TOWARDS SUSTAINABLE TRUCKING: LINKING OCCUPATIONAL REALITIES AND DRIVER-TRIP ASSIGNMENT OPTIMIZATION IN INDIA'S TRUCKING NETWORK

A Thesis Submitted in Partial Fulfillment

of the Requirements for the

Doctoral Programme in Management (DPM)

of the

Indian Institute of Management Indore

By

Pankesh Dhadwal (2021FPM13)

Operations Management & Quantitative Techniques (OM & QT)

March, 2026

Thesis Advisory Committee

Prof. Saurabh Chandra (Chair)

Prof. Amit Kumar Vatsa (Member)

Prof. Sayantan Mukherjee (Member)

Table of Contents

भारतीय प्रबंध संस्थान इन्दौर
प्रबंध शिखर, राऊ–पीथमपुर रोड़, इन्दौर–453 556 (म.प्र.), भारत
INDIAN INSTITUTE OF MANAGEMENT INDORE
Prabandh Shikhar, Rau-Pithampur Road, Indore - 453 556 (M.P.), India

Institutional Review Board
Indian Institute of Management Indore

Certificate of Approval

Title of the study: Challenges in Indian trucking industry: drivers' perspective.

Principal Investigator(s): Pankesh Dhadwal

This is to certify that the above proposal has been reviewed by the Institutional Review Board (IRB) at the Indian Institute of Management Indore (IIM Indore), and it meets the requirements of the IRB. The proposal has been APPROVED on 09/02/2024, with IRB Approval No. IRB/DPM/09022024/17.

This approval remains valid for a maximum of three years from the date of approval.

The principal investigator(s) is/are responsible for adhering to the conditions of the approval.

The principal investigator(s) is/are required to submit a completion report to the IRB after the conclusion of the study.

Signed:

Sayantan Banerjee
Chair, Research & Publications
Indian Institute of Management Indore

Phone : +91-731-2439400, Fax : +91-731-2439800 Website : http://www.iimidr.ac.in

Acknowledgements

The completion of this doctoral thesis marks the culmination of a long and intellectually demanding journey that would not have been possible without the guidance, encouragement, and support of numerous individuals and institutions. I take this opportunity to express my sincere gratitude to all those who contributed, directly or indirectly, to this research.

First and foremost, I would like to express my deepest gratitude to my Thesis Advisory Committee (TAC) members for their invaluable academic guidance, constructive feedback, and continued encouragement throughout my doctoral research. I am especially grateful to Prof. Saurabh Chandra, my TAC Chair, for his sustained mentorship, intellectual leadership, and rigorous guidance throughout my Ph.D. journey. His critical insights, high academic standards, and unwavering encouragement were instrumental in shaping the direction of this thesis and in pushing me to think more deeply and systematically about both the qualitative and quantitative dimensions of my thesis work.

I'm sincerely thankful to Prof. Amit Kumar Vatsa and Prof. Sayantan Mukherjee for their time, patience, and insightful comments at various stages of my research. Their diverse perspectives helped shape the direction of this thesis, strengthening both its conceptual clarity and methodological rigor. The TAC discussion was instrumental in refining my research questions, sharpening my theoretical framing, and ensuring coherence between the qualitative and quantitative components of the study. I sincerely appreciate their critical engagement with my work and their unwavering support during moments of intellectual uncertainty.

I am also thankful to Prof Shrihari S. Sohani, who played a pivotal role in guiding the second chapter of this thesis, which focuses on the qualitative exploration of truck driver disengagement and turnover. His mentorship was crucial in helping me navigate the complexities of qualitative research, particularly in grounding empirical insights within robust theoretical frameworks such as the Job Demands-Resources model and dirty work theory. His guidance significantly improved my understanding of qualitative research design, interview techniques, and analytical rigor. I am deeply grateful for his thoughtful feedback and encouragement, which helped me develop confidence as a qualitative researcher.

I would also like to acknowledge the institutional support from IIM Indore, which provided a stimulating academic environment conducive to interdisciplinary research. I am thankful to the faculty members, administrative staff, research office, and DPM office for facilitating access to resources, infrastructure, and academic platforms necessary for conducting this research. The opportunity to engage with peers across disciplines enriched my thinking and helped me view operations research through broader social and behavioral lenses. I also gratefully acknowledge the institute's support in enabling my participation in national and international conferences, workshops, and doctoral forums, where feedback from the academic community has meaningfully contributed to the refinement and development of this research.

I extend my sincere appreciation to all the truck drivers and participants who generously shared their time, experiences, and personal stories during interviews and informal conversations. Their willingness to speak candidly about their work, struggles, and aspirations forms the foundation of this thesis. This research would not have been possible without their trust and openness. I hope this work contributes, even in a small way, to improving the recognition, dignity, and working conditions of truck drivers in India.

I'm also grateful to my friends and colleagues for their companionship and support throughout this journey. Informal discussions, academic debates, and shared moments of frustration and celebration made this long process more manageable and meaningful. I would like to extend my particular thanks to my cohort members for creating a collaborative and supportive academic atmosphere. I would especially like to acknowledge the support and friendship of Abhinay, Rimleena, Priya, Akansh, Karthik, and Anshul, whose encouragement and camaraderie made this journey far more enriching. I also appreciate friends outside academia who patiently listened, encouraged me during my Ph.D. journey, and reminded me of life beyond research deadlines and solver runtimes.

Above all, I owe my deepest gratitude to my parents and family, whose unwavering faith in me has been the cornerstone of my Ph.D. journey. Their sacrifices, patience, and unconditional support have sustained me throughout the years. They instilled in me the values of perseverance, humility, and hard work, which guided me through the challenges of doctoral

research. Words cannot fully express my gratitude for their unwavering encouragement and constant belief in my abilities.

I'm profoundly thankful to my wife, Radhika, whose love, understanding, and resilience made the completion of this thesis possible. Her emotional support, patience during long working hours, and ability to stand by me through periods of stress and uncertainty have been invaluable. She shared in both the struggles and triumphs of this journey, often putting my work before her own comforts. This thesis is as much hers as it is mine.

Finally, I acknowledge that this thesis represents a collective effort shaped by many influences. Any errors or omissions that remain are solely my responsibility. I hope that this work reflects the guidance I have received and makes a meaningful contribution to research on human-centered logistics, truck driver well-being, and scheduling optimization.

Abstract

Transportation is one of the most crucial and cost-intensive functions of global supply chains worldwide. It accounts for a large share of total logistics costs while also improving the quality and responsiveness of freight services (Waters, 1990). This position has been recently confirmed by worldwide logistics studies, which evidence that transport costs account for 50-60% of logistics costs, reinforcing its strategic role for the competitiveness of supply chains (World Bank, 2023; IRU, 2023). While various freight transportation modes, such as water, air, rail, and road, are available, long-haul trucking has been the most prevalent due to its operational flexibility and ease of availability (Williams et al., 2017). India has been no different, with truck transportation accounting for 70% of ton-miles of goods movement across the country (NITI Aayog, 2022). This indicates that truck drivers play an integral role in India's economic productivity. However, trucking in India has been largely informal and disorganized for years, leading to several structural challenges, including high driver turnover, inconsistent regulations, and additional institutional barriers (Belzer, 2000; Mittal et al., 2018). These structural issues diminish the logistics sector's performance and raise serious concerns about the future of truck drivers in India.

To address these challenges, an integrative understanding of both human and operational dimensions of the Indian trucking industry is required. This thesis adopts a mixed-methods approach to investigate the determinants and consequences of truck driver turnover in India, combining qualitative inquiry with quantitative optimization modeling to develop analytical frameworks for improving driver management and scheduling. The first study employs a qualitative methodology, conducting 25 semi-structured interviews with truck drivers supplemented by vlog analysis and field observations. The qualitative data are analyzed using the Job Demands-Resources (JD-R) framework (Bakker & Demerouti, 2007) and the dirty work theory (Ashforth & Kreiner, 1999; Hughes, 1962).

While the JD-R framework is used to understand truck drivers' psychosocial work demands and resources that lead to disengagement and turnover, the dirty work theory offers an interpretive lens for understanding how drivers internalize occupational stigma. These theories, when combined, provide a theoretical lens for understanding how demands, such as extended driving

hours, irregular rest periods, inadequate facilities, and prolonged separation from families, combined with insufficient resources like managerial support, fair scheduling, and social recognition, cause imbalance, making drivers feel fatigued, stressed, and experience identity degradation. The analysis further highlights how informal employment arrangements and exploitative pay structures heighten vulnerability, linking occupational stigma with structural insecurity (Soral et al., 2022; Xu et al., 2024).

In the second study, we develop an Integer Programming (IP) model for optimizing truck driver scheduling in a relay-based logistics network. The formulation includes real-world aspects of long-haul trucking that have been highlighted by prior research on scheduling and relay network design, including driver-truck compatibility, rest-time feasibility, relocation constraints, home-return requirements, and relay mechanisms that allow freight transfers between drivers at intermediate hubs during multi-leg journeys (Üster & Kewcharoenwong, 2011; Vergara & Root, 2013). Freight systems based on relays have recently attracted attention as a potential way to reduce driver fatigue and increase regularity of home time without compromising network efficiency (Melton, 2012; Ziaeifar & Üster, 2023). By embedding relay logic directly into the model, we can design sustainable multi-leg schedules in which drivers complete shorter but connected trips and return home more frequently. Further, we have discussed the fatigue and retention problems in detail in Chapter 2.

The proposed model minimizes the total operational cost, which includes driver salaries, fixed deployment costs, relocation costs, rest-time costs, and the cost of using external or outsourced drivers when the internal driver pool is insufficient to complete the available trip legs. The formulation incorporates conventional optimization strengthening techniques, such as valid inequalities, heuristic chaining algorithms, and column generation-based decomposition, commonly used in large-scale crew and vehicle scheduling problems (Barnhart et al., 1998; Desaulniers et al., 2005), to make the model more realistic and computationally scalable. The model is tested across multiple datasets, including both synthetic and real-world-inspired scenarios, over multi-day planning horizons. Computational experiments demonstrate that the proposed IP model can achieve a balance between minimizing operational costs while meeting all regulatory and operational constraints, outperforming the conventional industry scheduling practices. The results also indicate that the integrated relay-based scheduling structure reduces

overall relocation and rest costs, increases the frequency of driver home visits, and achieves higher utilization of both drivers and trucks.

The thesis makes three significant contributions. Theoretically, it extends the JD-R framework by positioning occupational stigma and informality as central job demands in the freight logistics context of a developing economy, thereby bridging the behavioral and structural dimensions of disengagement (Bakker & Demerouti, 2007; Ashforth & Kreiner, 1999). The integration of JD-R and dirty work theory provides a novel framework for understanding identity-based strain in stigmatized, low-status occupations, such as trucking. Methodologically, it makes a novel contribution to the research on driver scheduling by using IP-based optimization techniques in informal labor and trucking environments that lack standardized employment contracts, regulated rest infrastructure, and formal centralized dispatch systems. From a policy and practice perspective, the study offers actionable insights for logistics firms and policymakers on how to enhance scheduling, rest policies, and driver retention efforts, ultimately reducing burnout and turnover.

To conclude, this thesis helps pave the way for a better understanding of the complex issues around truck driver turnover from both qualitative and quantitative perspectives. A qualitative study of drivers' daily experiences offered unique insights into the myriad human factors that influence their job satisfaction and turnover intentions. By contrast, quantitative research on optimizing driver schedules to improve the driver experience could help logistics companies reduce driver turnover by creating an efficient driving environment that better meets drivers' needs. Integrating both studies, this thesis contributes to the broader body of knowledge on sustainable workforce design in freight logistics. First, it demonstrates that economic efficiency goals are not inherently opposed to drivers' well-being; rather, they can be jointly optimized through human-centric driver scheduling. Second, the findings underscore the need to implement socially responsible, data-driven freight logistics solutions, particularly in emerging economies like India, where workforce sustainability and operational efficiency must be addressed simultaneously.

List of Tables

References

American Trucking Associations (ATA, 2022). The truth about trucking turnover. Accessed: 2022- 03–25, https://www.trucking.org/news-insights/truth-about-trucking-turnover

Apostolopoulos, Y., Sönmez, S., Shattell, M. M., & Belzer, M. (2010). Worksite-induced morbidities among truck drivers in the United States. *AAOHN journal*, *58*(7), 285-296.

Ashforth, B. E., & Kreiner, G. E. (1999). "How can you do it?": Dirty work and the challenge of constructing a positive identity. *Academy of Management Review*, *24*(3), 413–434.

Ashton, D., & Patel, K. (2017). Vlogging careers: Everyday expertise, collaboration, and authenticity. *The new normal of working lives: Critical studies in contemporary work and employment*, 147–169.

Autry, C. W., & Daugherty, P. J. (2003). Warehouse operations employees: linking person-organization fit, job satisfaction, and coping responses. *Journal of Business Logistics*, 24(1):171–197.

Bag, S., & Anand, N. (2014). Retention of long distance company truck drivers in India. *International Journal of Operations and Logistics Management*, *3*(3), 222-240.

Bakker, A. B., Demerouti, E., & Sanz-Vergel, A. (2023). Job demands–resources theory: Ten years later. *Annual review of organizational psychology and organizational behavior*, *10*(1), 25-53.

Bakker, A. B., Demerouti, E., & Verbeke, W. (2004). Using the job demands-resources model to predict burnout and performance. *Human resource management: Published in Cooperation with the School of Business Administration, The University of Michigan, and in alliance with the Society of Human Resources Management*, *43*(1), 83–104.

Bakker, A. B., & Demerouti, E. (2007). The job demands-resources model: State of the art. *Journal of managerial psychology*, *22*(3), 309-328.

Banerji, S. (2016). The case of the vanishing drivers. *Business Today*. Accessed: 2016-05-02, https://www.businesstoday.in/magazine/features/story/road-transport-decline-due-to-high-demand-for-truck-drivers-63151-2016-05-02

Basnyat, S., & Clarence Lao, C. S. (2020). Employees' perceptions on the relationship between human resource management practices and employee turnover: A qualitative study. *Employee Relations: The International Journal*, *42*(2), 453-470.

Bauer, G. F., H¨ammig, O., Schaufeli, W. B., and Taris, T. W. (2014). A critical review of the job demands-resources model: Implications for improving work and health. *Bridging occupational, organizational and public health: A transdisciplinary approach*, pages 43–68.

Belzer, M. H. (2000). *Sweatshops on wheels: Winners and losers in trucking deregulation*. New York, NY: Oxford University Press.

Berryman, R., & Kavka, M. (2018). Crying on YouTube: Vlogs, self-exposure and the productivity of negative affect. *Convergence*, *24*(1), 85–98.

Bhardwaj, A., Sergeeva, A., Mahoney, J., & Nickerson, J. (2025). Theorizing as Problem Solving: A Pragmatist Perspective on the Logic of Pursuit. *Strategy Science*.

Blue Energy Motors. (2024). Beyond the engine: The role of digitalisation and AI in the future of trucking. https://blueenergymotors.com/

Bosmans, K., Mousaid, S., De Cuyper, N., Hardonk, S., Louckx, F., & Vanroelen, C. (2016). Dirty work, dirty worker? Stigmatisation and coping strategies among domestic workers. *Journal of Vocational Behavior*, *92*, 54–67.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77–101.

Bureau of Labor Statistics. (2024). *Unemployment rate changed little at 4.2 percent in November 2024* [News release]. U.S. Department of Labor. https://www.bls.gov/opub/ted/2024/unemployment-rate-changed-little-at-4-2-percent-in-november-2024.htm

Burks, S. V., Carpenter, J. P., Goette, L., & Rustichini, A. (2009). Cognitive skills affect economic preferences, strategic behavior, and job attachment. *Proceedings of the National Academy of Sciences*, *106*(19), 7745–7750.

Burks, S. V., & Monaco, K. (2019). Is the US labor market for truck drivers broken. *Monthly Lab. Rev.*, *142*, 1.

Burks, S. V., Cowgill, B., Hoffman, M., & Housman, M. (2015). The value of hiring through employee referrals. *The Quarterly Journal of Economics*, *130*(2), 805–839.

Cantor, D. E., Macdonald, J. R., & Crum, M. R. (2011). The influence of workplace justice perceptions on commercial driver turnover intentions. *Journal of Business Logistics*, 32(3):274–286.

Centre for Monitoring Indian Economy (2024). Unemployment rate rises to 9.2. Accessed: 2024-07-01, https://www.cmie.com/kommon/bin/sr.php?kall=warticle&dt=20240701180501&%20msec=110

Charmaz, K. (2014). *Constructing Grounded Theory*. SAGE.

Chen, C. F., & Yu, T. (2014). Effects of positive vs negative forces on the burnout-commitment-turnover relationship. *Journal of Service Management*, *25*(3), 388–410.

Conroy, S. A., Roumpi, D., Delery, J. E., & Gupta, N. (2022). Pay volatility and employee turnover in the trucking industry. *Journal of Management*, *48*(3), 605–629.

Construction World Team. (2024, June 4). *Truck driver shortage disrupts logistics industry.* Construction World. https://www.constructionworld.in/urban-infrastructure/warehouse-and-logistics/truck-driver-shortage-disrupts-logistics-industry/56432

Costello, B., & Suarez, R. (2015). Truck driver shortage analysis 2015. *Arlington, VA: The American Trucking Associations*.

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.

CRISIL Research. (2023). *Indian logistics sector: Growth outlook and industry trends*. CRISIL Ltd.

Crum, M. R., & Morrow, P. C. (2002). The influence of carrier scheduling practices on truck driver fatigue. *Transportation Journal*, 20-41.

da Silva-Júnior, F. P., de Pinho, R. S. N., de Mello, M. T., de Bruin, V. M. S., & de Bruin, P. F. C. (2009). Risk factors for depression in truck drivers. *Social psychiatry and psychiatric epidemiology*, *44*, 125-129.

de Croon, E. M., Sluiter, J. K., & Frings-Dresen, M. H. (2003). Need for recovery after work predicts sickness absence: a 2-year prospective cohort study in truck drivers. *Journal of psychosomatic research*, *55*(4), 331-339.

Deery, S., Kolar, D., & Walsh, J. (2019). Can dirty work be satisfying? a mixed method study of workers doing dirty jobs. *Work, Employment and Society*, 33(4):631–647.

Demerouti, E., Bakker, A. B., Nachreiner, F., & Schaufeli, W. B. (2001). The job demands-resources model of burnout. *Journal of Applied Psychology*, *86*(3), 499.

E. Ashforth, B., E. Kreiner, G., A. Clark, M., & Fugate, M. (2007). Normalizing dirty work: Managerial tactics for countering occupational taint. *Academy of Management Journal*, *50*(1), 149–174.

Fetters, M. D., Curry, L. A., & Creswell, J. W. (2013). Achieving integration in mixed methods designs—principles and practices. *Health services research*, *48*(6pt2), 2134–2156.

Forbes. (2023, August 21). *How truck driver retention strategies impact safety and profit.* Forbes. https://www.forbes.com/councils/forbesbusinesscouncil/2023/08/21/how-truck-driver-retention-strategies-impact-safety-and-profit/

Francis, J. J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J. M. (2010). What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology and health*, *25*(10), 1229–1245.

Gauche, C., de Beer, L. T., & Brink, L. (2017). Managing employee well-being: A qualitative study exploring job and personal resources of at-risk employees. *SA Journal of Human Resource Management*, 15:13.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational research methods*, *16*(1), 15–31.

Gioia, D. A. & Thomas, J. B. (1996). Identity, image, and issue interpretation: Sensemaking during strategic change in academia. *Administrative Science Quarterly*, pages 370–403.

Grandey, A. A., & Melloy, R. C. (2017). The state of the heart: Emotional labor as emotion regulation reviewed and revised. *Journal of Occupational Health Psychology*, *22*(3), 407.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods*, *18*(1), 59-82.

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis*. Thousand Oaks, CA: Sage Publications.

HBR. (2021). The future of flexibility at work. Retrieved from https://hbr.org/2021/09/the-future-of-flexibility-at-work

Hertz, R. P. (1991). Hours of service violations among tractor-trailer drivers. *Accident Analysis & Prevention*, 23(1):29–36.

ILLUMINZ. (2023). *Role of mobile apps in transportation and logistics business*. Medium. Role of Mobile Apps in Transportation and Logistics Business | by illuminz | Medium

Kang, H. J., Gatling, A., & Kim, J. (2015). The impact of supervisory support on organizational commitment, career satisfaction, and turnover intention for hospitality frontline employees. *Journal of Human Resources in Hospitality & Tourism*, *14*(1), 68-89.

Koul, S., & Singh, A. (2022, December). Mapping vulnerabilities of Indian long-haul truck drivers. In *2022 IEEE International Conference on Service Operations and Logistics, and Informatics (SOLI)* (pp. 1–8). IEEE.

Keller, S. B. & Ozment, J. (1999). Managing driver retention: Effects of the dispatcher. *Journal of Business Logistics*, 20(2):97–119.

Kemp, E., Kopp, S. W., & Kemp Jr, E. C. (2013). Take this job and shove it: Examining the influence of role stressors and emotional exhaustion on organizational commitment and identification in professional truck drivers. *Journal of Business Logistics*, 34(1):33–45.

Kozinets, R. V. (2015). *Netnography: redefined*. Thousand Oaks, CA: Sage

Kraimer, M. L., Seibert, S. E., Wayne, S. J., Liden, R. C., & Bravo, J. (2011). Antecedents and outcomes of organizational support for development: the critical role of career opportunities. *Journal of Applied Psychology*, *96*(3), 485.

Kreiner, G. E., Ashforth, B. E., & Sluss, D. M. (2006). Identity dynamics in occupational dirty work: Integrating social identity and system justification perspectives. *Organization science*, *17*(5), 619-636.

LeMay, S. & Keller, S. B. (2019). Fifty years inside the minds of truck drivers. *International Journal of Physical Distribution & Logistics Management*, 49(6):626–643.

Levy, K. (2022). Data-driven: Truckers, technology, and the new workplace surveillance. Princeton, NJ: Princeton University Press.

LogixMindz. (2025, March 25). *Demand & supply trends in India's trucking industry: Challenges & strategies* LogixMindz. https://logixmindz.com/demand-supply-trends-in-indias-trucking-industry-challenges-strategies/

Lupton, D. (2014), *Digital sociology*, Routledge, New York (NY).

Magnani, G., & Gioia, D. (2023). Using the Gioia Methodology in international business and entrepreneurship research. *International Business Review*, *32*(2), 102097.

Makadok, R., Burton, R., & Barney, J. (2018). A practical guide for making theory contributions in strategic management. *Strategic Management Journal*, *39*(6), 1530-1545.

Masa, J. F., Rubio, M., Findley, L. J., & Cooperative Group. (2000). Habitually sleepy drivers have a high frequency of automobile crashes associated with respiratory disorders during sleep. *American Journal of respiratory and critical care medicine*, *162*(4), 1407-1412.

McFarlin, D. B. & Sweeney, P. D. (1992). Distributive and procedural justice as predictors of satisfaction with personal and organizational outcomes. *Academy of Management Journal*, 35(3):626–637.

McKinsey & Company. (2022). Will autonomy usher in the future of truck freight transportation? https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/will-autonomy-usher-in-the-future-of-truck-freight-transportation

Miller, J. W., Saldanha, J. P., Rungtusanatham, M., & Knemeyer, M. (2017). How does driver turnover affect motor carrier safety performance and what can managers do about it?. *Journal of Business Logistics*, *38*(3), 197–216.

Miller, J. W., Bolumole, Y., & Muir, W. A. (2021). Exploring longitudinal industry-level large truckload driver turnover. *Journal of Business Logistics*, *42*(4), 428-450.

Miller, J. W., Phares, J., & Burks, S. V. (2024). Job gain and job loss dynamics in the truck transportation industry. *Journal of Business Logistics*, *45*(3), e12391.

Min, H. & Lambert, T. (2002). Truck driver shortage revisited. *Transportation Journal*, 42(2):5–16.

Mittal, N., Udayakumar, P. D., Raghuram, G., & Bajaj, N. (2018). The endemic issue of truck driver shortage--a comparative study between India and the United States. *Research in transportation economics*, 71:76 84.

National Academies of Sciences, Engineering, and Medicine. (2024). *Pay and working conditions in the long-distance truck and bus industries: Assessing for effects on driver safety and retention*. Washington, DC: The National Academies Press

NextBillion.ai. (2024, November 11). *7 proven strategies for improving truck driver retention*. NextBillion. https://nextbillion.ai/blog/strategies-for-improving-truck-driver-retention

NITI Aayog (2022). Share of freight logistics in India in 2022, by mode. Accessed: 2024-10-16, https://www.statista.com/statistics/1248877/india-share-of-freight-logistics-by-modes/

Ouellet, L. (1994). *Pedal to the metal: The work life of truckers*. Philadelphia, PA: Temple University Press.

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health services research*, *34*(5 Pt 2), 1189.

Phares, J., & Balthrop, A. (2022). Investigating the role of competing wage opportunities in truck driver occupational choice. *Journal of Business Logistics*, *43*(2), 265-289

Phares, J., Miller, J. W., & Burks, S. V. (2025). Shedding light on truck driver supply and demand: Heterogeneous state-level recovery of trucking employment following the COVID-19 employment shock. *Transportation Journal*, *64*(1), e12038

Philip, P., Sagaspe, P., Moore, N., Taillard, J., Charles, A., Guilleminault, C., & Bioulac, B. (2005). Fatigue, sleep restriction and driving performance. *Accident Analysis & Prevention*, *37*(3), 473-478.

Pink, S. (2007). Visual interventions: Applied visual anthropology (Vol. 4). New York, NY: Berghahn Books.

Prockl, G., Teller, C., Kotzab, H., & Angell, R. (2017). Antecedents of truck drivers' job satisfaction and retention proneness. *Journal of Business Logistics*, 38(3):184–196.

Sastry, S. (2016). Long distance truck drivers and the structural context of health: a culture-centered investigation of Indian truckers' health narratives. *Health Communication*, *31*(2), 230–241.

Saunders, M. N., & Townsend, K. (2016). Reporting and justifying the number of interview participants in organization and workplace research. *British Journal of Management*, *27*(4), 836–852.

SaveLIFE Foundation. (2020). *Status of Truck Drivers in India.* SaveLIFE Foundation. https://savelifefoundation.org/wp-content/uploads/2020/02/design-single-page-27th-feb-2020.pdf

Schaufeli, W. B. (2017). Applying the job demands-resources model. *Organizational dynamics*, 2(46):120–132.

Schaufeli, W. B., & Bakker, A. B. (2004). Job demands, job resources, and their relationship with burnout and engagement: A multi-sample study. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, 25(3):293–315.

Schaufeli, W. B., & Taris, T. W. (2013). A critical review of the job demands-resources model: Implications for improving work and health. *Bridging occupational, organizational and public health: A transdisciplinary approach*, 43–68.

Schaufeli, W. B., Bakker, A. B., & Van Rhenen, W. (2009). How changes in job demands and resources predict burnout, work engagement, and sickness absenteeism. *Journal of Organizational Behavior: The International Journal of Industrial, Occupational and Organizational Psychology and Behavior*, *30*(7), 893–917.

Sersland, D. & Nataraajan, R. (2015). Driver turnover research: Exploring the missing angle with a global perspective. *Journal of Service Management*, 26(4):648–661.

Singh, A., & Parihar, M. (2018). Analysis of issues relating to work life balance in trucking operation: A human resource perspective. *Int J Comput Sci Eng*, *5*(8).

Soral, P., Pati, S. P., Singh, S. K., & Cooke, F. L. (2022). Coping with dirty work: A meta-synthesis from a resource perspective. *Human Resource Management Review*, *32*(4), 100861.

Statista (2022). U.S. freight movement mode share in 2020. Accessed: 2024-10-16, https://www.statista.com/statistics/184595/us-freight-movement-mode-share-by-tonnage/

Suzuki, Y. (2007). Truck driver turnover: what rate is good enough? *International Journal of Physical Distribution & Logistics Management*, 37(8):612–630.

Suzuki, Y., Crum, M. R., & Pautsch, G. R. (2009). Predicting truck driver turnover. *Transportation Research Part E: Logistics and Transportation Review*, *45*(4), 538–550.

TransPlus. (2024). 8 ways to reduce driver turnover. https://www.transplus.io/blog/8-ways-to-reduce-driver-turnover

Transport Corporation of India. (2023). *Logistics sector report*. Transport Corporation of India Ltd.

Viscelli, S. (2016). *The big rig: Trucking and the decline of the American dream*. Oakland, CA: University of California Press.

Williams, D. F., Thomas, S. P., & Liao-Troth, S. (2017). The truck driver experience: Identifying psychological stressors from the voice of the driver. *Transportation Journal*, 56(1):54–76.

Williams, Z., Garver, M. S., & Stephen Taylor, G. (2011). Understanding truck driver need-based segments: Creating a strategy for retention. *Journal of Business Logistics*, *32*(2), 194-208.

Willig, C. (2013). *EBOOK: introducing qualitative research in psychology*. McGraw-Hill Education (UK).

WorkHound. (2021, May 11). *Truck driver turnover rates: Why you should know your truck driver turnover rate*. WorkHound.

Xu, Y., Wang, T., & Li, J. (2024). Working with stigma: the buffering role of self-compassion. *Asia Pacific Journal of Management*, *41*(4), 2389-2404.

Yin, R. K. (2018). *Case study research and applications: Design and methods*. Thousand Oaks, CA: Sage Publications.

Ali, T. H., Radhakrishnan, S., Pulat, S., & Gaddipati, N. C. (2002). Relay network design in freight transportation systems. *Transportation Research Part E: Logistics and Transportation Review, 38*(6), 405–422. https://doi.org/10.1016/S1366-5545(02)00016-9

Shijun, C. H. E. N., Yindong, S. H. E. N., Xuan, S. U., & Heming, C. H. E. N. (2013). A crew scheduling with Chinese meal break rules. *Journal of Transportation Systems Engineering and Information Technology*, *13*(2), 90-95.

Desaulniers, G., Desrosiers, J., and Solomon, M. M., editors (2005). *Column Generation*. Springer.

De Leone, R., Festa, P., & Marchitto, E. (2011). A Bus Driver Scheduling Problem: a new mathematical model and a GRASP approximate solution. *Journal of Heuristics*, *17*(4), 441-466.

Taş, D., Jabali, O., & Van Woensel, T. (2014). A vehicle routing problem with flexible time windows. *Computers & Operations Research*, *52*, 39-54.

Drexl, M., Rieck, J., Sigl, T., & Press, B. (2013). Simultaneous vehicle and crew routing and scheduling for partial-and full-load long-distance road transport. *Business Research*, *6*(2), 242-264.

Gopalakrishnan, B., & Johnson, E. L. (2005). Airline crew scheduling: State-of-the-art. *Annals of Operations Research*, *140*(1), 305-337.

Goel, A. (2010). Truck driver scheduling in the European Union. *Transportation Science, 44*(4), 429–441. https://doi.org/10.1287/trsc.1100.0330

Goel, A., Archetti, C., & Savelsbergh, M. (2012). Truck driver scheduling in Australia. *Computers & Operations Research*, *39*(5), 1122-1132.

Goel, A., & Kok, A. L. (2012). Truck driver scheduling in the United States. *Transportation Science, 46*(3), 317–326. https://doi.org/10.1287/trsc.1110.0382

Goel, A., & Rousseau, L. M. (2012). Truck driver scheduling in Canada. *Journal of Scheduling*, *15*(6), 783-799.

Goel, A., & Vidal, T. (2014). Hours of service regulations in road freight transport: An optimization-based international assessment. *Transportation science*, *48*(3), 391-412.

Heil, J., Hoffmann, K., & Buscher, U. (2020). Railway crew scheduling: Models, methods and applications. *European journal of operational research*, *283*(2), 405-425.

Üster, H., & Kewcharoenwong, P. (2011). Strategic design and analysis of a relay network in truckload transportation. *Transportation Science*, *45*(4), 505-523.

Jütte, S., & Thonemann, U. W. (2012). Divide-and-price: A decomposition algorithm for solving large railway crew scheduling problems. *European Journal of Operational Research*, *219*(2), 214-223.

Kang, L., Chen, S., & Meng, Q. (2019). Bus and driver scheduling with mealtime windows for a single public bus route. *Transportation Research Part C: Emerging Technologies*, *101*, 145-160.

Lin, D. Y., Juan, C. J., & Chang, C. C. (2020). A Branch-and-Price-and-Cut Algorithm for the Integrated Scheduling and Rostering Problem of Bus Drivers. *Journal of Advanced Transportation*, *2020*(1), 3153201.

Melton, K. D. (2012). *Truckload freight transportation utilizing relay points to improve the driving job*. Oklahoma State University.

Smith, B. M., & Wren, A. (1988). A bus crew scheduling system using a set covering formulation. *Transportation Research Part A: General*, *22*(2), 97-108.

Tóth, A., & Krész, M. (2013). An efficient solution approach for real-world driver scheduling problems in urban bus transportation. *Central European Journal of Operations Research*, *21*(Suppl 1), 75-94.

Van den Bergh, J., Beliën, J., De Bruecker, P., Demeulemeester, E., & De Boeck, L. (2013). Personnel scheduling: A literature review. *European journal of operational research*, *226*(3), 367-385.

Vergara, H. A., & Root, S. (2013). Mixed fleet dispatching in truckload relay network design optimization. *Transportation Research Part E: Logistics and Transportation Review*, *54*, 32-49.

Hamdan, A., Hamdan, S., Benbitour, M. H., & Jradi, S. (2025). On the fair scheduling of truck drivers in delivery companies: balancing fairness and profit. *Central European Journal of Operations Research*, *33*(3), 1081-1106.

Wen, X., Sun, X., Sun, Y., & Yue, X. (2021). Airline crew scheduling: Models and algorithms. *Transportation research part E: logistics and transportation review*, *149*, 102304.

Yan, S., & Chang, J. C. (2002). Airline cockpit crew scheduling. *European Journal of Operational Research*, *136*(3), 501-511.

Yan, S., & Tu, Y. P. (2002). A network model for airline cabin crew scheduling. *European Journal of Operational Research*, *140*(3), 531-540.

Haase, K., Desaulniers, G., & Desrosiers, J. (2001). Simultaneous vehicle and crew scheduling in urban mass transit systems. *Transportation science*, *35*(3), 286-303.

Boyer, V., Ibarra-Rojas, O. J., & Ríos-Solís, Y. Á. (2018). Vehicle and crew scheduling for flexible bus transportation systems. *Transportation Research Part B: Methodological*, *112*, 216-229.

Caprara, A., Fischetti, M., & Toth, P. (1999). A heuristic method for the set covering problem. *Operations research*, *47*(5), 730-743.

Chandra, S., Christiansen, M., & Fagerholt, K. (2016). Combined fleet deployment and inventory management in roll-on/roll-off shipping. *Transportation Research Part E: Logistics and Transportation Review*, *92*, 43-55.

Desaulniers, G., & Hickman, M. D. (2007). Public transit. *Handbooks in operations research and management science*, *14*, 69-127.

Kewcharoenwong, P., & Üster, H. (2017). Relay network design with capacity and link-imbalance considerations: A Lagrangean decomposition algorithm and analysis. *Transportation Science*, *51*(4), 1177-1195.

Rodriguez, J., Kosir, M., Lantz, B., Griffin, G., & Glatt, J. (2000). *The costs of truckload driver turnover* (SP-146). Upper Great Plains Transportation Institute, North Dakota State University.

Kohl, N., & Karisch, S. E. (2004). Airline crew rostering: Problem types, modeling, and optimization. *Annals of Operations Research*, *127*(1), 223-257.

Lettovský, Ladislav, Ellis L. Johnson, and George L. Nemhauser. "Airline crew recovery." *Transportation Science* 34, no. 4 (2000): 337-348.

Ziaeifar, A., & Üster, H. (2023). Relay network design with direct shipment and multi-relay assignment. *Annals of Operations Research*, *328*(2), 1585-1614.

Barnhart, C., Johnson, E. L., Nemhauser, G. L., Savelsbergh, M. W., & Vance, P. H. (1998). Branch-and-price: Column generation for solving huge integer programs. *Operations research*, *46*(3), 316-329.

Rancourt, M. E., Cordeau, J. F., & Laporte, G. (2013). Long-haul vehicle routing and scheduling with working hour rules. *Transportation Science*, *47*(1), 81-107.

Nemhauser, G. L., & Wolsey, L. A. (1988). *Integer and combinatorial optimization* (Vol. 18). New York: Wiley.

Lübbecke, M. E., & Desrosiers, J. (2005). Selected topics in column generation. *Operations research*, *53*(6), 1007-1023.

Lübbecke, M. E. (2010). Column generation. *Wiley encyclopedia of operations research and management science*, *17*, 18-19.

Anbil, R., Tanga, R., & Johnson, E. L. (1992). A global approach to crew-pairing optimization. *IBM Systems Journal*, *31*(1), 71-78.

Irnich, S., & Desaulniers, G. (2005). Shortest path problems with resource constraints. In *Column generation* (pp. 33-65). Boston, MA: Springer US.

Desrochers, M., Desrosiers, J., & Solomon, M. (1992). A new optimization algorithm for the vehicle routing problem with time windows. *Operations research*, *40*(2), 342-354.

Desrochers, M., & Soumis, F. (1988). A generalized permanent labelling algorithm for the shortest path problem with time windows. *INFOR: Information Systems and Operational Research*, *26*(3), 191-212.

Feillet, D., Dejax, P., Gendreau, M., & Gueguen, C. (2004). An exact algorithm for the elementary shortest path problem with resource constraints: Application to some vehicle routing problems. *Networks: An International Journal*, *44*(3), 216-229.

Atamtürk, A., & Savelsbergh, M. W. (2005). Integer-programming software systems. *Annals of operations research*, *140*(1), 67-124.

Pochet, Y., & Wolsey, L. A. (2006). *Production planning by mixed integer programming*. New York, NY: Springer New York.

Ben-Tal, A., Nemirovski, A., & El Ghaoui, L. (2009). Robust optimization.

Birge, J. R., & Louveaux, F. (1997). *Introduction to stochastic programming*. New York, NY: Springer New York.

Ben Amor, H., Desrosiers, J., & Valério de Carvalho, J. M. (2006). Dual-optimal inequalities for stabilized column generation. *Operations Research*, *54*(3), 454-463.

Feillet, D. (2010). A tutorial on column generation and branch-and-price for vehicle routing problems. *4or*, *8*(4), 407-424.

Pessoa, A., Uchoa, E., De Aragão, M. P., & Rodrigues, R. (2010). Exact algorithm over an arc-time-indexed formulation for parallel machine scheduling problems. *Mathematical Programming Computation*, *2*(3), 259-290.

Hu, C., Lu, J., Liu, X., & Zhang, G. (2018). Robust vehicle routing problem with hard time windows under demand and travel time uncertainty. *Computers & Operations Research*, *94*, 139-153.

Waters, C. D. J. (1990). Expert systems for vehicle scheduling. *Journal of the Operational Research Society*, *41*(6), 505-515.

Logistics Insider. (2024, June 12). *Trucking in turmoil: Unravelling the critical case of driver deficits*. Logistics Insider. https://www.logisticsinsider.in/trucking-in-turmoil-unravelling-the-critical-case-of-driver-deficits/

Association for Supply Chain Management (ASCM). (2025, February 8). *How the trucking talent gap affects your business*. Inside Supply Management. https://www.ascm.org/ascm-insights/how-trucking-talent-gap-affects-your-business/

Gong, Q., & Adams, T. M. (2017). *Strategic Truckload Relay Network Design Considering Travel Time and Reliability* (No. 17-06597).

The Strategy Story. (2021, April 25). Business model of Rivigo – Humanizing the logistics. Retrieved from https://thestrategystory.com/2021/04/25/rivigo-relay-business-model/

YourStory. (2019, August 23). Rivigo launches driver relay model as 'RaaS' for fleet owners, truck pilots. Retrieved from https://yourstory.com/2019/08/rivigo-driver-relay-model-raas-service-fleet

Li, J., Liu, X., Dahan, M., & Montreuil, B. (2024). Stochastic service network design with different operational patterns for hyperconnected relay transportation. *arXiv preprint arXiv:2402.06222*.

Cordeau, J. F., Toth, P., & Vigo, D. (1998). A survey of optimization models for train routing and scheduling. *Transportation science*, *32*(4), 380-404.

Motor Transport Workers Act, 1961 (Act No. 27 of 1961). India Code. Retrieved from https://www.indiacode.nic.in/bitstream/123456789/19026/1/motor_transport_workers_act_1961.pdf

Federal Motor Carrier Safety Administration. (FMCSA). *Summary of hours-of-service regulations*. U.S. Department of Transportation. Retrieved [October 31, 2025], from https://www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations

International Transport Forum (ITF). (2019). *ITF Transport Outlook 2019*. Paris: OECD Publishing. https://www.oecd.org/en/publications/itf-transport-outlook-2019_transp_outlook-en-2019-en.html

International Transport Forum. (2023). *ITF Transport Outlook 2023.* Paris: OECD Publishing. https://www.oecd.org/en/publications/itf-transport-outlook-2023_b6cc9ad5-en.html

Fleetx. (2021, April 28). *The challenges faced by an Indian truck driver.* Fleetx Blog. https://blog.fleetx.io/blog-the-challenges-faced-by-an-indian-truck-driver/

Gino, F., & Pisano, G. (2008). Toward a theory of behavioral operations. *Manufacturing & Service Operations Management*, *10*(4), 676-691.

Bendoly, E., Croson, R., Goncalves, P., & Schultz, K. (2010). Bodies of knowledge for research in behavioral operations. *Production and operations management*, *19*(4), 434-452.

Boudreau, J., Hopp, W., McClain, J. O., & Thomas, L. J. (2003). On the interface between operations and human resources management. *Manufacturing & Service Operations Management*, *5*(3), 179-202.

Bakker, A. B., & Demerouti, E. (2017). Job demands–resources theory: taking stock and looking forward. *Journal of occupational health psychology*, *22*(3), 273.

Hughes, E. C. (1962). Good people and dirty work. *Social problems*, *10*(1), 3-11.

Bakker, A. B., Albrecht, S. L., & Leiter, M. P. (2011). Key questions regarding work engagement. *European journal of work and organizational psychology*, *20*(1), 4-28.

International Road Transport Union (IRU). (2023). *Global truck driver shortage report 2023*. IRU. https://www.iru.org/news-resources/newsroom/global-driver-shortages-2023-year-review

World Bank. (2023). *Connecting to compete 2023: Trade logistics in the global economy*. World Bank. https://lpi.worldbank.org/sites/default/files/2023-04/LPI_2023_report_with_layout.pdf

National Heavy Vehicle Regulator (NHVR). (2022). *Fatigue Management and Heavy Vehicle Regulation Framework*. https://www.nhvr.gov.au/

UK Department for Transport. (2020). *Simplified Guidance on EU Drivers' Hours Rules*. https://www.gov.uk/government/publications/eu-rules-on-drivers-hours-and-working-time?

Economic Times. (2018, July 10). *How Rivigo is disrupting long-haul trucking with relay model*. https://economictimes.indiatimes.com/prime/technology-and-startups/inside-rivigos-disruptive-scaling-model-offer-relay-trucking-as-a-service-to-small-fleet-owners/primearticleshow/71057545.cms?from=mdr

LiveMint. (2018, April 18). *BlackBuck raises funding to digitize India's trucking industry*. https://www.livemint.com/companies/news/blackbuck-turns-unicorn-with-67-million-fund-raise-11626927920869.html

ElasticRun. (2023). *Technology platform overview*. https://elastic.run/

Trukky Logistics. (2023). *Digital logistics solutions and driver network services* *https://www.trukky.com/*

Hopp, W. J., & Spearman, M. L. (2011). *Factory physics*. Waveland Press.

Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The international journal of logistics management*, *20*(1), 124-143.

Sheffi, Y., & Rice Jr, J. B. (2006, November). The resilient enterprise. In *Conference on National Security, Natural Disasters, Logistics & Transportation: Assessing the Risks & the Responses, University of Rhode Island, RI, September* (pp. 25-26).

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of international political economy*, *12*(1), 78-104.

Williamson, O. E. (1985). The economic institutions of capitalism. Firms, markets, relational contracting. In *Das Summa Summarum des Management: Die 25 wichtigsten Werke für Strategie, Führung und Veränderung* (pp. 61-75). Wiesbaden: Gabler.

Eisenhardt, K. M. (1989). Agency theory: An assessment and review. *Academy of management review*, *14*(1), 57-74.

Hayes, R. H., & Wheelwright, S. C. (1984). Restoring our competitive edge: competing through manufacturing. *(No Title)*.

Jensen, M. C., & Meckling, W. H. (2019). Theory of the firm: Managerial behavior, agency costs and ownership structure. In *Corporate governance* (pp. 77-132). Gower.

Porter, M. E., & Kramer, M. R. (2006). The link between competitive advantage and corporate social responsibility. *Harvard business review*, *84*(12), 78-92.

Skinner, W. (1969). Manufacturing-missing link in corporate strategy.

DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American sociological review*, *48*(2), 147-160.

Fagnant, D. J., & Kockelman, K. (2015). Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. *Transportation Research Part A: Policy and Practice*, *77*, 167-181.

Holmström, J., Partanen, J., Tuomi, J., & Walter, M. (2010). Rapid manufacturing in the spare parts supply chain: Alternative approaches to capacity deployment. *Journal of manufacturing technology management*, *21*(6), 687-697.

Ivanov, D., Dolgui, A., & Sokolov, B. (2019). The impact of digital technology and Industry 4.0 on the ripple effect and supply chain risk analytics. *International journal of production research*, *57*(3), 829-846.

Christopher, M., & Peck, H. (2004). Building the resilient supply chain.

Mobisoft Infotech (2022). Relay Trucking: How Relay Trucking Can Revolutionize the Trucking Industry.