Developing a Framework for Economy-Based Game Simulations: Laying the Groundwork for Future Player Engagement Studies

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Abstract:

This dissertation presents ‘Stock & Shop’, a foundational framework for a retail-based economy simulation game developed using Unity and C#. The primary objective of this project is to create a scalable game framework that models complex economic and reputation systems within a virtual retail environment. Players assume the role of a shop owner tasked with managing inventory, setting prices, and influencing customer behaviours through AI-driven customer interactions. The game integrates dual economy systems—balancing monetary profits and shop reputation—requiring thoughtful decision-making that impacts both player success and customer satisfaction.

Key features of the framework include an Inventory Management System for real-time stock level updates, a Pricing Strategy Mechanism that uses color-coded indicators for pricing feedback, and a Customer AI system that simulates basic shopping behaviours influenced by pricing and product availability. Additionally, the Reputation System dynamically adjusts based on customer interactions, influencing customer frequency and behaviour.

The project sets a benchmark for how games can simulate and teach complex economic principles, serving as a valuable tool for both educational and commercial purposes. While the current implementation does not encompass full game development or player testing, it lays a solid groundwork for future iterations and enhancements.

The complete framework and codebase for ‘Stock & Shop’ are available on GitHub: https://github.com/Richard-Casey/StockAndShop.

The artefact was made using Unity Editor Version number 2021.3.30f1.

Contents

1 Lay Summary:

This dissertation develops 'Stock & Shop', a foundational framework for a retail-based economy simulation game, utilising Unity (a cross-platform game engine) and C# (a programming language), which are commonly used for developing interactive content like video games.

The project is designed to simulate complex economic and reputation systems within a retail shop setting, pushing the boundaries of digital simulations for strategic learning and management. Players assume the role of a shop owner, tasked with managing inventory, setting prices, and influencing customer behaviours through AI (Artificial Intelligence), which refers to sophisticated algorithms designed to mimic human intelligence and adapt to various gaming scenarios.

This dual economy system—balancing monetary profits and shop reputation—demands thoughtful decision-making that impacts both player success and customer satisfaction.

The unique aspect of 'Stock & Shop' is its integration of Customer AI, which aims to exhibit varied personalities and shopping habits, influencing the game dynamics based on item availability, pricing and specific customer needs. Players must strategically balance fair pricing, conceptualised as a 25% markup from wholesale prices, to enhance their shop's reputation, while avoiding overpricing that could harm customer satisfaction.

Although this dissertation does not encompass the full development of the game or player testing, it lays a solid groundwork for future iterations. It sets a benchmark for how games can simulate and teach complex economic principles, serving as a valuable tool for both educational and commercial purposes. The framework is designed with scalability in mind, allowing future researchers or game developers to implement and test various economic scenarios and their effects on player decision-making and strategic management.

This contribution to game development provides a detailed blueprint for a retail-based economy game simulation framework, emphasising the importance of foundational work in game design. It highlights the potential of such frameworks to facilitate in-depth studies on gameplay mechanics, player experiences, and the interplay between monetary and reputational economies in future research endeavours.

This dissertation is structured as follows: Chapter 1 introduces the game development framework 'Stock & Shop', Chapters 2 and 3 discuss the literature review and methodology, and Chapters 4 to 6 present the results, discussions, and conclusions.

2 Literature Review:

2.1 Introduction:

This literature review explores research on the influence of economy-based simulations in video games, focusing on player decision-making, strategic thinking, and overall gameplay experiences. Recent advances in artificial intelligence and its application in economic simulations have further enhanced the complexity and realism of these models.

AI techniques (methods to enable machines to mimic human decision-making) in game design often involve algorithms that enable decision-making in complex environments, drawing from areas such as machine learning and neural networks to simulate realistic player and NPC (Non-Playable Characters)

behaviour, where NPC's are characters in a game that are not controlled by players but by the game's AI to enrich the gaming environment.

The integration of AI techniques has been particularly transformative in simulating complex economic environments, offering more nuanced and dynamic interactions within games (Granic, Lobel, and Engels, 2014).

2.2 Project Objective:

The objective focuses on the design and development of 'Stock & Shop', a scalable game framework for a retail-based economy simulation. This framework aims to model economic and reputation systems within a virtual retail environment, providing a foundation for future research to explore player interactions and decision-making processes in such settings.

Educational technology through game-based learning offers a robust platform for simulating complex systems in a dynamic learning environment, which refers to educational settings designed to adapt to the learner's needs, allowing players to experiment with economic and managerial scenarios in a risk-free environment.

Such simulations enhance cognitive skills including problem-solving and strategic thinking (Squire, 2006). Additionally, the integration of AI into these simulations is crucial for adapting economic models in real-time based on player behaviour, offering a more dynamic learning environment (Adams, 2021).

2.3 Economy-Based Simulations in Video Games:

Economy-based simulations are widely used in video games to provide players with virtual economic systems (structured sets of monetary regulations and resources) to navigate and control (Sierra & Rodriguez-Conde, 2023). These simulations include resource management (allocation and efficient use of resources), trade, production, and economic interactions, aiming to create realistic and engaging gameplay experiences that require strategic decision-making (the process of selecting logical choices based on available information) and efficient resource allocation.

Research has demonstrated that economy-based simulations in video games significantly impact player decision-making processes (Camerer, 2003). Players analyse market conditions, assess risks and rewards and make choices to maximise their economic outcomes. The complexity of these simulations can vary, ranging from simplified models to more intricate representations of real-world economic systems.

Additionally, economy-based simulations in video games offer opportunities for players to enhance their strategic thinking abilities. Engaging in resource management requires problem-solving, decision-making and analytical skills to optimise economic performance. These simulations foster adaptive decision-making by requiring players to adjust strategies in response to changing market conditions or unexpected events.

Incorporating established economic theories, such as the Nash Equilibrium into game simulations provides a realistic foundation for player decision-making processes.

Nash Equilibrium is a key concept in game theory (the study of mathematical models of strategic interaction among rational decision-makers) that occurs when each player in a game chooses a strategy that is optimal given the strategies chosen by other players, leading to a state where no player

benefits by changing strategies if others remain unchanged. This encourages strategic planning and competitive gameplay (Nash, 1950).

While this literature review focuses on economy-based simulations, it is worth noting that game features beyond economic systems also influence strategic thinking. For example, Penczynski (2016) examines the impact of differing objectives and move order in the 'hide and seek' game on participants' strategic sophistication.

Although Penczynski's study may not directly align with economy-based simulations, it emphasises the significance of game features in shaping strategic thinking.

Future research could incorporate insights from studies like Penczynski's (2016) to further understand the impact of different game design elements on strategic thinking within economy-based simulations in video games. Exploring the relationship between game features, player decision-making and strategic thinking can contribute to the development of more engaging and effective gameplay experiences.

However, further research is needed to explore the specific cognitive processes underlying strategic thinking in the context of economy-based simulations in video games. Understanding these processes can provide insights into players' decision-making approaches, risk evaluation and strategy formulation within virtual economic environments. One approach that addresses the limitations of traditional game theory and offers a psychological perspective on strategic thinking is the cognitive hierarchy (CH) modelling proposed by Camerer, Ho, and Chong (2015).

CH Theory helps in modelling how people actually make decisions in games, considering that players can be at different levels of strategic thinking, from those making random decisions to those deeply analysing the game's structure, where strategic depth involves the layers of complexity in decision-making processes that a player can explore within a game. They highlight that traditional equilibrium analysis in game theory, which studies optimal decision-making conditions where no participant can benefit by changing strategies alone, often relies on unrealistic assumptions and fails to consider the bounded and heterogeneous nature of human thinking. Heterogeneous thinking refers to the diverse ways in which individuals process information and make decisions, influenced by variations in personal experiences, cognitive biases, and reasoning patterns.

Camerer et al. (2015) critique these limitations and introduce CH modelling as a more psychologically plausible approach for analysing strategic thinking in games. Unlike traditional models, CH modelling accounts for the varied levels of strategic thinking across different players and has been validated in various experimental and field settings. By incorporating the insights from Camerer et al. (2015), future research can deepen our understanding of the cognitive processes involved in strategic thinking within economy-based simulations in video games. This knowledge can contribute to the design and development of more engaging and challenging gameplay experiences.

2.4 Research Gap and Contribution:

While there is extensive research on economy-based simulations in video games, a notable gap exists in understanding the development and application of scalable game frameworks, particularly in retail-based simulations like 'Stock & Shop'. This dissertation seeks to address this gap by not only developing such a framework but also by laying out a roadmap for its future expansion and application in studying player behaviour in virtual retail environments.

‘Stock & Shop’ implements a straightforward economic model where players buy items from a wholesaler, mark up the prices, and sell them for a profit. Although the current system does not dynamically adjust prices based on complex market conditions or intricate player decisions, it sets the foundation for future enhancements that could introduce adaptive pricing and inventory management. This basic yet effective approach allows players to engage with fundamental economic principles of supply, demand and profit-making in a controlled setting.

This approach contrasts with many traditional simulations that rely on static economic models, but it provides a solid base for potential future development where the system could evolve to include more dynamic interactions, as inspired by the principles discussed by Millington and Funge (2009). They explore the use of AI to enhance the realism and responsiveness of game environments, which could be a critical component for modern interactive systems. ‘Stock & Shop’ is poised for future adaptations that could integrate these more complex functionalities, enhancing its utility as a tool for economic and retail management education.

2.5 Key Question:

How can the development of a scalable game framework for a retail-based economy simulation, like ‘Stock & Shop’, contribute to future research and game development, particularly in understanding player interactions with economic and reputation systems in a virtual retail environment?

2.6 Gameplay Elements and Player Engagement:

In the context of ‘Stock & Shop’, player engagement is influenced by various gameplay elements unique to a retail simulation. These include pricing strategies, inventory management and reputation building. Understanding how these elements interact and affect player decision-making is crucial. Research highlights that well-designed game mechanics in educational simulations can significantly enhance learning and engagement by providing players with control over complex systems, which mimics real-world challenges more closely (Ritterfeld and Weber, 2006).

This section of the research will explore how different gameplay strategies and scenarios within a retail-based economy can impact player engagement, satisfaction and overall gaming experience. Understanding player psychology and engagement is crucial in game design. Schell (2008) identifies key lenses through which game designers can enhance player interaction, such as the balance of challenge and skill.

In ‘Stock & Shop’, the reputation system dynamically adjusts based on customer interactions—whether customers find and purchase their desired items at reasonable prices. Positive interactions increase reputation, while the inability to meet customer needs decreases it. This dynamic adjustment ensures that the game remains engaging across different skill levels. While reputation dynamics directly reflect real-time player decisions, the overall economic performance of the shop, indicated by profits, is influenced more indirectly through these interactions rather than dynamically adjusted in real-time. Thus, while the reputation reacts immediately to player actions, economic outcomes are a cumulative result of strategic decisions over time.

2.7 Overall Gameplay Experiences:

The simulation of economic systems in strategy games has a significant impact on players' overall gameplay experiences, enhancing engagement, immersion and satisfaction. Well-designed economic systems provide meaningful challenges and goals, contributing to a strong sense of achievement. A study by Granic, Lobel, and Engels (2014) highlights how video games can be used to enhance cognitive skills (mental capabilities like thinking, problem-solving, and remembering) and emotional states, underlining the role of complexity and realism in game design.

Recent studies shed light on the relationship between economic systems and overall gameplay experiences:

- Huotari and Hamari (2017) define gamification and discuss its impact on player engagement and satisfaction, highlighting the importance of well-designed economic simulations in providing meaningful challenges and rewards. Their findings emphasise how gamified elements (design techniques borrowed from games, used to enhance non-game contexts for increased engagement and motivation) can significantly enhance player involvement and motivation.

- Salen and Zimmerman (2004) explore the design of games in a way that highlights the interaction between game mechanics and player experiences, stressing the role of game systems in enhancing player agency and realism in simulations. They argue that complex systems in games can significantly influence player satisfaction by enhancing the player's sense of control and strategic freedom.

- Plass, Homer, and Kinzer (2020) discuss the effects of economic system complexity on player motivation in strategy games, emphasising how varied economic features can enhance or diminish player enjoyment depending on their implementation. Their research suggests that the intricacies of economic systems significantly affect strategic decision-making and overall player engagement.

These studies collectively demonstrate how sophisticated economic systems within games can lead to richer gameplay experiences, promoting both cognitive engagement and emotional investment in the game.

2.8 Enhancing Player Engagement through Game Balancing in Physical Games:

Altimira et al. (2017) conducted a study on the effects of game adjustments on game balancing and player engagement in digitally augmented physical games. They explored the impact of altering game equipment, such as table size and bat-head size, both statically and dynamically in a digitally augmented table tennis game. The study found that these adjustments enhanced player engagement compared to the no-adjustment condition. The insights gained contribute to the development of balancing strategies that facilitate engaging game experiences, particularly in physical games.

Moving forward, it is suggested that future research could focus on resolving conflicts in game design strategies to optimise player engagement. Additionally, investigating the implementation of the derived game design strategies in non-parallel games such as basketball or football could provide further insights into adapting balancing adjustments based on different game dynamics.

In summary, Altimira et al. (2017) offer valuable insights into the effects of game adjustments on game balancing and player engagement in physically augmented games. Their research highlights the potential of digital technology as a resource for enhancing player engagement and provides design strategies for creating engaging balancing experiences in physical games.

2.9 Building Scalable Game Frameworks:

The development of scalable game frameworks represents a critical aspect of modern game design, especially in the context of economy-based simulations like 'Stock & Shop'.

Scalability involves designing systems that can handle increasing amounts of work or accommodate growth, which is critical for games that may need to add more content, handle more users, or integrate more complex interactions over time, ensuring that the system remains efficient and responsive as it scales. Scalable frameworks are essential for allowing iterative development, flexibility in design, and the potential for future expansion and testing.

- **Importance of Scalability in Game Design:**

Scalable game frameworks offer the flexibility to adapt and expand game features over time. This is particularly relevant for 'Stock & Shop', where the economic and reputation systems may evolve based on future research and future player feedback. Scalability ensures that the game can grow and adapt without the need for complete redesigns, making it a sustainable and future-proof approach to game development.

- **Challenges in Framework Development:**

Building a scalable framework involves several challenges, including ensuring code maintainability, designing modular systems, and anticipating future expansion needs. It requires a deep understanding of both the technical aspects of game development and the theoretical underpinnings of economy-based simulations. The framework must be robust enough to support future iterations, including the integration of complex AI behaviours and varying economic scenarios.

- **Contributions to the Game Development Field:**

By focusing on the development of a scalable game framework, this research contributes to the broader field of game development by providing insights into best practices for framework design. It addresses the need for flexible, adaptable, and expandable game systems that can accommodate evolving gameplay mechanics and player interactions.

Having reviewed the existing literature and identified gaps, particularly in scalable game frameworks for economic simulations, the following section details the methodology adopted in developing 'Stock & Shop', aiming to address these gaps.

3 Methodology:

3.1 Framework Development

The core of this dissertation involves the development of a comprehensive game framework for 'Stock & Shop', a retail-based economy simulation constructed using Unity (Unity, 2024) and C#. This framework is designed to provide a realistic retail management experience through several interconnected systems, which are related subsystems that interact for overall functionality (Millington & Funge, 2009).

The overall architecture and interconnectivity of the framework components are illustrated in Fig. 1, which provides a visual overview of the systems and their relationships.

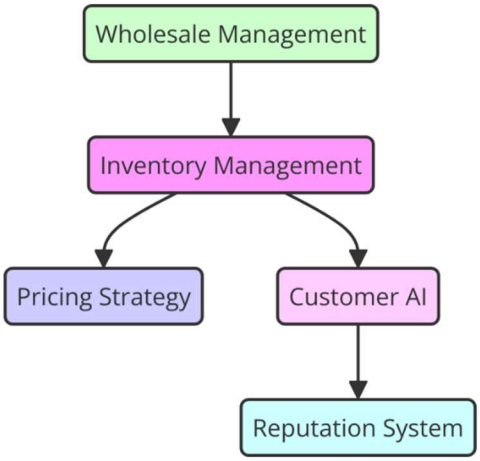

Fig. 1: System Architecture Diagram of 'Stock & Shop'

The Inventory Management System is crucial for handling various aspects of inventory such as stock levels and item pricing. Leveraging Unity's robust scripting capabilities, this system facilitates real-time inventory updates. It is tightly integrated with the game's user interface (UI) to dynamically reflect changes in stock levels, ensuring that inventory data is accurately and promptly displayed to enhance gameplay realism.

In addition to inventory management, the framework incorporates a straightforward Pricing Strategy Mechanism. This system allows players to manually set prices based on a markup of 25% over the wholesale cost. Pricing items within this limit is viewed as fair, maintaining a positive shop reputation, while setting higher prices can negatively impact customer satisfaction and reputation. The system uses colour-coded indicators to visually communicate whether the set prices are within the acceptable range, offering immediate feedback to guide player decisions. This simplified pricing mechanism helps players understand the basic economic principles of supply and demand without complex simulations of market conditions (Mankiw, 2020).

Another vital component is the Customer AI Development, which focuses on simulating basic shopping behaviours influenced by factors like pricing and product availability. This subsystem scripts a variation in price tolerance and budget among AI customers, reflecting some diversity in customer responses within the game's economic environment. Although the customers do not possess distinct personality profiles, the random variation in price sensitivity and budget adds a level of

unpredictability to each customer's shopping experience, enhancing the interaction between players and the game's economic system (Millington & Funge, 2009).

Lastly, the framework incorporates a Reputation System that tracks and responds to player decisions, particularly those related to pricing strategies. This system affects customer frequency and behaviour, mirroring the consequences of customer satisfaction and store reputation, similar to those found in real-world retail settings (Kahneman & Tversky, 1979). By integrating this system, the game not only challenges players to manage their business wisely but also reflects the delicate balance of customer relations in a competitive retail market.

Together, these components form a framework that supports the game's basic functional requirements and enhances player engagement through straightforward interactions and a simplified representation of business management.

3.2 Framework Testing and Iteration

To ensure the functionality and basic reliability of the game framework, an iterative approach to testing was used, focusing primarily on debugging during development and informal testing techniques. While formal structured testing phases were not implemented, continuous testing was conducted throughout the development process to identify and resolve issues.

Iterative Development and Debugging: Each component of the framework, from inventory management to customer interactions, was developed and tested iteratively. This process involved writing scripts, integrating them within the Unity environment and making adjustments based on immediate testing results. The aim was to ensure basic functionality and to address any bugs or issues as they arose.

Integration Observations: Rather than formal integration testing, components were observed in combination during development to ensure that they worked together as expected. This informal observation helped identify functional discrepancies and interaction issues, particularly between the pricing mechanism and customer AI.

Performance Checks: Performance was monitored qualitatively by assessing the game's stability and response under varying conditions during development. While this did not include formal scalability testing, it involved evaluating the game's performance as new elements were added and as the complexity of interactions increased.

Evaluation Strategy: The overall testing strategy was adaptive, relying on direct observation and developer-led testing to refine the framework. This approach allowed for immediate problem-solving and enhancements based on real-time feedback from the development environment.

3.3 Documentation and Future Research Planning

Alongside the development of the game framework, comprehensive documentation was prepared using Doxygen to capture the full details of its architecture, component interfaces and interactions. This documentation is designed to be a robust resource for future developers or researchers who might wish to expand or modify the framework. The use of GitHub for version control further ensured that all developmental milestones and changes were meticulously tracked and documented.

It will serve as a detailed guide, providing insights into the system's structure and functionality, ensuring that subsequent enhancements and modifications can be made efficiently and effectively (Bruegge & Dutoit, 2010). Furthermore, the documentation will outline the best practices and lessons learned throughout the development process, offering valuable insights that can aid in the replication or adaptation of the framework in future projects.

This dual focus ensures that the documentation not only preserves the technical details but also passes on practical wisdom to foster innovation and improvement.

4. Results and Discussion:

4.1 Implementation Outcomes for the Inventory Management System

The Inventory Management System serves as a core component of the 'Stock & Shop' game framework, designed to manage various aspects of inventory like stock levels and item pricing. Utilising Unity's robust scripting capabilities, this system updates the game's inventory in real-time. High-performance inventory systems are essential in maintaining the pace and complexity of modern games (Gregory, 2014).

To better understand the interactions within this system, Fig. 2 provides a visual depiction of the data flow for inventory and sales processes within the game framework.

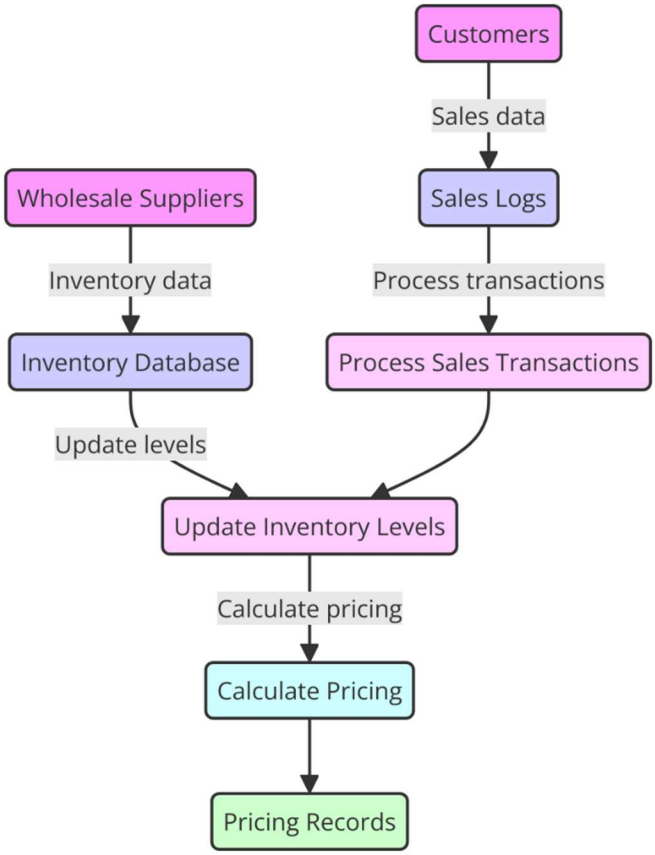

Fig. 2: Data Flow Diagram for Inventory and Sales Processes

Each transaction, whether adding or removing items, is seamlessly handled by the InventoryManager.cs, which is closely integrated with the game's user interface. This integration allows the system to display new stock levels immediately after items are purchased from wholesalers or when they are sold to customers. The immediacy of these updates is critical for real-time simulations.

Moreover, the system's real-time updates are essential for maintaining gameplay fluidity. It employs event-driven programming to dynamically adjust UI elements as changes in the inventory occur, ensuring that players always have access to up-to-date information, enhancing the responsiveness of the game. This approach aligns with current trends in interactive design and effective user interface management.

4.2 System Integration and Performance

The integration between the Inventory Management and Wholesale Management systems is critical to the smooth operation of 'Stock & Shop'. The InventoryManager.cs collaborates closely with the WholesaleManager.cs, ensuring that all purchases from wholesalers are accurately reflected in the shop's inventory. This precise synchronisation (coordinated functioning) between systems underpins the game's economic realism and supports strategic decision-making for inventory control. Efficient integration techniques are vital for maintaining system integrity and performance (Smith & Williams, 2012).

In terms of user interface performance, the UI components are intricately linked to the inventory data through Unity's data binding and event handling capabilities. This connection allows for changes to be reflected on the screen instantaneously, eliminating the delays often associated with traditional polling mechanisms. By leveraging Unity's advanced rendering capabilities, the game enhances overall performance and ensures a seamless and responsive experience for players, maintaining engagement through dynamic updates.

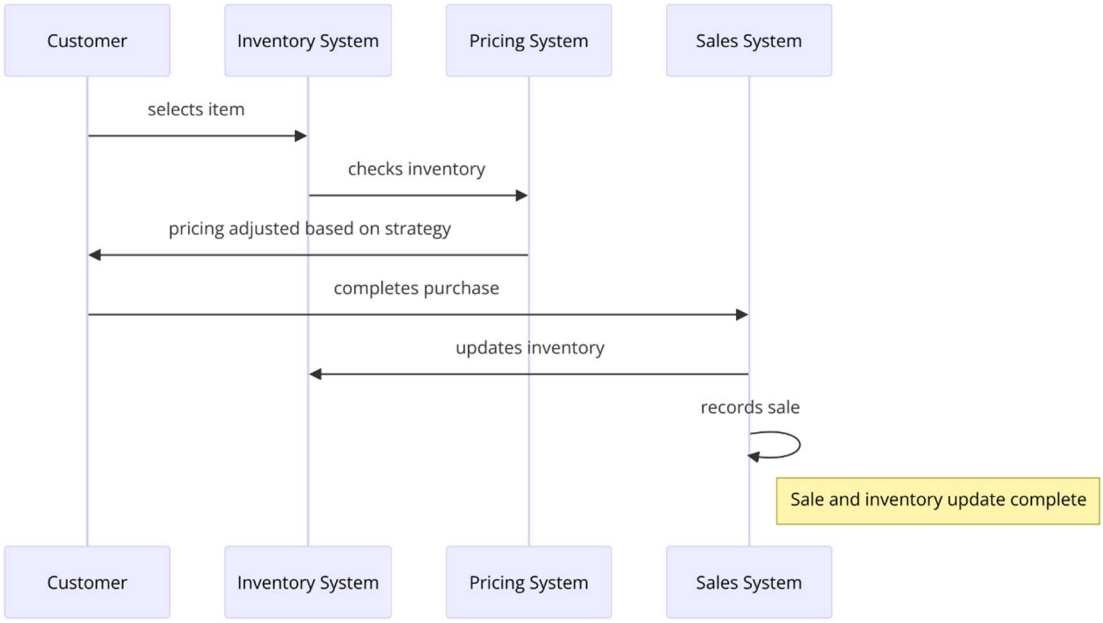

Fig. 3: Sequence Diagram for Customer Purchase Process in 'Stock & Shop'

As illustrated in Fig. 3, the sequence of customer interactions within the game 'Stock & Shop' is structured to ensure a seamless experience from product selection to purchase completion. This sequence diagram highlights the critical role of the integrated Inventory and Pricing Systems, facilitating a smooth transaction process that enhances the user's engagement and reflects real-world purchasing dynamics.

4.3 Discussion on Inventory Management Challenges and Responses

A primary challenge in the development of 'Stock & Shop' was the theoretical management of multiple simultaneous transactions, particularly envisioned for peak gameplay moments when numerous customers might interact with the store. The system was designed with the intention to handle these scenarios efficiently, utilising optimised data structures and algorithms aimed at preventing lag and errors to ensure smooth gameplay.

Although formal robustness testing to simulate real-world retail operations like Black Friday sales or promotional events was not conducted, the design was strategically planned to cope with rapid inventory changes and high customer engagement. This approach was based on theoretical considerations and informal debugging during development, which helped identify potential issues in handling multiple transactions. These observations were crucial in making iterative improvements to ensure the system maintained stability during complex operational scenarios (Kaner et al., 1993).

The dynamic update of the user interface is another critical aspect meticulously engineered to enhance player interaction and system responsiveness. By adopting reactive programming principles, the UI immediately reflects changes in the inventory data model, thus eliminating the need for manual refreshes or reloads. This real-time update capability significantly improves user experience by keeping players constantly informed of their inventory status.

Moreover, strategic decision-making is greatly facilitated by visual feedback mechanisms integrated within the UI. For instance, if a popular item is nearing depletion, the UI alerts the player through visual cues, enabling quick and informed decisions about restocking or modifying pricing strategies to manage sales pace. This feature not only augments gameplay engagement but also educates players on effective inventory and sales management strategies, thereby enriching the overall gaming experience.

4.4 Scalability and Future Enhancements

To address the long-term sustainability and growth of the 'Stock & Shop' framework, scalability was a key consideration during the design process. While extensive formal scalability tests were not conducted, the framework was developed with scalability in mind, ensuring that it could theoretically manage an increasing volume of items and accommodate rising player interactions as the game evolves. Theoretical analysis and informal monitoring during development helped identify potential areas for optimisation in data management and UI updates to prevent bottlenecks (specific points in the software that limit overall performance).

Looking ahead, the integration of predictive analytics into the inventory management system is planned as a key enhancement. This technology aims to leverage historical sales data and customer behaviour patterns to recommend optimal restocking levels and timing. The goal is to refine

inventory decisions and improve operational efficiency, thereby further enhancing player engagement and supporting the game's economic model.

4.5 Summary and Future Directions

The detailed examination of the Inventory Management System through this phase of development has proven its efficacy in bolstering the game's economic framework and engaging players with efficient, real-time interactions (Smith, 2016). As we progress, the dissertation will continue to explore deeper into other system components, analysing their individual and collective impacts on the game experience, guided by established methodologies in interactive design and system integration.

4.6 AI Capabilities and Game Mechanics Enhancement

In 'Stock & Shop', AI-controlled customers significantly influence the gameplay dynamics. Each customer's AI is designed with variable price sensitivities and budget limits, reflecting a simplified model of consumer psychology that dynamically reacts to player-set prices (Russell & Norvig, 2016). This variability introduces a layer of unpredictability and strategy, as players must adjust their pricing to maximise profits while maintaining customer satisfaction.

Dynamic interactions with AI customers are central to the game's economic feedback loop, where pricing decisions directly affect sales outcomes and store reputation. Players engage in strategic decision-making to cater to diverse customer preferences and manage economic pressures simulated within the game environment (Kotler & Keller, 2015).

Future enhancements to the AI will aim to incorporate adaptive behaviours that respond to accumulated player actions and market conditions, potentially utilising advanced analytics to predict and react to economic trends (Miikkulainen et al., 2019). These developments will further deepen the strategic complexity of 'Stock & Shop', offering players a more nuanced and challenging economic simulation.

4.7 Pricing Strategy Mechanism

The Pricing Strategy Mechanism within 'Stock & Shop' not only allows for dynamic price adjustments but also draws from fundamental microeconomic theories, particularly the principles of supply and demand, which describe the relationship between product availability and consumer desire (Mankiw, 2020). This practical application helps players understand how pricing influences market dynamics and consumer behaviour, providing a simplified yet effective simulation of economic principles.

The game mechanism incorporates behavioural economics insights, particularly from Kahneman and Tversky's Prospect Theory, which explores how perceived gains and losses influence decision-making (Kahneman & Tversky, 1979). In the game, this is reflected in how AI customers react to pricing, simulating loss aversion by potentially reducing sales volume if prices are set too high.

To facilitate understanding of these concepts, 'Stock & Shop' employs a visual demand indicator within the InventoryItemUI script. This colour-coded bar changes from green to red, indicating the consumer reaction to different pricing levels relative to the base cost. This visual feedback mechanism supports player learning by allowing them to observe the direct impact of their pricing decisions on consumer interest and adjust their strategies accordingly. These features collectively

enhance gameplay realism and economic education, underscoring the application of microeconomic theories in a simulated environment.

4.8 System Integration and Performance

The Pricing Strategy Mechanism is closely integrated with the Inventory Management System in 'Stock & Shop', ensuring seamless operation between pricing decisions and inventory control. Changes made to pricing strategies have immediate effects on inventory turnover rates. These changes are tracked in real-time, providing players with clear insights into how their pricing decisions impact the game's economy.

Furthermore, the game continuously monitors key performance metrics such as sales volume, revenue, and customer satisfaction. This real-time data is crucial as it enables players to refine their pricing strategies effectively, basing their decisions on actual game performance and market conditions. This integrated system not only enhances the gameplay experience but also instils a deeper understanding of economic principles among players (Chen, 2018).

4.9 Evaluation of Pricing Strategy and Its Economic Impact

One of the foremost challenges in developing the Pricing Strategy Mechanism was striking a balance between the realism of economic principles and the entertainment value of the game. The mechanism has been fine-tuned to ensure that price adjustments are both impactful and reasonable, offering a realistic yet engaging simulation experience (Thaler, 2015).

The pricing mechanism is designed to support strategic gameplay by compelling players to critically evaluate how their pricing decisions influence other aspects of their business operations, such as sales volume and reputation. This approach requires players to weigh short-term profits against long-term impacts on customer satisfaction and overall reputation, fostering a deeper strategic engagement (Kotler and Armstrong, 2020).

Furthermore, the feature of manually adjusting prices alongside the demand indicator provides crucial feedback to players. These tools offer immediate insights into how price changes affect consumer interest, enabling players to make informed decisions about pricing strategies. While the adjustments are not automated based on market dynamics, this system enhances the gameplay experience and serves an educational function by familiarising players with basic economic principles of supply and demand through interactive learning (Mankiw, 2020).

4.10 Scalability and Future Enhancements of Pricing Strategy

As 'Stock & Shop' evolves, the incorporation of adaptive learning algorithms is anticipated. These algorithms will dynamically adjust the game's market conditions based on player behaviour, ensuring that the challenges remain fresh and engaging over time (Russell and Norvig, 2016).

Further developments will focus on enhancing the predictive modelling capabilities of the pricing strategy. This will allow for sophisticated simulations of economic trends and market dynamics, providing players with a deeper and more realistic economic environment (Varian, 2014).

Additionally, future versions of the game are expected to expand the range of market factors that influence pricing. These factors will include economic events, seasonal demands, and competitive

actions, all aimed at enriching the economic simulation aspect of the game. This expansion will not only add complexity but also increase the authenticity of the game's economic environment, encouraging players to adapt their strategies in increasingly diverse scenarios (Porter, 1998).

4.11 Summary and Future Directions

This comprehensive review of the Pricing Strategy Mechanism has highlighted its crucial role in shaping the gameplay dynamics of 'Stock & Shop'. The mechanism facilitates interaction within a controlled economic environment, enhancing strategic depth and player engagement by challenging players to make economically sound decisions. While the system does not dynamically react to these decisions through automated adjustments, it effectively simulates the impact of pricing strategies on consumer behaviour, offering a structured simulation of retail pricing strategies.

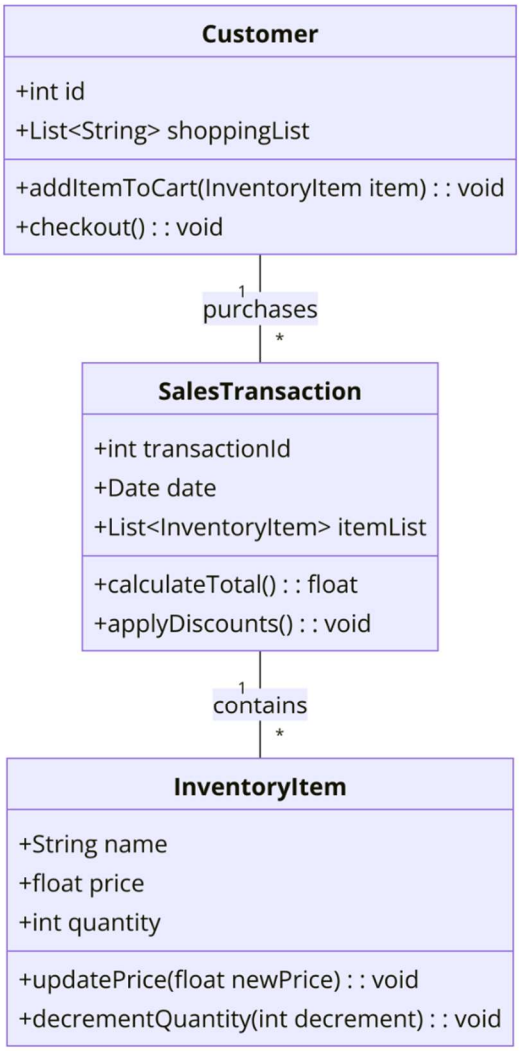

Fig. 4: Class Diagram for the Game Model in 'Stock & Shop'

As illustrated in Fig. 4, the class diagram provides a structured visualisation of how different game components—InventoryItem, Customer, and SalesTransaction—are interconnected. This diagram showcases the relationships between classes and the flow of data, which underpin the functional aspects discussed, such as inventory management and customer interactions. Understanding these

relationships is essential for grasping how strategic decisions impact the overall game architecture and player experience.

Moving forward, the discussion will extend to other core components of the game system, delving deeper into their integration and the impact on the overall game architecture and player experience.

4.12 Customer AI Development

As we delve deeper into the 'Stock & Shop' gameplay, the role of artificial intelligence becomes increasingly significant, especially in how it influences player interactions and economic strategies. AI in games like 'Stock & Shop' simulates customer behaviour using algorithms (step-by-step procedures or formulas for solving a problem) that factor in individual preferences, budget limits, and responsiveness to pricing and product availability, creating a diverse range of customer interactions. Advanced AI techniques can significantly enhance the realism of economic interactions in games.

Millington and Funge (2009) discuss how AI can be programmed to adapt and respond to player strategies, increasing the dynamic and unpredictable nature of game environments. While the current implementation of AI in 'Stock & Shop' does not evolve over time, it does incorporate decision-making processes that respond predictably to player-set prices and inventory levels, thus affecting the game's economic feedback loop.

4.13 Behavioural Influences

The shopping behaviour of AI customers in 'Stock & Shop' is influenced by a straightforward set of in-game factors designed to simulate basic retail dynamics. Each customer generates a shopping list of up to 10 random items available in the wholesale inventory, which can be stocked by the player. This mechanism ensures that every stocked item has a chance of being purchased, without a built-in preference for certain types of items. This design is based on principles found in consumer behaviour research, which emphasises the randomness and variability of consumer choices (Solomon, 2014).

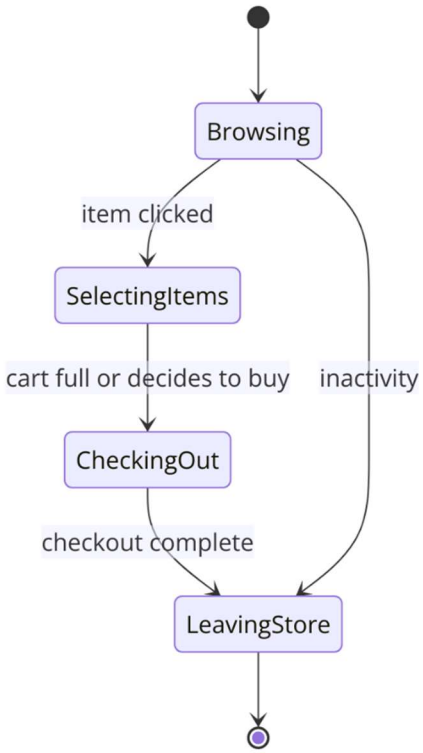

Fig. 5: State Diagram for Customer Behaviour in 'Stock & Shop'

As depicted in Fig. 5, this state diagram illustrates the transitions between different customer states within the game environment. The states include Browsing, Selecting Items, Checking Out and Leaving Store. These transitions are influenced by indirect player actions, such as inventory stocking and pricing, and by AI decision-making logic. This diagram clarifies how customer actions transition from one state to another based on gameplay mechanics, providing a structured visualisation of the AI's behaviour within the game. This approach is akin to flow models discussed in service operations management (Fitzsimmons and Fitzsimmons, 2018).

4.14 Integration with Game Systems

The integration of AI customers within 'Stock & Shop' significantly contributes to the game's economic and reputational systems. These AI-driven customers directly influence the economic feedback loop through their purchasing decisions, which are based on the dynamic interplay of pricing and the store's reputation, thereby impacting the shop's financial performance. The impact of reputation on customer behaviour and business success is well-documented in service management literature, demonstrating similar dynamics in virtual environments (Heskett et al., 2017).

4.15 Challenges and Solutions

Developing realistic AI behaviour posed an initial challenge in simulating basic customer interactions within the 'Stock & Shop' environment. To address this, simple decision rules were implemented, focusing on key aspects like price sensitivity. This setup allows customers to make purchasing decisions based on a static price increase tolerance, which simulates sensitivity to pricing but does

not adapt dynamically to changing economic conditions (Kahneman, 2011). This foundational approach lays the groundwork for more sophisticated AI developments in future iterations.

Another significant challenge was to design the AI interactions within the game to manage a sustainable volume of customer interactions as the game progresses. To address this, the framework limits the number of active customers to a maximum of ten at any one time, which helps maintain stable performance and manage system resources effectively. This controlled scalability approach draws on principles discussed by Laird (2001), emphasising the importance of designing AI systems that adapt to maintain integrity without compromising gameplay. This design choice ensures that the game environment remains manageable and responsive, reflecting a foundational strategy for scalability in game development.

4.16 Discussion on AI Development and Strategic Gameplay Impact

The development of Customer AI in 'Stock & Shop' strategically simulates straightforward customer behaviours based on item pricing and availability. Initial tests ensured the AI's reactions closely followed preset decision rules under controlled conditions, reflecting basic consumer dynamics without advanced adaptability. This is in line with findings from behavioural economics, which suggest that even simple models can significantly affect consumer behaviour and decision-making processes (Thaler, 2015).

While the AI currently lacks deep learning or dynamic economic models, it effectively supports strategic gameplay by encouraging players to deliberate on pricing and inventory decisions. This engagement enriches the strategic depth by aligning closely with fundamental economic theories (Mankiw, 2020). Moving forward, the AI's evolution will aim to incorporate more complex behaviours and adaptive economic scenarios, enhancing both realism and strategic challenge.

4.17 Summary and Future Direction for Customer AI Development

The exploration of Customer AI in 'Stock & Shop' illustrates its essential role in enhancing the gameplay experience by simulating customer interactions. These interactions, driven by simple yet foundational AI behaviours, test business strategies and subtly influence the game environment, particularly through mechanisms like reputation impact (Russell & Norvig, 2016). While the current AI system does not dynamically adapt to complex economic conditions, it lays a foundational framework for future developments.

Looking forward, enhancements in AI complexity and the introduction of adaptive behaviour patterns are anticipated to create a more immersive experience. Future versions aim to offer increasingly sophisticated scenarios that more accurately reflect the challenges of real-world retail management (Boden, 2016). This discussion sets the stage for further exploration of integrating and expanding other core components of the game system, emphasising their collective impact on the overall player experience.

4.18 Operational Impact of the Reputation System

The Reputation System in 'Stock & Shop' plays a pivotal role by tracking and responding to the player's decisions related to pricing and customer interactions. Designed to reflect real-world

reputation management dynamics within a retail setting, this system is crucial for understanding the impact of player strategies on the game's environment (Kotler & Keller, 2015).

Changes in reputation, driven by player actions, have significant and visible effects on how often customers visit the store and how they interact with the inventory. This shift in customer behaviour and frequency not only illustrates the tangible effects of reputation but also underscores the direct consequences of player choices, enhancing the realism and strategic depth of gameplay.

4.19 System Integration and Feedback Mechanism of the Reputation System

The Reputation System in 'Stock & Shop' is closely integrated with the game's basic mechanics to monitor player performance through several key metrics. These metrics include customer satisfaction, influenced by product availability and pricing fairness and the frequency of stock shortages. These factors collectively determine the shop's overall reputation score. The system employs straightforward feedback loops that have direct impacts on player decisions, manifesting through visible consequences such as changes in customer frequency and satisfaction. This mechanism ensures that players receive clear and immediate feedback on their management strategies, influencing their subsequent decisions within the game.

Positive interactions with these systems can boost the shop's reputation, leading to increased customer visits and potentially higher sales. Conversely, negative interactions can harm the reputation, resulting in decreased customer engagement and sales. This dynamic offers a realistic simulation of the consequences of reputation management within a retail context.

4.20 Challenges and Solutions in Reputation Management

Addressing the challenges within the Reputation System required significant efforts, notably in quantifying the impacts of reputation based on player decisions. To tackle this, a direct metric system was developed that translates player actions into measurable impacts on their shop's reputation. This system is carefully designed to reflect the actual consequences of player strategies and interactions within the retail environment. While the system is straightforward, it demands players to understand and respond to feedback actively, enhancing their engagement with the game's economic dynamics (Boulding et al., 1993)

Furthermore, the reputation metrics underwent refinement based on a careful consideration of economic principles and consumer behaviour theories. This theoretical analysis involved examining how similar mechanisms are employed in real-world retail settings and hypothetical scenarios to ensure logical and noticeable impacts on gameplay. These refinements were crucial for ensuring that the reputation impacts not only simulate realistic outcomes but also engage players in deeper strategic management, making the gameplay experience both dynamic and realistic (Oliver, 1999)

4.21 Discussion on Strategic Implications and Gameplay Realism

The Reputation System in 'Stock & Shop' introduces a significant layer of strategic depth, challenging players to weigh their immediate profits against long-term reputation impacts. This aspect of the game compels players to make thoughtful decisions regarding pricing strategies and inventory management, reflecting the complex decision-making processes of real retail business owners, as noted in strategic management literature (Porter, 1998).

Moreover, the integration of a dynamic and responsive reputation system enhances gameplay realism by requiring active reputation management. This system not only affects player strategies but also encourages deep engagement with the economic and social elements of the game world, providing a rich, immersive experience that reflects the realities of managing a retail business (Kotler & Keller, 2015).

4.22 Strategic Implications and Future Directions of Pricing Strategy

This comprehensive review highlights the pivotal role of the Reputation System within the gameplay mechanics of 'Stock & Shop'. Acting as a critical barometer for player success, the system significantly influences other gameplay elements, including customer behaviour and economic outcomes.

Anticipated future enhancements aim to provide more detailed feedback on reputation changes and introduce additional factors that could influence reputation, thereby granting players even more nuanced control over their business's public perception.

Ongoing development will further explore these aspects, seeking to increase the complexity and realism of managing a retail business within the virtual environment of the game.

4.23 Evaluation of Framework Functionality and Player Engagement

The 'Stock & Shop' game framework was developed using an iterative testing approach, primarily focusing on debugging during development to ensure basic functionality and reliability. This process involved a continuous cycle of development, testing and adjustments within the Unity environment, which allowed for immediate responses to any operational issues encountered.

Iterative Development and Debugging: Instead of formal unit testing, each component—from the Inventory Management System to the Customer AI—was developed and refined through direct coding and immediate testing. This approach helped identify and resolve bugs early in the development process, ensuring that each module functioned effectively within the framework.

Integration Observations: The framework components were continuously monitored to ensure they worked together seamlessly. This ongoing observation was crucial for spotting and rectifying interaction issues, particularly between the pricing mechanism and customer AI, enhancing the overall system integration.

Performance Checks: The framework's performance was evaluated informally, focusing on its stability and responsiveness as new elements were integrated. These evaluations were crucial for assessing the framework's capacity to handle typical gameplay scenarios without formal scalability testing.

Evaluation Strategy: The testing strategy was inherently adaptive, relying heavily on developer-led insights and direct observations from within the development environment. This method proved effective for enhancing the framework's functionality and player engagement capabilities, although it did not include the structured testing phases typically associated with formal software testing methodologies.

4.24 Challenges and Solutions in Testing

During the development of the 'Stock & Shop' framework, testing was primarily iterative and focused on debugging and informal evaluations rather than structured testing phases. This approach presented unique challenges, particularly in managing data interactions and assessing the system's capacity for handling simulated user interactions.

Data Management and Performance Optimisation:

The complexity of managing a significant number of inventory items and customer interactions was addressed using Unity's built-in data structures, such as arrays and lists, rather than more complex data structures like hash tables. These choices were made to balance efficiency and simplicity in data handling, ensuring that the system could manage gameplay activities effectively without undue complexity.

Testing for Single User Scenarios:

The system was informally tested in a single-user environment, where the focus was on ensuring that the game could handle intensive operations, such as inventory management and customer transactions, under typical usage conditions. While comprehensive scalability tests for multiple users were not conducted, the observations made during these single-user tests provided valuable insights into the system's operational feasibility and areas for potential optimisation.

Performance Checks and Improvements:

Throughout development, performance was monitored to ensure that the game remained responsive and stable. Adjustments were made based on real-time feedback and direct observation, which included optimising data handling and improving system responses to ensure smooth gameplay even as the game's complexity increased.

Future Scalability Considerations:

As ‘Stock & Shop’ continues to develop, plans include exploring scalability enhancements that could support more complex gameplay scenarios and larger user bases. Potential future improvements might involve integrating advanced technologies like cloud-based resource management and machine learning to better predict and handle peak demands, thereby enhancing the game’s adaptability and performance as it evolves.

4.25 Theoretical Insights on Player Engagement

Theoretical analyses indicate a high level of player engagement driven by the economic system and AI interactions within ‘Stock & Shop’. The engagement primarily stems from the economic system that requires players to adapt their strategies (Garris et al., 2002). This nature of pricing and inventory management keeps players deeply involved as they respond to economic feedback from the game environment.

Additionally, the AI interactions significantly contribute to the gameplay depth. The AI customers are designed to behave in ways that reflect realistic consumer responses to pricing and product availability (Norman, 2013). This design not only enhances the realism of the customer interactions but also challenges players to refine their strategies to optimise both short-term gains and long-term customer satisfaction, thereby enriching the overall gameplay experience.

4.26 Hypothetical Feedback and Proposed Improvements

Anticipated feedback from hypothetical gameplay scenarios suggests that players would greatly benefit from increased economic transparency within 'Stock & Shop'. To enhance this aspect, future enhancements might include implementing visual indicators or more direct feedback mechanisms (Csikszentmihalyi, 1990). These additions are expected to help clarify how each decision impacts the game's economy, making the economic dynamics more accessible and understandable to players.

Moreover, enhancing the variation in AI behaviour is identified as a crucial development area. Based on the design and potential interactions, it is projected that diversifying the AI behaviours to better reflect a broader range of customer types could significantly enrich the gameplay (Picard, 1997). Such enhancements would not only increase the realism of customer interactions but also expand the strategic options available to players, encouraging deeper engagement with the game's economic and social elements.

4.27 Assessment of Strategic Depth and Gameplay Realism

The framework of 'Stock & Shop' is designed to promote both strategic depth and realism, fostering an engaging player experience. The ongoing development of the game will greatly benefit from empirical feedback gathered from players (Zimmerman, 2004). Such insights will be instrumental in refining and enhancing the game's strategic and realistic elements, ensuring that the gameplay remains challenging and immersive for players at all levels.

4.28 Summary and Future Directions for Player Engagement

The insights garnered from theoretical engagement analysis play a crucial role in the ongoing refinement of 'Stock & Shop'. As the game progresses through its development cycles, future iterations will focus on implementing these enhancements (Squire, 2006). This approach is aimed at continuously testing and improving the game's capacity to engage players, ensuring that it offers a robust and immersive simulation of retail management that evolves in response to player interactions and feedback.

4.29 Educational Impact and Learning Outcomes

Subsection Introduction:

'Stock & Shop' is designed not only to engage players in managing a retail environment but also to educate them on fundamental economic principles. This subsection evaluates the potential educational impact of the game, discussing how it aligns with educational objectives in economic literacy.

Potential Learning Outcomes:

The game introduces players to core concepts of microeconomics such as supply and demand, market equilibrium, pricing strategies and consumer behaviour, all within a simulated business environment. By actively making decisions on inventory management and pricing, players experience the consequences of their actions in real-time, promoting an experiential learning environment where theoretical economic principles are applied in practical scenarios (Becker, 2004).

Alignment with Educational Objectives:

'Stock & Shop' aligns with educational objectives by:

- **Enhancing Economic Understanding:** Players gain insights into how market forces affect business operations and consumer behaviour. This direct interaction with economic models helps solidify their understanding of complex concepts such as price elasticity, market saturation, and competitive pricing (Mankiw, 2020).

- **Developing Strategic Thinking:** The game encourages players to think strategically about long-term business management, integrating economic forecasting and risk assessment into their decision-making processes (Schoemaker, 1993).

- **Promoting Financial Literacy:** Managing the financial aspects of the store, from setting prices to maintaining inventory levels, helps players develop a practical understanding of financial management and business economics (Lusardi and Mitchell, 2014).

Evaluation Methods for Learning Outcomes:

To assess the educational impact effectively, the following metrics and methods could be utilised in future studies or testing phases:

- Pre and Post-Game Surveys: Evaluating player knowledge on economic concepts before and after gameplay can measure learning gains.

- In-Game Decision Tracking: Analysing the decisions players make during the game can provide insights into their understanding and application of economic theories.

- Feedback Mechanisms: Implementing in-game feedback on players' decisions regarding pricing and inventory management can serve as an immediate form of educational feedback, allowing players to learn and adjust their strategies in subsequent gameplay sessions.

Future Research Directions:

Further research could explore integrating more complex economic scenarios and additional theoretical frameworks to enhance the educational value of the game. Collaborations with

educational institutions could also be explored to test the game's effectiveness in a formal learning environment, providing a richer dataset for assessing its impact on economic literacy.

5 Contributions and Technical Challenges:

5.1 Actual Contributions:

The research undertaken for this dissertation has culminated in the creation of 'Stock & Shop', a scalable game framework tailored for retail-based economy simulations. This framework contributes to the field of game development by addressing the specific needs of simulations that manage economic interactions within a retail setting (Adams, 2020).

The framework is designed with features that allow for adaptation to various retail scenarios and includes a basic customer AI that integrates smoothly with a dynamic pricing strategy mechanism. Although not yet tested in diverse scenarios and with a relatively simple AI, the framework serves as a foundational step, identifying areas for future enhancement such as the development of more complex AI behaviours and expanded scalability tests to support larger-scale implementations.

This dual focus on strengths and areas for improvement underscores the framework's potential as a foundational tool for further research and development in game design.

5.2 Technical Challenges and Solutions

During the development of 'Stock & Shop', several technical challenges critical to the framework's functionality and robustness were encountered and addressed. A significant challenge involved the synchronisation of multiple components—InventoryManager, WholesaleManager, and Customer—to manage inventory operations effectively, such as adding, removing, or updating items.

A system was implemented using class methods like AddItem, RemoveItem, and UpdateInventoryUI within the InventoryManager (Bassil, 2012). This system ensured that changes in the inventory were accurately reflected across all relevant game interfaces. Additionally, listeners and method calls across different managers were utilised to maintain consistent inventory states, which was crucial for the game's operational coherence and reliability.

5.3 Dynamic UI Updates

A core component of the development was enhancing the user interface to ensure it was both responsive and accurate, reflecting changes in the game state in real time. This was particularly critical for managing inventory and customer transactions. Unity's UI system was leveraged, supplemented by event listeners for actions like button clicks, and TextMeshPro was used for dynamic text updates (Nystrom, 2014).

Through methods like UpdateUI implemented in the UI scripts, an immediate refresh of data following any changes was achieved. This setup not only minimised delays typically associated with traditional polling mechanisms but also enhanced the overall gameplay experience by ensuring fluidity and immediate feedback within the game environment.

5.4 Customer Interaction Management

Managing realistic customer behaviour in a retail environment presented unique challenges, as each customer's decisions critically affect both game dynamics and inventory. To address this, a Customer class was developed that encapsulates methods enabling purchase decisions based on item availability and pricing.

AI behaviours were integrated to provide a variety of predetermined consumer reactions, simulating basic interaction within the game environment. This includes a range of price tolerances and item selection processes, which, while straightforward, contribute to a more engaging gameplay experience by mimicking some aspects of consumer decision-making (Millington, 2009). While the AI is not sophisticated in terms of learning or adaptability, its seamless integration supports the foundational gameplay dynamics and offers clear areas for future development and enhancement.

Feedback systems were implemented to guide player strategies and enhance the decision-making process. This approach not only adds depth to the gameplay but also closely mirrors the complexities of real-world retail management.

5.5 Economic Model Integration

Creating a flexible economic model that could dynamically adjust pricing and accurately reflect the impact of player decisions on the game's economy was a major challenge addressed through the InventoryItemUI script. This script incorporates a visual representation of price elasticity via a colour-coded demand bar that changes in response to item pricing relative to its original cost. This simple yet effective mechanic not only provides players with immediate visual feedback on their pricing decisions but also helps them grasp basic supply and demand concepts in a clear, interactive manner.

While the system does not implement real world economic models, its integration effectively demonstrates economic principles within a retail simulation, enhancing the game's educational value. The inclusion of these interactive elements aligns with the educational approaches discussed by Holt & Villamil (2013), emphasising the importance of engaging learning methods in comprehending complex economic theories.

5.6 Scalability and Performance

As the game complexity increased with a growing number of items and customers, ensuring optimal performance and scalability became a crucial focus. Basic data structures and algorithms were employed for managing inventory and customer interactions, which helped maintain functional performance as activity levels rose. Additionally, Unity's profiling tools were used to monitor and adjust game performance in real-time. These tools were instrumental in identifying and addressing bottlenecks particularly with item instantiation and UI updates, helping to keep the game responsive and stable under increased loads.

5.7 Error Handling and Debugging

The complexity of 'Stock & Shop' introduced numerous potential points for errors and bugs, especially due to the intricate interactions between various game components. To mitigate these risks, a comprehensive logging system was implemented and rigorous error checks were performed, focusing particularly on transaction handling and UI updates (McConnell, 2004). This proactive

approach not only enabled early detection of issues but also significantly enhanced the overall reliability of the game framework, ensuring that any potential disruptions could be swiftly addressed and resolved.

5.8 Roadmap for Future Research

The development of 'Stock & Shop' opens numerous avenues for future research, particularly in enhancing educational outcomes and adapting to diverse economic scenarios. Continued exploration into the integration of sophisticated economic theories and multiplayer environments could further validate the game's educational effectiveness and extend its applicability to broader learning contexts (Squire, 2011).

Study on Educational Effectiveness:

A proposed study could involve a controlled experiment where participants are divided into groups that use the 'Stock & Shop' simulation and traditional learning methods. Pre and post-tests on economic concepts would quantify the learning efficacy, providing robust data on the simulation's educational value. This method follows established practices in educational research to measure learning impacts accurately (Hattie, 2009).

Adaptability to Retail Scenarios:

Future research could explore the framework's adaptability by customising the economic model to different types of retail environments—from high-end luxury stores to budget retail outlets. This study would assess how changes in economic dynamics affect player decisions, engagement, and learning outcomes. Such adaptability tests are crucial for understanding the application of theoretical economic principles in varied retail settings (Varian, 2014).

Longitudinal Strategy Development Analysis:

Another promising research direction is a longitudinal study that tracks players over extended periods. This would provide insights into how players refine their strategies in response to economic feedback and game dynamics, offering deeper understanding into strategic learning processes within economic simulations (Ployhart & Vandenberg, 2010). Such studies are essential for examining the sustainability and long-term impact of educational games on strategic thinking and decision-making.

These studies would not only validate the effectiveness of 'Stock & Shop' as a learning tool but also refine its design for broader applications in educational and commercial contexts.

6. Reflections and Learnings

Throughout the development and analysis of the 'Stock & Shop' framework, profound insights into the intricate dynamics of economic systems within digital games were gained. The application of economic theories, especially those related to pricing strategies and market dynamics, revealed the complex interplay between player decision-making and game outcomes.

Drawing on concepts such as those explored by Camerer et al. (2015) concerning CH theory, the importance of accommodating various levels of player strategic thinking became apparent. While the AI customer behaviours in 'Stock & Shop' are not based on distinct profiles, they are designed to reflect a simplified model of consumer psychology. The behaviours are generated through a randomisation process within a predetermined range, allowing for diverse reactions to pricing changes that loosely mimic real-world consumer dynamics (Camerer, 2003).

This experience has bridged theoretical knowledge from academic readings with practical application, offering a deeper understanding of both the potentials and limitations of economic simulations in gaming. These insights not only enhance my perspective as a game developer but also contribute to the academic field by demonstrating practical applications of economic theories in game design (Gee, 2003).

7. Conclusion and Future Directions:

This dissertation culminates in the successful development of 'Stock & Shop', a scalable framework tailored for retail-based economy simulations. Integrating elements such as inventory management, customer AI and dynamic pricing strategies, it effectively simulates a comprehensive retail environment.

'Stock & Shop' serves as a practical tool for future game developers and enriches academic discourse around simulating economic and reputation systems within digital games. Looking ahead, the project is set to incorporate more nuanced AI behaviours and deeper player interactions, enhancing both empirical validity and gameplay experience. The potential testing of the framework with actual players could provide further valuable insights (Anderson & Dill, 2000).

Future explorations could assess the impact of diverse economic strategies on player engagement and satisfaction, potentially leading to innovations in game design and development. Ultimately, 'Stock & Shop' stands as a testament to the potent applications of game development techniques in modelling complex economic systems, offering a significant contribution to both the practical and theoretical aspects of game studies (Adams, 2020).

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