Enhancing Supply Chain Technology Learning with Mind Mapping and Group Discussion: Evidence from UiTM Students

Norzawani Ibrahim[1], *Norasekin Abd Rashid, [2]Ahmad Rais Mohamad Mokhtar

[1,2]Department of Technology and Supply Chain Management Studies, Faculty of Business and Management, University Technology MARA, Puncak Alam Campus, Selangor, Malaysia.

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.91100360

Received: 19 November 2025; Accepted: 26 November 2025; Published: 11 December 2025

ABSTRACT

Supply chain technology is an essential component of business education as organisations increasingly adopt digital tools to enhance efficiency, visibility, and responsiveness across supply chain networks. However, students often face challenges in understanding and retaining the wide range of technologies involved. This study investigates the effectiveness of mind mapping as a pedagogical strategy to enhance comprehension of supply chain technology concepts among undergraduate students at the Faculty of Business and Management, Universiti Teknologi MARA (UiTM) Puncak Alam. Using a pre- and post-test design, the lecturer provided a structured mind map on the topic, followed by group discussions where students completed an exercise covering 17 areas of supply chain technology. Findings reveal a transformative shift in learning outcomes. Pre-intervention, only 25.0% of students reported possessing basic knowledge, with the majority (63.3%) remaining neutral. Post-intervention, positive agreement surged to 100%, eliminating the neutral and negative sentiment blocks. Specifically, the ability to differentiate technologies was initially the lowest-rated metric, with only 31.7% positive agreement that improved to 100%, while the mean score for this competency rose from 3.10 to 4.59. Additionally, student confidence in the application increased from a mean of 3.55 to 4.54. The study concludes that mind mapping serves as a critical cognitive scaffold, effectively converting uncertainty into mastery. By aligning with visual learning preferences, the tool bridges the gap between passive retention and active application, suggesting it is an essential strategy for teaching data-dense supply chain curriculum.

Keywords: Supply Chain Technology, Mind Mapping, Collaborative Learning, Business Education

INTRODUCTION

In the field of supply chain education, technological knowledge has become increasingly critical as organisations adopt digital tools such as the Internet of Things (IoT), blockchain, enterprise systems, data analytics, and automation to enhance operational efficiency. Within the Business and Technology Management programme at the Faculty of Business and Management, Universiti Teknologi MARA (UiTM), the chapter "Technologies in Supply Chain Management" plays an important role in equipping students with foundational digital competencies that align with current industry expectations. The chapter also contributes substantially to the final assessment, ranging from 15 to 25 marks, underscoring its academic significance. Despite this importance, educators have observed that many students face difficulties in understanding and retaining the interconnected technological concepts discussed in this chapter. These challenges may stem from the basic concept and technical nature of the content, the breadth of emerging technologies, and the need for students to link conceptual understanding to practical supply chain scenarios. Traditional instructional approaches, including lectures and linear notetaking, may therefore be insufficient to support deep learning and meaningful knowledge organisation.

Due to that, mind mapping has been proposed as a visual and non-linear strategy that may address these learning challenges. As an instructional tool, mind maps allow students to organise complex information using hierarchical, associative, and interconnected structures. This method encourages active participation, deeper processing, and associative thinking, which are essential for understanding multi-dimensional topics such as supply chain technologies. Substantial empirical evidence supports the benefits of mind mapping across educational contexts. Meta-analytic studies have shown that mind-mapping–based instruction significantly improves students' cognitive learning outcomes, including comprehension, conceptual understanding, and retention, when compared with traditional teaching approaches (Shi et al., 2022; Liu & Zhao, 2016). Research in STEM education also demonstrates that mind mapping enhances the organisation of knowledge structures, supports procedural learning, and improves higher-order thinking (Kefalis et al., 2025). Similarly, studies in health and nursing education have reported improvements in information retrieval and long-term memory among students who used mind maps as part of their learning process (Jabade & Nadaf, 2024).

Although these findings suggest that mind mapping is a promising pedagogical tool, its effectiveness can vary depending on the subject matter, educational level, and method of implementation. Prior research has predominantly focused on STEM and health disciplines, where content structures and learning objectives may differ from those of business and supply chain programmes. Furthermore, existing studies highlight those factors such as whether students construct their own maps, whether maps are used digitally or on paper, and how they are integrated into lessons can significantly influence learning outcomes. As a result, findings from other disciplines cannot be assumed to generalise directly to supply chain management education, particularly within the Malaysian higher education context.

These methods require students to understand conceptual linkages and technological interactions within supply chain management. Mind mapping may serve as a complementary tool that strengthens students' conceptual frameworks, thereby enabling better performance in simulation-based or application-oriented tasks. However, research exploring the integration of mind mapping into supply chain technology instruction is limited, and empirical evidence specific to UiTM's curriculum is still lacking. Given these gaps, examining the effectiveness of mind mapping within the "Technologies in Supply Chain Management" chapter is both timely and necessary. This study aims to determine whether mind mapping can enhance students' understanding, retention, and application of key supply chain technology concepts. By evaluating changes in student performance and learning perceptions, the study seeks to provide evidence-based insights that can inform instructional design for supply chain management courses. The findings will contribute to the growing body of literature on visual learning strategies while offering practical recommendations for educators seeking to strengthen student comprehension in technologically oriented business subjects.

LITERATURE REVIEW

Effectiveness of Mind Mapping

Mind mapping can be defined as an externally visible, non-linear graphic technique for organising ideas around a central concept. It has re-emerged in recent years as a pedagogical tool intended to support comprehension, retention, and higher-order learning across multiple disciplines. Meta-analytic and systematic syntheses published in the early 2020s report overall positive effects of mind mapping interventions on cognitive learning outcomes, while noting important moderators such as who constructs the map (student-generated vs. instructor-provided), map format (digital vs. paper), the instructional sequence, and discipline-specific differences (Shi, Yang, Dou, & Zeng, 2022; Kefalis, Skordoulis, & Drigas, 2025). A study by Shi et al.'s (2022) on meta-analysis of 21 studies found that mind mapping instruction produced significantly better cognitive outcomes versus conventional instruction, although effect sizes varied by subject area and learner level, signalling the importance of context when applying these findings to business, specifically on supply chain education.

Various field of education has applied mind mapping as a learning tool. For example, Yang et al. (2022) found that reflective learning supported by visual mind maps improved nursing students' reflective ability and learning outcomes compared with reflective journals. Jabade and Nadaf (2024) reported significant gains in information retrieval and longer-term retention among nursing students who used mind-mapping techniques, with participants noting enhanced clarity and organisation of complex clinical information. Similarly, randomized, or quasi-experimental studies in clinical training contexts (Ye et al., 2025; Alsuraihi, 2022) demonstrated improved procedural understanding and creativity when mind mapping was combined with problem based or reflective instruction.

Supply Chain Technology

Supply chain technology refers to the set of digital tools, systems, and platforms that enable organisations to plan, coordinate, monitor, and optimise the flow of materials, information, and activities across supply chain networks. It encompasses technologies such as the Internet of Things (IoT), cloud computing, big data analytics, artificial intelligence (AI), blockchain, robotics, and digital twins, all of which enhance visibility, integration, automation, and decision-making throughout procurement, production, logistics, and distribution processes (Christopher, 2016; Ivanov & Dolgui, 2022). These technologies improve supply chain performance by enabling real-time data collection, predictive analytics, operational efficiency, and better responsiveness to disruptions (Kache & Seuring, 2017). Overall, supply chain technology acts as a foundation for digital transformation and Industry 4.0 practices, supporting firms in achieving resilience, agility, and sustainability in increasingly complex supply networks (Alicke, Rexhausen, & Seyfert, 2017).

Teaching supply chain technology has become increasingly important in business and management education due to the rapid digital transformation and technological disruption occurring across global supply networks. Modern supply chains rely on technologies such as big data analytics, cloud systems, the Internet of Things (IoT), automation, artificial intelligence, and blockchain to enhance visibility, efficiency, and integration across procurement, operations, and logistics processes (Ivanov & Dolgui, 2022; Wang et al., 2016). As organisations adopt Industry 4.0 and digital supply chain practices, graduates entering the workforce must possess technological literacy, analytical skills, and a strong understanding of digital systems that support real-time decision-making and operational excellence (Alicke et al., 2017; Schoenherr & Speier-Pero, 2015).

METHODOLOGY

This study adopted a quasi-experimental pre-test and post-test design to evaluate the effectiveness of a mind-mapping based learning activity in improving students' understanding of key concepts in the "Technologies in Supply Chain Management" chapter. The respondents consisted of undergraduate students enrolled in the Supply Chain Technology course under the Faculty of Business and Management, Universiti Teknologi MARA (UiTM), Puncak Alam Campus. The chapter used in this study is a core component of the course syllabus with a significant contribution to final assessment marks. A purposive sampling method was used to include students who were present during the intervention session. Participation was voluntary, and only students who completed both the pre-test and post-test were included in the final analysis.

Intervention: Mind-Mapping Group Activity

The intervention centred on a collaborative group exercise using a mind map provided by the lecturer. The lecturer introduced the chapter content and shared a partially completed mind map that illustrated the key concepts of supply chain technologies. Students were then organised into small groups and tasked with discussing and completing the exercise by filling in the 17 supply chain technology areas. During the activity, groups discussed the definition, characteristics, functions, and example of each technology area. The lecturer facilitated by providing prompts, clarifications, and guidance, but students were encouraged to complete the exercise collaboratively based on their understanding. The session lasted approximately 45–60 minutes.

Research Procedure

Data were collected in three stages:

1. Pre-test: Students completed a pre-test measuring their baseline understanding of supply chain technology concepts, including factual knowledge, conceptual links, and application.
2. Mind-Mapping Group Exercise: The lecturer provided a mind map to the students as a guide to collaboratively complete the 17 areas of technology exercise in groups.
3. Post-test: Immediately after the exercise, students completed a post-test of similar structure and difficulty as the pre-test to assess learning gains.

FINDINGS

Frequency Analysis

The findings of the frequency analysis are summarized in the following tables.

Table 1: Pre-Intervention Baseline (Student Awareness and Learning Readiness)

BEFORE THE USE OF LEARNING TOOLS (MIND MAPPING)					
	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Understanding & Awareness	Percentage (%)				
I am familiar with the concept of Supply Chain Technology.	1.7	1.7	35	53.3	8.3
I have basic knowledge of the 17 areas of Supply Chain Technologies.	3.3	8.3	63.3	20	5
I understand how technology can improve supply chain operations.	1.7	1.7	38.3	41.7	16.7
Confidence in Learning					
I feel confident in my ability to understand topics related to supply chain technologies.	1.7	5	38.3	46.7	8.3
I find the 17 SCT areas easy to differentiate and remember.	1.7	23.3	43.3	26.7	5
I feel prepared to learn about the various technological applications, such as IoT, Blockchain, and AI.	1.7	5	35	38.3	20
Perceived Difficulty					
The topics in this chapter seem challenging for me.	0	3.3	46.7	43.3	6.7
I often require visual aids (charts, diagrams, mind maps) to understand complex topics.	0	5	33.3	43.3	18.3
Learning Readiness					
I am motivated to learn the new supply chain technologies presented in this course.	0	1.7	16.7	56.7	25
I believe the upcoming activity (using learning tools such as mind map or brainstorming) will help me understand the topics better.	0	1.7	15	55	28.3

Table 1 presents the pre-intervention survey results, which revealed a significant degree of uncertainty regarding the course material. When assessing basic knowledge of the 17 areas of Supply Chain Technologies (SCT), only 25.0% of participants responded positively ("Agree" or "Strongly Agree"). The dominant sentiment was neutrality, with 63.3% of respondents selecting "Neither Agree nor Disagree," indicating a lack of conceptual clarity.

The most pronounced cognitive barrier was identified in the students' ability to differentiate between various technologies. This metric yielded the highest negative score in the baseline assessment, where 25.0% of participants actively disagreed that the areas were easy to differentiate, and an additional 43.3% remained neutral. Consequently, only 31.7% of the cohort felt capable of distinguishing the topics before the intervention. Concurrently, the baseline data established a strong demand for pedagogical adjustment: 61.6% of participants self-identified as visual learners who require charts or diagrams to comprehend complex topics.

Table 2: Post-Intervention Assessment (Efficacy of Mind Mapping Tools on Learning Outcomes)

AFTER THE USE OF LEARNING TOOLS (MIND MAPPING)					
	Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
Improve Understanding	**Percentage (%)**				
The learning tool (mind map/ branstorming/ flowchart/ infographics) helped me understand the 17 supply chain technology areas more clearly.	0	0	0	35.7	64.3
I can now explain the function of major technologies such as Cloud, IoT, Blockchain, and Machine Learning.	0	0	3.6	42.9	53.6
I am able to differentiate the various supply chain technologies better after using the learning tool.	0	0	0	41.1	58.9
I am able to remember visually presented information more effectively.	0	0	1.8	48.2	50
Engagement & Learning Experience					
The learning tool increased my interest and engagement in the topic.	0	0	1.8	30.4	67.9
The activity helped simplify complex concepts into easier-to-understand ideas.	0	0	0	35.7	64.3
The visual representation helped me see the relationship between different SCT areas.	0	0	0	44.6	55.4
Attractive and colourful graphics capture my attention better than long paragraphs.	0	0	1.8	41.1	57.1
Confidence & Application					
I now feel more confident in applying SCT concepts in discussions or assignments.	0	0	1.8	42.9	55.4
The mind-mapping/infographics/brainstorming session improved my ability to recall the technologies.	0	0	0	41.1	58.9
The learning tool helped me identify real-world applications of supply chain technologies.	0	0	0	39.3	60.7
Overall Perception					
Overall, the learning tool enhanced my understanding and learning experience for this topic.	0	0	0	23.2	76.8

Following the implementation of the Mind Map learning tool, the Post-Intervention Outcomes (Table 2) data indicate a comprehensive positive shift in student comprehension. Uncertainty was effectively eliminated where 100% of participants responded positively regarding their understanding of the 17 SCT areas, with zero responses recorded in the "Neutral," "Disagree," or "Strongly Disagree" categories. Notably, 64.3% of participants "Strongly Agreed" that the tool clarified the subject matter, representing a complete conversion of the 63.3% neutral block identified in the pre-test. In addition, the intervention successfully addressed the specific challenge of topic differentiation. In the post-intervention survey, 100% of students reported an improved ability to differentiate between the various supply chain technologies (41.1% "Agreed," 58.9% "Strongly Agreed"). This finding suggests that the visual structuring inherent in mind mapping effectively reduced the cognitive load associated with distinguishing complex, overlapping concepts.

Furthermore, the results strongly validated the students' initial self-assessment regarding their learning preferences. Post-intervention, 98.2% of participants agreed that the "attractive and colourful graphics" captured their attention more effectively than traditional text-based instruction. Moreover, 100% of respondents indicated that the visual representation facilitated the identification of relationships between distinct SCT areas, confirming the tool's utility in synthesizing complex information. The intervention also elicited a marked increase in learner self-efficacy. While pre-intervention confidence was characterized by hesitation (38.3% neutral), post-intervention data reveal that 98.3% of students felt confident applying SCT concepts in discussions and assignments. The density of "Strongly Agree" responses regarding confidence rose to 55.4%, highlighting a transition from passive motivation to active mastery.

The comparative analysis demonstrates a "Neutral Swing," where the large cohort of students previously occupying the "Neither Agree nor Disagree" category (40–60%) did not merely shift to moderate agreement but bypassed this tier to reach "Strongly Agree." This distributional change indicates that the Mind Map tool was transformative rather than merely supplementary, neutralizing the risk of student failure identified in the baseline data.

Comparative Analysis

A comparative analysis of pre- and post-intervention survey data reveals a statistically significant improvement in student performance and perception following the introduction of Mind Mapping tools. The intervention resulted in a shift from a baseline state of "Moderate Uncertainty" (Overall Mean = 3.3) to "High Competence" (Overall Mean = 4.6). Table 3 summarizes the specific gains across key competency areas, highlighting the net improvement in mean scores on a 5-point Likert scale.

The most substantial growth was observed in the students' ability to differentiate between the 17 distinct Supply Chain Technology (SCT) areas. In the pre-intervention phase, this metric represented the lowest mean score (M=3.10), suggesting that the volume of information caused confusion and overlapping concepts. Post-intervention, this metric tied for the highest net improvement (+1.49), reaching a mean of 4.59. This indicates that the visual hierarchy inherent in mind mapping successfully reduced cognitive load, allowing students to compartmentalize and distinguish complex topics effectively.

Table 3: Comparative Analysis of Pre- and Post-Intervention Mean Scores

Key Competency / Metric	Pre-Intervention (M)	Post-Intervention (M)	Net Improvement
Basic Understanding (Knowledge of 17 SCT Areas)	3.15	4.64	1.49
Differentiation (Ability to distinguish technologies)	3.1	4.59	1.49
Recall & Memory (Ability to remember topics)	3.1	4.59	1.49
Confidence in Application (Self-efficacy in usage)	3.55	4.54	0.99
Engagement/Interest (Motivation level)	4.05	4.66	0.61

Visual Learning Efficacy (Perceived utility of visuals)	3.75	4.55	0.8
Overall Perception	N/A	4.77	High Satisfaction

The results validate the students' initial self-assessment regarding their learning styles. Baseline data indicated a moderate to high demand for visual aids (M=3.75). The post-intervention data confirmed that this was a genuine pedagogical need rather than a preference; students rated the simplification of concepts via visual tools at 4.64 and the effectiveness of graphics over text at 4.55. The strong correlation between the stated pre-intervention need and post-intervention satisfaction suggests that prior difficulties stemmed from a lack of visual structure rather than the complexity of the content itself.

A critical shift occurred in the learner's confidence. While pre-intervention scores indicated high "Learning Readiness" (M=4.05), "Confidence in Learning" was significantly lower (M=3.55), depicting a cohort that was motivated but anxious. The intervention bridged this gap, raising confidence in application to 4.54. Furthermore, the high score for "Identifying real-world applications" (4.61) suggests that the tool facilitated a move from rote memorization to the active synthesis and application of knowledge.

Finally, the "Overall Perception" score of 4.77 (out of 5.00) indicates near-universal student approval. In the context of educational interventions, an average exceeding 4.5 represents exceptional efficacy. This suggests that the use of Mind Maps functioned as a critical corrective measure rather than a mere supplementary activity. By targeting the specific weaknesses identified in the baseline, specifically differentiation and basic knowledge, the tool yielded an approximate 30% increase in self-reported understanding across all measured variables.

DISCUSSION AND CONCLUSION

The findings indicate that the Mind Mapping intervention successfully mitigated the cognitive load associated with the 17 areas of Supply Chain Technology. The most significant quantitative gain was observed in differentiation, where the mean score rose from a low of 3.10 to 4.59 (+1.49). This suggests that the primary learning barrier was not a lack of motivation, but the structural complexity of the material. By providing a visual hierarchy, the tool enabled students to successfully categorize and distinguish overlapping concepts.

Furthermore, the results empirically validated the students' pre-existing demand for visual learning support (M=3.75). The alignment between this stated need and the high post-intervention satisfaction (M=4.77) confirms that the instructional gap was methodological rather than conceptual. Ristiliana (2022) supports this observation, noting that mind mapping directly correlates with increased student engagement and active participation by catering to diverse cognitive processing styles. Consequently, the intervention fostered a transition in learner self-efficacy, moving students from passive hesitation (M=3.55) to active confidence in applying concepts (M=4.54).

This study demonstrates that Mind Mapping is a highly effective pedagogical strategy for complex technical subjects. The intervention resulted in a ~30% improvement across all key metrics and the complete elimination of uncertainty found in the baseline survey. By resolving the specific challenges of differentiation and visualization, the tool transformed the learning experience from one of confusion to mastery. Given the exceptional overall perception score of 4.77/5.00, Mind Mapping should be regarded not merely as a supplementary activity but as an essential scaffolding tool for enhancing retention and comprehension in a dense curriculum.

ACKNOWLEDGEMENT

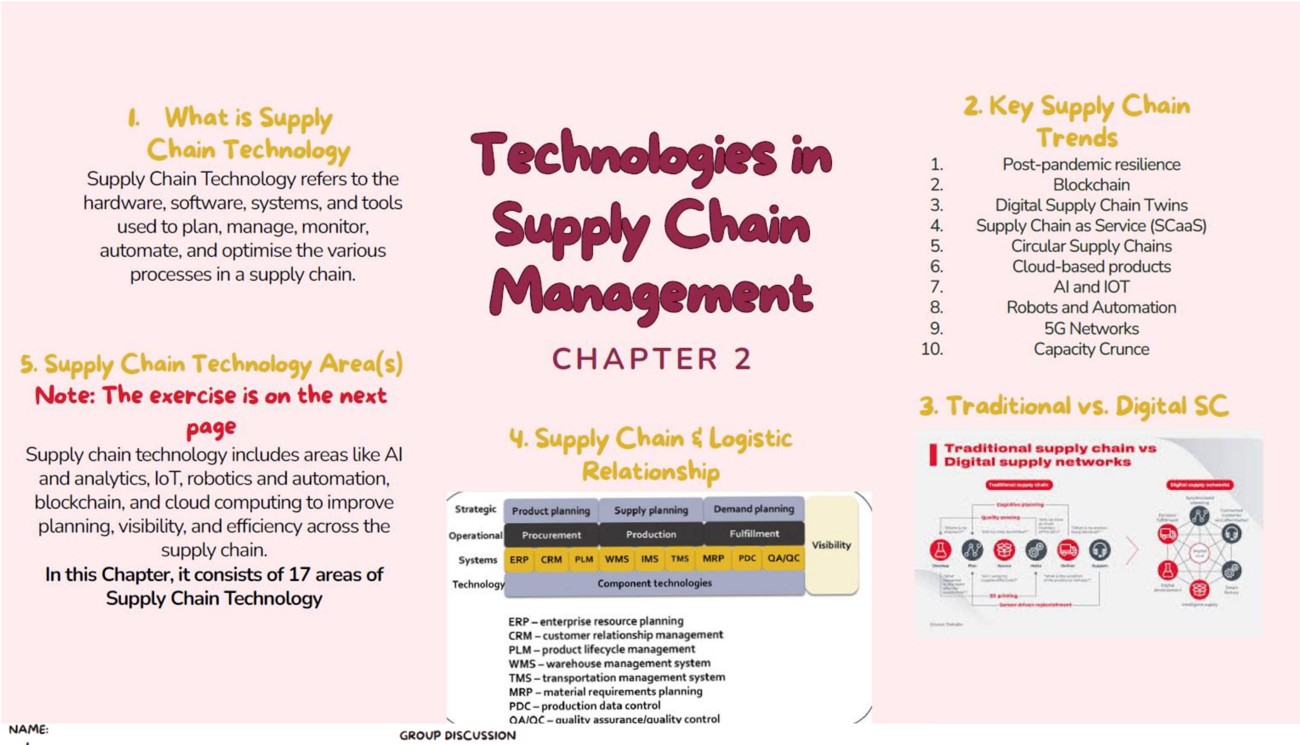
The authors would like to sincerely thank the members of the study and the Faculty of Business and Management, Universiti Teknologi MARA Puncak Alam campus, for the opportunities given to complete this research.

REFERENCES

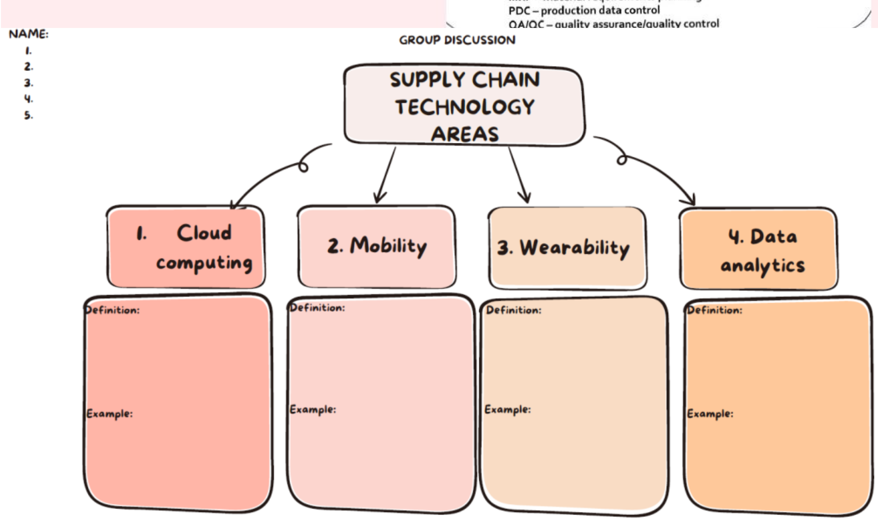
1. Alicke, K., Rexhausen, D., & Seyfert, A. (2017). Supply chain 4.0 in consumer goods. McKinsey & Company, 1(11), 1–11.
2. Alsuraihi, A. A. (2022). The effect of implementing mind maps for online learning and assessment on students during COVID-19 pandemic: A cross sectional study. BMC Medical Education, 22(1), 169.
3. Buran, A., & Filyukov, A. (2015). Mind mapping technique in language learning. Procedia-Social and Behavioral Sciences, 206, 215–218.
4. Christopher, M. (2016). Logistics & supply chain management (5th ed.). Pearson.
5. Haiyao, Z., Abd Halim, N. D., & Xiaoying, S. (2025). The use of mindmap and its effectiveness in different fields of foreign language learning: A systematic review (2014-2024). International Journal of Academic Research, 14(1).
6. Ivanov, D., & Dolgui, A. (2022). The shortage economy and its implications for supply chain and operations management. International Journal of Production Research, 60(24), 7141–7154.
7. Jabade, M., & Nadaf, H. (2024). Assessing the efficacy of mind mapping as a learning technique to enhance information retrieval in nursing students. Journal of Education and Health Promotion, 13(1), 371.
8. Kache, F., & Seuring, S. (2017). Challenges and opportunities of digital information at the intersection of big data analytics and supply chain management. International Journal of Operations & Production Management, 37(1), 10–36.
9. Kefalis, C., Skordoulis, C., & Drigas, A. (2025). A systematic review of mind maps, STEM education, algorithmic and procedural learning. Computers, 14(6), 204.
10. Liu, Y., Zhao, G., Ma, G., & Bo, Y. (2014). The effect of mind mapping on teaching and learning: A meta-analysis. Standard Journal of Education and Essay, 2(1), 17–31.
11. Parikh, N. D. (2016). Effectiveness of teaching through mind mapping technique. The International Journal of Indian Psychology, 3(3), 148–156.
12. Ristiliana, L. (2022). Enhancing student engagement through visual learning strategies in higher education. International Journal of Educational Methodology, 8(1), 112–125.
13. Schoenherr, T., & Speier-Pero, C. (2015). Data science, predictive analytics, and big data in supply chain management: Current state and future potential. Journal of Business Logistics, 36(1), 120–132.
14. Shi, Y., Yang, H., Dou, Y., & Zeng, Y. (2023). Effects of mind mapping-based instruction on student cognitive learning outcomes: A meta-analysis. Asia Pacific Education Review, 24(3), 303–317.
15. Yang, K. H., Chen, H., Liu, C. J., Zhang, F. F., & Jiang, X. L. (2022). Effects of reflective learning based on visual mind mapping in the fundamentals of nursing course: A quasi-experimental study. Nurse Education Today, 119, 105566.
16. Ye, G. C., Liu, C. P., Li, W., Zhu, H. C., Lv, L., Zhu, Z. H., ... & Wang, H. L. (2025). Effectiveness of multiple teaching methods in standardized training of internal medicine residents in China: A network meta-analysis. BMC Medical Education, 25(1), 535.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue XI November2025

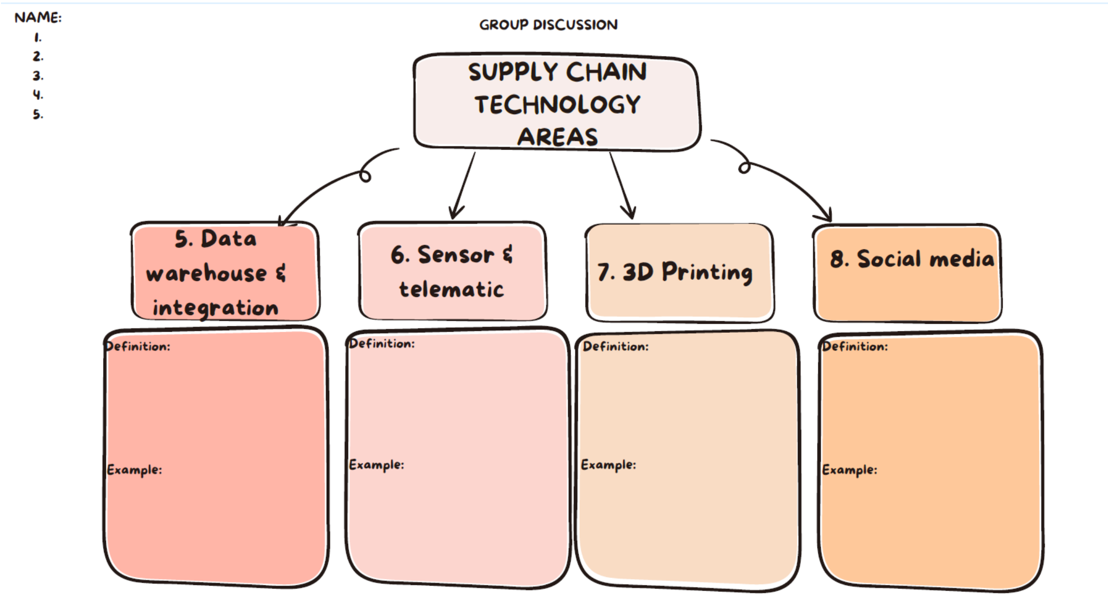
APPENDIX



17.

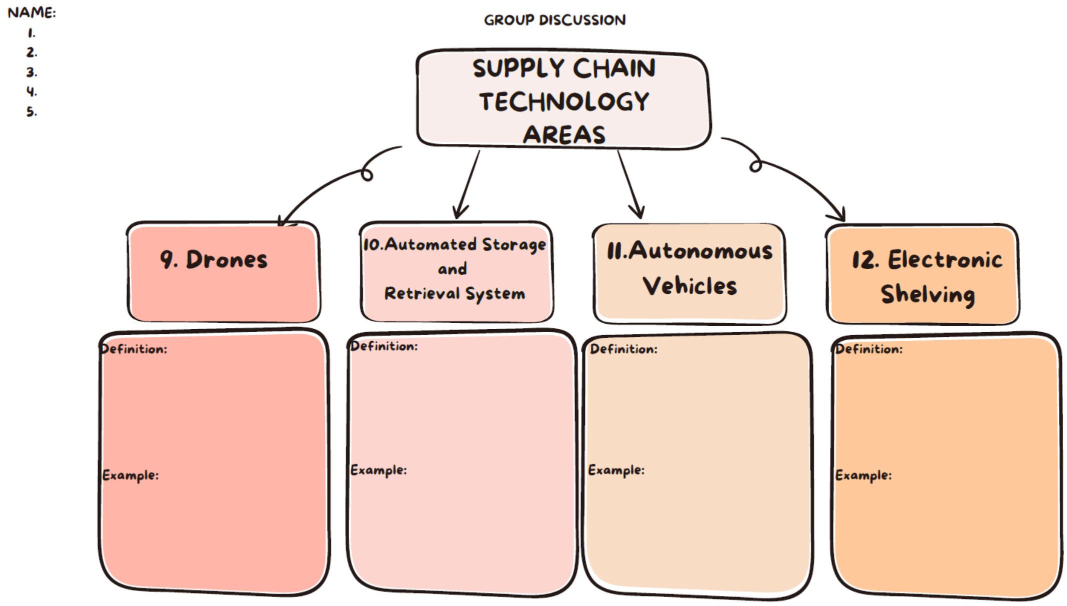


18.

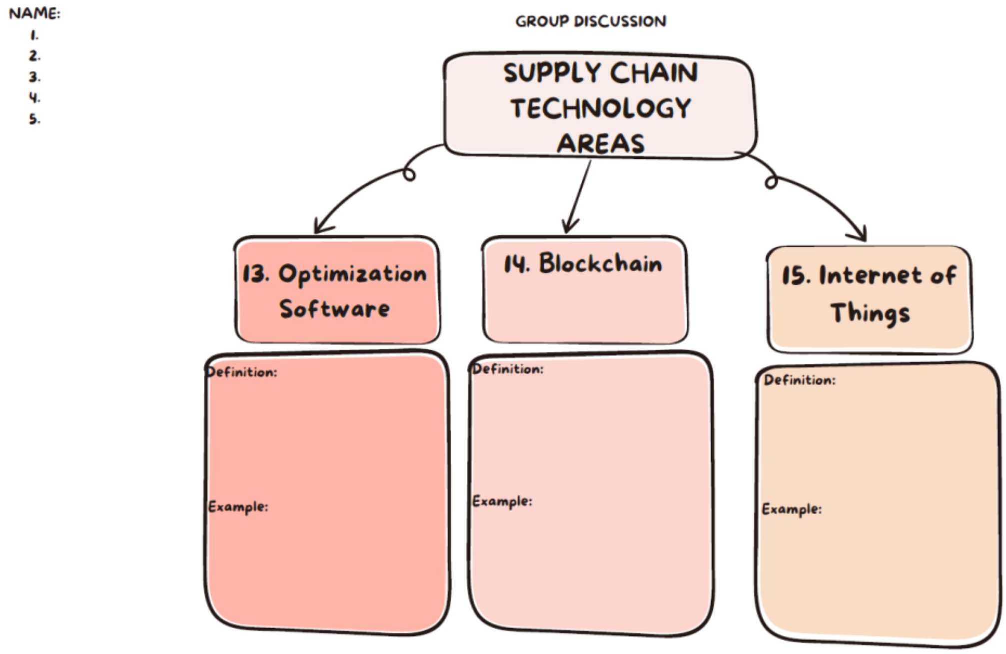


19.

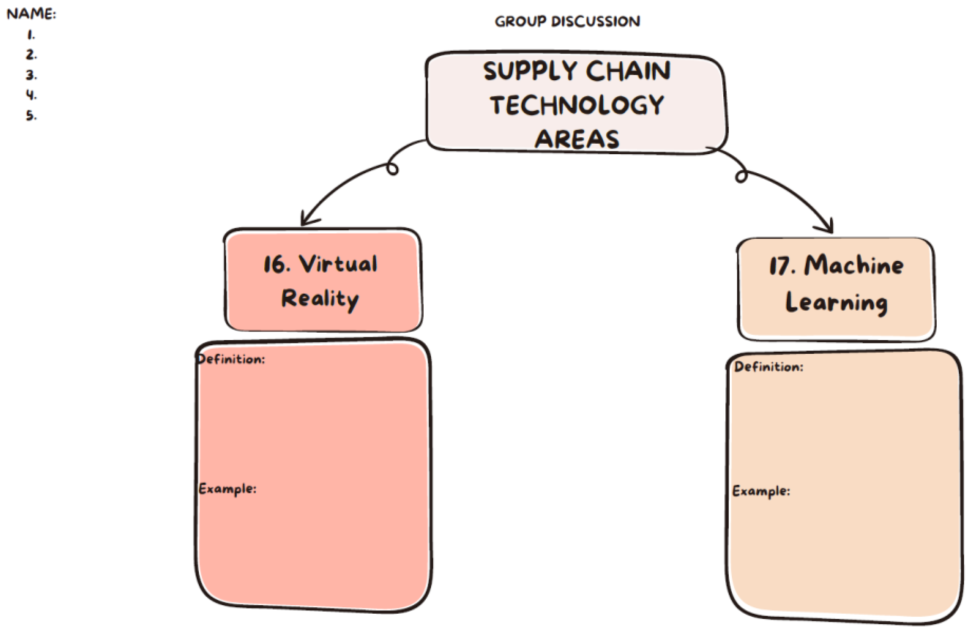
ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume IX Issue XI November2025



20.



21.



22.