there remains a significant gap in understanding how these technologies directly affect worker well-being.

Perception of Robots

The prevalence of technophobia – the fear of technological innovation – has significantly risen over the past decade. Recent surveys reveal that fears of automation are widespread: cyberterrorism is the top concern (45%), followed by robots replacing workers (30%), trusting AI to do work (26%), unemployment (24%), and not understanding the technology (19%). These fears and general anxiety are highly correlated; individuals expressing technophobia have 95% greater odds of not being able to stop or control worrying compared to others (McClure, 2018).

Most individuals assume robots are typically in the form of humanoids or animal-type robots rather than in construction or assembly tasks (Nomura et al., 2016). When comparing the Roomba vacuum robot to a complex humanoid-esque Boston Dynamics robot (Figures 1 and 2), it was discovered that when a robot is more advanced, people have increased fears regarding that technology (Küster et al., 2021). The Roomba evoked less discomfort from participants due to its familiarity and simple design.

Figure 1: "Roomba," Vacuum Robot (iRobot, 2025)



Figure 2: "Spot," Dog Robot (Boston Dynamics, 2025)



Fears of robots resulted in lower life satisfaction in a study of 1000 individuals. (Hinks, 2021). These fears were different by age group, with participants aged 41-50 expressing the highest fears and the largest correlation between these fears with life satisfaction. Finally, both employed and unemployed individuals with fears of robots reported lower life satisfaction. This could be correlated to specific fears about unemployment and job loss directly tied to automation, but the fears and these effects on employees were not directly studied.

Perception is also influenced by the prevalence of humanoid robots in media. Generally, if people are exposed to robots in media, it can positively affect the acceptance of automation. This is especially true in portrayals of robots in movies like "Bicentennial Man" and "Wall-E," which exhibit levels of sympathy from viewers, which accordingly reduced levels of robot anxiety (Sundar et al., 2016). On the contrary, Frankenstein syndrome is a term that suggests that as robots become more human-like, people believe that they will pose a greater danger to society (Kaplan, 2004). Antagonizations of robots in movies like "Terminator" have associated robots and automation with Frankenstein syndrome (Sundar et al., 2016); negative portrayals lead to negative perceptions by the general public. In the study of the two robots in Figures 1 and 2, the

participants exhibited high levels of empathy towards the “Spot” robot, while simultaneously expressing high levels of discomfort in its presence. These conflicting opinions of robots have led to discourse on job replacement and the extent to which this is a legitimate concern.

Automation in the News

In recent political news, President Donald Trump’s tariffs on international trade have resulted in companies considering moving their supply chains and manufacturing to within the United States. In a statement issued by the White House, “Large and persistent annual U.S. goods trade deficits have led to the hollowing out of our manufacturing base; resulted in a lack of incentive to increase advanced domestic manufacturing capacity; [and] undermined critical supply chains” (The White House, 2025). For these processes to be comparable to the cost of manufacturing abroad, robots are becoming a solution to avoid high labor costs in the United States and make U.S. manufacturing feasible.

Elon Musk, head of the Department of Government Efficiency (DOGE) and founder of Tesla, has described using automation to replace federal employees. 280,253 government employees have already been fired as of March 2025, and DOGE plans to continue mass layoffs based on automating their jobs. (Wallace, 2025). Within Tesla, the Optimus human robot has already been introduced as a “general purpose, bipedal, autonomous humanoid robot capable of performing unsafe, repetitive or boring tasks” (Tesla, 2025). This could then be implemented in their supply chain to replace humans.

Drive-through AI robots are being implemented in fast-food chains such as Taco Bell (Yum! Brands, 2024). Physical automation is slowly being rolled out in other restaurants, such as Chipotle; the company is experimenting with a robotic bowl maker, which takes mobile orders

and uses a robotic arm to place ingredients in a burrito bowl (Wong, 2024). At Starbucks, where coffee was once prepared manually by workers grinding beans and brewing each cup, the Vertica Machine now automates the process, which brews fresh cups on demand (Brown, 2022). Restaurants with robot baristas have appeared across the U.S. and can take orders, make 90 beverages per hour, and bring orders to customers (Hwang et al., 2024). As robots become more prevalent in individuals' daily lives, this exposure can positively or negatively impact their concerns.

History of Automation in Industrial Revolutions

This study focuses on the manufacturing and automotive industries primarily because these industries were the first to utilize automation on a mass scale. These followed the timeline of the Third, Fourth, and Fifth Industrial Revolutions.

Industry 3.0, or the Third Industrial Revolution (1970-2010), refers to using automation to streamline processes. This is where general robotics, automated production, and computers were implemented in supply chains. Industry 4.0 (2011-2019), the Fourth Industrial Revolution, builds on 3.0 by using data to make decisions. These include the "Internet of Things" (IoT), which uses sensors and intelligent processing to respond to user input (Mathur et al., 2022). These are the most common forms of innovations in companies utilizing automation. When looking at Industry 4.0 innovations such as blockchain, 5G, 3D printing, and augmented reality, the economic benefits from these technologies are projected to be over $3.7 trillion by the end of 2025. Additionally, in this survey, 68% of enterprises perceived technology implementations as their top strategic plan for growth. (Choi et al., 2022). For companies that implement these innovations, their cash flows can improve by 122%. Conversely, if these companies do not adopt

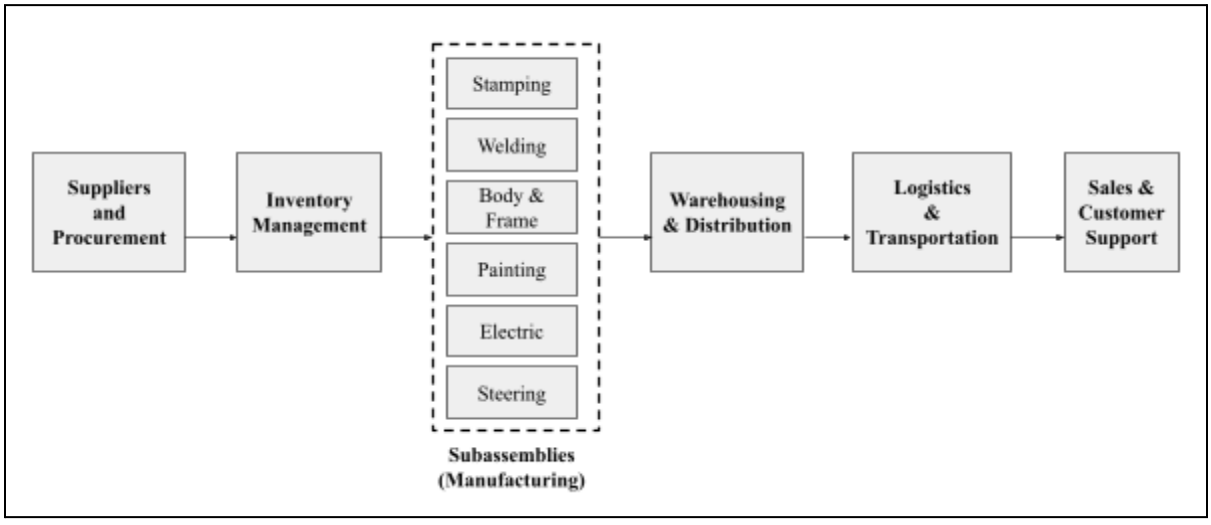
4.0 innovations, their cash flows could decrease by 23% (McKinsey, 2022). Finally, Industry 5.0 (2020-Present), the Fifth Industrial Revolution, includes human-robot collaboration and personalization to individuals beyond 4.0 innovations.

Supply Chain Automation Overview

The manufacturing industry as a whole includes the development of a product from design to delivery to a customer (U.S. Census Bureau, 2024). The automotive industry is a subset of the manufacturing industry, which is made up of various suppliers at different levels that interact with each other to build the final product assembly. This study will consider these industries together due to their similarities and overlap in automation technologies and supply chain functions.

The automotive and manufacturing supply chains consist of interconnected nodes that work together to deliver a product to the customer. Figure 3 illustrates the key stages and relationships within this supply chain. The specific automation technologies employed in these supply chain nodes are discussed in the subsections below.

Figure 3: Automotive Supply Chain Nodes



In these supply chains, both Digital Process Automation and Physical Automation are present. Digital automation refers to software-based technologies like inventory management software, chatbots, and demand forecasting programs. Physical automation uses machinery and

robots to automate tasks and includes technologies such as robots, self-driving vehicles, and cobots.

Robotics Process Automation (RPA) is for any repetitive and defined processes. RPA is present in fully manual, fully automated, and hybrid systems involving human-robot collaboration, or cobots (Figures 4a, 4b, 4c). This is different from Artificial Intelligence (AI), which uses large sets of data to train machine learning algorithms that adapt and improve over time. Although these processes are systematically different, the general public does not make this distinction, so employees surveyed in this research considered AI as part of the automation technologies implemented in companies. To separate RPA, this study will also isolate RPA-related responses to see what current opinions are on its implementation in supply chain companies.

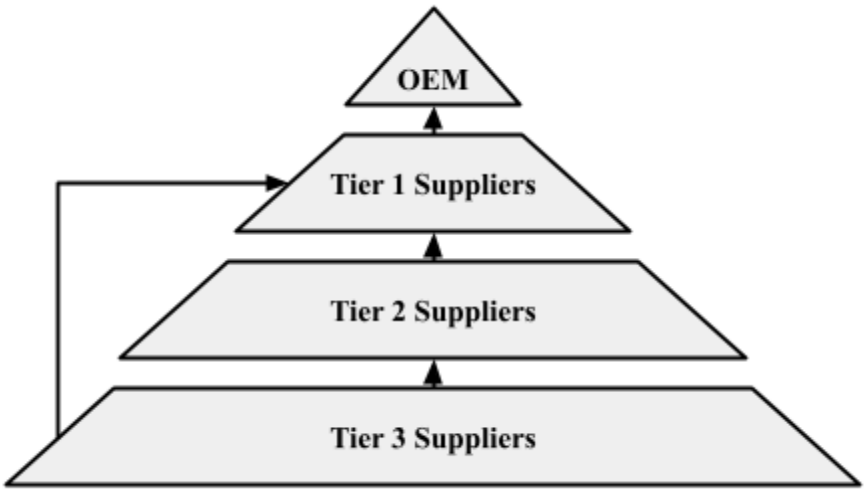
Figure 4a: Fully Manual	**Figure 4b:** Cobots - Hybrid	**Figure 4c:** Fully Automated
		

Procurement

The first step of the supply chain is procurement, which involves buying and gathering parts. Negotiation-based procurement can be automated using e-auctions. These auctions handle supplier matching, demand forecasting, and contract negotiation, which shortens procurement cycles. There are three types of e-auctions: English reverse auctions (suppliers compete to be the lowest bidder), Dutch reverse auctions (buyers set a low price and suppliers bid accordingly),

and Japanese reverse auctions (more complex, but buyers set a high price and suppliers bid for lower prices). These saved money compared to person-to-person negotiations and identified more qualified suppliers by price. Upon implementation, Walmart gained 5% in additional value and 65% of its indirect uses of e-auctions. Danish company Maersk saved 8% in savings compared to manual negotiations and implemented a total of 10,000 e-auctions. (Hoek & Lacity, 2023). These sourcing strategies use AI algorithms and therefore require large amounts of data points and data training before implementation. In the automotive industry, these are used for commodities where prices are constantly fluctuating based on market demand. Suppliers in the automotive industry follow a four-tiered hierarchy as shown in Figure 5.

Figure 5. Automotive Supply Chain Hierarchy



At the top of the hierarchy are Original Equipment Manufacturers (OEMs); examples of OEMs include Toyota, Tesla, Ford, General Motors, and Rivian. Next are Tier 1 suppliers, which are defined as suppliers that directly supply to OEMs and design complex subsystems like car seats, engines, and braking systems. Next, there are Tier 2 suppliers, who provide parts to Tier 1 suppliers. These parts are for the subsystems designed by Tier 1 suppliers. Finally, at the bottom

of the hierarchy, there are Tier 3 suppliers that produce raw material inputs. These are typically commodity suppliers for materials like steel, metal, and plastics. They supply to Tier 2 suppliers, but can also supply directly to Tier 1 suppliers. Once materials are collected, they are stockpiled and logged in inventory.

Inventory Management

Predicting consumer demand and looking at various product lines is a key part of the supply chain. The sequencing point, defined as the part of the supply chain where everything comes together, is a primary piece of RPA. In an automotive supply chain, this can also be referred to as the start of production, where all the suppliers have to converge and be ready to start at a certain point. When testing this sequencing point, cycle time (the total time it takes a task from start to finish) was decreased by 30% in an assembly line (Swaminathan et al., 2007). Dynamic pricing algorithms are a type of automation currently used to forecast demand during times of fluctuating demand and volatile markets. These are done with log-log regressions, control functions, and binary search algorithms that are embedded in pre-programmed software to predict demand. (Bollinger & Hartmann, 2020). In a manufacturing supply chain, this can reduce lead times and allow for more accurate inventory at any point in time.

Manufacturing & Assembly

The most time-consuming and complex part of the supply chain is Manufacturing & Assembly. These encompass tasks like cutting, welding, painting, and screwing which, when automated, have been experimentally supported to improve efficiency. In a study at Texas A&M, a FANUC CRX10iA cobot – which executes gripping and screwing operations used in

manufacturing applications – was used to compare manual versus human-robot assembly. Cobot use at an average speed reduced screwing time by an average of 4 minutes and was consistent regardless if the worker was experienced or not (Manikandan et al., 2024). In a study of collaborative robots, tradeoffs between time and strain on the employee were measured. This was a task where a human worker would complete tasks such as reaching, grasping, pushing, and pulling. This was measured by physical strain on the employee's limb, and it was found that these tasks improved time and reduced strain for these employees. Additionally, these robots working in collaboration with humans would allow multiple tasks to run concurrently and allow the human employee to complete more diverse manufacturing tasks (Pearce et al., 2018). Similar studies to find measurable effects in manufacturing tasks are heavily prevalent in the current literature.

Warehousing & Distribution

After Manufacturing & Assembly, warehousing is among the most automated areas in the supply chain, with robots performing tasks like picking, packing, and sorting. Wang et al. (2022) discuss the integration of robots in mobile-rack warehouses, where automated guided vehicles (AGVs) assist human workers by delivering racks directly to them, streamlining order-picking and reducing worker fatigue.

Benefits of Automation

Automation has multiple reported benefits, including increased efficiencies, accuracy, and cost savings for companies. Flexible automation which is a type of variable automation that can be “flexed” to be utilized in many different processes. This was found to be impactful in

areas with high setup costs, high carrying costs, and high forgetting rates. Other notable benefits were reduced labor costs through wages, the ability for an automated system to remember a set of instructions perfectly, and it also allows for long-term economies of scope (Smunt & Meredith, 2000).

On the company side, this is beneficial because robots can perform low-cost tasks and work around the clock. They don't require temperature control, light, and wages, resulting in long-term cost savings that humans would otherwise incur. (Ritchie & Landis, 2021). Other direct benefits include increased efficiency, reduced error, and improved safety for employees in high-risk environments (Deloitte, 2017). Beyond cost and efficiency, an experiment with Amazon MTurk for image classification found that the accuracy was most efficient using human-robot collaboration and was more efficient than either party working alone (Fügener et al., 2022).

Stress on Employees

The negative consequences have also been analyzed in past surveys of workers. Workers have reported unreasonable workload once automation was implemented, on account that they were "treated like robots" (Wang et al., 2022). For these companies, it was pivotal to understand fluctuations of human capabilities and optimize how automation is implemented in human-robot coordinated systems. In manufacturing industries, robots have intensified production timeframes while minimizing human involvement in dangerous tasks. (Ritchie & Landis, 2021). This puts pressure on employees who have to align to tighter timelines while conversely keeping them safe. Despite cobots being more efficient in ideal situations, if workers' limitations are not considered, they can cause high inconsistencies in picking time (Sheu & Choi, 2023).

One of the few research studies on the workplace effects of Industry 4.0 automotive technologies indicates that employees report lower job satisfaction in the service sector (Brougham & Haar, 2018). Factors such as computer anxiety, defined as anxiety related to the inability to adapt to AI, and communication apprehension tend to be more pronounced in contexts where individuals feel a higher risk of job displacement. Technological changes have been found to eliminate blue-collar jobs, primarily for manual, assembly-line work (McClure, 2018). Additionally, studies on human-robot collaboration reveal both productivity gains and worker resistance. Fügener et al. (2022) found that performance improves when humans delegate specific tasks to AI based on confidence thresholds, yet workers often demonstrate "algorithm aversion," where reluctance to trust AI diminishes potential productivity gains.

Finally, Deloitte (2017) identifies a skills gap in the current labor market: as automation increases the demand for data-driven roles, workers must develop new analytical skills to manage and interpret data outputs. Without being trained and reskilled, there is a risk that certain segments of the workforce may be left behind, especially in companies that are slow to adopt technological advancements. Therefore, reskilling initiatives are crucial to ensuring that workers can transition to new roles within a newly automated workplace. This juxtaposition of the costs and benefits of automation highlights trade-offs employees face in automated environments.

Preliminary Interviews Summary

To supplement findings from the literature review and gain a deeper understanding of real-world industry perspectives, I conducted a series of preliminary interviews with industry professionals. These professionals have noted similar tradeoffs to automation as those noted in the literature review.

Five professionals were interviewed to understand differing perspectives on automation and guide the development of the survey design. These participants included a Robotics Application Specialist in a small-scale robotics company, a Warehouse Operations Manager in a medium-scale automotive company, a Senior Engineer, a Supply Chain Analyst, and a Senior Vice President in three different large-scale legacy automotive companies.

Over time, the senior engineer indicated that there were dramatic overhauls in automation in 2016, which allowed efficient processes to take over and jobs to be replaced. However, in application, this has been a positive change because it has made responsibilities more efficient and has cut out parts of the convoluted hierarchies that engineering companies typically have. In another company, the supply chain analyst explained that humanoid robots may be able to start working on a line. This individual mentioned that their supply chain considers the benefits of automation in terms of life cycle and cost. For example, if a robot lasts five years and can replace one human, the company will evaluate these benefits at scale.

The Senior Vice President noted that turnaround times to receive parts are as little as five hours overnight. Any disruption to these deliveries can proliferate lead times and affect many moving parts in the supply chain. Additionally, they stated that inventory managers in large-scale automotive companies do not like holding parts for long periods because it wastes stock space and time. In these operations, efficiency, productivity, and error reduction are key to keeping the supply chain running accurately.

From the perspective of the Robotics Application Specialist, they identified union status as a key factor that influenced discrepancies in job satisfaction. This is because Unions work to protect workers' rights and facilitate slow transitions over drastic overhauls of processes. Their

robots delivered raw materials from storage to the production line, replacing forklifts that would have originally been manually operated by human workers. These robots are fully autonomous with onboard 3D Lidar sensors and cameras to guide their movements around a warehouse. The individual also indicated that the reception of these smaller robots from older and union workers tends to be adopted more slowly, in this their opinion.

Research Questions

Building on insights from the literature review and preliminary interviews, the following research questions are to examine how differing levels of exposure to automation may shape employee perceptions.

RQ_1: How has automation affected the job satisfaction, safety, and productivity of employees in supply chain companies in the United States?

RQ_2: What (if any) concerns are held by supply chain employees in companies that do not currently use automation?

Justification of this Problem

Automation effects on employees are currently broad and do not focus on the automotive and manufacturing supply chains specifically. This research also addresses gaps in the literature regarding employees' firsthand opinions and experiences with automation.

Isolating the automotive and manufacturing industries specifically will provide a unique perspective. Automation in these companies has been implemented since as early as 1913, when Henry Ford introduced a moving assembly-line style of production for vehicles (Ford Motor Company, n.d.). These employees are found to be more exposed to job replacement from any automation than other industries (52% of workers compared to 28%). This is also because automation is more well-integrated and prevalent in automotive manufacturing industries (Bureau, 2023).

Additionally, the research surrounding these industries does not focus on the effects of automation specifically on job satisfaction and worker opinions.

Theoretical Framework

This research is guided by two theories related to automation integration in companies.

Technology Acceptance Model (TAM)

The Technology Acceptance Model states that for an individual to accept a new technology, it depends on two factors: perceived usefulness (PU) and perceived ease of use (PEOU). PU refers to the belief that using a system would enhance an individual's job performance, and PEOU refers to the belief that using a system exerts minimal effort. (Davis, 1989).

In the context of RQ_1, this would indicate that an individual's job satisfaction would be tied to their level of PU and PEOU of a new automation technology. If they perceive the technology as detrimental to their job performance or require significant effort, they would be less satisfied, and vice versa. This would then change their use of the technology and its overall reception by workers.

Sociotechnical Systems Theory (STS)

The Sociotechnical Systems Theory asserts that joint optimization between social and technical systems is needed to successfully implement automation (source). In this study, the social party would be an employee at a supply chain company, and the technology would be the automation technology employed. (Trist & Bamforth, 1951) In addressing RQ_2, this would

indicate that optimization needs to be considered before implementing automation, so employee reception is high, and they don't feel unprepared to utilize automation technologies.

Hypotheses

Building on the theoretical framework, the following hypotheses were developed.

H_1: After the introduction of automation, supply chain employees will experience lower job satisfaction, higher safety, and higher productivity.

H_2: Workers in supply chain companies without automation will express concerns about potential future automation, which may include narratives reflecting resistance to its implementation.

I predict employees will experience lower job satisfaction because they may perceive automation to be detrimental to their jobs in the long term; in this case, their PU would be low. However, when looking at objective workplace outcomes like safety and productivity, these employees may still see short-term improvements, indicating their PEOU is high. In companies that have not yet implemented automation, I believe employees will express concerns due to their lack of exposure to these technologies. As such, they may be apprehensive towards automation overall since they have not seen its effects firsthand.

Methodology

200 participants on the Prolific platform were given a Qualtrics survey. The survey design is detailed in Appendix X. Depending on the respondent's response to Q8: Do you use automation in your workplace?, they were given the "Companies with Automation" or "Companies without Automation" questionnaire. These datasets were analyzed separately to answer each Research Question. Only employees in companies with automation were asked questions about job satisfaction, productivity, safety, and task complexity. Employees in companies without automation were asked about their concerns about future automation. Likert Scale responses and open-ended prompts allowed for a mixed-methods approach for quantitative and qualitative data analysis. The relationships between employee characteristics of years of experience, supply chain function, and supervision status were measured against these responses using group-level averages and keyword analysis.

For the quantitative analysis, the average Likert score changes for Q13, Q14, and Q15 were averaged and compared as either the raw score value or as a percent increase. P-values for two-variable averages were calculated using t-tests, and for three or more variable averages, these were calculated using ANOVA in R. The specific p-value evaluation methods are shown in Appendix X.

For the qualitative analysis, first, the frequency of all keywords was calculated. After looking at the top 20 keywords for each column, they were grouped according to relevant categories for the analysis. After grouping, the total number of responses with text entry was calculated to ensure all responses were included in the data analysis. If a respondent's response was not included in the grouping, they were added to the Other group.

Results

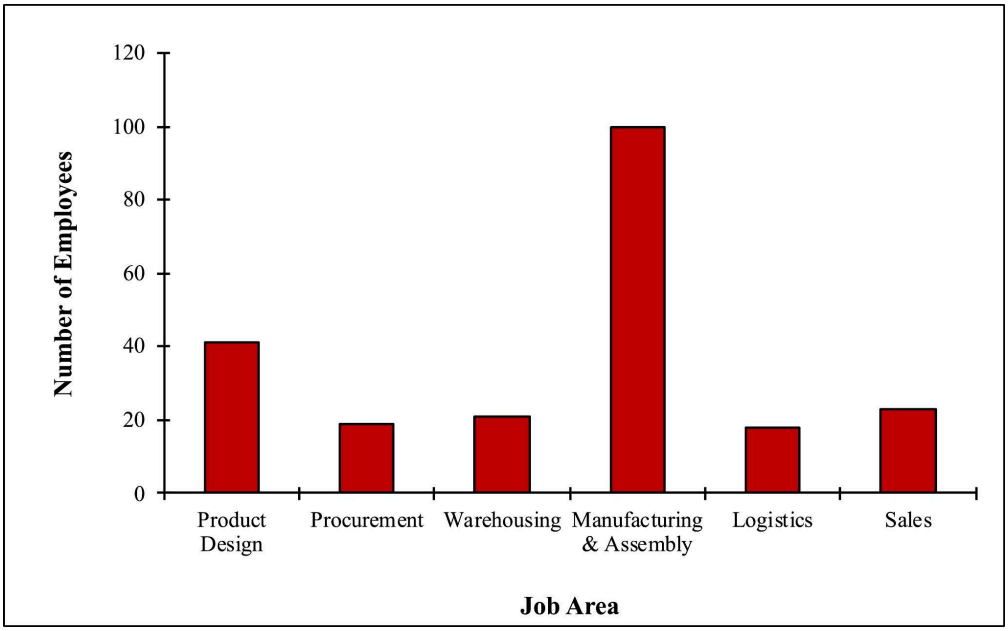
Of the 200 respondents surveyed, 149 were employed at companies with automation, and 51 were employed at companies without automation.

Companies with Automation

Sample Overview

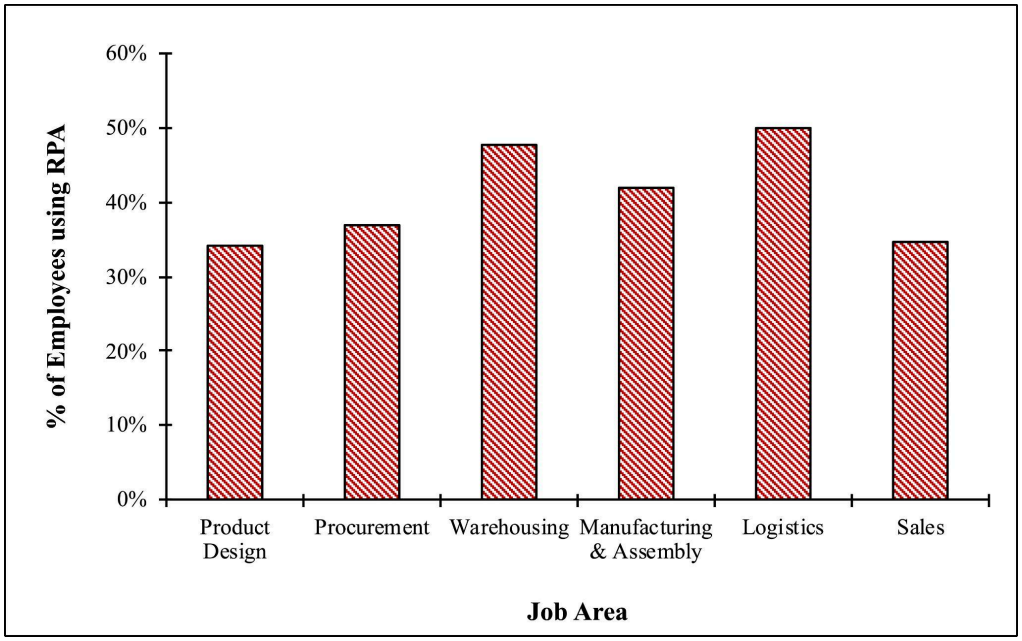
The distribution of the 149 employees in companies with automation by job function is displayed in Figure 6. The total number of employees represented in this graph exceeds 149 because respondents were allowed to select multiple options. The data skewed toward Manufacturing & Assembly functions (67.11% of automation employees). This distribution may be attributed to the Industry Prescreening criteria (Appendix A), so respondents were more likely to work in assembly-related processes if their industry was already Manufacturing, Automotive, or Engineering.

Figure 6. Number of Employees in each Job Area



Given that RPA represents the most recent technological advancements adopted by these companies in Industry 4.0, identifying the percentage of employees utilizing RPA across different job functions offers a more contemporary measure of automation, displayed in Figure 7.

Figure 7. % of Employees using RPA in each Job Area



When filtering based on automation technologies in the Robotics Process Automation grouping in Appendix D, the distribution of employees across job functions became notably less variable, with a coefficient of variation (CV) of 0.17, compared to 0.86 for the overall employee population.

Workplace Outcomes

Next, to test H_1, the average workplace outcome (job satisfaction, productivity, safety, and task complexity) was analyzed. The average change was self-reported by employees' responses to Likert scale questions Q13, Q14, and Q15.

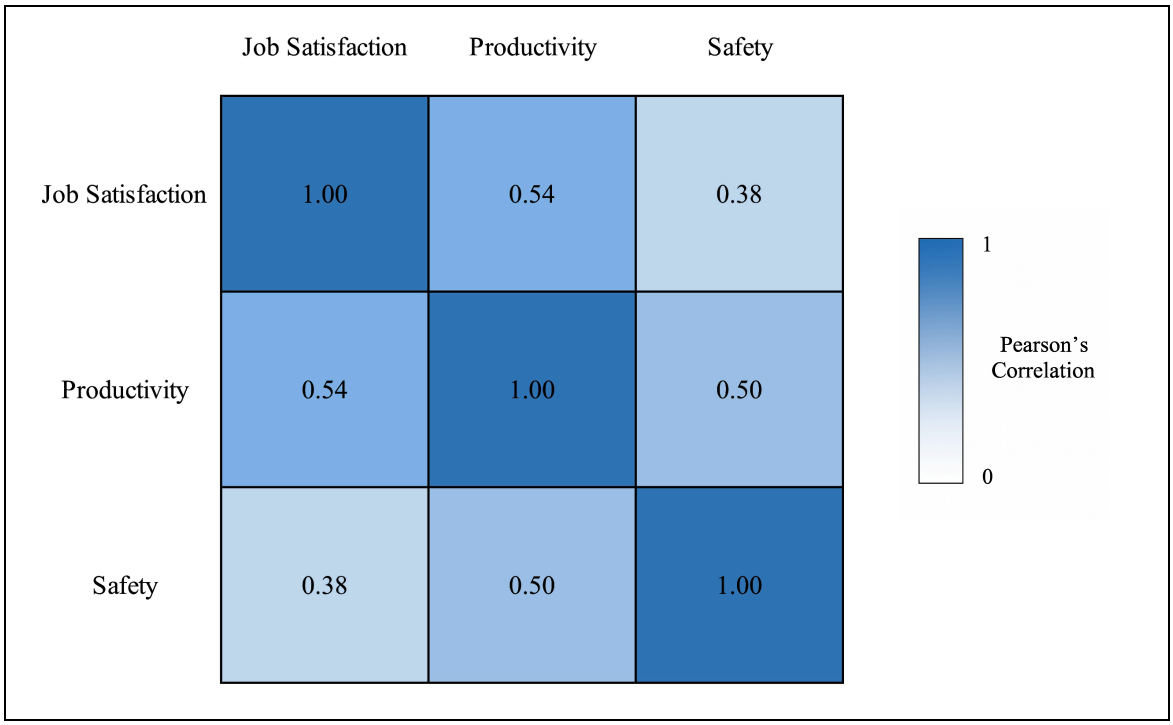
Table 1: Average Workplace Outcome Changes for Respondents in Companies with Automation

Workplace Outcome	Average Change	p-value
Job Satisfaction	+1.42	1.98E-12***
Productivity	+2.63	1.91E-101***
Safety	+1.98	7.55E-83***
Task Complexity	+1.24	3.99E-64***

$p<0.001$***

Employees in companies with automation reported an average higher job satisfaction, productivity, safety, and task complexity than before automation was implemented in their companies. This partially supports H_1, as job satisfaction increased rather than decreased. The correlations between each value are visualized in Figure 8.

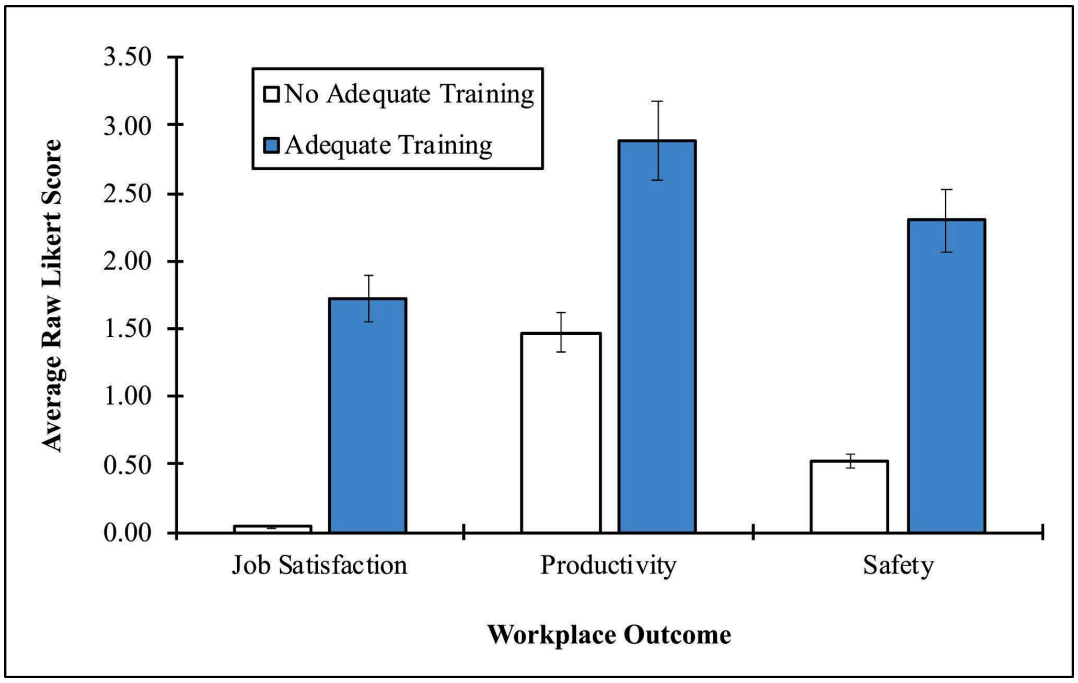
Figure 8: Correlations between Workplace Outcomes



Correlations between job satisfaction and safety were low and positive, suggesting that increased feelings of safety may not necessarily translate to higher job satisfaction. In contrast, the relationship between job satisfaction and productivity was stronger, meaning productive employees report higher levels of satisfaction. Safety and productivity were moderately correlated, implying that perceived safety may result in higher productivity.

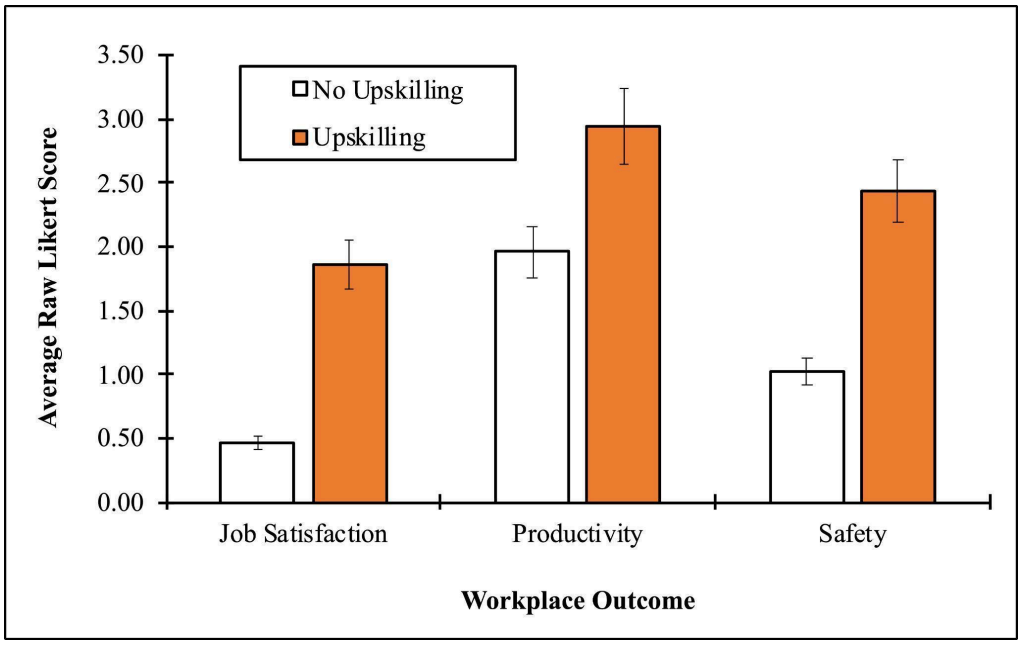
If employees were given adequate training, their mean job satisfaction, productivity, and safety increased compared to employees who felt they did not receive adequate training related to automation. This was highest for safety, with a +1.77 increase, as noted in Appendix Table B1.

Figure 9: Average Workplace Outcome Changes for Respondents With and Without Adequate Training



Similarly, workplace outcomes increased for employees who were allowed to upskill or transition into new roles after automation was introduced (Figure 10).

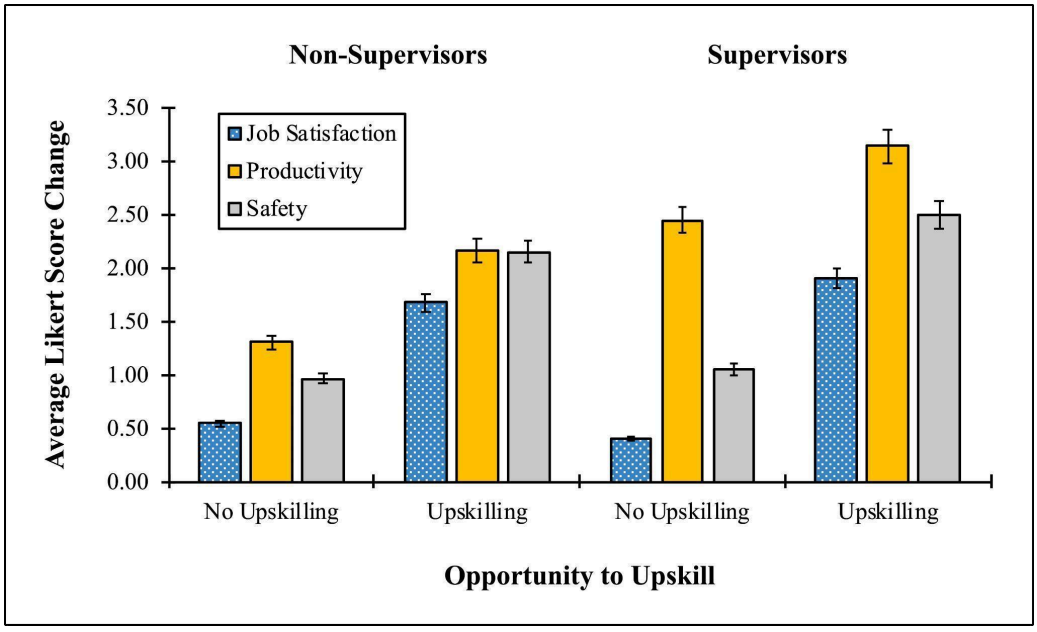
Figure 10: Workplace Outcomes vs Opportunity to Upskill



Upskilling is defined as an opportunity to learn new skills or transition into new roles because of automation. In general, when respondents were allowed to upskill, their job satisfaction went up by 1.39, productivity by 0.98, and safety by 1.42.

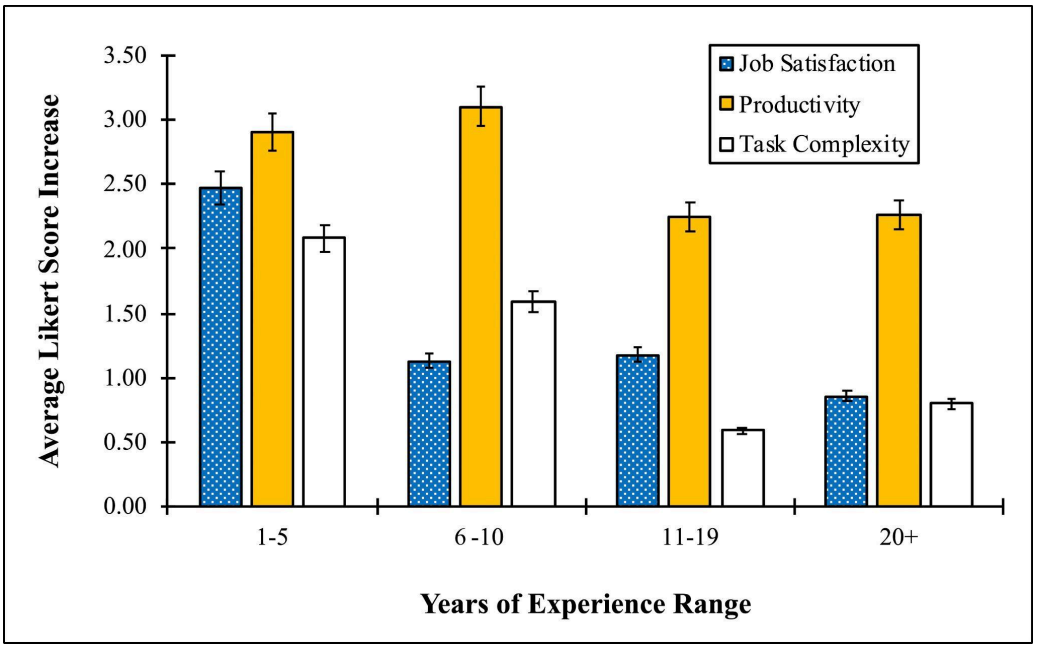
When segmenting for supervisors were allowed to upskill vs. no upskilling opportunities, their job satisfaction between groups was +1.50 points, +0.70 for productivity, and +1.44 for safety, as shown in Figure 11 and Appendix Table B2.

Figure 11: Workplace Outcomes based on Supervision Status and Upskilling Opportunities



Four years of experience buckets were isolated: 1-5, 6-10, 11-19, and 20+. Safety was omitted from the years of experience analysis due to its lack of statistical significance at the 95% confidence interval. This was replaced with task complexity in white in Figure 12. There is a downward progression between years of experience and the Likert score change, even though they are still positive. This means the positive reception goes down with an increase in years of experience.

Figure 12: Workplace Outcomes segmented based on Years of Experience ranges



Companies without Automation

Of the 51 respondents in companies without automation, When explicitly asked if they have concerns about automation (Q7), 33.33% said Yes. Of these 33.33%, 58.82% of respondents stated they had some type of job-related concerns. Anecdotes from these individuals are displayed in Table 2.

Table 2: Thematic responses to the question: "What concerns do you have about automation?"

Concern Theme	% of Responses	Quote Sample
Job Loss	58.82%	"... I am concerned about other employees losing their jobs due to automation making their jobs mostly obsolete."
Safety & Risk	17.6%	"I am concerned that companies won't have people supervise automated processes."
Human Impact & Ethics	11.71%	"Loss of Human Agency, Dependence and vulnerability, Erosion of meaningful work, Ethical oversight"
Training & Skills	11.71%	"Issues regarding processes that are expected to automated but are not implemented or are but not correctly."

Employees were also asked about barriers to automation in their companies, these anecdotes are displayed in Table 3.

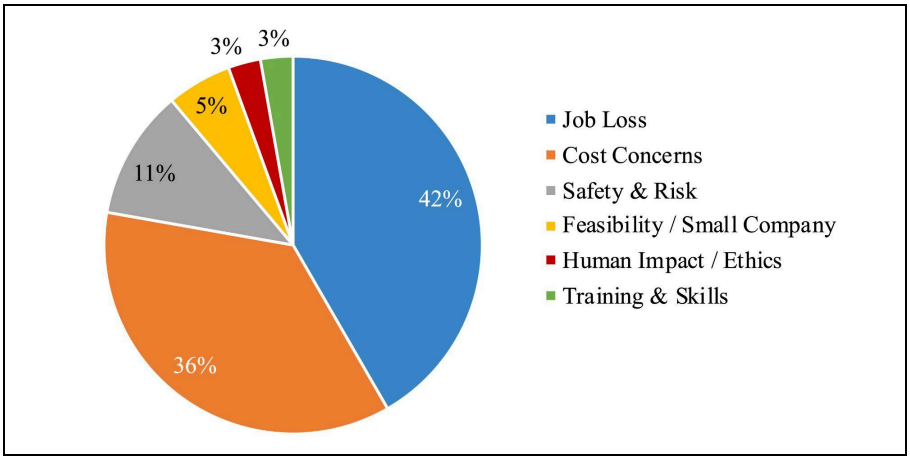
Table 3: Employees' Perspectives on Barriers to Automation

Concern Theme	% of Responses	Quote Sample
Cost of Capital	34.69%	“I think because of cost and economic instability right now…”
Feasibility / Small Company	24.49%	“They just haven't got around to it yet I guess because this a very small company with 10-12 employees”
Not Useful	12.24%	“I just think the need has not risen up to use automation. I'm sure as the business calls for it it will be implemented.”
Lack of Training & Skills	8.16%	“Our work is very technical and requires a lot of hands on work with a lot of knowledge.”
Ethical Concerns	2.04%	“My company puts a focus on handling client concerns directly.”
Other	18.37%	“I don’t know,” “Not sure”

There was a split on whether individuals believed automation would be implemented in their company in the future, with a slight majority saying Yes, 52.94% vs 47.05%.

Across all open-ended responses (Q10, Q11, Q12), 70.59% of respondents expressed automation-related concerns compared to when directly asked. The most profound concerns were job loss and the cost of capital. The specific word groupings are in Appendix D.

Figure 13: Employee-Reported Concerns in Companies without Automation



These responses support H_2, since there were found to be some concerns held by employees. Additionally, these concerns express resistance towards automation on account of the negative effects it is perceived to have in their workplace.

Discussion

The presence of RPA did not vary significantly across supply chain nodes, suggesting a widespread and uniform integration of automation across manufacturing and automotive supply chains. This is notable because current literature tests RPA effects primarily in Manufacturing & Assembly tasks over other areas and is underrepresented in areas such as Logistics & Transportation and Customer Service. Additionally, employees reported higher levels of job satisfaction, productivity, safety, and task complexity after automation was introduced. As shown by the downward trend in satisfaction and productivity, higher-tenured employees tend to be less open to automation, which is similar to studies discussed in the literature review. However, over time, as newer employees enter the workforce, attitudes toward automation will start to trend more positively because older employees will exit. Significant increases in workplace outcomes were found when adequate training was given to employees before the adoption of automation. Similarly, when opportunities to learn new skills and transition into new roles because of automation, workplace outcomes increased further. These effects were even more pronounced if the individual was a supervisor and was then given opportunities to upskill. Concerns toward automation were present in companies that have not yet implemented those technologies. Anecdotal accounts across all text-entry responses showed that a clear majority exhibited these concerns. The most common areas of concern were job loss, as predicted by the literature review, but the cost of capital and feasibility of implementing automation in small companies were also reasons for apprehension.

Limitations and Future Implications

There were some data points collected that yielded no statistical significance but were not detrimental to the overall goals of the study. Effects of Job Description, Union Status, Number of People Supervised, and Year Started were not considered in this study, but some data analysis is shown in Appendix C. However, these were still deemed important areas to look at by industry professionals in the preliminary interviews. Additionally, this study only surveyed 200 respondents, which may not be representative of broader populations with more nuanced understandings of automation.

Additionally, I initially wanted to analyze the automotive industry alone, but this was not possible because of the lack of automotive workers available to survey on Prolific; therefore, this study is broader, as it had to be expanded to the manufacturing and engineering industries. This can also be an area to look into in future studies.

Finally, the effects of unemployment relative to these results are a metric that would strengthen this work. This type of study was not feasible due to time, budget, and resource constraints given the nature of an undergraduate thesis. If possible, the isolated effects of automation on these industries and supply chain nodes individually would be an insightful metric on average.

Conclusion

The primary objective of this research was to evaluate workers' well-being after automation was introduced and understand what concerns they may have before its introduction. For companies that want to implement automation, the effects of these business decisions should

consider the opinions of workers and the capabilities of these workers before implementing mass automation that may be detrimental without adequate training and upskilling opportunities. These findings not only inform practical implementations of automation but can also help to positively shift rhetoric and alleviate fears of automation in supply chains.

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Appendix A: Survey Design

Survey Prescreen Criteria:

1. Current Country of Residence: United States
2. Industry: Manufacturing, Other Manufacturing, Automotive, Engineering
3. Employer Type:
    - Employee of a for-profit company or business or of an individual, for wages, salary, or commissions,
    - Employee of a not-for-profit, tax-exempt, or charitable organization,
    - Local government employee (city, county, etc.),
    - State government employee,
    - Federal government employee
4. Work Function:
    - Chemical / Mechanical / Electrical / Civil Engineering,
    - CX / Customer Experience / Support,
    - Data Analysis,
    - Design or Creative,
    - Engineering (e.g. software),
    - IT / Information Networking / Information Security,
    - Operations,
    - Product or Product Management,
    - Project or Program Management,
    - Research,
    - Sales / Business Development

Survey Questions:

1. What year did you start working in your industry?
2. How many years of experience do you have in your industry?
3. Describe your job (role, industry, etc).
4. Which area of the supply chain do you work in? (Please select as many that apply).
    a. Product Design & Development
    b. Sourcing & Procurement
    c. Warehousing, Inventory Management, & Distribution
    d. Manufacturing & Assembly
    e. Logistics & Transportation
    f. Sales, Service, Customer Support
    g. Other, please specify: _____
5. Do you supervise anyone?
    a. Yes
    b. No
6. How many people do you supervise?
7. Is your company union or non-union?
    a. Union
    b. Non-Union
    c. Other - describe: _____
8. Does your company currently use automation?

Companies without Automation:

9. Do you have any concerns related to automation in general?
    a. Yes
    b. No
10. What are your concerns relating to automation?
11. Why do you think your company has not implemented automation?
12. Do you foresee automation being implemented in the future at your company?
13. Do you have any other comments relating to automation in your job?

Companies with Automation:

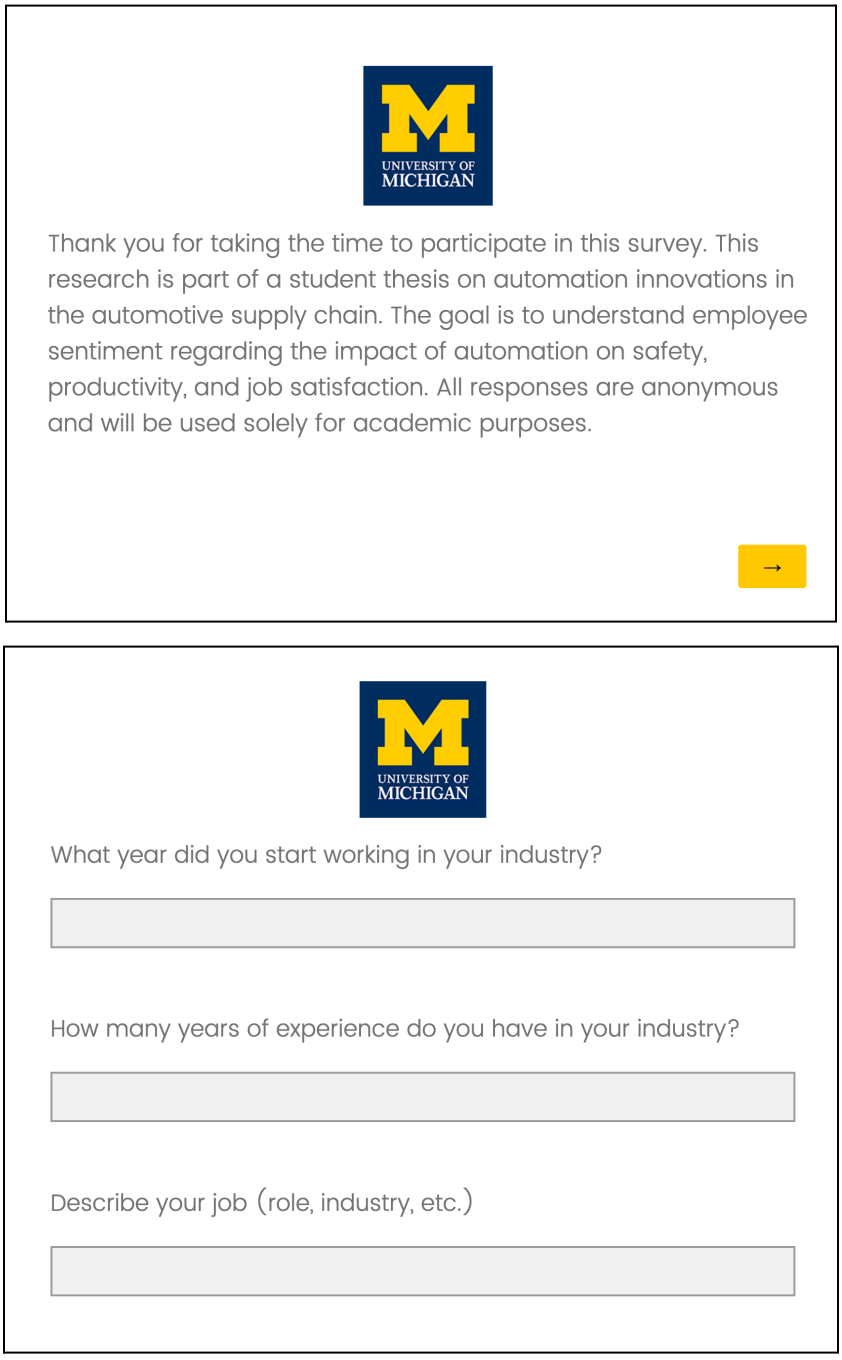
9. Which process (or processes) in the supply chain does your company use automation?
10. Which automation technologies does your company implement?
11. In general, has the automation you described in the previous question led you to complete repetitive tasks or complete more complex work than before?
    a. Likert Scale: 0 - More repetitive, 10 - More complex
12. Do you think you have received adequate training to adapt to automation-related changes in your role? Optional – describe these
    a. Yes: _____
    b. No: _____
13. Have you been given opportunities to learn new skills or transition into different roles because of automation? Optional – describe these
    a. Yes: _____
    b. No
14. How has automation impacted your productivity levels?

    a. Likert Scale: 0 - Significantly decreased, 10- Significantly increased

15. How has automation impacted your safety?
    a. Likert Scale: 0 - Significantly worsened, 10 - Significantly improved
16. How satisfied would you describe yourself with your job after the introduction of automation?
    a. Likert Scale: 0 - Significantly less satisfied, 10 - Significantly more satisfied
17. Do you have any other comments relating to automation in your job?

Permission for work with human subjects (IRB approval) has been obtained from the Ross School of Business Doctoral Studies program for this research. No sensitive data will be collected, and the survey will be anonymous to protect respondents' identities.

Figure A1: Respondent Preview of Survey Interface in Qualtrics



Appendix B: Additional Tables and Figures for Companies with Automation

Table B1: Average Workplace Outcome Changes for Respondents With and Without Adequate Training

Variable	P Value	Average Not Adequate	Average Adequate	Delta
Job Satisfaction	1.45E-03	0.04	1.73	+1.69
Productivity	1.21E-04	1.47	2.89	+1.42
Safety	3.91E-05	0.53	2.30	+1.77

Table B2: Average Workplace Outcome Changes for Respondents With and Without Upskilling Opportunities

		Upskilling Opportunities		
Variable	P Value	Average No Upskilling	Average Upskilling	Delta
Job Satisfaction	7.10E-04	0.47	1.86	+1.39
Productivity	1.13E-03	1.96	2.94	+0.98
Safety	1.41E-04	1.02	2.43	+1.42

Table B3: Workplace outcomes based on opportunity to upskill and supervision status

	No Supervisor			Supervisor			
Values	No Upskill	Upskill	Delta	No Upskill	Upskill	Delta	p-values
Job Satisfaction	0.55	1.68	**1.13**	0.41	1.91	**1.50**	5.10E-03
Productivity	1.31	2.17	**0.86**	2.45	3.15	**0.70**	2.68E-05
Safety	0.97	2.16	**1.19**	1.06	2.50	**1.44**	1.22E-03

Appendix C: Variables Analyzed with No Statistically Significant Findings

The following variables were analyzed during this study, but were not included in the main body of the report. Since these were important variables and gaps in current literature, they are still documented below and can serve as starting points for future research.

Figure C1: Average Likert Scores Changes for Non-Union and Union employees.

Variable	Average Non-Union	Average Union	p-value
Job Satisfaction	1.54	1.21	0.38
Productivity	2.66	2.58	0.77
Safety	1.84	2.23	0.30
Task Complexity	1.24	1.26	0.96

p-value > 0.05, so the data was not significant.

Similar analyses with non-significant p-values were conducted but not recorded for the year started in the industry and the number of people supervised. Another analysis on job responsibilities of employees, given by Q3 (Job Description) could further be compared against the workplace outcomes and possible concerns, but the dataset was too small to find measurable differences in job responsibilities.

Appendix D: Grouping Criteria for Companies without Automation

Overall Concerns:

- Job Loss: jobs, job, losing, loss, lose, replacement, replacing, obsolete, eliminate, workers, human
- Cost Concerns: cost, expensive, budget, funding, investment, financial, pricing, profit, savings, maintenance, overhead, affordable
- Feasibility/Small Company: feasible, feasibility, resources, capacity, small, limitations, infrastructure
- Safety & Risk: safety, accidents, oversight, risk, danger, vulnerable, mistake
- Training & Skills: training, skills, learning, supervision, knowledge, guidance
- Ethics: ethical, fair, humane, meaningful, values, morale
- Perceived Use: useful, use, no need

Types of Automation:

- AI: AI, machine learning, predictive, blockchain, GPT, chat bots, chatbots
- Robots Process Automation: robots, robotics, machines, collaboration bots, cobots, and arms
- Manufacturing & Assembly: painting, taping, wrap, assembly, weld, 3d print, belts, manufacturing, sorting, packaging, packing, CNC, cutting, production
- Inventory Management: analytics, flow, software, ERP, program, data, forecasting
- Warehousing: warehouse, TMS, purchase order, power BI, barcode, track
- Quality: quality, testing, safety
- Delivery to Customer: vehicle, lgv, deliver, transport