Journal of Information Systems Education

Volume 37
Issue 1
Winter 2026

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Recommended Citation: Soto-Ferrari, M., Chams-Anturi, O., Casile, M., & Escorcia-Caballero, J. P. (2026). Teaching Tip: Simulated Interface for Management and Collaborative Decision Systems: A Computer-Based Supply Chain Application for Teaching Information Transparency. *Journal of Information Systems Education*, 37(1), 18-46. https://doi.org/10.62273/TFRC4843

Article Link: https://jise.org/Volume37/n1/JISE2026v37n1pp18-46.html

Received:	March 20, 2025
First Decision:	July 3, 2025
Accepted:	September 12, 2025
Published:	March 15, 2026

ISSN: 2574-3872 (Online) 1055-3096 (Print)

Journal of Information Systems Education, 37(1), 18-46, Winter 2026
https://doi.org/10.62273/TFRC4843

Teaching Tip
Simulated Interface for Management and Collaborative Decision Systems: A Computer-Based Supply Chain Application for Teaching Information Transparency

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ABSTRACT

This teaching tip presents the Simulated Interface for Management and Collaborative Decision Systems (SIMCDS), an Excel-based simulation designed to teach the role of information transparency in strategic supply chain decision-making. In the activity, students assume the roles of Manufacturer, Distributor, and Retailer, managing inventory decisions under both limited and full information-sharing conditions. The simulation illustrates how transparency affects service levels, costs, and overall system coordination. Implemented in an undergraduate strategic management course, SIMCDS was associated with measurable increases in students' self-reported understanding of data-driven collaboration and inter-node decision-

making. By combining active learning with realistic supply chain dynamics, the tool reinforces key operational concepts and aids experiential exploration of transparency's strategic value.

Keywords: Simulation, Excel, Business game, Data analytics, Strategic planning

1. INTRODUCTION AND MOTIVATION

In today's complex and data-driven business environments, there is a critical demand for educational programs that not only break down functional silos but also equip students with skills directly applicable to real-world scenarios (Clayton & Clopton, 2018). This need is especially critical in supply chain management (SCM) and strategic management curricula, where the ability to integrate data analysis and strategic oversight is central to effective decision-making (Baveja et al., 2024; Opatrny-Yazell & Nelson, 2021). Key topics such as inventory management, bullwhip effect mitigation, supply chain contracts, procurement, forecasting, analytics, and information transparency significantly influence supply chain efficiencies, and these are often reinforced and taught through various simulation-based tools (Song et al., 2021; Sweeney et al., 2010; Zhao et al., 2023).

In particular, information transparency is increasingly recognized as a cornerstone of modern SCM strategies, driving greater coordination and responsiveness throughout the supply chain. When organizations share operational data, including inventory levels and lead times, stakeholders can make more accurate decisions, reduce costs, and optimize inventory policies (Wadhwa et al., 2010). However, the pursuit of information transparency in supply chains involves critical trade-offs beyond operational considerations. Information sharing fundamentally affects trust dynamics between supply chain partners, as transparency can both build confidence through verification and accountability, and paradoxically erode it when shared data exposes strategic vulnerabilities or benefits competitors (Ebrahim-Khanjari et al., 2012).

These complex trade-offs intensified during the COVID-19 pandemic, as supply chain disruptions forced organizations to rapidly adapt while balancing transparency needs with competitive concerns (Sarkis, 2020). The crisis exposed how information sharing, though essential for coordinating pandemic responses and building supply chain resilience, could also expose strategic vulnerabilities and competitive disadvantages. Given the dual nature of transparency, which facilitates necessary coordination while potentially compromising a competitive position, it has become increasingly important to teach business students how to navigate these strategic information-sharing decisions thoughtfully.

To address this educational imperative, recent research has shown that furthering engagement through active learning models that foster student participation can significantly improve academic performance, particularly for entering college students (Soto-Ferrari et al., 2024). Building on these findings, our respective institutions have integrated interactive simulations and practical applications into their business programs curricula, especially in courses emphasizing SCM, strategic management, and analytics. These implementations span a range of topics, from foundational principles, such as basic inventory policies, to specialized areas, including forecasting, data mining, and the strategic importance of sharing information within business networks. Our empirical experience suggests that students who directly engage with real or simulated supply chain data exhibit stronger connections with the topics and a deeper understanding of complex business environments.

Nevertheless, despite the diversity and usefulness of available SCM simulation tools (Boute & Lambrecht, 2009; D'Amours et al., 2017; Gardner, 2008; Kaminsky & Simchi-Levi, 1998; Ngai et al., 2012; Reyes, 2007; Song et al., 2021; Whitelock, 2020; Zhao et al., 2023; Zhong & Huang, 2014), we consistently encountered a significant limitation: the restricted integration with standard software solutions, such as spreadsheets and data visualization platforms. Many existing applications, whether computer-based platforms or hands-on simulators, function as self-contained systems, offering only partial or cumbersome paths to extract meaningful data, which undermines students' ability to connect theoretical knowledge with actionable implementations. To compensate, instructors in our programs resort to manually duplicating data in spreadsheets and recreating simulation scenarios for analysis. However, we found that this extra step often detaches students from the decisions they make in their own simulations, diluting the educational impact of the activity and reducing their overall engagement.

Seeking to address this shortfall, we created our own simulation tool: the Simulated Interface for Management and Collaborative Decision Systems (SIMCDS). Our objective was twofold: (1) incorporate proven SCM concepts found in established educational games and materials, and (2) enable seamless data export for deeper data-driven evaluations. The SIMCDS environment is specifically designed to advance and teach information transparency, allowing students to examine the ripple effects of their decisions across various entity tiers and understand how integrated data can enhance supply chain performance. With user-friendly data-download features compatible with industry-standard analytics software (e.g., Excel, Minitab, R), SIMCDS aims to supplement experiential learning and equip students with the analytical proficiency required in today's interconnected marketplace.

Likewise, aligning with the experiential nature of modern business programs, SIMCDS was conceived to operate within Excel through Visual Basic for Applications (VBA), providing both students and instructors with a familiar and accessible platform. The simulation engages students in decision-making within a three-tier supply chain composed of Manufacturer, Distributor, and Retailer that delivers novelty avocado-shaped watches to a Client. While supply chains may include both distributors and wholesalers as distinct entities, our simplified model consolidates these intermediary functions into a single Distributor tier for pedagogical clarity. Fondly nicknamed by students as "The Avocado Game" for its playful setting, the application highlights how restricted information flows can lead to inefficiencies and costs, illustrating the benefits of data sharing and transparent processes for both operational and strategic outcomes.

Although simplified for instructional use, the SIMCDS framework was intentionally designed to reflect core dynamics observed in real-world supply chains. The simulation models each supply chain tier as a single entity rather than the multiple competing firms typically found at each level. This generalization allows students to focus on fundamental coordination challenges before considering competitive dynamics. The simulation structure replicates typical operational challenges such as sequential decision-making, fragmented information flows, and decentralized coordination between tiers. These conditions often lead to inefficiencies, such as inventory imbalance, demand distortion, and the bullwhip effect, challenges that have been extensively documented in both academic literature and industry practice (Simchi-Levi et al., 2007; Wadhwa et al., 2010). The single-entity design aids precise observation of these phenomena without the added complexity of within-tier competition, making it particularly suitable for introductory and intermediate instruction.

In this research, we showcase the integration of SIMCDS into an undergraduate Strategic Management course taught at a Colombian university. Participants completed pre- and post-SIMCDS activity surveys to capture shifts in their perceptions about information transparency, supply chain coordination, and data-based decision-making. The findings indicate that continuous engagement with the simulation can enhance learners' comprehension of collaborative approaches and the strategic implications of seamless data sharing. To facilitate adoption in other instructional settings, the complete SIMCDS application and supporting documentation are available upon request from the corresponding author of this article and are also archived in the repository: https://osf.io/gu5tx. The software runs on Microsoft Excel® (version 2010 or higher) with VBA macros enabled and is compatible with both 32-bit and 64-bit systems.

To guide the reader through the remainder of this teaching tip, Section 2 reviews existing supply chain simulation tools, categorizing them by pedagogical roles and technological affordances. Section 3 introduces the SIMCDS simulation, outlining its structure, logic, and instructional features. Section 4 describes the instructional strategy and classroom implementation. Section 5 presents the evaluation framework and key findings from a recent student cohort. Finally, Section 6 offers concluding reflections and discusses implications for future instructional use and development.

2. LITERATURE REVIEW

Although courses and programs in SCM have long been established, in recent years instruction in this field has gained renewed prominence, largely due to the disruptions precipitated by the COVID-19 pandemic. These disruptions exposed deep vulnerabilities in sourcing, logistics, and inventory management systems, significantly raising the visibility of SCM and emphasizing its strategic role across industries (Opatrny-Yazell & Nelson, 2021; Sarkis, 2020). This adjustment coincides with an institutional push to prepare future professionals for increasingly dynamic and technologically complex business environments, an effort in which information systems education plays a pivotal role (Baveja et al., 2024; Topi, 2019).

Topi (2019) highlights the importance of students evaluating emerging technologies, defining business requirements, and designing integrated, data-driven solutions that align with organizational goals. These include understanding how information systems must balance transparency for operational efficiency with security and confidentiality to maintain a competitive advantage and stakeholder trust. Consequently, information systems analytical competencies, especially the ability to structure and interpret data, have become essential in SCM. In response, many academic institutions have turned to experiential learning and mentoring programs to expand the academic–industry synergy and develop students' technical and decision-making capabilities (Edwards & Mitchell, 2025).

Among these experiential strategies, educational simulations have proven particularly effective in teaching complex systems. Within business curricula, simulations alongside case studies and dynamic classroom lectures are consistently recognized by students and peers as influential tools for developing applied knowledge (Farashahi & Tajeddin, 2018; Murray, 2022; Ruhi, 2016). Beyond improving conceptual understanding, classroom simulations have also been linked to enhanced motivation, engagement, and learner attitudes (Zulfiqar et al., 2018). Additionally, pedagogical developments have increasingly focused on gamification, i.e., the integration of game-like mechanics into non-recreational learning contexts. These approaches have demonstrated positive outcomes in both academic and organizational settings, particularly in domains that require compound, iterative decision-making (Patwary et al., 2025). Together with simulations and scenario-based modules, gamification belongs to a broader class of experiential tools designed to support active learning (Siddiqui et al., 2008).

Given this evolving educational frame, our literature review synthesizes findings from the literature on a representative set of simulation tools used in SCM instruction and evaluates them based on both technological affordances and their pedagogical value. We categorize these tools by implementation type to clarify how each supports interactive decision-making, information systems, scenario experimentation, and post-simulation data analysis capabilities that are increasingly vital in data-driven learning environments.

2.1 Excel-Based Applications

Excel-based simulations remain a foundational component in SCM education, valued for their accessibility, intuitive interface, and ease of integration into business and engineering curricula. These tools permit the modeling of core supply chain activities such as material requirements planning (MRP), inventory control, and production scheduling within a familiar spreadsheet environment, making them particularly suitable for introductory and intermediate instruction.

Gardner (2008) introduced one such simulation designed to teach MRP, inventory management, and quality control through student-built spreadsheet models. This application reinforces the conceptual understanding of enterprise resource planning (ERP) by requiring learners to construct logical workflows from scratch. However, despite its pedagogical strengths, the tool does not support the export of simulation data, which may limit opportunities for more extensive post-activity analysis or integration with external analytics tools. Similarly, Boute and Lambrecht (2009) developed a spreadsheet-based simulation that explores the bullwhip effect through experiments involving replenishment policies and forecasting methods. This tool effectively demonstrates inventory variability across supply chain nodes; however, it does not support data export, thereby restricting further analytical exploration.

In contrast, Adams et al. (2006) proposed a hybrid simulation that combines manual operations with spreadsheet functionality to teach just-in-time (JIT) production and stochastic operating strategies. This simulation allows students to compare manual and computational approaches, thereby enhancing their understanding of system variability and responsiveness. Notably, this model supports data export, making it one of the few Excel-based tools that facilitate extended data analysis beyond the simulation session.

2.2 Web-Based or Online Applications

Web-based and online simulations have gained substantial traction in SCM education due to their flexibility, remote accessibility, and support for asynchronous and collaborative learning environments. These platforms offer students the opportunity to explore supply chain dynamics in real-time, often without the constraints of physical materials. However, despite their pedagogical richness, many of these tools lack support for exporting decision data, an increasingly valuable feature for post-simulation analysis and reflective learning.

Several foundational web-based tools illustrate these design limitations. Haines et al. (2005) developed an online version of the classic Beer Game to demonstrate the bullwhip effect and facilitate engagement in distributed learning contexts. Similarly, Dobson and Shumsky (2006) introduced simulations that focus on queuing theory, Little's Law, and inventory systems, allowing learners to adjust parameters and immediately observe the impact of system variability and utilization. Although these simulations are practical at actively visualizing operational concepts, neither supports data export for detailed subsequent analysis.

Other platforms aim to incorporate strategic interaction and performance evaluation within a digital framework. Ngai et al. (2012) established the Web-based Supply Chain Management Game (WSCMG), which enables students to make operational decisions, generate performance reports, and engage in peer-based feedback. Likewise, Feng and Ma (2008) introduced a simulation in which participants manage procurement, inventory, and production activities in real time. Both simulations promote applied learning through real-time feedback but similarly lack data export functionality, which may constrain their use for structured follow-up analysis or cross-platform evaluation.

The simulation developed by Zhou et al. (2008) augments the Beer Game framework by embedding a management information system. This feature allows learners not only to collaborate on decision-making but also to extract data for analysis, providing a notable example of a web-based simulation aligned with post-analytical pedagogies. In contrast, tools such as the Wood Supply Game (D'Amours et al., 2017), which is accurately fitted for industry-specific applications like forestry, and the Hunger Chain Simulation (Song et al., 2021), which incorporates scarcity and disruption dynamics, are also primarily designed as closed systems.

More progressive online environments have also been developed. For instance, Zhao et al. (2023) introduced the FloraPark Simulation, focused on contract negotiation and conflict-resolution strategies in supply chains. Meanwhile, the Supply Chain Trading Agent Competition (TAC-SCM), developed by Arunachalam and Sadeh (2005) and later extended by Eriksson et al. (2006), offers a multi-agent, competitive framework where participants manage virtual firms in a dynamic marketplace, fostering real-time strategic thinking. These simulations more accurately reflect market pressures and the challenges of supply chain integration, considering varying levels of data accessibility based on platform design.

Lastly, immersive virtual environments have been explored as platforms for SCM education. Wriedt et al. (2008) utilized the 3D virtual world Second Life to simulate supply chain flows, where students interact via avatars to visualize and manage material and information streams. Complementing these innovations, Siddiqui et al. (2008) proposed the Supply Chain Simulator, which permits experimentation with procurement, production, and distribution decisions across various scenarios. Although rich in design and scenario variation, it also lacks support for exporting decision data, thereby constraining opportunities for post-simulation analysis.

2.3 Hands-on Applications With Physical Materials

Hands-on simulations using physical materials remain a powerful pedagogical approach, particularly for fostering experiential learning, teamwork, and tactile understanding of logistics processes. These simulations often rely on tangible objects and face-to-face interaction to replicate key supply chain functions such as planning, production, distribution, and coordination. Although effective in facilitating engagement and collaboration, these tools typically lack digital integration, particularly in data export, which limits their compatibility with data-driven learning environments.

A well-known example is the Lean Leap Logistics Game developed by Holweg and Bicheno (2002), which employs LEGO®/DUPLO® pieces to model industrial supply chain flows. Designed as a collaborative exercise, the simulation immerses participants in decision-making under uncertainty, illustrating core principles such as lean thinking, coordination, and mitigation of the bullwhip effect. While pedagogically effective, this tool does not interface with digital platforms or support post-simulation data extraction.

Building on the traditional Beer Game, Reyes (2007) introduced a modified version that incorporates more complex supply chain dynamics, such as parallel interactions, rationing, and product substitution. This adaptation enhances the richness of the decision-making environment but remains limited by its analog format, lacking means for data export or digital performance tracking. In a similar vein, Whitelock (2020) developed BPIsim, a physical simulation that guides participants through end-to-end supply chain activities, including planning, purchasing, production, delivery, and returns. By using tokens representing goods and currency, the simulation provides a tangible framework for understanding operational cycles and the cash-to-cash construct. Despite its strengths in illustrating real-time interactions and financial flows, BPIsim does not currently include digital export capabilities, which may limit direct analytical follow-up outside the classroom setting.

Zhong and Huang (2014) offer a more technologically integrated approach with an RFID-enabled physical simulation designed to mimic global supply chain operations. This learning environment combines problem-based learning with collaborative planning and distribution tasks, heightened by real-time feedback from RFID tracking. Nevertheless, despite its technological innovation, the simulation lacks functionality for exporting session data to external analytical tools, therefore restricting its potential for deeper, post-activity evaluation.

2.4 Traditional Digital Applications With Restricted Analytical Integration

Traditional computer-based simulations have played a crucial role in the conceptual teaching of SCM, offering immersive environments that feature key principles such as coordination, integration, and system variability. However, despite their educational value, many of these tools function as closed systems, lacking compatibility with analytical platforms such as spreadsheets, visualization tools, or statistical software. They are often neither web-enabled nor designed for hands-on or tactile interaction, and they rarely support post-simulation data extraction, limiting their usefulness for data-driven analysis or decision reflection.

An example is the computer-based version of the Beer Game developed by Kaminsky and Simchi-Levi (1998), which translates the physical simulation into a digital format aimed at illustrating supply chain integration and the bullwhip effect. While this version enhances accessibility and repeatability, facilitating the implementation beyond the classroom, it does not allow for the export of simulation data or integration with external analytics platforms, thereby reducing opportunities for extended reflection or comparative analysis.

Similarly, Anderson and Morrice (2000) introduced the Mortgage Service Game, a service-sector-oriented simulation that emphasizes the role of information transparency in managing service capacity and minimizing delays. Although pedagogically focused on process efficiency and system feedback, the simulation remains self-contained and lacks features for external data handling or visualization. In a more strategic context, Sweeney et al. (2010) examined the adaptation of commercial software tools such as SAILS and Network Strategy for educational use. These tools support high-level decision modeling and logistics network design. However, their original industrial focus and lack of learner-centered features such as scenario-based experimentation or accessible data output may pose challenges for use in experiential learning contexts that require greater interactivity or data accessibility. Finally, further advancing the strategic element, D'Amours and Rönnqvist (2013) developed a simulation on collaborative logistics, wherein participants form coalitions and negotiate cost-sharing strategies based on game-theoretical concepts. While this simulation excels in modeling inter-organizational dynamics, it similarly lacks data export functionality and post-game analytical flexibility.

As evidenced previously, numerous tools contribute to experiential learning by immersing students in real-world SCM challenges. Therefore, we have successfully implemented many of these simulations in our institutions. Still, while most implementations effectively support conceptual learning and student engagement, a key feature often underrepresented is the ability to export data compatible with external software applications, which augments the ability to inform real-time decisions by allowing learners to make data-driven assessments and experience the transformative benefits of information transparency in improving SCM performance. While a handful of simulations offer some level of data output, they are often limited or not fully accessible to all supply chain nodes, which may require workarounds or additional steps for integration into external applications.

To address this need for reflective data integration and a more holistic understanding of supply chain dynamics, we developed SIMCDS. Specifically designed to streamline and enrich data analysis, SIMCDS builds upon the effective and practical tools previously described to convey key SCM concepts. The application is designed to boost post-simulation data analysis, aligning with our educational objective of furthering seamless data export and evaluation. By enabling students to retrieve and operate complete sets of simulation data directly, we aim to strengthen their mastery of data-driven decision-making, which can inform their decisions in line with business objectives and showcase the importance of transparent information sharing throughout the supply chain.

3. SIMULATED INTERFACE FOR MANAGEMENT AND COLLABORATIVE DECISION SYSTEMS (SIMCDS)

SIMCDS operates as an Excel-based simulation built with VBA, where students assume the roles of Retailer, Distributor, and Manufacturer within a simplified three-tier supply chain. This simplified structure represents each tier as a single entity rather than multiple competing firms, allowing students to focus on understanding vertical coordination and information flows before progressing to more complex multi-entity scenarios found in practice. The simulation unfolds over two rounds: one representing limited information sharing and the other complete transparency among supply chain nodes. Each round follows a structured five-step workflow: Step 1 – configuring parameters, Step 2 – running the simulation, Step 3 – viewing operational reports, Step 4 – exporting data, and Step 5 – evaluating performance indicators.

Students interact with SIMCDS through a guided interface composed of intuitive menus and buttons, including the Main Menu, Data Menu, Simulation Console, Reports Menu, and Results Dashboard. These components are designed to streamline navigation and facilitate decision-making throughout the simulation. Visual illustrations of each interface element are provided in Appendix A to complement the explanations. The following subsections describe the SIMCDS configuration process in sequential stages, encompassing preloaded scenarios and transparency logic, simulation execution, data reporting and export functions, and the presentation of final performance indicators.

3.1 Data Configuration and Supply Chain Nodes

Upon launching SIMCDS, users are presented with the Main Menu, which contains four core buttons: Data, Simulation, Reports, and Results (Appendix A, Figure A1). The simulation begins by selecting the Data Menu, which introduces the three decision-making roles in the supply chain: Manufacturer, Distributor, and Retailer, each linked to a shared end consumer (the Client) (Appendix A, Figure A2). Note that in the SIMCDS interface, the Distributor may appear labeled as "Distributor/Wholesaler" to acknowledge that, in different supply chain contexts, this intermediary role can represent either entity. In practice, wholesalers typically purchase goods in bulk from multiple manufacturers and resell them to retailers. Simultaneously, distributors often have exclusive relationships with specific manufacturers and may provide additional services, such as logistics and marketing support. For pedagogical simplicity, our single-tier model consolidates these intermediary functions into a single Distributor node.

Students must configure operational inputs for each role by accessing dedicated submenus (Appendix A, Figure A3). These include the demand models, lead times, inventory policies, and cost parameters for the nodes. For example, the Retailer and Distributor must define selling prices, holding costs, ordering costs, initial inventory levels, and inventory policies (periodic or min-max). The Manufacturer, which produces novelty avocado-shaped watches, must specify production capacities using either a uniform or normal distribution. No backorders are allowed at any stage, reinforcing the importance of timely fulfillment.

Users then input demand parameters for the Client, whose orders must be fulfilled immediately by the Retailer. SIMCDS offers two demand distribution options, uniform and normal, to simulate variability. Missed demand results in lost sales, reinforcing concepts of service level and responsiveness. Throughout the configuration menus, question mark ("?") icons appear next to key inputs, providing in-context definitions to support student understanding. This feature helps learners quickly grasp supply chain and logistics terminology without disrupting the simulation flow. A comprehensive list of required configuration inputs is summarized in Table 1, outlining the parameters associated with each role.

Node	Category	Parameter	Options / Notes
Client	Demand Settings	Demand Distribution	Uniform or Normal
Retailer	Financial Inputs	Selling Price, Holding Cost, Product Cost, Ordering Cost	User-Defined
	Operational Settings	Initial Inventory, Lead Time	User-defined
	Inventory Policy	Inventory Control Method	Periodic (M, T) or Min-Max (s, S)
Distributor	Financial Inputs	Selling Price, Holding Cost, Product Cost, Ordering Cost	User-Defined
	Operational Settings	Initial Inventory, Lead Time	User-Defined
	Inventory Policy	Inventory Control Method	Periodic (M, T) or Min-Max (s, S)
Manufacturer	Financial Inputs	Selling Price, Holding Cost, Product Cost, Ordering Cost	User-Defined
	Operational Settings	Inventory Threshold: Maximum Inventory Level	User-Defined
	Production Settings	Production Distribution	Uniform or Normal

Table 1. Summary of Parameters for SIMCDS

3.2 Preloaded Scenarios

To facilitate classroom implementation and ease of use, SIMCDS includes three preconfigured scenarios that instructors and students can load directly from the Data menu. These are accessible via the Scenario Configuration Panel (Appendix A, Figure A2) and are designed to illustrate the impact of various inventory strategies on supply chain dynamics. Users select one of the following scenarios:

- Scenario 1 (S1): Min-Max Inventory Policy for both Retailer and Distributor
- Scenario 2 (S2): Periodic Inventory Policy for both Retailer and Distributor
- Scenario 3 (S3): Mixed Policy: Retailer uses Periodic, Distributor uses Min-Max

Preset values for demand distributions, costs, inventory thresholds, and lead times are automatically provided for each scenario, accompanying the demand distributions, costs, inventory thresholds, and lead times across all supply chain nodes. These settings enable a quick start and facilitate discussion about how policy differences impact system behavior.

All scenarios begin with a limited information-sharing setting, where each node operates independently without visibility into upstream or downstream decisions. This concept can be reviewed by clicking the Information Transparency button in the Data menu (Appendix A, Figure A2). In the simulation's simplified single-entity environment, students first explore the operational benefits of transparency without the trust and competitive concerns that arise when multiple competing entities share sensitive data. This progression allows students to understand why, despite clear operational advantages, many real-world supply chains maintain limited information sharing due to concerns about trust, auditing, and competitive considerations.

Each scenario adjusts the inventory levels, cost structures, and demand or production distributions to reflect realistic supply chain challenges. The demand from the Client follows a normal distribution with a mean of 1,800 units and a standard deviation of 800 units across all scenarios. The Manufacturer's production capacity is also normally distributed, simulating supply-side variability. The complete configuration for Scenarios S1, S2, and S3 is summarized in Table 2, including all financial inputs, policies, and inventory settings across the three entities and consumers: Client, Retailer, Distributor, and Manufacturer.

Parameter	Client	Retailer (R)	Distributor (D)	Manufacturer (M)
Demand Distribution	Normal (Mean = 1800, SD = 800)	–	–	–
Selling Price per Unit	–	20	10	5
Holding Cost per Unit	–	2	2	1
Product Cost per Unit	–	10	5	2
Ordering Cost	–	5	10	1
Initial Inventory / Inventory Cap	–	10,000 (S1) 12,000 (S2, S3)	6,000 (S1, S2) 8000 (S3)	10,000 (inventory threshold)
Order Lead Time	–	2 (all scenarios)	2 (all scenarios)	–
Inventory Policy	–	S1: Min-Max S2: Periodic S3: Periodic	S1: Min-Max S2: Periodic S3: Min-Max	–
Production Capacity Distribution	–	–	–	Normal (Mean = 2000, SD = 500)

Table 2. Parametrization for Scenarios S1, S2, and S3

3.3 Running the Simulation

Once all configuration parameters have been entered, participants return to the Main Menu and proceed by clicking the Simulation button to initiate the execution phase. This launches the simulation console (Appendix A, Figure A4), where students input the number of periods over which to simulate supply chain operations. The default unit of time is flexible, typically interpreted as weeks, though instructors may adjust this depending on course objectives. We recommend simulating at least 60 periods to generate meaningful operational and financial data across all nodes. The simulation unfolds in a time-stepped sequence that follows this core workflow:

1) Input Duration: Students enter the desired number of periods (e.g., 60 weeks).
2) Simulate Flows: The application simulates the interaction between the Client and each supply chain entity across all time steps based on the pre-specified parameters (e.g., demand distribution, inventory policies, lead times).
3) Compute Performance: SIMCDS calculates inventory movements, ordering decisions, fulfilled and missed demand, and associated costs (holding, ordering, and lost sales) for each period.
4) Enforce Node Rules:
    a) Retailers attempt to fulfill the Client's demand. Any unmet demand results in lost sales; there is no backordering.
    b) Distributors receive orders from Retailers, fulfill them from available inventory when possible, and place replenishment orders with the Manufacturer, also without backorders.
    c) Manufacturers produce watches based on probabilistic production capacity and fulfill Distributor orders accordingly. Any production shortfall results in unfulfilled orders and lost sales downstream.

Each step attempts to mimic real-world trade-offs where lead times cause delays, information limitations constrain responsiveness, and supply-demand mismatches create service shortfalls. The simulation encourages students to think critically about coordination, policy configuration, and the role of transparency in these areas.

3.4 Viewing and Exporting Reports

After the simulation is run, participants access the Reports section via the main interface (Appendix A, Figure A5). This section provides a detailed visualization of operational outcomes across the supply chain, including both tabular data and graphical summaries. The Reports Menu enables the following actions:

1) Visualize Node-Level Performance: Students can view time-series charts for each entity (Retailer, Distributor, Manufacturer), including:
    a) Inventory levels over time
    b) Order quantities placed and received
    c) Demand fulfillment vs. missed demand
    d) Bullwhip effect indicators (order amplification across nodes)
2) Drill Into Period-Specific Details: The system displays detailed values for each simulation period, including beginning inventory, order size, actual demand, and ending inventory. This setting helps students link operational behavior to performance outcomes.
3) Export Full Data Set: A key feature of SIMCDS is the Export Data button, which allows users to download all simulation results in a clean Excel format. This includes simulation variables such as:
    a) Initial and final inventories
    b) Inventory net positions
    c) Holding costs, ordering costs, and product costs
    d) Revenues, missed demand, and fulfilled demand

The ability to export raw data is intentionally built into SIMCDS to support post-simulation analysis, letting students validate built-in reports with manual calculations, conduct extended analysis using spreadsheet tools, statistical software (e.g., R, Minitab), or data visualization platforms (e.g., Tableau, Power BI), and build presentations or written assessments using authentic, simulation-generated data. This export capability supports evidence-based learning, empowering students to analyze the downstream effects of their decisions and grasp a deeper understanding of the role of information transparency in operational performance. Additionally, this data permits investigation of various supply chain phenomena beyond information transparency. For instance, the bullwhip effect visible through order amplification metrics across nodes can be studied under various transparency conditions. Students can analyze how demand variability propagates differently when information is restricted versus shared, examining which condition actually occurs more frequently in practice. Moreover, the exported data support the investigation of inventory policy effectiveness, lead time impacts, service level trade-offs, and cost optimization strategies, independent of transparency considerations.

3.5 Results and Performance Indicators

Once the simulation has been executed, participants can navigate to the Results section from the main menu (Appendix A, Figure A6). This module summarizes the overall performance of the supply chain by presenting both system-level and node-level metrics. The Results interface is organized into two core components:

1) Overall Supply Chain Performance: At the top left of the interface, aggregate indicators provide a snapshot of the supply chain's performance during the simulation. Key metrics include:
    a) Service Level: The percentage of demand fulfilled at the node level.
    b) Income-to-Cost Ratio: A profitability measure that compares total revenue to total operational costs across all nodes.
2) Node-Specific Analysis: Detailed indicators are available by clicking through four categorical tabs in the top-right corner:
    a) Costs: Summarizes total holding, ordering, and production costs per node.
    b) Missed: Displays the total number of unfulfilled orders or lost sales.
    c) Revenue: Shows total income generated by each supply chain entity.
    d) Times: Reflects lead times, order delays, and other temporal performance measures.

This dual-level presentation is designed to help students connect micro-level decisions to macro-level outcomes. For example, a poorly chosen inventory policy at the Distributor level may lead to stockouts, which in turn reduce the system's overall service level. By isolating these effects through node-specific indicators, students can increase their understanding of the interdependence between supply chain decisions. Moreover, this section complements the data export functionality. Therefore, students are encouraged to cross-check visual metrics using the raw exported data, develop their own dashboards or analytical summaries, and critically evaluate how transparency, lead times, and inventory choices affect system-wide efficiency. In doing so, SIMCDS reinforces the importance of data-driven strategic thinking and encourages students to assess performance through both real-time feedback and post-simulation reflection.

4. SIMCDS TEACHING APPROACH

4.1 Context

In this study, SIMCDS was implemented in a Strategic Management course at a Colombian university. Typically taken in the junior year, the course develops students' ability to analyze, formulate, and implement business strategies that align organizational objectives with dynamic market conditions. The curriculum covers both foundational and advanced topics, including competitive analysis, resource allocation, and cross-functional alignment. Open to all business majors as well as industrial engineering students, the course combines in-person classroom instruction with practical, experiential activities that underline collaborative thinking, ethical considerations, and data-driven decision-making. Assessment is conducted through multiple assignments during the semester, culminating in a final evaluation that integrates key strategic management concepts.

SIMCDS was incorporated to demonstrate how information transparency can influence strategic decision-making, particularly in supply chain contexts that require coordination among multiple stakeholders. By simulating realistic scenarios, the activity allows students to observe how the flow or absence of critical information can shape outcomes in complex strategic environments. The exercise reinforces the importance of timely and accurate communication in supporting sustainable and effective business strategies, demonstrating how transparency can be a decisive factor in achieving a competitive advantage. Appendix B presents the handout given to students to guide their participation in the SIMCDS activity and document their findings.

4.2 Implementation Phases

The SIMCDS implementation was conducted in a focused 75-minute session, beginning with a formal lecture presentation on the critical role of information transparency in achieving organizational goals, which is the typical format for teaching the session. Following this, a pre-activity (PRE) survey was administered to assess students' understanding of the topic after the presentation. Students were then guided through the SIMCDS framework and engaged directly with the simulation in class. The activity was divided into two distinct phases (see Appendix B):

1) Non-Transparent Operations: In this initial stage, students interacted with the simulation under conditions where information sharing between supply chain nodes was limited or non-existent. This setup mimicked real-world scenarios where entities operate independently without access to comprehensive data from other stakeholders.
2) Transparent Operations: In the second stage, students had complete visibility into all data across all nodes. This contrast enabled them to identify the performance improvements resulting from sharing inventories, lead times, and demand information. Students analyzed how transparent operations can lead to better coordination, reduced uncertainty, and more cohesive strategic decisions at every level of the supply chain.

During both phases, participants conducted sensitivity analyses to evaluate the impact of varying degrees of information access on key performance indicators (KPIs). They were tasked with capturing simulation data, synthesizing their findings, and submitting an assignment that included Excel workbooks, data visualizations, and a concise report articulating how transparency impacted strategic outcomes. Throughout the session, instructors facilitated discussions around the observed results and challenges, stressing how information transparency can drive more informed and effective strategic choices in real-world business contexts.

4.3 Assessment and Feedback

At the end of the simulation exercise, students completed a post-activity (POST) survey specifically designed to measure whether their understanding of information transparency had improved. Comparing these responses with the PRE survey results (i.e., survey performed after the lecture presentation typically used by instructors to teach the topics) allowed us to assess how effectively SIMCDS shifted students' perceptions from viewing transparency as merely an operational detail to recognizing it as a strategic asset capable of influencing both short- and long-term organizational performance.

4.4 Step-by-Step Session Application

The session begins with the formal presentation that introduces and details the concept of information transparency in strategic management, as typically covered in this course. Students learn how the availability or lack of comprehensive data can shape strategic decisions, resource allocation, and overall performance in a supply chain context. Following this presentation, the instructor displays SIMCDS and demonstrates the key features of the interface, specifying how to input data, interpret outputs, and connect these results to broader strategic objectives.

4.4.1 Phase 1: Non-Transparent Operations. In the first phase, the simulation was configured in "Non-Transparent" mode to replicate the fragmented decision-making commonly observed in real-world supply chains. Students were organized into teams and assigned individual workstations, with each student taking responsibility for one of the three supply chain nodes: Manufacturer, Distributor, or Retailer. In larger teams, multiple students could work on the same node independently to encourage diverse strategies.

Each student was permitted to modify only the parameters of their assigned node (e.g., inventory policy, production capacity, initial inventory), running SIMCDS multiple times to refine their decisions iteratively. They were not allowed to alter the settings of the other nodes. This design assured that decisions were made in silos, simulating the limitations of minimal information sharing across the supply chain.

Once students finalized their individual configurations, each team submitted their set of three node-specific decisions to the instructor. The instructor then compiled these into a full-team configuration and executed the simulation using SIMCDS, sharing the resulting performance with the class (students also ran the complete configurations in their workstations). Because students often proposed distinct strategies for the same node across different teams, each group's combined configuration produced unique supply chain outcomes, even when using the same scenario structure (S1, S2, or S3). This phase typically lasted 20–30 minutes and focused on the following:

- Each node optimized its local performance objectives without access to or knowledge of decisions made by other nodes.
- Retailers and Distributors adjusted inventory policies and initial inventory levels (preset to a maximum threshold of the chosen inventory policy).
- Manufacturers modified production capacity and inventory thresholds using the predefined distributions.
- Market prices and cost inputs remained fixed, isolating the effect of decision visibility.

This phase demonstrates not only the operational inefficiencies resulting from limited information sharing but also reflects the reality that many supply chains operate with restricted transparency due to concerns about trust, competitive dynamics, and the dual role of information as both a coordination mechanism and a source of competitive advantage. Students experience firsthand why organizations might rationally choose operational suboptimality to preserve strategic information assets. The setup provided students with a practical understanding of the risks and inefficiencies that arise when strategic alignment is lacking and critical information is not shared across supply chain partners.

4.4.2 Phase 2: Transparent Operations. In the second phase, all student teams operated SIMCDS in "Transparent" mode, which enabled complete visibility across the supply chain. Each participant could now view real-time data on inventory levels, demand patterns, lead times, and cost structures for all nodes in the system. Using the same preloaded scenarios (S1, S2, S3), students were tasked with collaboratively refining their prior decisions based on this expanded data access.

Teams reconvened to reassign or retain node roles and worked together to develop integrated parameter sets that aimed to optimize system-wide performance. Students continued using their own SIMCDS workstations to test different configurations and compare outcomes iteratively. The transparent setup featured two additional dimensions:

- Collaborative Strategy: With complete visibility, team members coordinated their decisions across all nodes, evaluating how adjustments at one level impacted performance at both downstream and upstream levels. The objective shifted from isolated efficiency to global optimization.
- Lead-Time Negotiation: Students were introduced to a strategic trade-off; Retailers and Distributors could reduce their lead times by one period in exchange for a tenfold increase in ordering cost. This option allowed teams to experiment with rush-ordering strategies and assess whether the benefits (e.g., higher service levels, reduced lost sales) justified the added cost.

Once consensus was reached, teams tested their revised configurations using SIMCDS and compared the new performance metrics to those observed in the non-transparent phase. This hands-on process helped students recognize how transparency facilitates better coordination, mitigates inefficiencies, and influences trade-offs in operational decision-making. As in the previous phase, the instructor facilitated a debrief discussion, prompting students to reflect on the impact of data visibility and cross-functional alignment.

This phase typically lasted 25–30 minutes and culminated in the submission of updated results, which formed the basis for post-simulation reflection and analysis.

4.4.3 In-Class Debrief and Assignment. Following both phases, teams share their outcomes, denoting how transparency influenced their strategic decisions. The class examines how reduced lead times, collaborative planning, and full visibility can lead to a more cohesive supply chain strategy. The instructor guides a broader reflection on the potential real-world implications, emphasizing how transparent data sharing fosters alignment with the organization's overarching goals. Finally, students may optionally complete a complementary assignment that requires them to present the simulation's data-driven understandings obtained from the Export data capability provided in SIMCDS. Teams can produce Excel-based analyses, visualizations, and concise reports summarizing their decision-making process, showcasing the specific impact that transparency (or its absence) has on supply chain performance.

4.5 Instructional Notes

4.5.1 Software. SIMCDS is designed to run entirely in Microsoft Excel, making it essential for students to have at least a basic familiarity with Excel operations. If students lack experience, instructors may need to provide a brief tutorial covering fundamental functions, such as cell references, data manipulation, and basic chart creation, before beginning the activity.

4.5.2 Prerequisite Knowledge. Students should have a foundational understanding of SCM. Instructors should briefly introduce or review these concepts if they have not already been exposed to SCM concepts, such as inventory policies. Because in our case, the course is also open to engineering students, some may be new to SCM theories or standard inventory systems (periodic vs. min-max). Nevertheless, the SIMCDS interface is straightforward enough that most learners adapt quickly, focusing on analyzing rather than manually calculating inventories and costs.

4.5.3 Preparation. Within the context of our Strategic Management course, students are typically familiar with Excel-based assignments and strategic frameworks. However, as this course is open to different majors, a concise overview of inventory policies and the supply chain structure may be necessary. While students tend to grasp the SIMCDS problem setup promptly, those who require additional support can benefit from video tutorials that demonstrate various parameter configurations. Instructors can also provide short guides explaining how to perform fundamental analyses in Excel, confirming that all students can effectively evaluate the simulation data.

4.5.4 Timeline. This activity is deployed in a 16-week undergraduate Strategic Management course, specifically in the module focusing on information transparency and strategic alignment. Students generally spend one session (75 minutes) on the in-class simulation; in most cases, learners require one additional week to finalize their analysis, prepare visualizations, and submit a written report. The assignment is optional (at the instructor's discretion), but consider that, if required, those less familiar with Excel or data analysis may need extra time to master the relevant functions and visualization tools.

4.5.5 Scope and Realism. Instructors should note that SIMCDS models each supply chain tier as a single entity, which simplifies the competitive dynamics present in actual supply chains. This design choice allows students to master fundamental concepts of information sharing and coordination without the added complexity of within-tier competition. For advanced courses, instructors might discuss how the dynamics would change with multiple competing entities at each level, where information sharing could inadvertently benefit competitors. This limitation can itself become a valuable teaching point about the tensions between collaboration and competition in real supply chain networks.

4.5.6 Variations. Varying the input values to create alternative versions of the problem is straightforward. To add even more complexity to the activity, instructors can develop as many scenarios as required by modifying the parameters for the supply chain nodes. Such variations allow the instructor to modify the difficulty according to the student's proficiency levels. Beyond varying input values, instructors can adapt SIMCDS to explore different supply chain concepts. While we emphasize information transparency, the simulation equally supports studying:

- The bullwhip effect under different information conditions
- Comparative analysis of inventory policies independent of transparency
- Lead time optimization and its cost implications
- Service level versus inventory cost trade-offs
- Demand forecasting accuracy impacts on system performance

4.5.7 Instructional Recommendations. Students often encounter an initial learning curve when working with the exported data, particularly in identifying which variables are most relevant for their assigned node and how to translate operational outcomes into broader strategic decisions. This difficulty, however, reflects a key learning objective of the SIMCDS tool. Unlike many traditional classroom exercises, SIMCDS is intentionally designed to expose students to the complexity and granularity of operational data, a level of realism they are likely to face in actual supply chain roles but rarely experience in academic settings.

Rather than simplifying or filtering outputs, SIMCDS encourages students to engage directly with raw, node-specific, and system-wide performance indicators, helping them practice the kind of data-driven thinking required in modern supply chain environments. To support this transition, instructors may find it helpful to walk through an example scenario early in the session, showing how a specific policy or parameter decision (e.g., inventory lead time or min-max thresholds) influences simulation results. Clarifying how local decisions cascade into broader system outcomes reinforces key strategic principles and deepens student engagement with the activity.

5. LEARNING EFFECTIVENESS

To evaluate the impact of the SIMCDS simulation on students' comprehension of information transparency within a supply chain context, we administered identical PRE and POST activity surveys. The PRE survey was given immediately after a formal presentation on information transparency in supply chains (the typical mode in which this session is taught), and the POST survey was administered upon completion of the SIMCDS exercise. Both surveys included five statements (Q1–Q5), each rated on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree).

The survey instrument was developed following a targeted review of literature in SCM, particularly on constructs related to information transparency, collaboration, and decision-making competence (Cao & Zhang, 2011; Morgan et al., 2018; Wadhwa et al., 2010; Zhao et al., 2023). Each item was explicitly aligned with a key learning objective addressed in the simulation: (1) conceptual clarity on information visibility, (2) awareness of the consequences of limited information sharing, (3) confidence in data-supported decision-making, (4) recognition of collaboration and negotiation among supply chain actors, and (5) the ability to incorporate information into strategic supply chain decisions. The instrument was purposefully designed to be concise, intuitive, and feasible for use within the time constraints of an in-class activity, while still capturing these core pedagogical goals. Table 3 presents the full text of the survey questions.

In total, 28 students participated in the session, which was performed during the Spring 2025 semester at a Colombian institution. All 28 students completed the PRE survey, although one student did not respond to Q5, resulting in 27 valid responses for that question. After the SIMCDS exercise, the POST survey was administered; 24 students provided complete responses to all five questions. Because the surveys were administered anonymously without individual identifiers, PRE and POST responses could not be linked at the student level; therefore, the two samples are treated as independent groups in the analyses that follow. The subsequent subsection presents the survey findings, comparing the results from the pre- and post-stages. This comparison features the extent to which the SIMCDS simulation influenced students' perception of how comprehensive data sharing can affect supply chain performance, costs, and collaboration.

Survey Questions
Q1: I understand how information transparency affects decision-making in supply chains.
Q2: I am aware of the impact that limited information sharing can have on supply chain performance, such as increased costs and inefficiencies.
Q3: I feel confident in using data analysis to make decisions within a supply chain context.
Q4: I recognize the importance of collaboration and negotiation among supply chain partners to improve overall performance.
Q5: I can identify strategies to optimize supply chain operations when given access to comprehensive information.

Table 3. PRE and POST-Survey Questions

5.1 PRE vs. POST Survey Results

Tables 4 and 5 report the descriptive statistics for the PRE and POST surveys, respectively. The PRE means for Q1–Q5 range between 2.21 and 2.43, indicating that, on average, students initially leaned toward "somewhat disagree" or "neither agree nor disagree" in their perceptions of information transparency and its influence on supply chain performance. Standard deviations in this phase are relatively high (1.34–1.50), indicating that student opinions varied considerably before engaging with the SIMCDS activity. In contrast, the POST score falls between 4.04 and 4.17, indicating that students shifted to "somewhat agree" or "strongly agree" after the SIMCDS practice. Standard deviations (0.41–0.69) are also notably lower, demonstrating greater convergence of opinions after students completed the simulation. Figure 1 visually compares these differences in mean Likert scores, along with their standard deviations.

Question	Mean	Std.dev	Min	Median	Max	n
Q1	2.21	1.42	1	2	5	28
Q2	2.36	1.34	1	2	5	28
Q3	2.43	1.5	1	2	5	28
Q4	2.36	1.42	1	2	5	28
Q5	2.26	1.35	1	2	5	27

Table 4. PRE Summary Results

Question	Mean	Std.dev	Min	Median	Max	n
Q1	4.12	0.45	3	4	5	24
Q2	4.17	0.56	3	4	5	24
Q3	4.08	0.41	3	4	5	24
Q4	4.04	0.69	3	4	5	24
Q5	4.17	0.56	3	4	5	24

Table 5. POST Summary Results

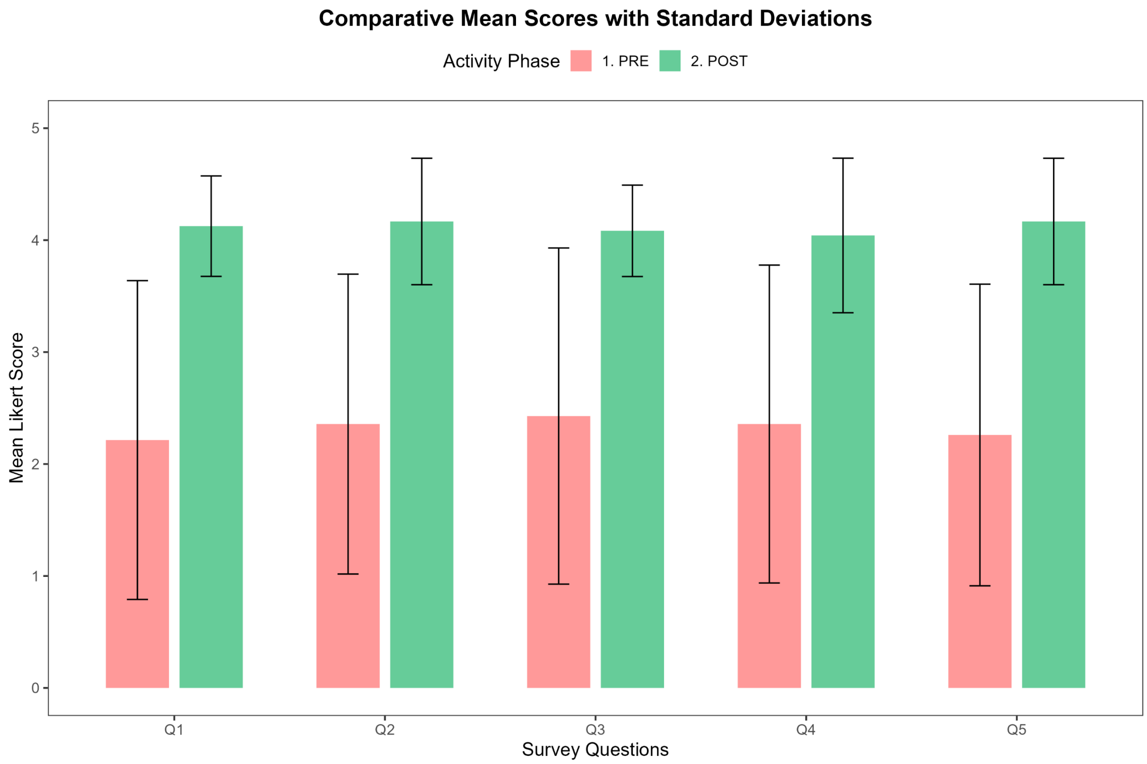

Figure 1. PRE vs. POST Results

Notably, all five questions register a similar increase of roughly 1.6 to 2.0 points on the Likert scale, indicating a substantial adjustment in students' attitudes and confidence levels. Specifically, for:

- Q1 (Information Transparency and Decision-Making): The mean response increased from 2.21 to 4.12, indicating a marked shift in student awareness regarding the strategic role of transparent information flows.
- Q2 (Limited Information and Supply Chain Performance): Responses rose from 2.36 to 4.17, reflecting greater recognition of how limited data visibility can lead to inefficiencies and cost escalation.
- Q3 (Confidence in Data Analysis): The increase from 2.43 to 4.08 suggests a notable boost in students' self-reported confidence in using data analytics to support strategic decisions.
- Q4 (Collaboration and Negotiation Importance): An improvement from 2.36 to 4.04 denotes a stronger appreciation for the role of stakeholder collaboration in enhancing overall supply chain performance.
- Q5 (Identifying Optimization Strategies): Scores increased from 2.26 to 4.17, signifying that access to comprehensive information allowed students to identify performance-improving strategies more effectively.

5.2 Evaluation Assessment

Survey responses suggest that the SIMCDS activity, particularly the shift from non-transparent to transparent operations, was associated with an improved understanding of the role of information sharing in supply chain contexts. Before the simulation (following the formal lecture presentation of the topics), many participants expressed uncertainty about how transparency and data-driven analysis affected operational outcomes. After completing the exercise, students reported greater recognition of the relationships between information flow, collaboration, and supply chain performance, reflecting increased familiarity with key SCM concepts.

To assess whether these observed differences are statistically significant, inferential tests were performed on the PRE and POST samples. Given that the surveys were anonymous and responses could not be paired at the individual level, the data were analyzed as independent samples. Preliminary assumption checks were conducted prior to test selection. Shapiro–Wilk tests indicated significant departures from normality for all items in both the PRE and POST distributions (all $p < 0.001$), and Levene's tests showed unequal variances for Q1–Q3 and Q5 (all $p < 0.05$). Given these violations of parametric assumptions, Mann–Whitney U tests were employed as the primary inferential procedure, appropriate for ordinal Likert-scale data with non-normal distributions. Welch's t-tests, which accommodate unequal variances, were used as a supplementary parametric reference.

Both tests yielded consistent results: all five survey items showed statistically significant increases from PRE to POST (all $p < 0.001$). Effect sizes, measured using Cohen's d, ranged from 1.45 to 1.81, all exceeding the conventional threshold for a large effect ($d > 0.80$). Table 6 summarizes the inferential results across all survey items.

Question	PRE Mean (SD)	POST Mean (SD)	Welch's t (df)	U	p-value	Cohen's d
Q1	2.21 (1.42)	4.12 (0.45)	6.72 (33.1)	562.5	< 0.001	1.75
Q2	2.36 (1.34)	4.17 (0.56)	6.51 (37.5)	568	< 0.001	1.71
Q3	2.43 (1.50)	4.08 (0.41)	5.60 (31.6)	526.5	< 0.001	1.45
Q4	2.36 (1.42)	4.04 (0.69)	5.56 (40.3)	553	< 0.001	1.47
Q5	2.26 (1.35)	4.17 (0.56)	6.72 (35.7)	555	< 0.001	1.81

Table 6. Inferential Statistics for PRE vs. POST Survey Comparisons

These results indicate that the improvements observed from the PRE to POST stages are not attributable to chance. The convergence of both non-parametric and parametric procedures, combined with uniformly large effect sizes, supports the conclusion that engagement with SIMCDS was associated with meaningful gains in students' self-reported understanding of information transparency, confidence in data-driven decision-making, and appreciation for collaborative supply chain coordination.

6. DISCUSSION AND CONCLUSIONS

This study examined the impact of integrating SIMCDS, a simulation tool focused on information transparency, into a Strategic Management course on students' understanding of supply chain dynamics, data-driven decision-making, and collaborative problem-solving. Through a two-phased simulation experience, students first operated within a non-transparent supply chain environment and subsequently worked under transparent conditions with comprehensive access to data from all nodes. The PRE and POST activity surveys indicated a significant increase in students' awareness of how limited information can lead to inefficiencies, escalate costs, and compromise overall performance.

6.1 Key Findings

The application results documented a statistically significant shift in student perceptions across all five survey items (Mann–Whitney U, all $p < 0.001$; Cohen's d = 1.45–1.81), with greater agreement that information sharing is an important component of effective SCM and strategic decision-making. Responses indicated increased recognition that transparent communication, such as access to real-time information on inventory levels, lead times, and production capacities, can facilitate alignment, coordination, cost control, and service level improvements. Additionally, the two-phase structure of the activity highlighted the importance of collaboration across supply chain nodes, demonstrating how limited information sharing can hinder performance compared to coordinated decision-making.

Classroom observations indicated that students interacted extensively with simulation-generated outputs, discussed decision trade-offs within their teams, and revisited parameter choices after reviewing performance indicators. These behaviors suggested that the activity prompted iterative decision-making and peer-to-peer collaboration. The structure also provided opportunities for students to compare the operational effects of different parameter settings and to discuss the system-wide implications of restricted versus transparent information flows. Such reflections mirror discussions found in modern supply chain practice, where decision-making often depends on the availability, quality, and timeliness of shared information.

6.2 Limitations and Future Directions

Despite its accomplishments, this study has limitations that warrant future exploration. First, our simulation's focus on operational outcomes does not fully capture the trust and auditing dimensions of information transparency. In practice, transparency decisions must balance operational benefits against strategic risks, including the potential for shared information to compromise competitive positions, reduce trust when data shows unfavorable patterns, or create auditing obligations that constrain flexibility. Future research could explore how students navigate these trade-offs when transparency has both positive operational impacts and negative competitive implications. The two-phased approach, non-transparent vs. transparent, could be expanded to include additional complexity, such as dynamic demand shifts, multi-product scenarios, or changing costs over time.

Furthermore, a fundamental limitation of the current SIMCDS design is its representation of each supply chain tier as a single entity. In reality, supply chains comprise multiple competing manufacturers, numerous distributors, and countless retailers, each with distinct inventory policies, cost structures, and strategic objectives. This simplification, while pedagogically valuable for introducing core concepts of information transparency and coordination, does not capture the coopetitive dynamics where entities are simultaneously collaborators and competitors that characterize supply chains. In such multi-entity environments, information-sharing decisions become significantly more complex because shared operational data could benefit direct competitors. Future iterations of SIMCDS could address this by implementing multiple agents at each tier, letting students explore how information transparency affects not only vertical coordination between tiers but also horizontal competition within tiers.

Moving forward, adopting blended learning models that combine SIMCDS with online modules or asynchronous discussion boards might extend student engagement beyond the physical classroom. Instructors could also experiment with group vs. individual play modes, compare outcomes under different forms of collaboration, or incorporate game-theoretic elements that reward or penalize information sharing. Additionally, while the PRE and POST surveys provide insight into students' perceived learning gains, a more robust assessment, potentially involving longitudinal tracking or control groups, could offer a deeper understanding of knowledge retention and skills transfer to other courses or real-world settings.

While this study focused on information transparency as the primary learning objective, SIMCDS supports the investigation of numerous other supply chain phenomena. Future implementations could focus on the bullwhip effect under various information conditions. Students could use SIMCDS to study how different inventory policies perform under realistic partial-information scenarios, examine the relationship between lead times and service levels, or investigate cost-quality trade-offs in supply chain design. These alternative applications may prove particularly valuable given that complete information transparency, while pedagogically useful for contrast, rarely exists in practice, where competitive and trust concerns constrain information sharing.

Beyond academic applications, SIMCDS has potential as a practical tool for supply chain professionals seeking to examine how varying degrees of information sharing and coordination influence operational performance. The simulation enables users to model streamlined versions of multi-tier supply chains and assess the impact of various decision-making strategies and visibility conditions on service levels, costs, and overall alignment. Future iterations could involve collaboration with industry practitioners to develop customized scenarios that reflect their operational realities, thereby enabling them to test strategies under diverse conditions of transparency, collaboration, and data availability.

6.3 Concluding Remarks

Implementing SIMCDS in a classroom setting reinforced the principle that information transparency is a pivotal driver of SCM and overall strategic success, as it allowed students to experience firsthand the transition from isolated, non-transparent operations to coordinated, transparent ones. This experiential approach fostered a deeper understanding of how data-driven decisions and cross-functional collaboration can influence both operational and strategic outcomes. The shifts observed in students' survey responses demonstrate the potential of simulation-based learning to enhance strategic thinking, foster collaborative problem-solving, and equip learners to navigate the complexities of modern supply chain environments.

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Journal of Information Systems Education, 37(1), 18-46, Winter 2026
https://doi.org/10.62273/TFRC4843

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APPENDICES

Appendix A. SIMCDS Platform

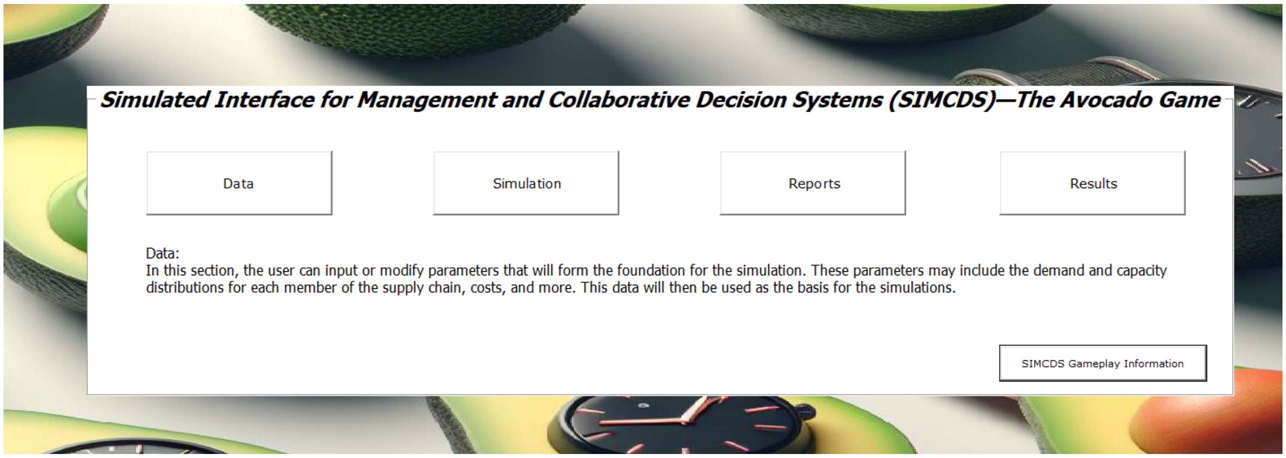


Figure A1. Main Menu

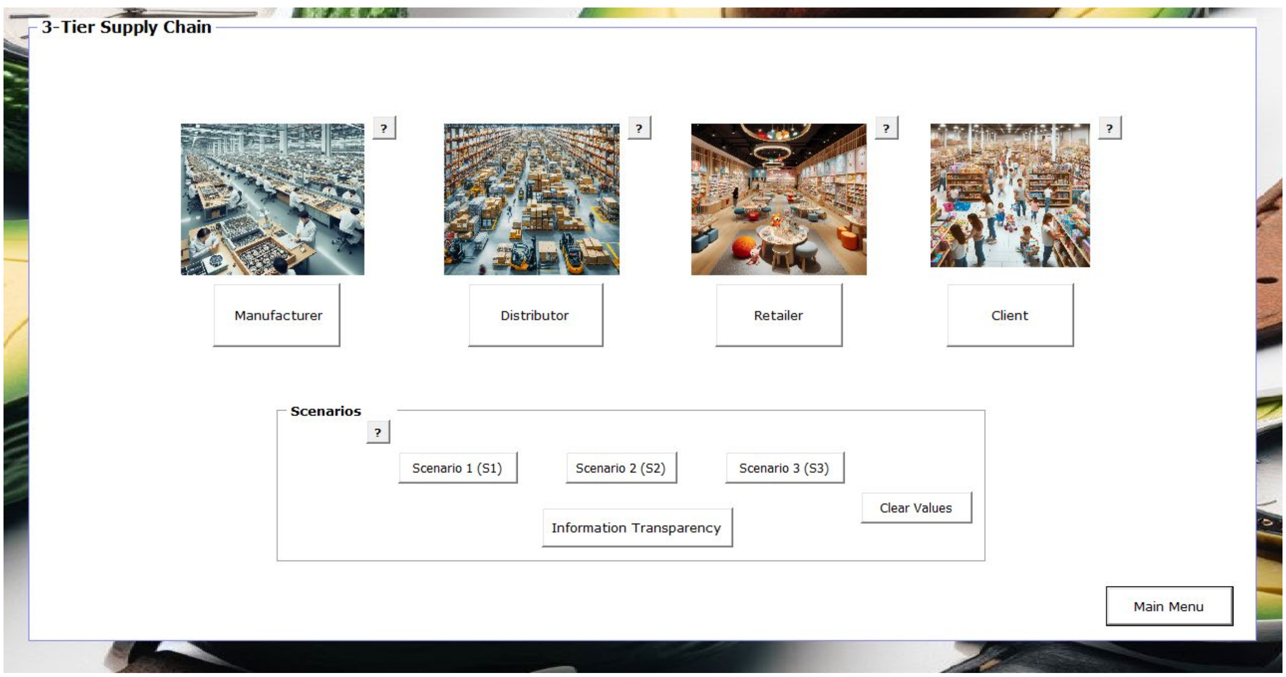


Figure A2. Data Menu

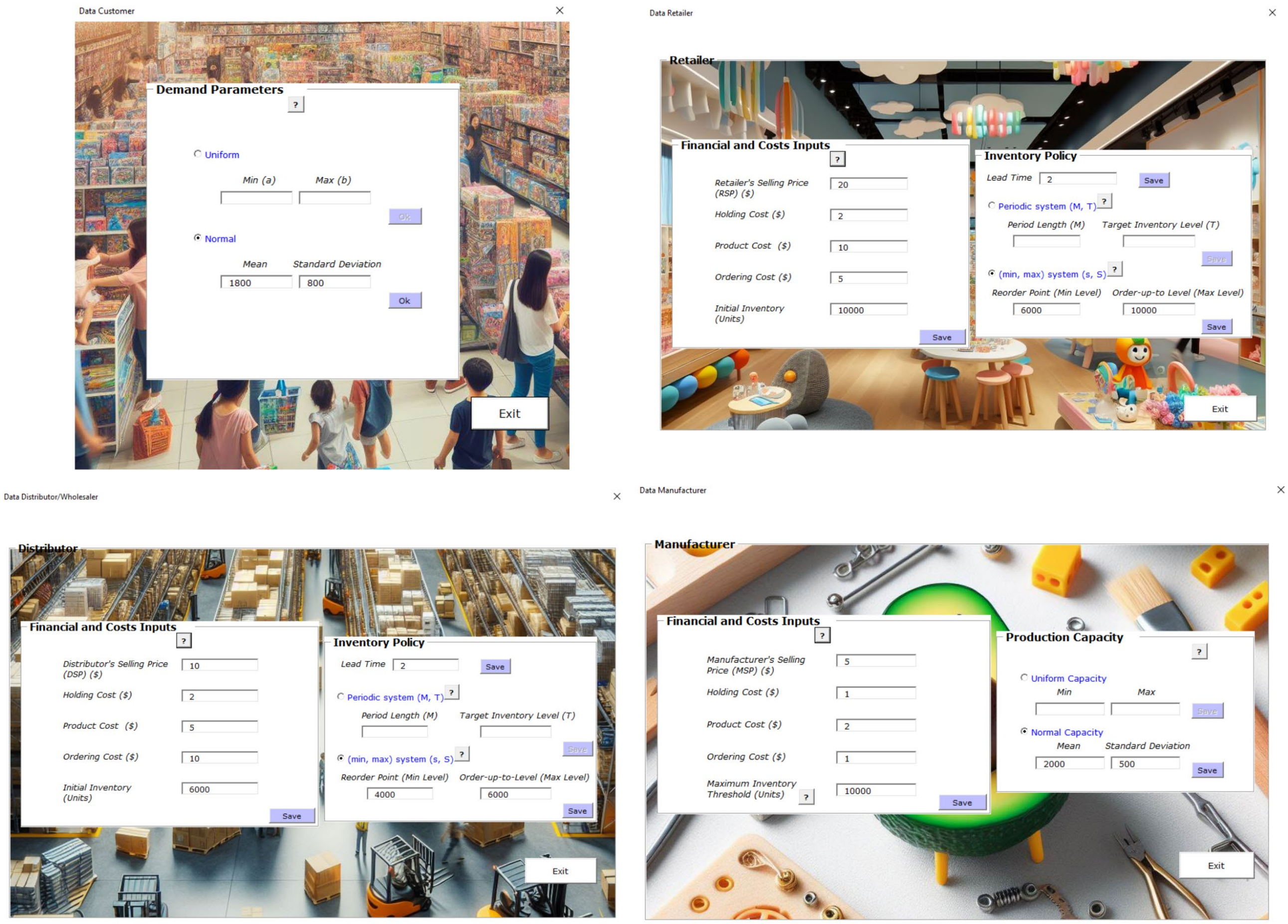


Figure A3. Data Submenus

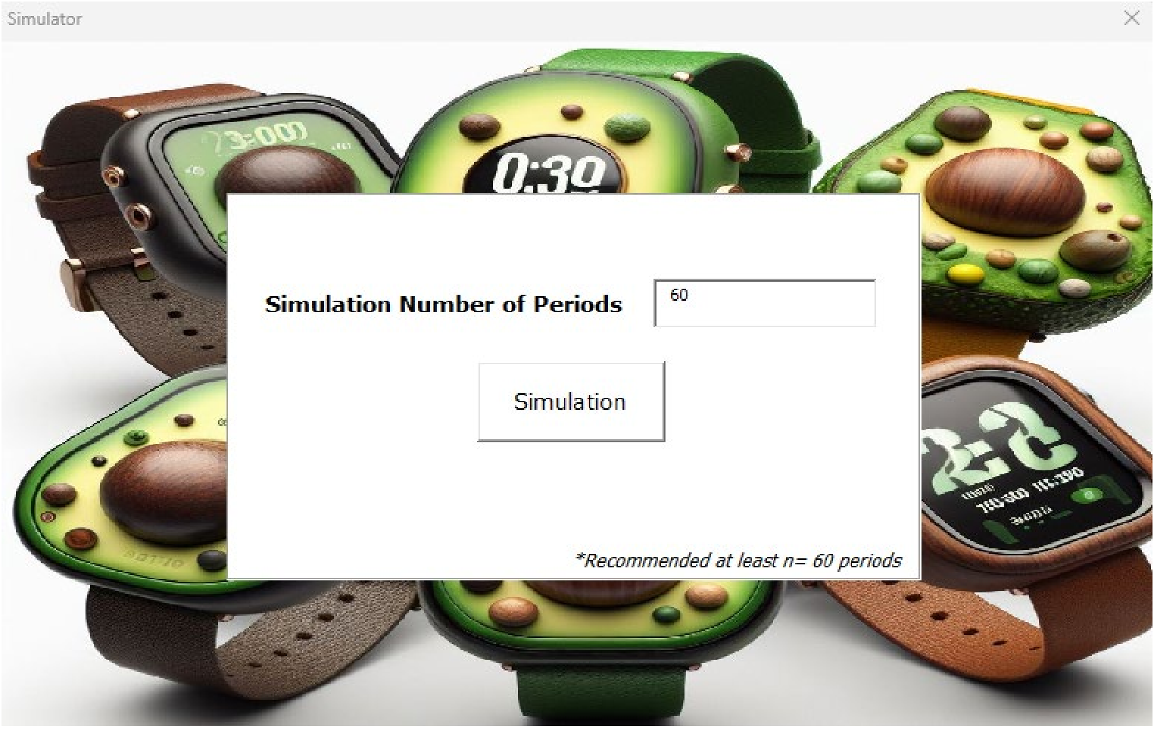


Figure A4. Simulation Menu

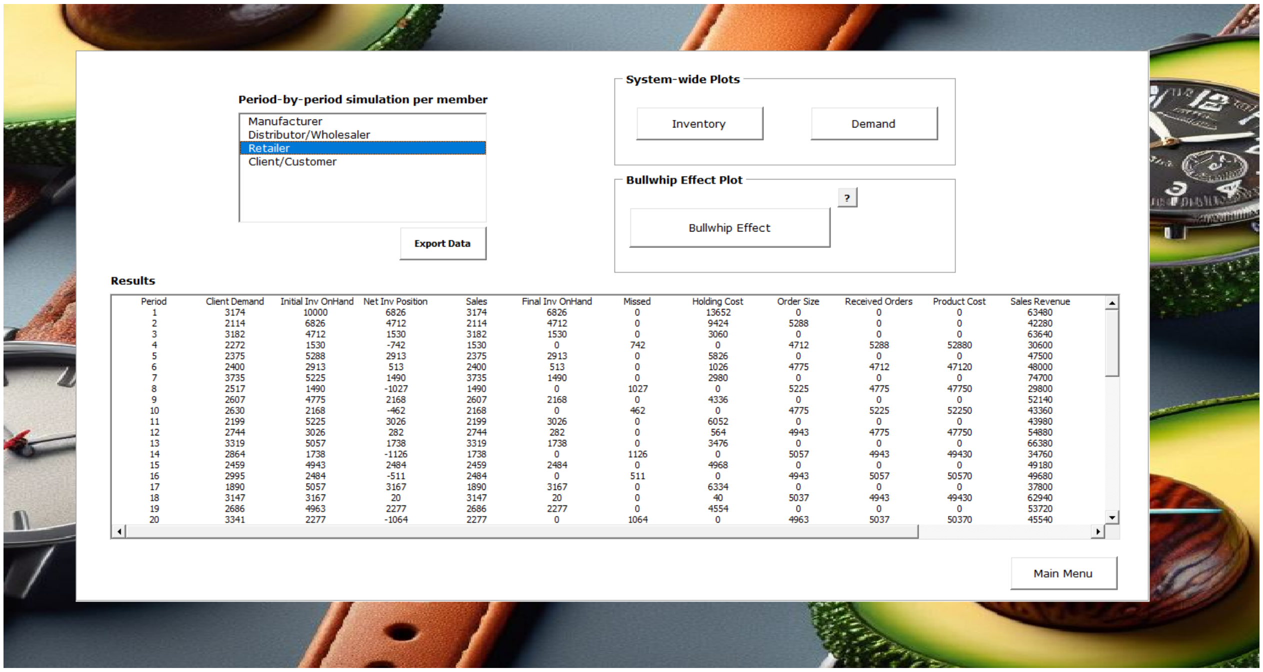


Figure A5. Reports Menu

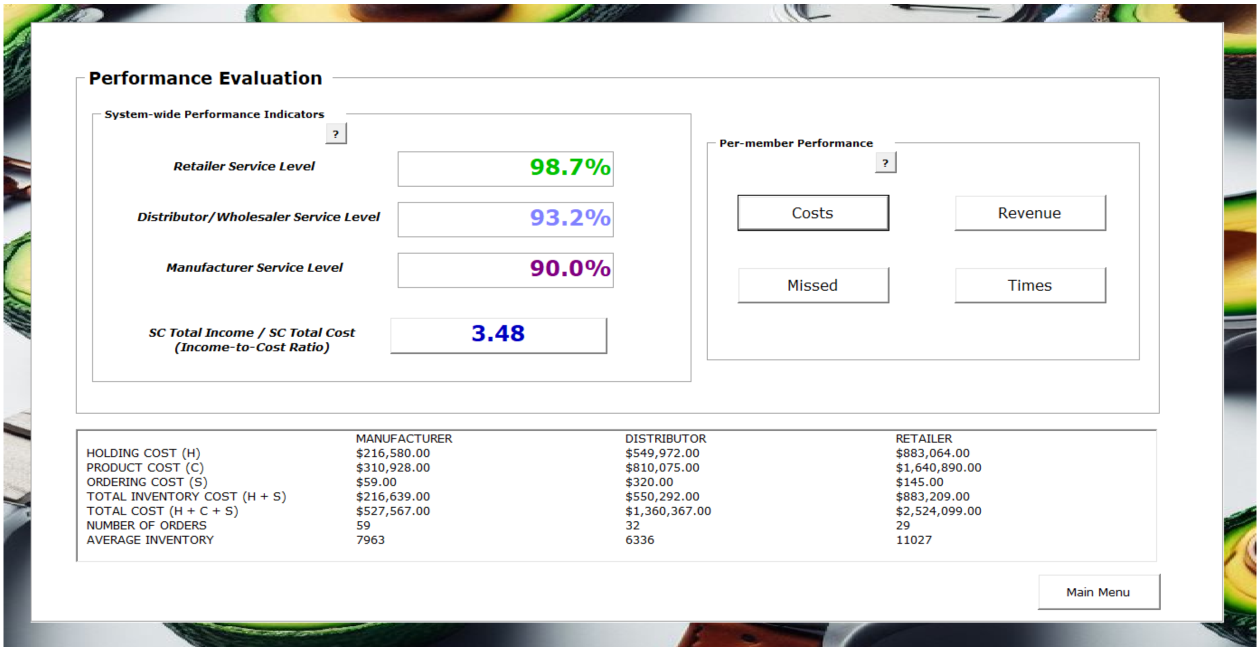
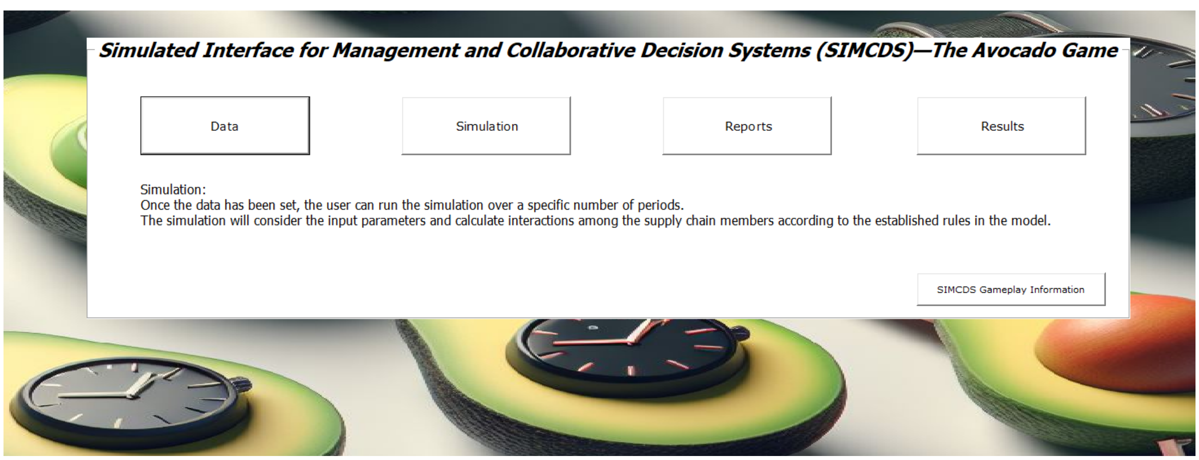


Figure A6. Results Menu

Appendix B. Student's Handout

SIMCDS Activity: Exploring Information Transparency in Supply Chains

Welcome to the Avocado Game!



In this activity, you will utilize the Simulated Interface for Management and Collaborative Decision Systems (SIMCDS) to examine how information transparency, or the lack thereof, impacts decision-making and negotiation in supply chains.

Objectives

- Understand the impact of information transparency on supply chain performance.
- Experience decision-making in both non-transparent and transparent settings.

- Collaborate with team members to improve overall supply chain efficiency.
- Apply analytical skills to conduct sensitivity analyses and interpret simulation data.

Activity Overview
The activity has two phases:

1) Non-Transparent Operations – Limited information sharing.
2) Transparent Operations – Full information sharing.

You will work in teams, with each member managing one of the following supply chain nodes:

Manufacturer, **Distributor**, or **Retailer**

Additional resources:
In-Game Help: Click the "*?*" buttons in SIMCDS to review SCM concepts.
Course Materials: Review notes on information transparency and negotiation strategies.
Concepts Refresher: Inventory policies and lead times.

<u>Phase 1 – Non-Transparent Operations</u>

Setup
Teams: 3–4 students each.
Roles: Each member (or pair) is assigned one of the following nodes: Manufacturer, Distributor, or Retailer.
Scenarios: Use the preloaded SIMCDS configurations:

- S1: Min-Max Inventory System
- S2: Periodic Inventory System
- S3: Mixed Inventory System

Your Task
Make decisions for your assigned node **only using** the data you have access to for all scenarios.

- Goals:
    - Minimize costs.
    - Optimize inventory turnover.
    - Maintain a high service level.
- Parameters you may adjust:
    - Distributor & Retailer: Inventory policy (Periodic or Min-Max) and initial inventory (set to the maximum threshold for chosen policy).
    - Manufacturer: Production capacity model (Uniform or Normal) and inventory threshold.
- Perform a sensitivity analysis to refine your parameters with SIMCDS individually.
- Record your final settings for each scenario.

After Individual Analysis
Share your results with your team.
The instructor will combine all node settings and run your team's full simulation for the class.
Discuss the approach you use to set your parameters for each node.

<u>Phase 2 – Transparent Operations</u>

Setup
All team members have **full visibility** of data for all nodes.

Your Task

- Adjust strategies collaboratively to optimize the entire supply chain with SIMCDS.
- Discuss with your team:
  - Inventory policies for all nodes.
  - Synchronization and efficiency improvements.
- New Component - Lead Time Negotiation:
  - Teams are allowed to reduce lead time by one period for the Distributor and Retailer.
  - Trade-off: Ordering costs will **increase tenfold** for that node (representing a delivery fee).
- Conduct a sensitivity analysis for the parameters, both with and without lead-time changes, for all nodes in SIMCDS, working with your team.
- Decide on your team's optimal parameters for the entire supply chain.

After Collaborative Analysis

Present your optimized solution to the class.
Compare these results to Phase 1.
Discuss how transparency influences decision-making and performance, and what the differences are in your chosen parameters.

Post-Activity Assignment

What to Submit:

- SIMCDS Summary Report (1–3 pages) covering:
  - Strategies in both phases.
  - Observations on transparency's effect on decisions.
  - Conclusions on performance improvements.
  - Reflections on negotiation and collaboration.
- Excel Files: All simulation data and calculations.
- Visualizations: Graphs/charts of your findings (Excel or Minitab).

Due: Next week's session.

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ISSN: 2574-3872 (Online) 1055-3096 (Print)