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Fluid Pricing in Hospitality: Integrating Biological, Physical, Mathematical and Economic Models for Adaptive Market Strategies

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Contents

Declaration

I, Marian D. Coca, solemnly affirm that I am the sole author of this dissertation on Fluid Pricing. The contents presented in this dissertation are the culmination of extensive research I conducted on the topic, combined with my personal experiences in the hospitality industry. This research was undertaken as part of my pursuit of a Doctorate in Business and Media at Selinus University.

I hereby declare that the work submitted for the degree of Doctorate in Business and Media is entirely my own original work. Any external sources, materials, articles, or data referred to in this dissertation have been duly cited and acknowledged in accordance with academic conventions. Proper referencing has been followed to ensure the accuracy and integrity of the information presented.

I acknowledge the importance of academic integrity and take full responsibility for the authenticity and originality of this dissertation. I am aware that any violation of academic ethics, such as plagiarism or misrepresentation, would have serious consequences, including the potential revocation of my degree.

By signing this declaration, I affirm that this dissertation represents my independent work and that I have not engaged in any form of academic misconduct in its creation. I further affirm that the research findings and conclusions presented in this dissertation are based on rigorous investigation and analysis.

Signed:

Date:

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Abstract

This thesis explores the dynamic and interconnected nature of pricing strategies, particularly in the hospitality industry, by drawing analogies from complex systems in biology, physics, and economics. Beginning with conceptualising a company as a living organism, the thesis delves into how adaptive systems function in competitive environments. It then examines the evolution of money and its analogy with ATP, highlighting the systemic interplay between resources, markets, and consumer behaviour.

The role of perception, decision-making, and consumer biases in shaping purchasing behaviour is analysed, incorporating insights from vision science, behavioural economics, and psychology. The Markovian model by conscious agents is proposed as a framework for understanding higher values in consumer choices.

Then the thesis focuses on the dynamic process of buying and the probabilities governing sales. The notion of signalling, both in biological and communication contexts, is applied to marketing and pricing strategies within the hospitality sector. Pricing is framed as a complex, fluid, and energetically charged phenomenon, where concepts such as superconductivity, geometry, and thermodynamics offer a new perspective on price creation.

The thesis introduces models, such as gas laws, to develop a fluid pricing strategy, where price behaves similarly to fluid dynamics. Analogies are drawn between gas laws and pricing behaviour in hotels, proposing that price can be understood as both a symbol and a quantifiable entity encapsulating energy. Further, a geometrical framework is developed to understand how price, like fluid, follows patterns dictated by internal and external forces.

In conclusion, this work offers a multi-disciplinary approach to pricing, merging economic theories with insights from natural sciences, to propose that price in hospitality is not static but a dynamic system influenced by both tangible and intangible factors

Chapter 1: Introduction and Aim of Study

1.1 Background of the Study

Pricing in the hospitality industry has long been a challenge due to the inherent volatility and complexity of the market. Traditional pricing strategies, such as fixed pricing or simple dynamic pricing, often fail to fully capture the rapidly changing demand patterns, the nuanced preferences of different consumer segments, and the variety of external market factors that influence purchasing behaviour. With the growth of digital platforms, online booking systems, and global competition, hospitality businesses are increasingly pressured to adopt more sophisticated, adaptive pricing models that can respond effectively to these market dynamics.

Historically, pricing models in hospitality have been driven largely by economic theories, focusing on the basic principles of supply and demand. While these models provide a foundation, they often fail to consider the complex and dynamic nature of both the market and price-making process. Modern consumers are influenced by a variety of factors, including psychological biases, cultural expectations, and perceived value, making pricing a much more intricate task. For instance, consumers may not always act rationally when assessing price and value, and their perceptions are shaped by external cues, or signals, that influence their decision-making.

At the same time, recent research in other fields—such as biology, physics, and mathematics—offers promising insights that could enhance traditional pricing models. For example, biological models of behaviour, which examine how organisms adapt to changing environments, provide useful analogies for how businesses and consumers interact in dynamic markets. Similarly, physical models, particularly those related to fluid dynamics and thermodynamics, offer a way to conceptualize pricing systems as fluid, constantly shifting in response to external pressures (such as market demand or competitive pricing).

Mathematical frameworks, such as dynamic systems theory and geometric models, also offer ways to better understand how prices evolve over time and how small changes in one factor can lead to significant shifts in market outcomes. In particular, the use of fluid dynamics analogies—where price is treated as a flow that changes based on varying pressures and temperature —provides a novel approach to thinking about how prices should be set in a fast-paced, competitive industry like hospitality.

Although some industries, such as aviation and e-commerce, have embraced dynamic pricing strategies that use algorithms to adjust prices in real-time based on demand and other factors, the hospitality industry has been slower to adopt such approaches. This is partly due to the complexity of integrating real-time data, consumer behaviour, and multiple external variables into a coherent pricing strategy. There is a need for an interdisciplinary approach that combines traditional economic models with insights from other fields, allowing for a more adaptive, flexible pricing strategy that can respond to the fluid nature of the hospitality market.

Thus, the background for this study is rooted in the recognition that hospitality pricing models must evolve to meet the challenges of a more interconnected, fast-moving, and consumer-driven marketplace. By integrating biological, physical, mathematical, and economic models, this study seeks to develop a fluid pricing strategy that better reflects the dynamic conditions of the modern hospitality industry, and offers solutions to understand and use to remain competitive while maximizing revenue and consumer satisfaction.

1.2 Statement of the Problem

In the hospitality industry, traditional pricing models often fail to account for the dynamic, ever-changing nature of market conditions, consumer behaviour, and the complex interplay of internal and external factors. With fluctuating demand, seasonality, varying consumer perceptions of value, and the rise of digital platforms, hospitality businesses face increasing challenges in optimizing their pricing strategies to remain competitive and profitable.

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Moreover, while advances in pricing strategies, such as dynamic pricing, have been adopted in industries like aviation and e-commerce, the hospitality sector has been slower to integrate these approaches comprehensively. The lack of adaptive models that can flexibly respond to market conditions in real time limits the ability of hospitality businesses to optimize their pricing for different customer segments, periods, and market conditions.

Therefore, the problem this thesis seeks to address is the lack of a holistic, interdisciplinary pricing framework in the hospitality industry that accounts for the fluidity of market dynamics, biological factors (such as consumer perception and decision-making), physical principles (such as energy and fluid flow), mathematical models (for predicting price behaviour), and economic theories. Without such an integrated approach, hospitality businesses struggle to create pricing strategies that are both adaptive and effective in maximizing revenue and consumer satisfaction in a constantly evolving market environment.

This thesis aims to fill this gap by proposing a fluid pricing model that integrates insights from these diverse fields to offer a more flexible, adaptive, and responsive approach to pricing in the hospitality industry.

1.3 Research Objective/Aim

The main objective of this study is to develop a comprehensive understanding of how complex systems, consumer behaviour, and pricing strategies interact in the hospitality industry, and to propose dynamic and adaptive pricing models that better reflect the intricacies of market forces, consumer perceptions, and organizational behaviour.

This will be achieved by:

- Analysing the hospitality industry as a complex, adaptive system.
- Investigating how consumer perceptions of value and price are influenced by various psychological and perceptual factors.
- Exploring the role of signalling in communication, specifically how prices function as signals of quality, quantity and value.
- Applying interdisciplinary concepts, including mathematical, geometric, and physics-based frameworks, to create innovative, responsive pricing strategies that account for the dynamic nature of hospitality markets.

1.4 Specific Objectives

1. To analyse how hospitality function as adaptive, dynamic, and interdependent systems in response to market complexities.
   - This objective aims to explore the application of complex systems theory to hospitality businesses, illustrating how they adapt and evolve in changing market conditions.
2. To investigate the influence of consumer visual perception and biases on decision-making related to pricing and perceived value in hospitality.
   - This objective focuses on understanding how perceptual factors (such as visual cues, price tags, and quality signals) affect consumer behaviour and their purchasing decisions.
3. To examine the role of signalling in communication within the hospitality industry, with particular emphasis on how prices signal quality, quantity and value
   - This objective will explore the concept of signalling theory in both biological and communication contexts and how these signals influence market behaviour and consumer perception in hospitality.
4. To evaluate different pricing strategies in hospitality, comparing causal and teleological approaches, and developing a framework for dynamic, adaptive pricing models**.**
   - The objective here is to differentiate between pricing strategies and provide a dynamic model that reflects the interaction between supply, demand, consumer perception, and market forces.
5. To apply mathematical and geometric frameworks (such as the Ulam-Borsuk Theorem) to understand the relationship between quantitative and qualitative factors in hospitality pricing decisions.
   - This objective will use geometric and mathematical tools to explore how quantitative elements (price, cost) and qualitative factors (consumer perception, value) interact in decision-making processes within hospitality pricing.
6. To develop and test fluid pricing models in hospitality, using physics-based analogies such as gas laws and thermodynamics to explain price fluctuations and dynamics**.**

- This objective is centred around applying physics-based models (e.g., gas laws, thermodynamic principles) to create a fluid pricing model that reflects real-time changes in market demand and supply conditions.

7. To investigate the relationship between pricing and consumer values, exploring how internal and higher values influence purchasing decisions and perceived quality in the hospitality industry.
   - This objective will delve into how internal and higher consumer values (e.g., personal beliefs, social factors, sustainability concerns) impact decision-making about pricing.
8. To explore the concept of price as an encapsulation of energy and apply this to hospitality pricing models, examining how energy dynamics affect price fluctuations.
   - This objective examines how pricing can be seen as a reflection of energy flow within a system, considering how various inputs (time, resources, consumer attention) influence price changes over time.
9. To compare traditional and dynamic pricing strategies in aviation and hospitality to identify key benchmarks and develop a more responsive pricing model for the hospitality sector.
   - By comparing industries (aviation and hospitality), this objective aims to create benchmark strategies that can inform a more adaptive pricing model for hospitality businesses.
10. To draw insights from consumer behaviour research, including biases and value perceptions, to propose effective pricing strategies that align with consumer expectations and market conditions.
    - This objective aims to combine consumer behaviour research with pricing strategy development to suggest actionable insights for hospitality managers to improve pricing decisions.

1.5 Research Questions

1. How can organizations, particularly in hospitality, be conceptualized as adaptive and dynamic systems, and how do these systems respond to market complexities?
2. What are the key factors that influence consumer perception and behaviour in decision-making processes, particularly in relation to pricing and perceived value in the hospitality industry?
3. How does the concept of visual perception influence consumer understanding of price and quality in hospitality, and how do biases impact decision-making?
4. How have money and pricing evolved as tools for signalling value in the hospitality industry, and what role do biological and communicative signals play in shaping market behaviour?
5. What are the key differences between causal and teleological pricing strategies, and how can these models be applied dynamically within the hospitality sector?
6. How can pricing be conceptualized as a dynamic system that reflects the interplay between quantifiable metrics (quanta) and qualitative perceptions (qualia), particularly within hospitality pricing strategies?
7. How can physics-based analogies, such as gas laws and thermodynamic principles, be applied to develop fluid pricing models in the hospitality industry, and what insights do these models offer for pricing optimization?
8. What insights can be drawn from the application of geometric frameworks (e.g., price container geometry and price molecule bonds) to understand the relationships between pricing structures and market dynamics in hospitality?
9. How do dynamic processes of buying and pricing interact in hospitality, and what factors contribute to the balance between supply, demand, and consumer value perceptions in determining pricing strategies?
10. What are the implications of applying analogies from physics, such as the Carnot engine and ideal gas laws, for understanding price fluctuations and energy dynamics in hospitality pricing systems?

1.6 Scope of the Study

The scope of this study is to explore the interplay between complex systems, consumer behaviour, and pricing strategies in the hospitality industry, drawing upon interdisciplinary concepts from systems theory, economics, psychology, biology and physics. The study focuses on understanding how businesses within hospitality operate as dynamic and adaptive systems, how consumer perceptions influence decision-making, and how innovative pricing models can be developed using both theoretical and practical frameworks.

1. Focus:

The primary focus is on pricing in the hospitality industry, where customer interaction, pricing, and value perception are key to business operations. The study also draws on comparisons with other industries (such as **aviation**) to examine pricing models in broader contexts.

2. Theoretical Scope:

The study will cover key theoretical frameworks including Complex systems theory and its application to price genesis and dynamics of sell-buy process.

Consumer behaviour and decision-making theories, with a particular emphasis on visual perception, biases, and the role of higher and internal values in influencing consumer choices.

Theories of money and pricing as signals of value, with special attention to the historical evolution of money, the nature of signalling in markets, and its role in the hospitality industry.

3. Methodological Scope:

A qualitative research method will be used to analyse:

Consumer behaviour patterns related to pricing.

Price dynamics in hospitality through case studies.

Pricing models as dynamic systems using mathematical and geometric frameworks.

Applying physics-based analogies (such as gas laws and the Carnot engine) to pricing models provides a novel way to examine fluidity and fluctuations in pricing strategies.

4. Key Areas of Exploration:

Consumer Perception: The study will investigate how consumers perceive value, quality, and price, and how these perceptions affect their decision-making processes.

Pricing Models: This section will examine various pricing systems, from traditional to dynamic models, consider causal and teleological approaches, and explore concepts like price as an encapsulation of energy and quanta vs. qualia in pricing decisions.

Signalling and Communication: The role of signalling in pricing will be analysed, with attention to how biological and communicative signals influence consumer behaviour and market outcomes.

Physics-Based Analogies: A major focus will be on the use of fluid dynamics and thermodynamic principles to explain and predict pricing behaviours in the hospitality sector, exploring how gas laws and geometric frameworks can enhance pricing strategies.

5. Limitations:

The study will primarily focus on pricing-making strategies and consumer perception within the hospitality sector, while interdisciplinary concepts from physics are applied, the study will limit the scope of mathematical formulations, focusing instead on their conceptual application

Chapter 2: Literature Review

The research presented in this thesis lies at the intersection of systems theory, consumer behaviour, and pricing strategies in the hospitality industry. By drawing from multiple disciplines, including biology, economics, and physics, the thesis offers a unique approach to understanding consumer decision-making, along with innovative pricing models. This literature review seeks to summarize and evaluate key themes in existing literature that relate to the following areas of study: complex systems and markets, consumer perception and decision-making, and the dynamic nature of pricing mechanisms.

2.1 Systems and Complex Structures in Organizations and Markets

The concept of organizations and markets as dynamic, adaptive systems has been well-explored in systems theory and complexity science. Kavanaugh describes organizations as living organisms (Kavanaugh, 2020), constantly adapting to external and internal pressures. This view has influenced research in fields such as management and economics, where companies are increasingly seen as interdependent systems that require adaptability to survive in complex, rapidly changing environments.

In the context of hospitality, markets are similarly understood as complex adaptive systems, where consumer preferences, economic conditions, and competitive dynamics create non-linear interactions. Anderson (1999) emphasized that market behaviour is unpredictable due to the interdependencies of its participants, which aligns with the thesis's focus on the company as a living organism. The analogy to biological systems reinforces the notion of organizations requiring continuous adaptation to external environments (Senge, 2009).

Additionally, literature on complexity in software design, such as Brooks (1995), is relevant to the discussion of coping with complexity, suggesting that understanding complex systems in hospitality can be informed by practices from the field of computer science.

2.2 Consumer Behavior and Perception in Decision-Making

Consumer decision-making is heavily influenced by perception, with foundational work by Kahneman and Tversky (1979**)** on prospect theory showing that individuals are not fully rational in their choices. This idea, further explored in the thesis (Chapter 3), highlights how the perception of price, quality, and value significantly impact purchasing decisions. Vervaeke's (2019) work on cognitive science and perception provides insights into how visual stimuli, like pricing, can alter consumer behaviour.

Hospitality, as a service industry, is particularly affected by biases in consumer perception. Studies like Matzler et al. (2004**)** on customer satisfaction in hospitality suggest that perceived quality often outweighs objective measures in driving consumer decisions. The thesis delves into hospitality biases, drawing on this body of research to discuss how visual perception and internal values influence decision-making.

The concept of conscious agents, likely referring to models of human cognition and decision-making, resonates with theories in behavioural economics and psychology, where individual decisions are framed not only by external stimuli but also by internal cognitive processes (Hoffman, 2019).

2.3 Pricing Systems and Theories

Pricing in dynamic markets has long been studied through both economic and psychological lenses. Traditional pricing models, such as cost-plus pricing and demand-based pricing, fail to account for the complexity of decision-making in industries like hospitality, where prices fluctuate based on consumer perception and external factors. This thesis explores the dynamic processes of pricing, introducing novel approaches rooted in complexity theory and physics-based analogies.

The application of signalling theory in hospitality aligns with literature on information economics, particularly the work of Spence (1973)**,** which suggests that prices act as signals of quality. This perspective has been expanded in modern marketing, where prices not only signal quality but also create expectations for the service experience, as discussed in Zeithaml's (1988) framework of perceived value in service industries.

The thesis further explores pricing through the lens of thermodynamics and fluid mechanics applying physical principles like the Carnot engine (Arthur, 1999)analogy and the ideal gas equation to understand pricing fluctuations.

2.4 Money, Pricing, and Signalling

The role of money in market transactions has evolved significantly, with recent studies emphasizing its symbolic nature**.** Baudrillard (1976) and Zelizer (1994) explore the social meaning of money, arguing that prices are not merely economic indicators but also cultural symbols. The thesis's examination of price as a symbol aligns with this view, suggesting that prices encapsulate not just value, but also energy, signalling deeper layers of meaning.

Moreover, the application of biological signalling theory to hospitality pricing provides an innovative perspective on how prices can communicate value beyond mere economic transactions. This builds on Grafen's (1990**)** work in evolutionary biology, where signals carry important information about the status or quality of an individual or entity and the costly idea of signalling.

2.5 Fluid Pricing Models and Physics-Based Analogies

The use of physics-based analogies to model pricing strategies is a novel approach, with few precedents in economic literature. However, some research, such as Beinhokerin his exploration of complexity economics (Beinhocker, 2009), suggests that physical systems can provide useful metaphors for understanding market behaviour. The thesis's application of gas laws and Dirac's energy perspectives to hospitality pricing draws on this interdisciplinary approach, offering a new lens for understanding how prices behave in dynamic environments.

2.6 Conclusion

In summary, the literature reviewed here provides a foundation for the multidisciplinary approach taken in the thesis. From systems theory and consumer behaviour to innovative pricing models, the integration of biological, economic, and physical theories offers a rich framework for understanding the complexities of price-making decisions, particularly in the hospitality industry. However, there remain gaps in the application of physical analogies to pricing, and further empirical research is needed to validate these innovative theoretical models. The thesis builds on these foundational theories while proposing new ways to conceptualize pricing as a dynamic, systemic process.

Chapter 3: Methodology

Research Design

The research design for this thesis adopts a qualitative approach to explore the various dynamics at play within the hospitality industry, specifically focusing on pricing, consumer behaviour, and market signals. By examining pricing as a dynamic system, incorporating interdisciplinary insights from physics, biology, and economics, this research employs a theoretical and conceptual framework to understand complex systems within the hospitality sector. This study does not rely on primary quantitative data collection, but instead on secondary data analysis, which integrates existing research, theoretical models, and case studies.

The methodology is primarily descriptive, exploratory and analytical, aiming to generate new insights by connecting multiple disciplines, including market theory, behavioural economics, and complex systems theory. This cross-disciplinary approach is necessary to capture the holistic and dynamic nature of pricing and consumer behaviour, particularly within the hospitality sector.

2. Data Collection Methods

2.1 Secondary Data Sources

Given the nature of the research, data is drawn from secondary sources including academic literature, industry reports, and previous studies. These sources provide the foundation for analysis in the areas of complex systems, fluid pricing models, and consumer behaviour.

Data Sources:

Journals and Papers**:** These include studies from fields such as economics, psychology, physics, biology and hospitality management.

Industry Reports**:** Reports from the hospitality and tourism industries provide insights into real-world pricing strategies and consumer behaviours, contributing to case studies.

Books and Theoretical Models**:** Works by scholars like Kahneman and Tversky, Giorgio Parisi, John Vervaeke, Donald Hoffman, Nick Lane, Jordan Peterson and Alexis Carrel are consulted to build the interdisciplinary connections that form the backbone of the theoretical analysis.

2.2 Case Studies

A part of the analysis is built on study cases from the hospitality and aviation industries. By applying concepts from complex systems and fluid dynamics, the research examines how companies adapt pricing strategies under varying conditions, focusing on dynamic pricing, signalling and descriptive and explanatory sell and buy processes.

3. Data Analysis Techniques

3.1 Conceptual Mapping

The research employs conceptual mapping to connect seemingly unrelated concepts across disciplines. For example, pricing models from hospitality are linked to thermodynamic principles and fluid dynamics (e.g., Carnot Engine Analogy and Ideal Gas Equation). These mappings allow to draw new insights about how dynamic and adaptive systems in hospitality behave similarly to physical systems, offering fresh perspectives on traditional pricing models.

3.2 Comparative Analysis

A comparative analysis of pricing models in different contexts (hospitality, aviation) highlights differences and similarities in pricing behaviour. This helps in understanding the implications of the quanta and qualia approach, as well as fluid pricing systems under fluctuating demand conditions.

3.3 Open Systems

The thesis adopts an open system approach, which is used to analyse the interdependencies within the hospitality ecosystem. By considering how consumer behaviour, market conditions, and pricing strategies are part of a larger complex system, this methodology aligns with open systems theory to explore how external factors like market demand or even cultural influences affect pricing decisions.

4. Theoretical Framework

4.1 Complex Systems Theory

The theoretical framework is rooted in complex systems theory, which draws from the work of scholars like Giorgio Parisi and Lane. This theory suggests that pricing and consumer behaviour in the hospitality industry can be understood through non-linear dynamics and emergent behaviour. For example, superconductivity models are used to explore the sell buy process.

4.2 Behavioral Economics

The thesis also heavily leans on behavioural economics, particularly the theories of Kahneman and Tversky. Their work on decision-making processes, biases, and perceptions of value informs much of the analysis of consumer behaviour, allowing a deeper understanding of how pricing signals are interpreted by consumers.

4.3 Thermodynamic and Fluid Dynamics Analogies

Through the Carnot Engine analogy and Ideal Gas Laws, the research explores the dynamic nature of pricing in the hospitality sector. These models offer a way to describe how price fluctuations resemble the behaviour of gases under pressure and temperature changes, with supply and demand acting as external forces.

5. Validation of Results

Although this study does not involve direct quantitative validation, the robustness of the findings is ensured through a rigorous theoretical cross-checking process. Concepts derived from complex systems theory, behavioural economics, and pricing theory are consistently aligned with case study results, creating a cohesive narrative.

The interdisciplinary approach is also validated by comparing theoretical predictions with real-world outcomes, particularly through case studies in hospitality and aviation, demonstrating the practical relevance of the theoretical models.

6. Limitations of the Methodology

6.1 Lack of Empirical Data

The main limitation of this methodology is the lack of primary empirical data, which restricts the ability to conduct statistical analyses or to directly test hypotheses. Instead, the study relies on the synthesis of existing research and conceptual models, which may limit the scope of empirical generalization.

6.2 Scope of Theoretical Models

While the use of interdisciplinary models offers valuable insights, some theoretical frameworks may not perfectly translate to real-world hospitality settings. The application of physical analogies (e.g., fluid dynamics) to pricing models is innovative, but it requires careful interpretation and may not always capture the nuances of human behaviour and market fluctuations.

7. Conclusion

This methodology outlines an innovative, interdisciplinary approach that combines qualitative data analysis, theoretical frameworks, and case studies to explore pricing and consumer behaviour in the hospitality sector. While the absence of primary empirical data poses some limitations, the use of complex systems theory, behavioural economics, and fluid dynamic models offers fresh insights into the dynamic nature of hospitality pricing and consumer decision-making processes. This methodology provides a holistic framework for understanding pricing in highly variable markets like hospitality, where traditional models may fall short of capturing the intricate interdependencies at play.

8. Ontological and Epistemological Considerations

In shaping this methodology, it's essential to recognise the ontological and epistemological assumptions underlying the research approach.

8.1 Ontological Perspective

From an ontological standpoint, this research operates under the assumption that the hospitality industry, and more broadly, functions as complex adaptive systems. This means they are dynamic, interconnected, and emergent, where individual agents (consumers, businesses, prices) are part of a larger, evolving system that cannot be reduced to its parts alone. Such systems are characterized by non-linearity and interdependence—ideas drawn from complex systems theory (Capra, 1996) and the works of physicist Giorgio Parisi on superconductivity and complex behaviour (Parisi, 2021).

The ontological stance of this thesis is realist, in that it assumes an objective, albeit complex, reality of economic systems. However, it also integrates a form of processual ontology, suggesting that economic phenomena like pricing are not static entities but ongoing processes (Rescher, 1996). This aligns with the dynamic nature of markets, which, much like natural systems, are constantly evolving based on interactions between their components and the environment.

In this context, pricing in hospitality is not a fixed value but an emergent property shaped by forces such as demand, consumer perceptions, and signalling mechanisms. By applying thermodynamic analogies, such as the Carnot engine and fluid dynamics, the research acknowledges that economic systems behave similarly to physical systems, constantly adapting and recalibrating.

8.2 Epistemological Perspective

Epistemologically, the research leans toward a constructivist approach, which posits that knowledge about pricing, markets, and consumer behaviour is not discovered but constructed through interaction with the environment and the theoretical frameworks we apply. In this regard, scientific knowledge about pricing, for instance, is built through theoretical modelling and analogy-making—drawing connections between physical systems and economic systems (Czarniawska, 1997). This constructivist view is evident in the use of analogies from physics (e.g., fluid dynamics) to understand how pricing evolves dynamically within the hospitality industry.

This thesis does not assume that a single "true" model of pricing exists but instead proposes that knowledge is always context-dependent and partial (Bourdieu, 1977). By blending concepts from behavioural economics, complex systems, and thermodynamics, the research constructs a multi-layered understanding of pricing mechanisms, one that acknowledges the limitations and affordances of each model.

8.3 The Interdisciplinary Epistemology

The thesis embraces an interdisciplinary epistemology, where knowledge is generated by integrating insights from diverse fields—economics, physics, behavioural science, and marketing. This epistemological approach enables a broader perspective on pricing and market behaviour, moving beyond the constraints of a single disciplinary framework. Such integration allows for a richer understanding of the dynamic and emergent nature of pricing systems in hospitality, as it combines the quantitative rigour of economics with the qualitative complexity of human behaviour and perception.

Chapter 4: Contents and Results

4.1 Introduction

In the world of economics, pricing strategies play a pivotal role in shaping market dynamics and influencing consumer behaviour. The concept of fluid pricing, characterized by the dynamic and flexible adjustment of prices, has emerged as a key area of interest for researchers, policymakers, and businesses alike. This thesis aims to delve into the realm of fluid pricing and explore its implications for economic theory and practice.

As Nobel laureate Milton Friedman once said, "Price is what you pay. Value is what you get" (Friedman M. , 2009). This succinctly captures the essence of pricing in economics, where prices serve as a mechanism to allocate scarce resources efficiently and reflect the perceived value of goods and services. However, the traditional notion of fixed prices is challenged by the concept of fluid pricing. In addressing this shift, we turn to the wisdom of renowned scholars and thinkers. Karl Popper, known for his work on the philosophy of science, emphasized the importance of adaptability in economic systems. In his book *The Open Society and Its Enemies*, (Popper, 1945) argued that a free and open society must embrace flexibility and continuous adjustments to meet changing circumstances. This perspective resonates with the idea of fluid pricing, which recognizes the need for businesses to adapt their pricing strategies in response to market dynamics and consumer behaviour.

David Hume, a prominent figure in the Scottish Enlightenment, delved into the intricacies of human nature and its impact on economic decision-making. In his seminal work *An Enquiry Concerning Human Understanding*, (Hume, 1784) highlighted the role of subjective judgments and individual preferences in shaping economic transactions. This notion is closely aligned with the concept of fluid pricing, as it acknowledges the dynamic nature of consumer perceptions and the need for businesses to align their prices with varying customer demands.

The groundbreaking research of Daniel Kahneman, as outlined in his book *Thinking, Fast and Slow*, provides further insight into the psychology behind pricing decisions. (Kahneman D. , 2011) demonstrated that individuals often rely on heuristics and biases when making choices, including purchasing decisions based on perceived value. This understanding of human cognition and decision-making processes informs the implementation of fluid pricing strategies, which aim to capitalize on these cognitive biases and effectively influence consumer behaviour.

Jordan Peterson, a clinical psychologist and professor, offers a unique perspective on the relationship between individuals and economic systems. In his book *12 Rules for Life: An Antidote to Chaos*, (Peterson, 2018) emphasizes the importance of personal responsibility and the pursuit of meaningful goals.

From an economic standpoint, fluid pricing can be seen as a manifestation of the call for individuals and businesses to adapt and thrive in an ever-changing world. By embracing fluid pricing, businesses can better navigate economic uncertainties and optimize their pricing strategies to align with their long-term objectives.

The classical approach to explaining phenomena, such as elasticity in prices, traditionally relied on the properties of matter, particularly elasticity as understood in the context of physics. This approach drew inspiration from the work of classical economists such as Adam Smith, David Ricardo, and Alfred Marshall, who sought to establish economic principles based on analogies to the physical world (Marshall, 1920). According to this classical perspective, price elasticity was viewed as a measure of the responsiveness of demand or supply to changes in price. It was likened to the elasticity of a physical material, whereby the extent to which a material stretches or compresses under external forces determines its elasticity.

In *Principles of Economics*, Alfred Marshall applied the concept of elasticity to the study of prices (Marshall, 1920). Marshall used the analogy of elasticity in physics to explain how changes in price affect demand or supply. This classical approach provided a foundation for understanding the relationship between price changes and the corresponding shifts in quantity demanded or supplied.

However, due to price volatility and dynamics, a new approach has emerged, drawing inspiration from the properties of fluids, to offer an alternative perspective on understanding prices. This approach considers the fluidity, dynamics, and adaptability observed in economic systems. One influential author who has contributed to this new approach is Joseph Stiglitz. In his book *Economics of the Public Sector*, (Stiglitz, 2000)explores the concept of price elasticity from a fluid perspective. He argues that the traditional view of price elasticity fails to capture the fluid nature of economic systems, which are characterized by changing market conditions, consumer behaviour, and technological advancements. Stiglitz proposes that a more comprehensive understanding of price elasticity can be achieved by incorporating the fluid properties of markets and the dynamic interactions between various economic agents.

Another notable author in this context is Richard Thaler. In his book *Misbehaving: The Making of Behavioural Economics*, (Thaler, 2015) challenges the classical approach by emphasizing the importance of psychological factors and human biases in determining prices. He argues that individuals' decision-making processes are influenced by cognitive biases and social influences, which impact their responsiveness to changes in price. Thaler's work highlights the need to consider the fluid nature of human behaviour when analysing price.

4.2 The Company as a Living Organism: Adaptive, Dynamic, and Interdependent Systems

The Living Organism Metaphor

The concept of a company as a living organism offers a rich and dynamic metaphor for understanding how organisations operate, grow, adapt, and interact with their environment. Like living organisms, companies are not static entities but rather complex, adaptive systems that must continuously evolve to survive in a competitive and ever-changing market environment. This metaphor draws from biological principles—*such as adaptation, homeostasis, growth, and interdependence*—and applies them to the business world, providing a framework for analysing how companies manage internal and external challenges to thrive.

Understanding companies in this way highlights their need to adapt to market conditions, maintain stability through balanced internal and external dynamics, grow through strategic development, and depend on a network of interrelationships. This chapter explores how the living organism metaphor can enhance our understanding of company behaviour and its implications for management and leadership practices.

Adaptation: Surviving and Thriving in a Changing Environment

In biology, adaptation is a fundamental principle of survival. Organisms that can respond and adjust to changes in their environment have a higher chance of survival and reproductive success. Similarly, adaptation is a key feature of successful companies. A company's ability to recognize shifts in market conditions, customer preferences, or technological advancements, and respond effectively, determines its capacity to remain competitive.

For example, Kotter (Kotter, 1966) emphasizes that companies must develop a "sense of urgency" in response to external changes and adopt innovative approaches to stay relevant. Companies that fail to adapt often face obsolescence.

The idea of adaptation in companies can be likened to Darwin’s theory of natural selection, where businesses that evolve in response to their environment can "survive" while others become extinct. (Beer, 2009)asserts that organizational adaptability is increasingly important in an era of globalization, digital transformation, and market volatility, emphasizing that companies must continually update their products, services, and strategies to meet emerging demands.

Homeostasis: Balancing Internal and External Dynamics

Homeostasis in biology refers to the process by which living organisms maintain stable internal conditions—such as temperature and pH levels—despite fluctuations in the external environment. For companies, the homeostasis metaphor involves balancing a variety of internal and external factors, such as revenues, costs, employee satisfaction, and customer loyalty, to maintain operational stability.

A company must continuously adjust its internal processes to respond to external market pressures, regulatory changes, or competitive threats. For instance, a sudden rise in production costs might necessitate adjustments in pricing strategies, while a decline in customer satisfaction might prompt internal restructuring to improve service quality. This constant balancing act is essential for long-term sustainability, much like a living organism's need to regulate its internal environment to survive external stressors.

According to Collins (Collins, 2001), companies that maintain internal coherence and alignment while adapting to external changes are more likely to sustain high performance over time. This concept aligns with (Senge, 2009) theory of systems thinking, which suggests that companies are made up of interconnected systems—financial, human, and operational—that must be managed holistically to achieve homeostasis. If one system is imbalanced, it affects the entire organization.

Growth and Development: Expansion and Evolution

Growth and development are key characteristics of living organisms, and they are equally important for companies. Just as organisms develop over time, successful businesses must expand, innovate, and evolve. Growth may involve entering new markets, developing new products or services, or acquiring other businesses to increase capacity and competitive advantage.

Penrose (Penrose, 1959), in the theory of the growth of firms, argues that growth is driven by a company’s ability to leverage its internal resources and competencies. As companies grow, they must develop new capabilities and continuously improve existing processes, much like organisms must enhance their abilities to survive and thrive in a changing environment. This growth-oriented mindset encourages companies to take calculated risks, invest in research and development, and embrace new technologies.

Interdependence: Systems, Networks, and Relationships

Just as living organisms rely on interdependent systems—such as the circulatory, respiratory, and nervous systems—companies depend on a network of relationships with stakeholders, including customers, suppliers, employees, and investors, to function effectively. The health and success of a company depend on the strength and balance of these interconnections.

The concept of interdependence extends to supply chain management, where companies rely on suppliers to deliver essential materials, and customer relationship management, where customer satisfaction drives revenue and brand loyalty. A breakdown in any part of this network can have cascading effects throughout the organization, much like a failure in one bodily system can affect an organism's overall health.

Furthermore, companies depend on their internal organizational structures, where teams and departments must collaborate to achieve common goals. Lawrence and Lorsch (Lawrence, 1977)emphasize the importance of integrating various departments—such as marketing, finance, and operations—within a company to ensure smooth functioning and effective decision-making. This intra-organizational interdependence is akin to the symbiotic relationships that sustain life in biological organisms.

Ernst Haeckel stated, "The organism is primary; the anatomy and physiology secondary." This quote highlights the importance of focusing on the big picture of a business, recognising that it is more than just its individual pieces. A company is an interconnected system that must work together to survive and thrive.

Furthermore, as molecular biologist Francis Crick stated, "Life is an emergent property of organization." This quote emphasizes the significance of an organised operation system within a business. Just like any living organism, businesses require structure to operate properly and reach their fullest potential.

Conclusion: The Implications of Viewing Companies as Living Organisms

The metaphor of a company as a living organism offers valuable insights into how organizations operate, adapt, grow, and interact with their environments. By embracing the principles of adaptation, homeostasis, growth, and interdependence, companies can develop strategies that ensure long-term success and resilience in the face of change.

The living organism metaphor reminds us that companies are dynamic, interconnected systems that must continuously evolve to meet the demands of an ever-changing marketplace. Just as organisms rely on a delicate balance of internal and external factors to thrive, companies must skillfully manage their resources, relationships, and strategies to achieve sustainable growth and profitability.

4.3 Markets and Complex Systems: Understanding Dynamics in Hospitality

In this chapter, we explore how markets operate within the hospitality industry using various systems and theories from both science and social sciences to understand their complexity, behaviour, and underlying dynamics.

4.3.1 Open Systems: Folklore

This section introduces the concept of open systems, illustrating how hospitality markets continuously interact with their external environment. The industry is shown as a dynamic system with constant input-output processes.

The Romanian story "The Heavenly Court" or "The Celestial Mansion" (Curtea Cerului in Romanian). This traditional folk tale has been passed down through generations in Romanian culture.

God and the Devil compete to see the better builder. God builds a beautiful house with sturdy walls and a solid roof. He also creates a magnificent violin with a perfect resonance box, which produces a beautiful sound.

On the other hand, the Devil builds a house without doors or windows, so it is completely closed off from the outside world. He also creates a violin without a resonance box, so it produces no sound at all.

God's House and Violin: God’s approach in the story, where he builds a house that is functional, beautiful, and open to others, symbolizes the efficient allocation of resources and the creation of things with intrinsic and extrinsic value. The violin with a resonant sound also reflects the idea of creating a product that has utility and provides satisfaction to others, a core goal of economic activity.

Devil's House and Violin: In contrast, the Devil’s creations—closed off, inaccessible, and useless—represent wasteful resource allocation. His house, being sealed, lacks functionality and provides no value, while the mute violin highlights the failure of a product to meet any demand or create satisfaction. This reflects economic models where poor investments lead to underutilized or valueless goods and services.

Competition and Antipodal Games:

The story presents a form of antipodal game, a situation where two opposing players (in this case, God and the Devil) take radically different strategies to achieve the same goal: to demonstrate their superiority as builders. In economics, antipodal games often reflect zero-sum competitions where one party's gain is another’s loss, and strategies differ drastically in terms of risk, innovation, or ethical considerations.

Strategy 1: God builds something with long-term value and functional purpose, mirroring a business strategy focused on sustainability, customer satisfaction, and innovation. His violin resonates, fulfilling its purpose, and his house provides shelter, reflecting positive externalities that benefit others.

Strategy 2: The Devil’s strategy is self-centred and short-sighted. By creating a closed-off house and a mute violin, he prioritizes form over function, symbolizing industries that may focus on superficial success or monopolistic control but fail to deliver value

Economic Conclusion: The competition between God and the Devil mirrors economic scenarios where firms compete with either sustainable innovation or extractive, non-value-creating strategies. Those who adopt a God-like approach (creating lasting, valuable goods) tend to succeed in the long run, while those who follow the Devil’s path may experience initial dominance but eventually lose out due to the lack of true value creation.

4.3.2 Path of Least Resistance

The principle of the path of least resistance is applied to consumer behaviour in the hospitality industry, explaining how customers tend to opt for the easiest, most efficient options when choosing services.

The concept of the "path of least resistance" can be explained scientifically based on the principles of physics and energy minimization. It refers to the tendency of a system to choose the path or route that requires the least amount of energy or offers the least resistance. This concept can be observed in various phenomena, such as the flow of fluids, the propagation of electrical currents, and even human behaviour.

In physics, the path of least resistance is closely related to the principle of least action, which states that a physical system tends to follow a path that minimizes the action (a quantity related to energy) along that path. This principle is derived from variational calculus and is a fundamental concept in classical mechanics and field theories. (Feynman, 1965)

From a scientific perspective, the path of least resistance can be understood through the principles of energy conservation and optimization. Systems, whether physical or biological, naturally tend to minimize their energy expenditure to achieve a state of equilibrium or stability. This means that energy will flow or propagate along the path that offers the least resistance, as it requires the least amount of work to be done. (Feynman, 1965)

In the field of electrical engineering, for example, electric currents follow the path of least resistance, known as Ohm's Law, where the current is directly proportional to the voltage and inversely proportional to the resistance. Similarly, in fluid dynamics, liquids or gases flow along the path of least resistance, determined by factors such as pressure differentials, viscosity, and obstacles in the flow

"Nature always tends to take the shortest and most efficient path in its processes." - Nikola Tesla

4.3.3 Participatory Universe

This concept suggests that hospitality markets are co-created by participants, where guests, employees, and service providers shape the market through their actions, decisions, and feedback

The Participatory Universe is a concept proposed by physicist John Archibald Wheeler, which posits that the observer plays an active role in shaping reality. Wheeler suggests that the universe does not exist in a fully independent or pre-determined state but instead comes into being through our observation. In his own words, “No phenomenon is a real phenomenon until it is an observed phenomenon” (Wheeler, 1978). This idea aligns with the principles of quantum mechanics, where the act of measurement influences the state of particles, leading to the conclusion that observation is integral to the manifestation of reality.

Application to Hospitality:

In the context of the hospitality industry, the Participatory Universe concept can be metaphorically extended to how consumers perceive and co-create their experiences. Just as Wheeler asserts that reality is shaped by observation, a guest’s experience is not a fixed or objective reality but is co-created through their perceptions, interactions, and observations.

The ambience, service quality, and pricing strategies are not simply static elements; they come into "existence" or take on particular meanings based on how they are observed and experienced by the customer. For example, a beautifully designed hotel lobby may only realize its value fully through the lens of the guests who experience it, shaping their perception of luxury or comfort. This is similar to how a quantum state is only determined upon measurement.

The participatory role of the customer in creating their hospitality experience highlights the importance of personalized service, flexible offerings, and attention to individual guest preferences. Just as Wheeler’s universe is partly a product of observation, the hospitality experience is dynamically shaped by the guests’ engagement and interpretation of their environment.

4.3.4 Bernays Propaganda

This section discusses the role of marketing and public relations in shaping consumer perceptions and behaviour within hospitality, drawing on historical propaganda techniques.

Bernay Propaganda used this same idea to develop his techniques for creating and shaping public opinion. He believed that by creating the illusion of popular support for a particular idea or product, he could persuade people to adopt that idea or product themselves

Also known as the public relations industry, refers to the systematic use of persuasive techniques to influence public opinion and behaviour. Developed by American public relations pioneer Edward Bernays in the early 20th century, propaganda has had a significant impact on economics and society as a whole.

One of the key ways in which propaganda has influenced economics is through its impact on consumer behaviour. By shaping the desires and preferences of consumers, propaganda has helped to create a culture of mass consumption in which people are encouraged to buy more and more goods and services. (Bernays, 1928)

This culture of consumption has had many economic consequences, including the growth of the advertising industry, the expansion of global markets, and the rise of consumer debt. Encouraging people to spend more than they can afford, propaganda has contributed to a cycle of economic growth and recession that has characterised the modern era.

In addition to its impact on consumer behaviour, propaganda has also impacted economic policy and regulation. Propaganda has helped create a pro-business environment where corporations can operate with minimal regulation and oversight by shaping public opinion and influencing political leaders.

This has led to several economic consequences, including the concentration of wealth and power in the hands of a few large corporations, the erosion of workers' rights and protections, and the increase in economic inequality.

Despite these negative consequences, propaganda continues to be a powerful force in shaping public opinion and behaviour. Its influence can be seen in everything from the advertising we see on television and social media to the political rhetoric of leaders.

Edward Bernays, the founder of the modern public relations industry, was the nephew of Sigmund Freud, the founder of psychoanalysis. His uncle's ideas heavily influenced Bernays, and he applied many of Freud's insights into human behaviour to his public relations and propaganda work.

One of the critical ways Freud's ideas influenced Bernays was through the concept of the unconscious mind. Freud believed that much of human behaviour was driven by unconscious *desires and impulses*, and he developed various techniques for uncovering and understanding these hidden motivations.

Bernays used these same ideas to develop his techniques for shaping public opinion and behaviour. He believed that by tapping into people's unconscious desires and fears, he could manipulate their behaviour in subtle and powerful ways.

Another way in which Freud's ideas influenced Bernays was through the concept of the "herd instinct." Freud believed that people naturally tend to conform to the opinions and behaviours of those around them. As a result, he developed a range of techniques for understanding and manipulating this social dynamic.

4.3.5 Superconductivity

This section introduces the physical concept of superconductivity and draws analogies for hospitality markets.

Heike Kamerlingh Onnes first observed the phenomenon of superconductivity in 1911. He discovered that at shallow temperatures, the electrical resistance of mercury dropped to zero, and it became a superconductor. Since then, many other materials have been discovered to have this property, and scientists have been exploring the various applications of superconductivity.

The property of superconductivity is quantified by the critical temperature (Tc) and critical magnetic field (Hc). The critical temperature is the temperature below which the material becomes superconductive, and the critical magnetic field is the maximum magnetic field that the material can withstand before it loses its superconductivity. The critical temperature and critical magnetic field vary for different materials. (Onnes, 1911)

The relevance: temperature plays a crucial role in the dynamic of the physical world by switching at extreme its s nature and behaviour.

4.3.5.1 Giorgio Parisi's Insights on Superconductivity and Complex Systems

Giorgio Parisi, has contributed significantly to the study of complex systems and superconductivity. His research focuses on how systems with numerous interacting components behave collectively, particularly in situations where order and randomness coexist. Parisi's work is essential to understanding how seemingly chaotic systems organize themselves under certain conditions, making his insights valuable for analyzing dynamic processes in various fields, including hospitality.

4.3.5.2 Superconductivity and Complex Systems

In his research on superconductivity, Parisi examined how certain materials exhibit zero electrical resistance when cooled below a critical temperature. Superconductivity is a perfect example of how complex systems undergo phase transitions—a sudden shift from disorder to a highly ordered state—based on external factors, like temperature.

Superconductors are governed by complex interactions between electrons, which become strongly correlated under low temperatures. This phase transition from a normal conductive state to a superconductive state is highly sensitive to environmental conditions, much like complex systems in other areas of science. Parisi's insights into how temperature influences the behaviour of these systems provide a broader framework for understanding how certain thresholds, once reached, can trigger dramatic changes in system behaviour.

In superconductivity, temperature serves as the critical variable, acting as a gatekeeper between the chaotic, resistive state and the organized, resistance-free state. This idea can be metaphorically applied to industries like hospitality, where fluctuating external conditions, such as market competition, consumer behaviour, and economic cycles, can cause sudden shifts in performance and operations. (Parisi, Superconductivity and Phase Transitions., 1980)

4.3.5.3 In Search of Starlings: Complex Systems and Emergent Order

A metaphor based on starling flocks is used to describe emergent behaviour in hospitality markets, where collective patterns arise from individual decisions.

In his book In Search of Starlings, Parisi explores how large systems of seemingly independent components—like flocks of starlings—form collective behaviour without centralised control. The flocks' coordinated movement is a striking example of emergent behaviour in complex systems, where individual agents follow simple rules, yet the collective dynamics produce sophisticated, organized patterns.

Parisi emphasizes that the behaviour of such systems cannot be fully understood by examining individual components in isolation. Instead, the interactions between agents and the overall system's dynamics lead to emergent phenomena that are greater than the sum of their parts. The flocks of starlings demonstrate self-organization—a principle that can be observed in many complex systems, including markets, economies, and hospitality businesses, where numerous factors (staff, customers, and market forces) interact to produce outcomes that are not predictable from any one factor alone.

4.3.5.4 Applications to Hospitality: Understanding Complex Systems

The hospitality industry can be seen as a complex system characterized by dynamic interactions between customers, services, markets, and external conditions. Parisi’s work offers a profound analogy for understanding how businesses must navigate the unpredictable nature of such systems.

Temperature in Superconductivity and Hospitality: Just as temperature serves as a critical factor for superconductivity, external conditions—such as seasonality, market competition, and economic conditions—act as the "temperature" in hospitality. Changes in these external factors can trigger phase transitions, such as surges in demand or changes in consumer behaviour, requiring businesses to adapt swiftly.

Emergent Behaviour: The coordinated behaviour of starlings, without a central leader, mirrors how customer preferences, market trends, and staff behaviour can spontaneously align, creating trends or operational patterns in hospitality. For example, small changes in customer reviews or service offerings can lead to large-scale shifts in market perception and demand.

Self-Organization: Like the flocking behaviour of starlings, the hospitality industry often experiences self-organized patterns, where individual actors (guests, staff, competitors) contribute to an overall dynamic system. These patterns, such as trends in customer preferences or pricing strategies, are not centrally planned but emerge from interactions between the components.

4.3.5.5 Conclusion: Complex Systems and Temperature in Hospitality

Parisi's work on superconductivity and complex systems provides a valuable framework for understanding the hospitality industry. The concept of phase transitions in superconductivity, where temperature serves as a critical variable, can be applied to hospitality, where external factors act as triggers for dramatic changes in system behaviour. Similarly, his study of emergent behaviour in systems like flocks of starlings helps illuminate how collective outcomes in hospitality arise from interactions between various agents, including customers, employees, and market forces.

4.3.6 Coping with complexity in software design

This section discusses the parallels between software design and market complexity, providing insights into how hospitality businesses can manage their intricate systems through technology and design thinking.

Coping with complexity in software design and system architecture is crucial to create manageable, maintainable, and scalable systems. *Modularity, abstraction, hierarchy, and layering* are five key principles that can help in managing complexity effectively. Here's an explanation of each:

1. *Modularity* involves breaking down a complex system into smaller, self-contained, and independent modules or components. Each module should have a specific, well-defined purpose and should interact with other modules through well-defined interfaces. The benefits of modularity include easier debugging, testing, and maintenance, as well as the ability to reuse modules in different parts of the system. Modules can be developed and tested independently, making it easier to scale a system as it grows (Parnas, 1972) .

2. *Abstraction* is the process of simplifying complex systems by focusing on the essential aspects while hiding unnecessary details. It allows developers to work with high-level concepts and ignore low-level implementation details. For example, an abstraction might represent a database as a simple API for data storage and retrieval, rather than exposing the complexities of database management. Abstraction helps in managing complexity by reducing cognitive overload and allowing developers to work at higher levels of abstraction (Brooks, 1995) .

3. *Hierarchy* is the organization of system components into a structured, layered, or nested arrangement. It establishes a clear order and relationship among different parts of the system. A hierarchical structure helps in managing complexity by providing a clear separation of concerns and responsibilities. It enables developers to focus on specific layers or levels of the system without being overwhelmed by the entire complexity (Simon, 1962) . For instance, in a software application, you might have a UI layer, business logic layer, and data access layer organized hierarchically.

4. *Layering* is a specific form of hierarchy where components or modules are organized into horizontal layers, each responsible for a specific aspect of the system's functionality. Each layer interacts with the layers above and below through well-defined interfaces or APIs. Common examples include the OSI model for networking and the layered architecture in software development (e.g., presentation, application, data layers). Layering simplifies complexity by dividing a system into manageable and interchangeable parts, making it easier to modify, extend, or replace specific layers without affecting the entire system (Liskov, 1987) .

5. *Information hiding* is a design principle closely related to abstraction and modularity. It involves encapsulating the internal details and state of a module or component and exposing only the necessary interfaces and functionalities to the outside world. This principle ensures that changes within a module do not affect other parts of the system, enhancing maintainability and reducing the risk of unintended side effects (Parnas, 1972) . Information hiding enforces a clear separation between the implementation and interface, making it easier to understand, modify, and extend a system,

4.3.7 Alexis Carrel on synthesis

Alexis Carrel a proponent of synthesis, which combines various elements or parts to form a more complex whole. He believed that a synthetic approach was essential for advancing medicine and that looking at the patient as a whole rather than just treating their symptoms was necessary. In his book, "Man the Unknown," Carrel writes, "The synthesis of all the sciences is necessary for the understanding of man, and it is only by the understanding of man that we can progress." (Carrel, 1935)

Carrel's emphasis on synthesis is particularly relevant today, as we face increasingly complex challenges requiring a multidisciplinary problem-solving approach. His approach to medicine and life serves as a reminder that a synthetic system that integrates diverse perspectives and knowledge is essential for progress and growth. Embracing a synthetic approach to economic processes, we can continue to refine our thinking and develop new problem-solving approaches.

Understanding the relationships from an energetical perspective is crucial.

We must become energetically frugal in our thoughts and actions to optimise our energy expenditure. Evaluating how we invest our energy and ensuring that it is channelled into productive endeavours leads to a more fulfilling and positive reality. Just as we manage our financial resources wisely, we should be mindful of our energy chequebook and invest it where we can receive positive returns.

4.3.8 Abstraction

Here, abstraction is used to simplify complex market behaviour in hospitality, offering a high-level view of how managers can distil complex problems into manageable solutions.

Our world is complex and full of intricacies that can be difficult to comprehend. To help us understand it all, we often use abstractions - ideas that represent the world in simplified forms. Abstractions can be found in many fields of study, from poetry and art to philosophy, mathematics, biology, physics, and chemistry.

The process of removing unnecessary details or features from an object, concept, or system to focus on its essential properties or characteristics. An abstraction is a powerful tool used across various disciplines, including language, mathematics, and other sciences. It simplifies and generalizes complex ideas, making them easier to understand and work with.

In *language*, abstraction is used to simplify and generalize concepts, such as classifying objects or ideas, using metaphors or analogies to convey complex ideas, and using abstract terms to express general concepts. For example, "love" is an abstraction that refers to a wide range of emotions and experiences. It is used to describe a general concept that encompasses many specific instances.

In *mathematics,* abstraction is used to simplify complex concepts, such as sets, numbers, and functions, by reducing them to their essential properties. For example, a function can be abstracted to a set of inputs and outputs without regard to the specific algorithm used to produce the outputs. This abstraction Allows mathematicians to study the properties of functions in a more general way and to apply them to a wide range of problems.

In other sciences, such as *physics, chemistry, and biology*, abstraction is used to simplify complex systems, such as atoms, molecules, and organisms, by focusing on their essential properties and characteristics. For example, in chemistry, the concept of a "molecule" is an abstraction that refers to a collection of atoms bonded together without regard to the specific types of atoms or the particular arrangement of bonds. This abstraction allows chemists to study the properties of molecules more broadly and apply them to a wide range of chemical reactions.

In all of these disciplines, abstraction is a key tool that allows for creation models and theories that can be used to understand and make predictions about complex phenomena. Moreover, by removing unnecessary details and focusing on essential properties, abstraction enables us to reason more clearly and effectively about the world around us.

4.3.9 Spooky action and invisible hand

The concept, borrowed from quantum mechanics and Adam Smith’s economic theory, discusses how invisible, interconnected forces shape hospitality markets in unexpected ways.

Einstein's spooky action, also known as quantum entanglement, is a phenomenon in quantum mechanics where two particles can become linked so that the state of one particle can instantaneously affect the other particle's state, regardless of the distance between them. This means that information appears to be transmitted faster than the speed of light, which contradicts the principles of relativity. (Einstein, 1935)

Adam Smith's "invisible hand" metaphor describes how pursuing self-interest in a free market can lead to economic prosperity and social well-being. The idea is that individuals acting in their self-interest will, through the mechanism of supply and demand, create a market that benefits everyone. (Smith A. , 1776)

Although Einstein's spooky action and Adam Smith's invisible hand may appear unrelated, they both share a fundamental characteristic - they involve transmitting information or influence over a distance. In the case of quantum entanglement, particles appear to be instantaneously linked in a way that defies traditional notions of space and time. In the case of the invisible hand, the actions of individuals in a market can have ripple effects that lead to broader economic and social outcomes.

The correlation between these two phenomena lies in the fact that both involve a form of "action at a distance" that is difficult to explain using traditional notions of causality. In both cases, there is a sense that something beyond our typical understanding of cause and effect is at work.

4.4 Consumer Behaviour and Perception in Decision-Making

An examination of consumer psychology, decision-making processes, and how perception plays a key role in these decisions, especially in the hospitality industry.

4.4.1 Visual Perception

Eyesight as the main instrument of perception

The main components of visual reasoning include:

1. Perception: The ability to derive meaning from sensory input, including recognising shapes, patterns, colours, and decoding visual information.
2. Attention: Selectively focusing on specific visual information and filtering out irrelevant information.
3. Analysis: Breaking down visual information into its components and analyzing the relationships between them.
4. Drawing Conclusions: Synthesizing the visual information and making informed decisions based on the analysis.

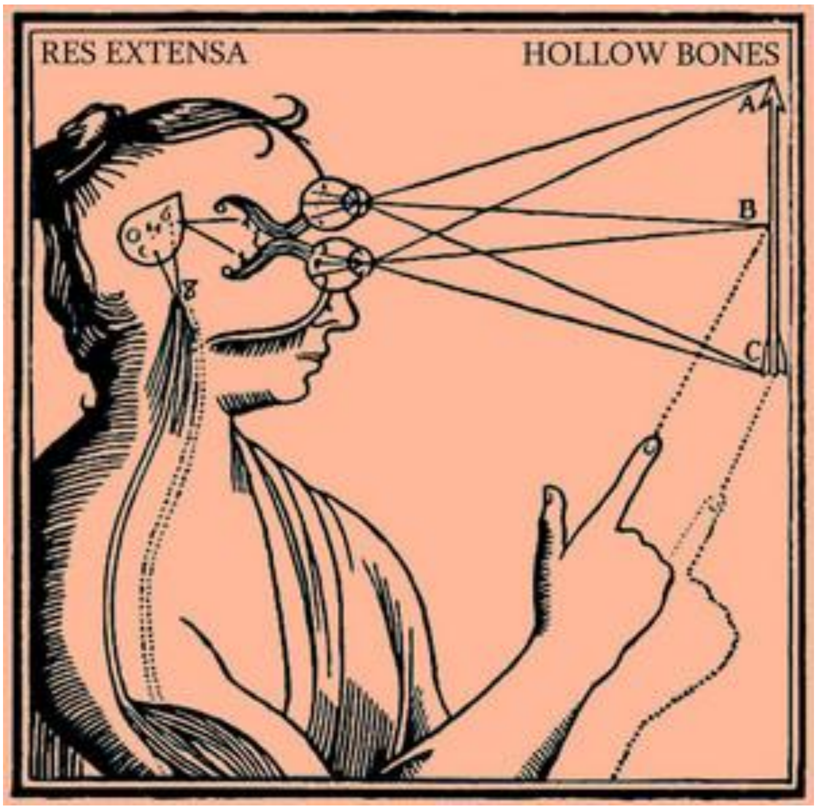

Figure 1Res Extensa, Descartes

Searching for answers can be likened to peering into the abyss, a concept that has fascinated thinkers for centuries. Friedrich Nietzsche famously remarked, "If you gaze long into an abyss, the abyss will gaze back into you," suggesting that deep exploration can have profound effects on the individual (Nietzsche, Beyond Good and Evil) (Nietzsche, 1986). This notion aligns with the perspective of Dr. Jordan Peterson, asserts that if looking into the abyss to long you may see the light (Peterson, Lex Friedman Podcast 2022).

The power of intentional gazing is explored by biologist Rupert Sheldrake, who conducted experiments revealing that focused observation can influence the object being observed, implying a connection between consciousness and the physical world (Sheldrake, The Sense of Being Stared At) (Sheldrake, 2003). Interestingly, even in the realm of law enforcement, the significance of the gaze is recognized, as FBI agents are trained not to maintain direct eye contact with individuals they are surveilling, to prevent telegraphing their intentions (Sheldrake, The Sense of Being Stared At).

René Descartes, also emphasized introspection and self-reflection to acquire knowledge. His scientific method, outlined in his Discourse on Method, involved scepticism, deductive reasoning, and careful observation to arrive at valid conclusions

(Descartes, Discourse on Method) (Descartes, 1985). Additionally, Descartes explored the role of memory in understanding the world, positing that memories are organized and can be recalled with practice and effort (Descartes, Discourse on Method) (Descartes, 1985).

Alexis Carrel sought to integrate science and spirituality, advocating for a holistic view of existence that encompassed both physical health and spiritual growth (Carrel, Man, the Unknown) (Carrel, 1935). Nick Lane's research on evolutionary biology sheds light on the origins of mitochondria, revealing the interconnectedness of organisms and their crucial role in sustaining life (Lane, 2015).

4.4.2 Res Extensa on prices

"Res Extensa," by René Descartes, refers to the concept of matter or several parallels. physical substance, dimensionality, emphasizing its extension in space. When attempting to understand complex systems like pricing through the analogy of visual perception.

Visual Perception and Pricing Analysis

1. Multidimensional Nature:
   - Visual Perception: Our visual system processes multiple dimensions simultaneously—colour, depth, motion, and form.
   - Pricing: Similarly, pricing involves various factors such as cost, demand, competition, perceived value, and market trends.
2. Integration of Information:
   - Visual Perception: The brain integrates sensory input from the eyes to create a coherent image of our surroundings.
   - Pricing: To determine the right price, businesses integrate information from market research, cost analysis, consumer behaviour, and competitor pricing.
3. Contextual Influence:

- Visual Perception: The perception of an object can change based on its context (e.g., lighting, surrounding objects).
- Pricing: Prices are also context-dependent. Factors like economic conditions, brand positioning, and seasonality can influence pricing decisions.

4. Adaptation and Learning:
    - Visual Perception: The visual system adapts to changes in the environment and learns to recognize patterns over time.
    - Pricing: Businesses must adapt to market changes and learn from past pricing strategies to refine their approach.
5. Subjectivity:
    - Visual Perception: Different people may perceive the same visual stimuli differently.
    - Pricing: Perceived value varies among consumers, leading to a different willingness to pay for the same product.
6. Focus and Attention:
    - Visual Perception: We selectively focus on certain elements within our field of vision while ignoring others.
    - Pricing: Companies must focus on key pricing elements (like cost structure or value proposition) and may strategically ignore less critical factors.

Practical Applications of Visual Perception Concepts in Pricing

1. Segmentation:
    - Just as the visual system segments scenes into objects, pricing strategies can segment markets into different customer groups, each with tailored pricing.
2. Dynamic Pricing:
    - Like our vision adapts to changing light conditions, dynamic pricing adjusts prices based on real-time supply and demand.

3. Psychological Pricing:
    - Similar to optical illusions that trick the eye, psychological pricing (e.g., 9.99 vs. 10.00) influences perception and consumer behaviour.
4. Data Visualization:
    - Effective data visualization in pricing analysis helps in comprehending complex data, akin to how visual perception aids in understanding complex environments.
7. Conclusion

Understanding pricing through the lens of visual perception involves recognizing the multidimensional, integrative, contextual, adaptive, subjective, and focused nature of both processes, applying these principles, businesses can develop more nuanced and effective pricing strategies that respond to the complexities of the market environment.

4.4.3 Conscious agents

Cognitive scientist Donald D. Hoffman challenges traditional approaches to visual representation and perception. According to the Hoffman Method, our perceptions are not accurate representations of the external world but are instead a species-specific interface designed to guide our behaviour and survival (Hoffman, 2019). Representing conscious agents using the Hoffman Method would involve focusing on the interface aspects rather than attempting to depict an objective reality. One way to approach it:

1. Iconic Symbols: Use abstract or iconic symbols to represent conscious agents instead of realistic depictions. These symbols should convey the essential information required for interaction and understanding without attempting to faithfully replicate the physical appearance.
2. Symbolic Interaction: Instead of representing explicit visual stimuli or objects, focus on the symbolic interactions that conscious agents engage in. Use arrows, lines, and diagrams to represent the flow of information, attention, and decision-making processes between different components of the agent's interface.
3. Interface Layers: Visualize conscious agents as a series of interface layers or filters. Each layer can represent a different level of abstraction or information

processing, such as sensory input, attentional filters, cognitive models, and behavioural outputs. Use graphical elements to show how these layers interact and shape the agent's perception and behaviour.

4. Perception-Action Loops: Highlight the reciprocal relationship between perception and action by depicting feedback loops between the agent and its environment. Show how the agent's actions and behaviour influence the incoming sensory information, and how updated perceptions guide subsequent actions.
5. Interactive Demonstrations: Develop interactive demonstrations or simulations that allow users to experience the limitations and biases of conscious agents based on the principles of the Hoffman Method. These demonstrations can help users understand the concept of interface-based perception and engage with the underlying ideas.

Conscious agents refer to entities that possess subjective experiences, awareness, and the ability to make decisions or take actions based on their internal states and external stimuli. These agents are considered to have a certain level of consciousness, enabling them to perceive, process information, and exhibit intentional behaviours.

One prominent framework for understanding conscious agents is the Integrated Information Theory (IIT) proposed by Giulio Tononi. According to IIT, consciousness arises from the integration of information within a system, with higher levels of consciousness corresponding to higher degrees of information integration. (Tononi, 2004)

Conscious agents can be found in various forms, ranging from simple organisms like insects to complex systems such as human beings. They can also be artificial entities like robots or computer programs designed to exhibit cognitive processes and conscious-like behaviours.

The study of conscious agents encompasses various disciplines, including neuroscience, cognitive science, psychology, philosophy of mind, and artificial intelligence.

4.4.3.1 *Perceptions formula*

To conceptualize a formula that captures the essence of Donald Hoffman's theory of perception with multiple conscious agents, we can start by defining a few key variables and relationships:

1. Conscious Agents (C): Denoted as Ci, where i indexes each conscious agent in the .
2. Perception (P): The perceptual experience of a conscious agent, which is influenced by interactions with other agents and the environment.
3. Interactions (I): The influence or interaction between conscious agents Ci and Cj.

A general formula might look like this:

$$P = f(Ci, \{Cj\}, E)$$

where:

- P is the perception of conscious agent Ci,
- {Cj} represents the set of other conscious agents interacting with Ci,
- E represents the environment or context within which the interactions occur,
- f is a function that models how Ci's perception is shaped by its interactions with other agents and the environment.

In practice, this formula is highly abstract and would need to be specified with particular functional forms and parameters to be useful. For instance, f could incorporate aspects such as:

- Communication or influence strength between agents (e.g., how much the perception of Ci is influenced by Cj),
- Perceptual filters unique to each conscious agent (e.g., biases, preferences),
- Contextual factors from the environment that might alter the perception.

The actual implementation of this formula would depend on the specifics of how conscious agents and their interactions are modelled, and how these models map onto perceptual experiences.

A more detailed and generalized formula:

- Ci be the i-th conscious agent.
- Pi is the perception of conscious agent Ci.
- {Cj} represent the set of all other conscious agents interacting with Ci.
- E represent the environment or context.
- We can model the perception Pi of agent Ci as a function of its interactions with all other agents Cj and the environment E. The formula could be written as:

$$Pi = f(Ci, \int_0^T \sum_{j \neq 1} Wij(t)\, II_{ij}\, (t) d(t), E)$$

- ∑ represents the aggregate influence or interaction from all other conscious agents Cj on Ci,

- Iij denotes the interaction strength or influence from agent Cj on Ci,
- f is a function that combines the effects of these interactions and the environment on the perception of Pi.

In more detail:

- **Interactions Iij**: Could be modelled as a matrix or set of values representing how Cj influences Ci. This could include direct communication, social influence, or other forms of interaction.
- **Environment E**: Could include factors like external stimuli, context, or situational factors that affect perception.

4.4.3.2 A Markovian Decision-Making model by conscious agents with multiple levels.

Decision-making can be framed as the process of transitioning from one state (level) to another over time.

Explanation and a formula for decision-making by five multiple-conscious agents using a Markovian model:

Markovian Model Explanation:

1. States (Levels): We have five states (levels), which represent the different cognitive or decision-making states of conscious agents. These states could represent different thought processes, beliefs, or decision strategies.
2. State Transitions: Agents move between these states over time. The transition from one state to another is determined by transition probabilities. These probabilities represent how likely an agent is to switch from one cognitive state to another in a given time step.
3. Initial State: At the start, agents begin in one of the states as their initial cognitive state.
4. Markov Property: The Markov property implies that the future state of an agent depends only on its current state and not on the sequence of states that preceded it. In other words, the transition probabilities are constant over time.

Markovian Model Formula:

Let's denote the five states as State 1, State 2, State 3, State 4, and State 5. We can represent the transition probabilities between these states using a transition matrix, denoted as P.

$$
\begin{array}{ll}
P & |\, P11 \;\; P12 \;\; P13 \;\; P14 \;\; P15 \,| \\
 & |\, P21 \;\; P22 \;\; P23 \;\; P24 \;\; P25 \,| \\
 & |\, P31 \;\; P32 \;\; P33 \;\; P34 \;\; P35 \,| \\
 & |\, P41 \;\; P42 \;\; P43 \;\; P44 \;\; P45 \,| \\
 & |\, P51 \;\; P52 \;\; P53 \;\; P54 \;\; P55 \,|
\end{array}
$$

In this matrix:

- Pij represents the probability of transitioning from State i to State j.

To compute the probability of being in each state at a given time step t, we can use the following formula:

X(t+1) = X(t) * P

Here:

- X(t) is a row vector representing the probabilities of being in each state at time t.
- X(t+1) is the row vector of probabilities at the next time step t+1.
- P is the transition matrix.

You can start with an initial probability vector X(0) representing the initial state of the agents and then iterate this formula over time to observe how the agents' decision-making states evolve.

This Markovian model allows to analyse and simulate the decision-making process of conscious agents with multiple levels, capturing how they transition between different cognitive states based on predefined transition probabilities. The specific transition probabilities (Pij values) would need to be determined based on the characteristics of the agents and the context of their decision-making.

Let's consider an example where the states represent different levels of certainty in a decision-making process, where:

- State 1 represents "No" (high certainty of a negative decision).
- State 2, State 3, and State 4 represent "Maybe" (varying levels of uncertainty).
- State 5 represents "Yes" (high certainty of a positive decision).

We'll define a transition matrix P to represent how an agent's certainty level evolves over time. In this example, we'll make some simplifications and assume the following transition probabilities for a single time step:

- The probability of staying in the same state is relatively high.
- There's a chance of moving to adjacent states (e.g., from "No" to "Maybe" or "Maybe" to "Yes").

- The probability of making a big jump (e.g., from "No" to "Yes") is relatively low.

A transition matrix P:

P = | 0.7 0.2 0.1 0.0 0.0 |

| 0.1 0.6 0.2 0.1 0.0 |

| 0.0 0.2 0.6 0.2 0.0 |

| 0.0 0.0 0.2 0.6 0.1 |

| 0.0 0.0 0.0 0.2 0.8 |

In this matrix:

- The diagonal values (from the top-left to the bottom-right) represent the probabilities of staying in the same state (certainty level).
- The off-diagonal values represent the probabilities of transitioning to adjacent states.

To simulate how an agent's certainty level evolves, we start with an initial probability vector X(0) where the agent is in a "No" state with high certainty:

X(0) = | 1.0 0.0 0.0 0.0 0.0 |

Now, we can use the formula X(t+1) = X(t) * P to calculate the agent's certainty level at the next time step (t+1) and so on. After several time steps, the agent's certainty level may evolve like this:

Time Step 1:

X(1) = X(0) * P

X(1) = | 0.7 0.2 0.1 0.0 0.0 |

Time Step 2:

X(2) = X(1) * P

X(2) = | 0.49 0.28 0.16 0.05 0.02 |

...

Time Step N:

X(N) = ... (continue iterating)

As time progresses, the agent's certainty level may transition from "No" to "Maybe" and eventually to "Yes" with varying levels of uncertainty in between. This model captures how the agent's decision-making evolves, moving from a high-certainty negative decision ("No") to a high-certainty positive decision ("Yes") with some uncertainty ("Maybe") in between.

4.4.4 Verveke on perception

John Vervaeke is a cognitive scientist who has contributed significantly to the study of perception. Vervaeke's theory of perception is based on the idea that perception is not a passive process but an active one. According to Vervaeke, perception is not just a matter of receiving sensory inputs and processing them but also involves top-down processes such as attention, memory, and intention.

One of the key concepts in Vervaeke's theory of perception is the idea of "reciprocal narrowing." This refers to how perception is influenced by *attention and intention.* In other words, the more we focus our attention on something, the more we "narrow" our perception to that thing, and the less we notice other things in our environment. This narrowing effect is reciprocal, meaning that it is influenced by both top-down processes such as attention and bottom-up processes such as sensory inputs.

Another important aspect of Vervaeke's theory of perception is the role of memory in perception. Vervaeke argues that memory is not just a passive store of information but an active process that helps to shape our perception of the world. Our memories influence the way we perceive new information, and our perceptions, in turn, influence the way we remember things. This means that our perception of the world is constantly being shaped and reshaped by our memories and experiences. Intention refers to our goals, desires, and motivations. According to Vervaeke, our intentions can influence the way we perceive the world by directing our attention and shaping our expectations. For example, if we are looking for something specific, we are more likely to notice it in our environment than if we were not actively searching for it.

By understanding these processes, we can gain a deeper insight into how we perceive the world and how perceptions are shaped by experiences and goals.

Quotes from John Vervaeke's :

1. "Attention is the gateway to perception, and perception is the foundation of our knowledge of the world" - from "Awakening from the Meaning Crisis" (page 91).
2. "Memory is not simply a record of the past, but an ongoing and active process that shapes our present and future" - from "Zombies in Western Culture: A Twenty-First Century Crisis" (page 37).
3. "Perception is not a mirror of reality, but an active and dynamic process that is shaped by our intentions, goals, and expectations" - from "The Meaning Crisis: The Essential Ideas and Patterns of Knowledge That Are Transforming Our World" (page 97).
4. "We do not just see the world, but we actively construct a model of it that is influenced by our experiences, expectations, and beliefs" - from "The Cognitive Science of Wisdom" (page 40).
5. "Our attention is not just directed outward, but also inward, as we reflect on our experiences and try to make sense of them" - from "The Cognitive Science of Wisdom" (page 36).

4.4.5 Kahneman and Tversky: The Role of Perception in Decision-Making

Daniel Kahneman and Amos Tversky's revealed that human decisions are not purely rational but are often driven by cognitive biases and heuristics. (Kahneman D. &., 1979) These insights are especially relevant in understanding consumer behaviour and how perception influences economic choices, particularly regarding pricing.

A major framework introduced by Kahneman in *Thinking, Fast and Slow* (Kahneman D. , 2011)is the distinction between System 1 and System 2 thinking. System 1 is fast, intuitive, and automatic, guiding most everyday decisions without much conscious effort. System 2, on the other hand, is slower, more deliberative, and analytical. Consumers often rely on System 1 when making quick purchasing decisions, meaning they are susceptible to cognitive biases such as anchoring, framing, and loss aversion. System 2 is employed when more complex or critical decisions are required, but it is often overridden by the faster, more instinctual System 1.

One of Kahneman and Tversky's key contributions to the study of perception is loss aversion, which is rooted in System 1 thinking. They found that people tend to perceive losses as more painful than equivalent gains are pleasurable. This asymmetry significantly impacts consumer decision-making, as individuals are more motivated to avoid perceived losses than to pursue equivalent gains. For example, a consumer may react more strongly to a potential price increase than to a corresponding discount, even if both changes have the same net effect.

Another bias rooted in System 1 thinking is the anchoring effect, where people rely too heavily on the first piece of information (the "anchor") when making decisions. In consumer behaviour, price anchors can significantly shape perceptions of value. For instance, when a high price is initially shown for a product, any subsequent lower price will seem like a better deal, even if it still exceeds the product's actual worth. This tactic is often used in retail to influence buyers by showing a "regular" price that anchors their perception before a discount is applied.

Kahneman and Tversky also highlighted the importance of framing effects, where the way information is presented influences decision-making. For example, consumers might perceive "10 off" a product differently than "10% off," even if the actual savings are the same. This bias reflects the intuitive nature of System 1, which is more sensitive to how options are framed than to actual numerical calculations, which would be processed by System 2.

Understanding these biases is crucial for businesses, particularly in pricing strategies leveraging insights from System 1 and System 2 thinking, companies can design more effective pricing models, promotional campaigns, and sales strategies that tap into consumers' intuitive decision-making processes. For example, framing a price discount to avoid the perception of loss or using price anchoring can significantly affect how consumers perceive the value of a product or service.

4.5 Perception of quality

Quality is perceived in various ways, and it can be subjective, context-dependent, and multifaceted. How quality is perceived often depends on the specific product, service, or context in question. Here are some key factors that contribute to the perception of quality:

1. Functionality and Performance: In many cases, the most basic measure of quality is whether a product or service performs its intended function effectively and consistently. For example, a high-quality car should run smoothly and reliably.
2. Durability and Reliability: The longevity and dependability of a product or service can greatly influence how it is perceived. Items that are built to last and perform consistently over time are generally considered of higher quality.
3. Aesthetics: Visual appeal and design can significantly impact the perception of quality, especially for products like clothing, furniture, or consumer electronics. People often associate well-thought-out design with higher quality.
4. Craftsmanship: For handmade or artisanal products, the level of skill and attention to detail in the craftsmanship can be a key factor in quality perception. Handmade items are often perceived as higher quality due to the care and skill invested in their creation.
5. Price: While not always accurate, people often associate higher prices with higher quality. A more expensive item may be perceived as higher quality because it is assumed to use better materials or have more advanced features.
6. Brand Reputation: Established brands with a history of producing high-quality products or services often benefit from a positive perception of quality. Consumers trust these brands based on their reputation.
7. User Experience: The ease of use, convenience, and overall experience of using a product or service can greatly influence its perceived quality. User-friendly interfaces and intuitive interactions can enhance quality perception.
8. Customer Reviews and Word of Mouth: People often rely on the experiences and opinions of others to gauge the quality of a product or service. Positive reviews and recommendations from friends or online communities can boost quality perception.

9. Compliance with Standards: In some industries, adherence to specific quality standards and certifications can be an objective measure of quality. For example, ISO certifications for manufacturing processes.
10. Personal Preferences: Individual preferences play a significant role in quality perception. What one person considers high quality, another may not. This is particularly true for subjective categories like food, art, and entertainment.
11. Context: The context in which a product or service is used can influence how quality is perceived. For example, a smartphone may be considered high quality for personal use but not suitable for professional photography.
12. Ethical and Sustainable Practices: Increasingly, consumers factor in ethical and sustainability considerations when assessing quality. Products and services that align with values like environmental responsibility or fair labour practices are often viewed more positively.

Ultimately, quality perception is a complex interplay of these factors, and it can vary from person to person and situation to situation. Companies and individuals seeking to convey quality should consider these factors and tailor their offerings accordingly to meet the expectations and preferences of their target audience.

4.6 Hospitality Biases over Perception

Category biases in hotel accommodation refer to the tendencies or predispositions that travellers have towards certain types of hotels based on various factors. These biases can influence their choices and perceptions. Here are some common category biases in hotel accommodation:

1. Star Ratings Bias
    - Preference for Higher Ratings: Travelers often prefer hotels with higher star ratings, associating them with better quality, service, and amenities (Ye, Law, & Gu, 2009).
    - Skepticism of Lower Ratings: Hotels with lower star ratings might be perceived as inferior, even if they offer excellent value for money (Li, Ye, & Law, 2013).

2. Brand Bias
   - Loyalty to Known Brands: Many travelers prefer staying with well-known hotel chains due to brand loyalty and the expectation of consistent quality and service (O'Neill & Mattila, 2010).
   - Reluctance to Try Independent Hotels: Independent or lesser-known hotels might be overlooked, despite potentially offering unique and high-quality experiences (Dolnicar & Otter, 2003).
3. Location Bias
   - City Center Preference: Hotels located in city centers or prime locations are often favored for their convenience and accessibility to attractions, business centers, and transportation (Tang, 2014).
   - Avoidance of Outskirts: Hotels on the outskirts or in less popular areas might be avoided, even if they offer better rates and amenities (Yang, Wong, & Wang, 2012).
4. Price Bias
   - High Price Equals Quality: There is a common belief that more expensive hotels provide better quality and service, leading some travelers to prefer higher-priced options (Sparks & Browning, 2011).
   - Budget Consciousness: Conversely, budget travelers might prioritize cost over quality, often selecting the cheapest available option (Huang & Chen, 2015).
5. Type of Accommodation Bias
   - Preference for Traditional Hotels: Some travelers prefer traditional hotels over alternative accommodations like boutique hotels, hostels, or vacation rentals (Guttentag, 2015).
   - Skepticism of Non-Traditional Options: Alternative accommodations might be viewed with skepticism regarding safety, quality, and service (Tussyadiah & Pesonen, 2016).
6. Review Bias

- Heavily Influenced by Reviews: Travelers often rely heavily on online reviews and ratings, with hotels having more positive reviews generally preferred (Sparks & Browning, 2011).
- Negative Impact of Few or Bad Reviews: Hotels with few or negative reviews might be avoided, even if the reviews do not fully reflect the current state of the hotel (Xie, Zhang, & Zhang, 2014).

7. Facility and Amenity Bias
    - Desire for Specific Amenities: Travelers might prefer hotels that offer certain amenities such as free Wi-Fi, breakfast, swimming pools, gyms, and business centers (Verma, Stock, & McCarthy, 2012).
    - Overlooking Other Qualities: Hotels lacking these specific amenities might be overlooked, even if they excel in other areas (Narangajavana, 2007).
8. Service and Experience Bias
    - Emphasis on Service Quality: High importance is often placed on the perceived level of service and guest experience (Choi & Chu, 2001).
    - Ignoring Small or New Hotels: Smaller or newly established hotels might be ignored due to the assumption that they cannot provide the same level of service as established ones (Matzler & Pechlaner, 2001).
9. Cultural and Regional Bias
    - Preference for Familiar Cultures: Travelers might prefer hotels that cater to their cultural preferences, including language, cuisine, and customs (Huang & Crotts, 2019).
    - Avoidance of Unfamiliar Regions: Hotels in regions or cultures unfamiliar to the traveler might be avoided, even if they offer unique and enriching experiences (Mok & DeFranco, 2000).
10. Mitigating Category Biases

To mitigate these biases, hotels can:

Provide Comprehensive Information: Detailed descriptions, high-quality photos, and virtual tours can help counteract biases.

Encourage and Highlight Reviews: Positive guest reviews and testimonials can build trust and attract more guests (Sparks & Browning, 2011).

Promote Unique Selling Points: Emphasize unique features, local experiences, and personalized services.

Offer Competitive Pricing and Packages: Attractive deals and packages can appeal to budget-conscious travellers while highlighting value.

Engage in Brand Building: Building a strong brand identity and reputation can reduce the impact of brand and star rating biases.

Understanding these biases can help hoteliers better market their properties and appeal to a broader range of travellers.

4.7 Decision Making

In the realm of consumer decision-making, adopting a focused perspective akin to looking in one direction can be incredibly powerful. By narrowing our gaze to a specific set of criteria or preferences, we can filter through the myriad of options available to us and hone in on what truly matters in our purchasing journey.

The importance of having a clear and defined set of criteria or preferences when searching for a product or service to buy. By looking in one direction metaphorically, we're directing our attention towards the factors that are most relevant to our needs and desires. This focused approach helps us avoid distractions and make more informed and satisfying purchasing decisions.

4.7.1 Consumer Higher Values

Known as consumer values or personal values, represent the fundamental beliefs and principles that guide an individual's behaviour, choices, and preferences. These values can vary from person to person and often play a significant role in consumer decision-making. Here are some commonly recognized consumer higher values:

1. Quality: Some consumers prioritize high-quality products or services and are willing to pay more for superior craftsmanship, durability, or performance.
2. Price Sensitivity: Others may value cost-effectiveness and seek the best deals, discounts, or value for their money.
3. Sustainability: Increasingly, consumers are concerned about the environment and seek products and brands that prioritize eco-friendliness, sustainability, and responsible sourcing.
4. Ethical and Social Responsibility: Consumers may value companies that demonstrate ethical business practices, social responsibility, and fair treatment of employees and communities.
5. Health and Wellness: Many consumers prioritize products and services that contribute to their health and well-being, including organic foods, fitness products, and wellness services.
6. Convenience: Convenience-driven consumers seek products and services that save time and simplify their lives, such as fast-food delivery or one-click online shopping.
7. Innovation: Some consumers are drawn to innovative and cutting-edge products and technologies, often embracing early adoption of new trends.
8. Tradition and Heritage: Others may place importance on tradition, heritage, and cultural values, preferring products and experiences that reflect their cultural background.
9. Individualism: Individualistic consumers value uniqueness and personal expression, often seeking customized or one-of-a-kind products.
10. Community and Relationships: Some consumers prioritize building and maintaining relationships and may favour brands or products that facilitate social connections.

11. Adventure and Exploration: Adventure-seekers value experiences and products that offer excitement, exploration, and a sense of adventure.
12. Education and Learning: Consumers interested in personal growth and knowledge may prioritize products, services, and experiences that support learning and self-improvement.
13. Family and Relationships: Family-oriented consumers place a strong emphasis on family values, relationships, and products that benefit their loved ones.
14. Security and Safety: Safety-conscious consumers prioritize products and services that provide security, protection, and peace of mind.
15. Freedom and Autonomy: Some individuals highly value independence and autonomy, seeking products and experiences that allow them to make their own choices.

It's essential to note that these values can coexist within an individual, and their importance can vary depending on the context and the specific decision being made. Understanding consumer values is crucial for businesses to tailor their products, marketing messages, and customer experiences to align with consumers' personal values and preferences.

4.7.2 Internal values

Known as personal values or intrinsic values, are the core principles and beliefs that guide an individual's thoughts, behaviours, and decision-making. These values are deeply ingrained and serve as a foundation for a person's ethical, moral, and personal compass. Internal values often shape how individuals interact with the world around them and influence their priorities and life choices. Here are some common examples of internal values:

1. Integrity: A commitment to honesty, truthfulness, and ethical behavior in all situations.
2. Authenticity: Being true to oneself and living in a way that aligns with one's beliefs and identity.

3. Compassion: A strong sense of empathy and a desire to help others, often characterized by kindness and understanding.
4. Respect: Treating all individuals with dignity and consideration, regardless of their background or beliefs.
5. Courage: The willingness to face challenges, take risks, and confront adversity with strength and determination.
6. Responsibility: A sense of duty and accountability for one's actions and their impact on others and the environment.
7. Justice: A commitment to fairness, equality, and the promotion of a just society.
8. Gratitude: A recognition and appreciation for the positive aspects of life, along with a willingness to express thanks.
9. Humility: A modest and unpretentious approach to life, coupled with an openness to learning from others.
10. Empathy: The ability to understand and share the feelings of others, often leading to a desire to support and uplift those in need.
11. Generosity: A willingness to give freely of one's resources, time, and energy to help others and contribute to the well-being of society.
12. Forgiveness: The capacity to let go of resentment and anger, choosing to grant pardon and move forward.
13. Self-discipline: The ability to control one's impulses and desires in pursuit of long-term goals and personal growth.
14. Perseverance: A determination to persist in the face of challenges and setbacks, often driven by a strong sense of purpose.
15. Simplicity: A preference for a minimalistic and uncomplicated lifestyle, valuing the essentials over material excess.

Internal values vary from person to person and can evolve over time as individuals gain new experiences and perspectives. They play a significant role in shaping an individual's identity, relationships, and decision-making processes. Understanding one's internal values can help in making choices that align with personal beliefs and lead to a more fulfilling and purposeful life. Additionally, organizations and institutions often have their own set of values, which may align with or differ from an individual's internal values, influencing how individuals interact with those environments.

Supposing we have to make a model based on a combination of 13 internal values, using combinatorics to calculate the total number of possible consumer profiles. Each consumer profile represents a unique combination of internal values. :

1. Create a List of Internal Values: First, list the 13 internal values you want to consider, such as Integrity, Authenticity, Compassion, and so on.
2. Determine the Number of Options for Each Value: For each internal value, consider how many options or levels it can have. For example, for "Integrity," you might have two levels: "High Integrity" and "Low Integrity."
3. Calculate the Total Number of Combinations: To find the total number of possible consumer profiles, you need to multiply the number of options for each internal value together. This is done using the product rule in combinatorics.

Total Number of Combinations = (Options for Value 1) x (Options for Value 2) x ... x (Options for Value 13)

For example, if each internal value has two options (High and Low), the calculation would be:

Total Number of Combinations = 2^13 = 8,192

So, we can have 8,192 different types of consumers based on these 13 internal values, assuming each value can have two options.

It's important to note that this calculation assumes that each internal value is binary (e.g., High or Low). If the internal values can have more than two levels or if they can take on continuous values, the number of possible consumer profiles would increase significantly.

Consumers are complex, and their values may not be strictly binary or independent of each other. Additionally, there may be correlations or interactions between different values that influence consumer behaviour. Therefore, this calculation provides a theoretical estimation of the number of potential consumer profiles based on the specified internal values but may not fully capture the complexity of real-world consumer behaviour.

4.7.2.1 *Decision-making by Values*

The goal is to create a linear equation that can predict decision-making based on the values of these independent variables

$$Decision\ Making = \beta 0\ +\ \beta 1\ *\ Internal\ Personal\ Higher\ Values\ +\ \beta 2\ *\ External\ Values\ +\ \varepsilon$$

In this equation:

- Decision-Making is the dependent variable you want to predict.
- Internal Personal Higher Values is the first independent variable.
- External Values is the second independent variable.
- β0 is the intercept, which represents the value of Decision-Making when both independent variables are zero.
- β1 is the coefficient for Internal Personal Higher Values, indicating how much Decision-Making is expected to change for a one-unit change in Internal Personal Higher Values while holding External Values constant.
- β2 is the coefficient for External Values, indicating how much Decision-Making is expected to change for a one-unit change in External Values while holding Internal Personal Higher Values constant.
- ε represents the error term, accounting for unexplained variability in Decision-Making.

The coefficients β1 and β2 can be positive or negative. A positive coefficient means that an increase in the corresponding independent variable is associated with an increase in decision-making, while a negative coefficient indicates a decrease in decision-making as the independent variable increases.

By using statistics and a dataset that includes observations of Decision-Making, Internal Personal Higher Values, and External Values. The regression analysis will provide you with the estimated values of β0, β1, and β2 based on your data, which you can then use to make predictions about decision-making for new observations.The quality of regression model depends on the quality and relevance of data, the assumptions of linear regression, and the presence of other potential variables that may influence decision-making. Additionally, it's important to interpret the coefficients in the context of specific problems and domain knowledge.

In order to extend the linear regression model to include multiple levels or factors affecting decision-making by conscious agents, we modify the equation to accommodate these additional independent variables. Let's create an example with five independent variables, each representing a different level or factor:

$$Decision - Making = \beta 0 + \beta 1 * Level1 + \beta 2 * Level2 + \beta 3 * Level3 + \beta 4 * Level4 + \beta 5 * Level5 + \varepsilon$$

In this extended equation:

- Decision-making is still the dependent variable you want to predict.
- Level1, Level2, Level3, Level4, and Level5 represent the five different levels or factors that influence decision-making.
- β0 is the intercept, representing the value of Decision-Making when all independent variables are zero.
- β1 to β5 are the coefficients for each level or factor, indicating how much Decision-Making is expected to change for a one-unit change in each level while holding the others constant.
- ε represents the error term, accounting for unexplained variability in Decision-Making.

As before, the coefficients β1 to β5 can be positive or negative, indicating the direction and strength of the relationship between each level and decision-making. Positive coefficients mean that an increase in the corresponding level is associated with an increase in decision-making, while negative coefficients imply a decrease in decision-making as the level increases.

To estimate these coefficients, is needed a dataset that includes observations of Decision-Making, as well as the values of Level1, Level2, Level3, Level4, and Level5 for each conscious agent.

4.7.3 Probability of sales

Let's say we have different prices p1, p2, p3, ..., pn for different types of customers c1, c2, c3, ..., cn, and we want to calculate the probability of making a sale to each of the customer types.

Let's assume that we have the following prices and probabilities of making a sale for each customer type:

Price p1 is offered to customers of type c1 with a 10% chance of a sale

Price p2 is offered to customers of type c2 with a 30% chance of a sale

Price p3 is offered to customers of type c3 with a 40% chance of a sale

...

Price pn is offered to customers of type cn with a probability of psale(cn)

To calculate the probability of making a sale to each customer type, we can use a similar formula as before:

$P(cn \cap s) = P(s|cn) * P(cn)$

where:

P(cn) is the probability of targeting customers of type cn

P(s|cn) is the probability of making a sale given that we target customers of type cn

$P(cn \cap s)$ is the probability of making a sale to customers of type cn

We can calculate the probability of making a sale to each customer type using the above formula, and then calculate the total probability of making a sale across all customer types as follows:

$P(s) = P(c1 \cap s) + P(c2 \cap s) + P(c3 \cap s) + ... + P(cn \cap s)$

For example, using the given probabilities, we can calculate the probability of making a sale to customers of type c1 as:

$P(c1 \cap s) = P(s|c1) * P(c1) = 0.1 * P(c1)$

Similarly, we can calculate the probability of making a sale to customers of type c2 as:

$P(c2 \cap s) = P(s|c2) * P(c2) = 0.3 * P(c2)$

And the probability of making a sale to customers of type c3 as:

$P(c3 \cap s) = P(s|c3) * P(c3) = 0.4 * P(c3)$

And so on, for all customer types.

Once we have calculated the probability of making a sale to each customer type, we can calculate the total probability of making a sale across all customer types as:

$P(s) = P(c1 \cap s) + P(c2 \cap s) + P(c3 \cap s) + ... + P(cn \cap s)$

For example, if we have 5 customer types and we have calculated the probability of making a sale to each type as follows:

$P(c1 \cap s) = 0.1 * P(c1)$

$P(c2 \cap s) = 0.3 * P(c2)$

$P(c3 \cap s) = 0.4 * P(c3)$

$P(c4 \cap s) = 0.2 * P(c4)$

$P(c5 \cap s) = 0.5 * P(c5)$

Then the total probability of making a sale would be:

$$P(s) = P(c1 \cap s) + P(c2 \cap s) + P(c3 \cap s) + P(c4 \cap s) + P(c5 \cap s) = 0.1 * P(c1) + 0.3 *P(c2) + 0.4 * P(c3) + 0.2 * P(c4) + 0.5 * P(c5)$$

4.8 A Theoretical Exploration of Money, Pricing, and Signalling

A theoretical exploration of money's evolution, the role of signalling, and how these principles relate to pricing in hospitality.

4.8.1 The Nature and Evolution of Money

Money, often described as encapsulated energy, plays a pivotal role in facilitating exchanges between individuals, businesses, and societies. It acts as a conduit through which value is transferred, serving as a medium that enables economic transactions across time and space. As Aristotle wisely noted, "Money is an instrument of change, not wealth itself" (Aristotle, Nicomachean Ethics). This distinction highlights money's role as a tool that facilitates the movement of value rather than being an end in itself. It provides a bridge for economic interactions, allowing societies to evolve beyond simple barter systems.

Milton Friedman similarly observed, "Money makes possible the exchange of goods and services at convenient locations and times" (Friedman, 1974). His statement emphasizes the utility of money in creating efficient markets serving as a universally accepted medium of exchange, money streamlines transactions and ensures that all parties involved can benefit. As an economic lubricant, money minimizes friction and enables more complex forms of trade.

Money: A Token of Exchange

One prominent theory of money regards it as a token of exchange. From this perspective, money holds no intrinsic value but operates as a universally accepted symbol through which people facilitate transactions. Economists and philosophers throughout history have built upon this understanding.

Adam Smith, in The Wealth of Nations, articulated the idea that money arose to eliminate the inefficiencies of barter. He argued that money's real value lies in its ability to be accepted in exchange for goods and services, thus simplifying trade and economic activity (Smith, 1776). Smith's work remains foundational to understanding how money functions as a medium of exchange, primarily as a tool of convenience and efficiency.

Friedrich Hayek introduced the concept of spontaneous order, explaining how money evolves from decentralized, voluntary exchanges between individuals. Hayek contended that money was not imposed by governments but emerged naturally to meet the needs of traders seeking efficiency and reliability in transactions (Hayek, 1976). This perspective positions money as a social institution that arises from collective human behaviour, rather than top-down design.

John Maynard Keynes contributed to this theory with his liquidity preference concept, which asserts that individuals hold money primarily for its liquidity and transactional convenience. Keynes argued that money serves as a reservoir of purchasing power, with its demand driven by its role in facilitating exchanges and satisfying immediate transactional needs (Keynes, 1936). This focus on money’s utility for day-to-day transactions underscores its function as a token for the exchange of value.

Collectively, these theories portray money as a medium of exchange, whose value is determined by its broad acceptance and utility in enabling economic transactions. Its worth is not derived from its physical form but from the social agreement that grants it value.

Properties of Money in Modern Times: Insights from Robert Breedlove

As economies evolve, the properties of money have also adapted, especially with the rise of digital currencies. Robert Breedlove, a thinker in financial philosophy, has explored the properties of money extensively, particularly in the context of Bitcoin. According to Breedlove, money functions as an essential technology underpinning civilization, and its properties must meet specific criteria to be effective. In modern times, Breedlove identifies seven key properties that define sound money:

1. Durability
   For money to serve as a store of value, it must withstand the test of time. Breedlove highlights how gold, with its historical resilience, and Bitcoin, with its immutable digital structure, are durable stores of value. In contrast, fiat currencies often degrade through inflation and devaluation (Breedlove, 2020).

2. Divisibility

   Money must be easily divisible into smaller units to facilitate transactions of varying sizes. Breedlove points to Bitcoin's ability to be divided into satoshis (1/100,000,000 of a Bitcoin) as an example of near-perfect divisibility, which enhances its practicality for a wide range of economic activities (Breedlove, 2020).

3. Portability

   Portability is another critical property, ensuring that money can be easily transferred across distances. Traditional assets like gold, though valuable, are cumbersome to move. Breedlove argues that Bitcoin surpasses all traditional forms of money in terms of portability, as it can be transferred globally with minimal effort and cost (Breedlove, 2020).

4. Recognizability

   Money must be easily recognizable to ensure authenticity and prevent fraud. Bitcoin's blockchain technology ensures a transparent and verifiable system of legitimacy, providing a clear advantage over fiat currencies, which rely on central authorities for verification (Breedlove, 2020).

5. Scarcity

   Scarcity is the most critical property of money. Historically, gold's value has been maintained due to its scarcity and difficulty to mine. Breedlove argues that Bitcoin takes this property to the next level with its fixed supply of 21 million coins, establishing an unprecedented form of absolute scarcity (Breedlove, 2020).

6. Censorship Resistance

   In an increasingly digital world, the ability to resist censorship is vital. Unlike fiat currencies, which can be controlled or confiscated by governments, Bitcoin is decentralized and operates without the need for permission from any authority, allowing individuals to transact freely (Breedlove, 2020).

7. Programmability

   Bitcoin and other digital currencies introduce programmability, a modern feature of money that allows for smart contracts, automated transactions, and other innovations. This property expands the potential use cases of money beyond simple exchange, making it a versatile tool for the digital economy (Breedlove, 2020).

Breedlove’s framework for evaluating the properties of money provides a modern lens through which to understand the evolution of money. As digital currencies gain prominence, these characteristics—durability, divisibility, portability, recognizability, scarcity, censorship resistance, and programmability—offer a comprehensive way to assess the utility and future potential of different forms of money.

Money as Energy: Bruce Lipton's Perspective

In addition to the living company as organism metaphor(Chapter 4.2), Bruce Lipton’s concept of money as energy provides a compelling lens through which to view corporate financial management. In Lipton’s view (Lipton, 2005), money is not a static or material resource but a dynamic flow of energy that can be influenced by the company’s goals and actions. Much like energy in biological systems, money flows in and out of companies, and the way it is managed can either promote growth or cause stagnation.

The ATP-Money Analogy:

Energy is central to the functioning of both biological organisms and businesses. Just as cells in living organisms rely on efficient energy transfer to sustain life, companies depend on the effective management of financial resources to thrive. Nick Lane's "Power and Control" hypothesis sheds light on the intricate relationship between energy generation and the emergence of complex life forms (Lane, 2015). Lane argues that the availability and utilization of energy were pivotal in the evolution of life, particularly in the transition from simple to complex organisms. His insights from The Vital Question: Energy, Evolution, and the Origins of Complex Life provide a valuable analogy for understanding the role of money in businesses. (Lane, 2015)

According to Lane, energy transformation within cells is primarily governed by ATP (adenosine triphosphate), which functions as the "energy currency" of the cell. He explains that "ATP is the coin of the realm in biological terms" (Lane, 2015), and without it, the biochemical processes that sustain life would cease. Just as money serves as the medium of exchange in an economy, ATP facilitates energy transfer within the body, powering essential functions such as muscle contraction, nerve transmission, and cellular repair. Without ATP, cells would not be able to perform these functions, much as a business without cash flow cannot operate.

In the corporate world, money functions similarly to ATP in a biological system. Money acts as the 'energy currency' for businesses, enabling transactions, investments, and the acquisition of resources necessary for growth. Much like ATP fuels biological processes, money fuels business activities—from paying employees and suppliers to investing in new technologies and expansion strategies. A shortage of ATP in a biological system leads to energy failure, just as a lack of financial resources can lead to bankruptcy or business collapse.

Lane emphasizes the importance of efficient energy use in driving complexity in life forms, a principle that is equally applicable to businesses. Efficient financial management allows companies to allocate resources wisely, invest in innovation, and optimize their operations. Just as cells must regulate their energy usage to survive, companies must manage their financial resources carefully to achieve sustainable growth. The second law of thermodynamics, which states that energy transformations tend to increase overall entropy, suggests that inefficiencies in energy use can lead to disorder. In a business context, this means that poor financial management can result in organizational chaos and failure.

As Lane notes, "The ability to generate and use energy efficiently was a key factor in the evolution of complex life" (Lane, 2015). Similarly, the ability of businesses to generate revenue, manage costs, and reinvest profits is crucial for their evolution and long-term success. Companies that adopt a mindset of financial efficiency are better equipped to grow, adapt to market changes, and invest in new opportunities, much like complex organisms that evolved by optimizing energy use.

The analogy between ATP and money underscores the importance of energy flow—whether in the form of cellular energy or financial resources—for the survival and prosperity of both living organisms and businesses. Understanding how these energy systems operate and managing them effectively is essential for achieving success in both biology and business.

4.8.2 Signalling in Biology

Cell signalling is a vital process where human cells communicate to regulate functions like growth, metabolism, and immune responses. The process involves several key components:

1. Signalling molecules (ligands): These include hormones and neurotransmitters that bind to specific receptors on target cells.
2. Receptors: Proteins on the cell surface or inside the cell that receives the signal.
3. Signal transduction: Once activated, receptors trigger intracellular pathways using second messengers like cAMP or calcium, amplifying the signal.
4. Response: The cell responds by altering gene expression, metabolism, or other functions.
5. Feedback: Regulatory mechanisms ensure the signal is properly controlled.

Proper signalling is essential for health, and its disruption can lead to diseases (Hanahan & Weinberg, 2011; Saltiel & Kahn, 2001).

In human cells, negative charge is primarily associated with the plasma membrane and certain cellular molecules. The inside of the cell membrane is negatively charged relative to the outside due to the distribution of ions like potassium (K^+) and sodium (Na^+). This membrane potential is critical for functions like nerve impulses, muscle contraction, and cell signalling.

Additionally, negatively charged molecules like DNA (due to phosphate groups) and proteins contribute to cellular processes, including gene regulation and protein interactions. Proper balance of charges is essential for maintaining cellular function and overall homeostasis.

Before signalling, a human cell maintains a negative resting membrane potential, typically between -60 to -90 millivolts (mV). This is due to the uneven distribution of ions across the plasma membrane, particularly with a higher concentration of potassium ions (K^+) inside the cell and sodium ions (Na^+) outside. The sodium-potassium pump

(Na^+/K^+-ATPase) actively maintains this gradient by pumping K^+ into the cell and Na^+ out, which is crucial for maintaining the cell's electrical stability and preparing for signalling events like action potentials in neurons and muscle cells (Hille, 2001).

The process of cellular signalling begins with the binding of signalling molecules, or ligands, to receptor proteins on the surface of a cell. These ligands can be hormones, neurotransmitters, growth factors, or other signalling molecules. Once the ligand binds to the receptor protein, it initiates a cascade of biochemical reactions inside the cell, ultimately leading to a specific cellular response.

Lipton suggests that the process of cellular signalling is not simply a one-way communication from the environment to the cell but is also influenced by the individual's thoughts, emotions, and beliefs. (Lipton, 2005) He argues that the environment can influence the expression of genes- epigenetics- within a cell but that the individual can also influence the environment through their thoughts and beliefs.

According to Lipton's theory, the cell membrane is not simply a passive barrier that separates the inside of the cell from the outside environment but is an active participant in cellular signalling. The cell membrane comprises lipids and proteins that can act as receptors for signalling molecules and transmit electrical signals across the membrane.

Lipton's theory also suggests that various factors, including environmental toxins, stress, and negative emotions, can disrupt cellular signalling. He argues that these disruptions can lead to a breakdown in cellular communication and ultimately contribute to various health problems.

4.8.3 Signalling in communication

In communication, signalling is the process by which individuals or entities convey information to one another through a shared system of symbols, language, or other forms of communication. The signalling process involves three essential components: the sender, the receiver, and the message.

The sender is the person or entity that initiates the communication by creating and sending the message. The message is the information or content conveyed, whether words, gestures, images, or other signals. The receiver is the person or entity that receives the message and interprets its meaning.

The signalling process also involves various channels or mediums through which the message is transmitted. These channels may include verbal communication (such as speaking or writing), nonverbal communication (such as body language or facial expressions), electronic communication (such as email or text messaging), or other forms of media.

For communication to be effective, the signalling process must be clear, concise, and accurately convey the intended meaning of the message. This requires both the sender and receiver to be aware of the cultural and social context in which the communication is taking place, as well as any potential barriers or noise that may interfere with the transmission or interpretation of the message.

4.8.4 The Signalling Process in Hospitality

In the hospitality industry, the signalling process plays a crucial role in how businesses communicate value, quality, and differentiation to potential customers. Signalling theory, initially developed in economics, describes how one party (the sender) conveys information to another party (the receiver) in environments of asymmetric information, where one party knows more than the other. In hospitality, companies often possess more information about the quality of their services than consumers, who must rely on signals—such as price, brand reputation, and certifications—to make informed decisions. (Spence, 1974) first introduced signalling theory to explain labour markets, but its application has since expanded to various industries, including hospitality.

This chapter explores how hospitality can use signals to reduce information asymmetry, enhance customer perceptions, and differentiate themselves in competitive markets. It also examines the types of signals commonly used in hospitality, the challenges associated with signalling, and the impact of signals on consumer decision-making.

Price as a Signal of Quality

One of the most prominent signals in the hospitality industry is price. Customers often rely on price as an indicator of service quality and overall experience. Rao and Monroe (Rao, 1989) suggest that higher prices are often interpreted as signals of superior quality, particularly when consumers lack direct experience with a product or service. In hospitality, a high room rate or expensive menu can convey exclusivity and premium service, while a lower price might signal affordability but also potentially lower quality.

However, price signals are not always straightforward. Clemons et al. (Clemons, 2012) point out that in some cases, excessively high prices can backfire, leading customers to perceive a service as overpriced or inaccessible. The effectiveness of price as a signal depends on the market segment. For luxury hotels, high prices reinforce brand prestige, but for budget hotels, low prices can be more attractive if the signal aligns with the customer's expectations of value for money.

Branding and Reputation as Signals

Branding is another powerful signal in hospitality. A well-known brand can serve as a trust signal, assuring customers of consistent quality and service standards. Erdem and Swait (Erdem, 1998)argue that brands reduce uncertainty by acting as signals that embody the company's commitment to quality.

In the context of signalling, a strong brand can help hospitality businesses attract new customers and foster loyalty among existing ones. Customers interpret brand signals based on their past experiences and the brand's reputation in the market. Therefore, maintaining a positive brand image is critical for hospitality firms looking to use their brand as an effective signal.

Certifications and Awards as Third-Party Signals

Third-party endorsements, such as certifications or awards, serve as credible external signals of quality and compliance with industry standards. These signals are particularly valuable in markets where customers may be sceptical of self-reported claims by businesses.

According to Connelly et al. (Connelly, 2011), third-party signals are often more trusted than self-promotional efforts because they involve external validation. For example, a

Michelin star signals high culinary excellence, and receiving such recognition can elevate a restaurant's reputation significantly. In the hospitality industry, where intangible factors like service quality and ambience are critical, third-party certifications and awards provide objective proof of excellence.

Online Reviews and User-Generated Content as Signals

In the digital age, online reviews and user-generated content have become vital signals in the hospitality industry. Reviews allow customers to share their experiences, providing valuable signals to potential guests. These reviews serve as peer-to-peer signals, which are often perceived as more authentic than corporate advertising.

Luca (Luca, 2011) highlights the impact of online reviews on consumer behaviour, noting that a one-star increase in a hotel's average rating on review platforms can lead to a significant increase in bookings. Positive reviews act as signals of satisfaction and quality, while negative reviews can signal poor service or facilities. As a result, managing online reputation has become a critical part of the signalling process for hospitality businesses.

Challenges and Risks in the Signalling Process

While signals are essential for communication in the hospitality industry, they come with certain risks and challenges. One challenge is signal credibility—if a signal is perceived as misleading or exaggerated, it can damage a company's reputation. For example, if a hotel charges premium prices but fails to deliver the expected quality, customers may feel deceived, leading to negative reviews and brand damage.

Spence (Spence, 1974) emphasized the importance of signal accuracy, arguing that for signals to be effective, they must be credible and aligned with reality. Hospitality firms must carefully balance their signals with the actual quality of their services to avoid creating expectation gaps, where customer expectations do not match their experiences.

Another challenge is the overabundance of signals in competitive markets. When too many businesses use similar signals (e.g., price reductions or promotional offers), the signals lose their distinctiveness, making it harder for consumers to differentiate between them. Kirmani and Rao (Rao, 1989) suggest that in such situations, businesses must innovate in their signalling strategies to stand out.

The Impact of Signals on Consumer Decision-Making

The signalling process significantly influences consumer decision-making in hospitality. Zeithaml (Zeithaml, 1988) argues that consumers use signals to evaluate the perceived value of a service, which is a combination of quality, price, and expectations. Positive signals such as high ratings, strong brand recognition, or prestigious awards increase the likelihood of customers choosing a particular service, as these signals reduce the perceived risk of making a poor choice.

In addition, signals help shape customer expectations. Oliver (Oliver, 1997) found that when the perceived signals of a service (e.g., price and brand reputation) align with the actual service experience, customers are more likely to be satisfied. On the other hand, when there is a disconnect between the signals and the actual service quality, dissatisfaction and negative reviews can follow, impacting the business's long-term success.

Conclusion: Effective Signaling in Hospitality

In conclusion, the signalling process is a fundamental aspect of how hospitality firms communicate value, quality, and trustworthiness to customers. By utilizing signals such as price, branding, third-party certifications, and online reviews, businesses can reduce information asymmetry and influence consumer perceptions. However, the effectiveness of these signals depends on their credibility, accuracy, and alignment with actual service quality. Hospitality companies that master the art of signalling can gain a competitive edge by effectively conveying the unique value they offer to potential customers.

4.9 Pricing Systems and Theories

4.9.1 Dynamical process of buying

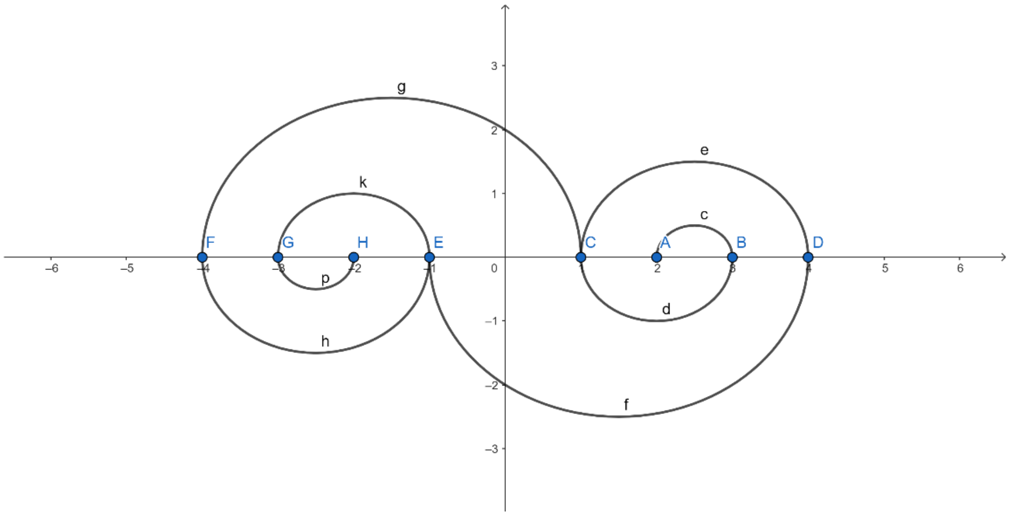

Figure 2Representation of Sell Buy process

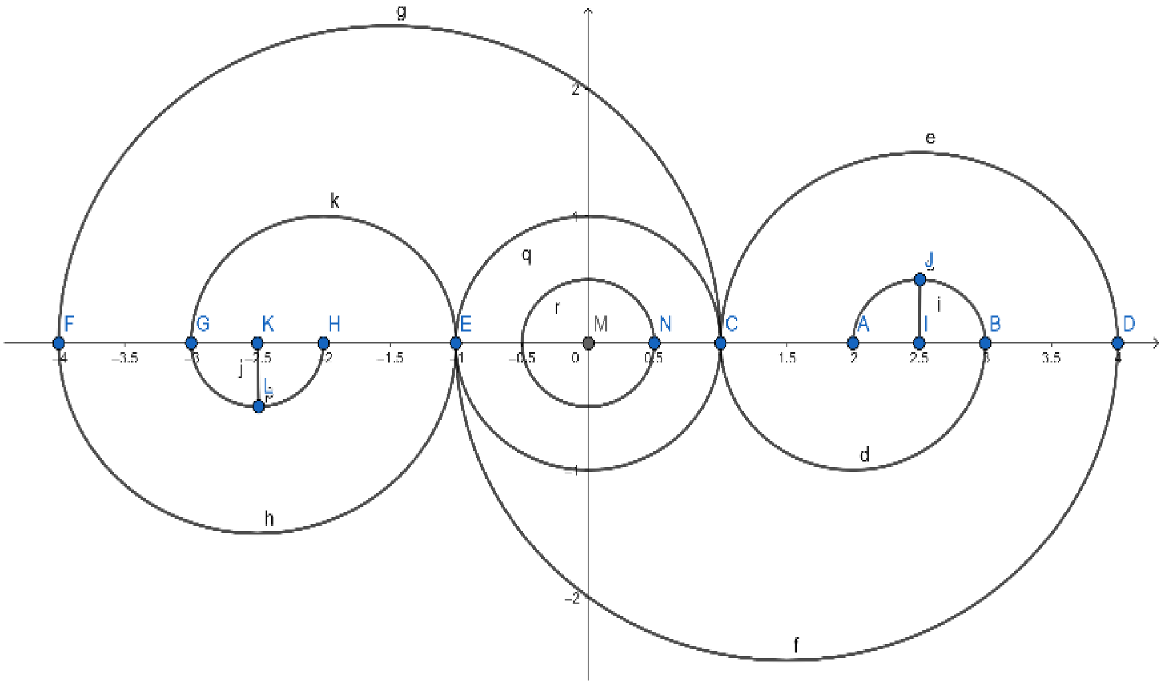

Figure 3 Key elements of SB Process 1

The KI(money asked) represents the seller's price expectation, which may fluctuate based on internal and market factors.

The IJ (money offered) represents the buyer's willingness to pay, which can change based on perceived value and negotiation.

In this context, if we consider that the meeting is at the circle centre (M), it symbolizes the point of agreement or equilibrium in the buy-sell process, where both parties—the buyer and seller—reach a mutually beneficial outcome. The idea that everything revolves around M suggests that the entire negotiation and interaction process is centred on reaching this agreement.

Key Elements in the Sell-Buy Process:

Centre M: The circle area centre M represents the agreement point. This is the optimal place where both the buyer and seller have aligned their expectations, demands, and offers. It's the point of equilibrium where the deal is made, and both sides are satisfied with the outcome.

In business transactions, this area could be the price container, after negotiations have taken place and all influencing factors (such as competition, market demand, and external forces) have been considered.

How Other Elements Revolve Around M:

1. Surrounding Loops:

The surrounding loops represent the fluctuations and interactions that take place during the negotiation process. They are the steps and adjustments both parties make as they move towards the centre area circle (M).

2. Dynamic Process:

    - The buy-sell process is dynamic, with several rounds of adjustments (represented by the curves and loops). Each side may initially set a price far from M, but through bargaining and adjusting expectations, they come closer to the centre.

  - The process can include market research, price comparisons, value perception, and external forces like promotions, discounts, or time-sensitive deals.

3. External Influences (Forces):
   - The curves could also represent external market forces—competition, supply and demand, or even emotional factors like urgency or scarcity—that influence how far the initial asking price or offered price deviates from M.
   - These forces push and pull the buyer and seller, changing their expectations over time.
4. The Meeting Point Circle M:
   - Circle M is ultimately the point where the buyer’s perceived value and the seller’s asking price converge.
   - It represents the final price, the completion of the transaction, or the successful closing of a deal.
   - If M is not reached, it implies that a deal may not happen, as both parties fail to find common ground.

Conclusion:

The circle centre (M) is where the buy-sell process is resolved. It represents the balance between what the seller expects and what the buyer is willing to pay. Every step of the negotiation (represented by the surrounding loops and paths) aims to bring both parties closer to this equilibrium.

In the context of hospitality pricing, for example, the process could involve the seller (hotel or service provider) offering a price based on costs and demand, while the buyer (customer) negotiates based on their perceived value. The final meeting point is circle area M is where the hotel adjusts the price to match the customer's expectations, reaching a final booking or sale.

4.9.2 Causal vs teleological pricing

In economics, the causal approach and the teleological approach are two different ways of thinking about how the economy works. The causal approach is based on the idea that underlying factors, such as changes in supply and demand, changes in government policies, or changes in technology, cause economic events (Smith, 2021). In this approach, economists focus on understanding the causal relationships between different variables in the economy. For example, they might investigate how an increase in the minimum wage affects employment levels or how a change in interest rates affects consumer spending (Johnson, 2020).

The teleological approach can help us understand the goals and motivations of economic actors, but it may only sometimes be able to explain why certain outcomes occur (Simon, 1962).

The philosophy and cognitive sciences have also been used to develop the teleological approach further, allowing it to incorporate more holistic concepts such as market psychology and consumer behaviour (Kahneman, 2011).

Both approaches have their strengths and weaknesses. The causal approach can help us understand how different economic variables are related to each other, but it may only sometimes capture the full complexity of human decision-making.

Additionally, recent advances in biological research have provided insight into how different organisms interact with each other when faced with exchange decisions (Dawkins, 1982).

4.9.3 *Price Revival in Hospitality: A Dynamic Approach to Pricing Strategies*

Introduction to Price Revival in Hospitality

In the hospitality industry, pricing revival are critical to maintaining competitiveness and profitability. The fluctuating nature of demand, influenced by seasonality, economic conditions, customer preferences, and competition, makes dynamic pricing a necessary component for success. Price Revival, grounded in the principles of system dynamics pioneered by Jay Forrester, provides a framework for understanding and managing the complex factors that influence decisions over time.

Forrester's work, along with contributions from Peter Senge and John Sterman, emphasizes the importance of viewing dynamic systems as part of an interconnected system where *feedback loops, delays, and external factors play* significant roles in determining optimal pricing strategies. Applying these concepts to hospitality allows for more adaptive and predictive pricing approaches that respond effectively to market dynamics.

Key Components of Price Revival in Hospitality

The hospitality industry is uniquely suited to the Price Revival framework due to the inherent complexity of its pricing environment. Factors such as occupancy rates, customer demand, competitor pricing, and operational costs are interrelated, and changes in one aspect can lead to significant ripple effects across the system. This section outlines the key components of Price Revival—stocks and flows, feedback loops, causal loop diagrams, delays, and simulation modelling—as they apply to hospitality pricing.

Stocks and Flows

In the context of hospitality, stocks represent key accumulations, such as available hotel rooms or inventory for food and beverages. These are finite resources that fluctuate based on customer demand and operational capacity. Flows are the rates at which these resources are consumed or replenished, such as the number of rooms booked per night or the volume of food consumed in a restaurant.

A hotel's available rooms (stock) decrease as bookings (flow) increase. Conversely, when occupancy drops, the stock of available rooms increases. Price Revival emphasizes the importance of managing these stocks and flows to optimize pricing decisions. For instance, pricing can be adjusted dynamically based on the flow of room bookings, increasing prices during periods of high demand and decreasing them when occupancy is low to stimulate sales.

As Forrester (1961) noted, "The interaction of stocks and flows is central to understanding system behaviour over time, particularly in industries where resource availability is a key driver of price."

Feedback Loops

Feedback loops describe how changes in one part of the system affect other parts, either reinforcing or balancing out those changes. In hospitality pricing, feedback loops can be classified as either positive or negative.

Positive Feedback Loops: These loops amplify changes in the system. For example, a hotel might lower its prices to attract more guests, leading to an increase in bookings (positive feedback). This increased demand can reduce the number of available rooms, which may then drive prices back up due to scarcity. Positive feedback loops in hospitality often create a reinforcing cycle, where increased bookings lead to higher demand and potentially higher prices during peak periods.

Negative Feedback Loops: These loops work to stabilize the system by opposing changes. For instance, if a hotel raises its prices too high, demand might decrease, leading to excess room availability. In response, the hotel need to lower prices to attract more guests, thus stabilizing occupancy rates. Negative feedback loops help maintain balance in the system and prevent prices from fluctuating too wildly.

Sterman (2000) emphasized the importance of understanding feedback loops, stating "Feedback loops are essential to navigating complex systems, where small changes in pricing can lead to significant shifts in customer behaviour and overall profitability."

Causal Loop Diagrams

Causal Loop Diagrams (CLDs) are valuable tools for visualizing the cause-and-effect relationships in pricing dynamics. In the hospitality industry, CLDs can be used to map out how factors such as customer demand, room availability, competitor pricing, and operational costs interact to influence pricing decisions.

A CLD might show how an increase in local events (such as conferences or festivals) leads to higher demand for hotel rooms, which in turn leads to price increases. However, if competitor hotels also increase their prices, there may be a negative effect on demand if customers seek lower-cost alternatives. Using CLDs allows hospitality managers to visualize these complex interactions and make more informed pricing decisions.

According to Senge (1990), "Causal loop diagrams help organizations understand the deeper structure of their systems, revealing the feedback dynamics that drive decision-making." In hospitality, CLDs can provide insights into how various market forces interact, enabling better strategic planning around pricing.

Delays

In the hospitality sector, delays occur when there is a lag between an action (such as a change in pricing) and its effect on customer behaviour. These delays can complicate pricing decisions, as it may take time for the full impact of a price change to become apparent. For example, a hotel may reduce its prices during an off-peak season to stimulate bookings, but the effect may not be immediate as customers need time to plan their trips. Delays can also occur in supply chains or in the availability of market data that influences pricing strategies. Recognizing these delays is critical for avoiding overreaction or underreaction to market changes. Failure to account for delays can lead to oscillations in pricing, where prices fluctuate too frequently, confusing customers and potentially reducing trust in the brand.

Sterman (2000) noted that "delays introduce complexity into decision-making, as they often obscure the relationship between actions and outcomes, leading to unintended consequences." In the hospitality industry, managing these delays effectively can help ensure smoother pricing adjustments and a more stable revenue stream.

Simulation Modelling

One of the most powerful applications of Price Revival in hospitality is the use of simulation modelling to test and predict the impact of various pricing strategies. Simulation modelling allows hospitality managers to create virtual models of their pricing systems and experiment with different scenarios, such as changes in demand, supply constraints, or competitor actions.

By running these simulations, managers can explore how different pricing strategies would play out over time without risking real-world revenue loss. For instance, a hotel could simulate the impact of lowering prices during an off-peak season to see how it affects overall occupancy and revenue. Similarly, simulations can help forecast the potential benefits of dynamic pricing models, where prices are adjusted in real time based on changes in demand.

Forrester (1971) highlighted the importance of simulation in managing complex systems, stating, "Simulation provides decision-makers with a powerful tool for understanding the long-term consequences of their actions, enabling them to design better strategies for system optimization."

Conclusion

Price Revival, rooted in system dynamics principles, provides a comprehensive framework for understanding and optimizing pricing strategies in the hospitality industry, incorporating key concepts such as stocks and flows, feedback loops, delays, and simulation modelling, Price Revival enables hospitality businesses to respond more effectively to the complex and dynamic nature of the market and helps hospitality managers make data-driven decisions that maximize revenue.

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4.9.4 Price Tag as a Symbol

A price tag can be understood as more than just a physical or digital label; it operates as a symbol that conveys important information about value, cost, and consumer perception. It serves as a representation of exchange value, signifying the monetary worth of a product or service in the marketplace. Zelizer (1997) highlights how price tags, as symbols, embed social, cultural, and economic meanings, reflecting not just the cost but also the societal context in which pricing occurs. The price tag thus operates as a shorthand for a broader set of assumptions about affordability, desirability, and market positioning.

"The Electric Meme: A New Theory about How We Think" by Robert Aunger, proposes a new theory about the nature of human thought and culture, which he calls the "electric meme."

Aunger's theory builds on the concept of the "meme," which was first introduced by Richard Dawkins in his book "The Selfish Gene." According to Dawkins, a meme is a unit of cultural transmission, similar to a gene, which can be transmitted from one individual to another through imitation, writing, speech, or other means.

Aunger expands on this idea by arguing that memes are not simply transmitted through cultural channels, but are encoded in the electrical activity of the brain. He suggests that the brain's electrical activity forms a kind of "mental code" that underlies our ability to think, reason, and communicate.

Aunger's theory proposes that the brain's electrical activity operates as a kind of "digital code," similar to the code used in computer programming. This code is capable of transmitting information from one brain to another, allowing for the rapid spread of cultural information and the evolution of new ideas and practices.

According to Aunger, the electric meme theory can help to explain a wide range of human behaviours and cultural phenomena, including the emergence of language, the spread of religious beliefs, and the evolution of scientific knowledge.

One of the key implications of Aunger's theory is that it suggests that the spread of cultural ideas and practices is not simply a matter of social influence, but is actually rooted in the basic structure of the brain itself. This has important implications for our understanding of human behaviour and the evolution of culture, as it suggests that the spread of cultural traits is not simply a matter of human choice or volition, but is actually shaped by the fundamental nature of the human brain.

While Aunger's theory is still relatively new and has yet to be fully tested, it represents an important contribution to our understanding of the nature of human thought and culture. By expanding our understanding of the basic mechanisms that underlie cultural transmission and evolution, the electric meme theory offers a powerful new framework for exploring the complex dynamics of human behaviour and culture.

Mircea Eliade and Richard Dawkins significantly contributed to studying symbols and cultural evolution, respectively. While they worked in different fields and used different terminology, there are some interesting connections that can be made between their ideas about symbols and memes.

Eliade was a Romanian historian of religion who explored the meaning and significance of symbols in various cultural contexts. He argued that symbols are fundamental to human experience, connecting the individual to a larger, transcendent reality. Symbols, for Eliade, represent a bridge between the sacred and the profane, allowing individuals to access and experience the divine in their everyday lives.

On the other hand, Dawkins, who coined the term "meme" to describe cultural units that spread and evolve through human culture similarly to genes. According to Dawkins, memes are units of cultural transmission capable of replication, variation, and selection. Memes can be anything from ideas and beliefs to cultural practices and behaviours, and they spread through social networks and cultural traditions.

Despite their differences, Eliade and Dawkins' ideas about symbols and memes share some common ground. Both recognized that cultural units can spread and evolve across time and space and can significantly impact the individuals and societies that adopt them.

One way to connect Eliade's ideas about symbols and Dawkins' ideas about memes is to view memes as a modern manifestation of symbols. Like symbols, memes can have deep cultural and emotional significance, connecting individuals to a larger cultural or ideological framework. Moreover, like symbols, memes can take on their own life, spreading and evolving in unpredictable ways.

However, there are also important differences between Eliade's approach to symbols and Dawkins' approach to memes. Eliade's emphasis on symbols' spiritual and transcendent aspects suggests a more holistic and integrated understanding of cultural meaning. In contrast, Dawkins' focus on replication and selection suggests a more reductionist and mechanistic view of cultural evolution. Both of these approaches influenced the economic environment

1. Mircea Eliade: "The symbol is always more than a mere image; it suggests a reality different from that which is immediately perceived." - from "The Sacred and the Profane: The Nature of Religion" (page 20).
2. Alexandru Dragomir: "Symbols are bridges between the individual and the universal, between the finite and the infinite, between the visible and the invisible." - from "The Way of the Transgressor" (page 63).

3. Joseph Campbell: "The symbol is the vehicle of communication. It serves to convey not the thing but the idea of the thing. It is the container of the thing, rather than the thing itself." - from "The Power of Myth" (page 45).
4. Umberto Eco: "Symbols grow in significance as they are used and reinterpreted within different cultural contexts." - from "Semiotics and the Philosophy of Language" (page 92).
5. Northrop Frye: "The symbol always refers to a higher level of meaning beyond itself, and this meaning is always connected with the divine or cosmic order." - from "Anatomy of Criticism" (page 20).

These quotes demonstrate the diverse perspectives on symbols and their meaning, from the religious and spiritual significance to the psychological and cultural interpretations.

4.9.5 Beauty

Beauty is a subjective and multifaceted concept that can be defined in many ways depending on the individual's cultural, historical, and personal context. It can refer to the appearance of a person, object, or natural scene, but it can also describe a feeling or an experience that is deeply moving or satisfying to the senses and the mind. Traditionally, beauty has been associated with *symmetry, proportion, and harmony*, as well as with *attributes such as grace, elegance, and refinement*. In art, beauty is often equated with aesthetic pleasure and can be expressed through colour, form, texture, and composition (Paglia, 1990).

In philosophy, beauty has been the subject of much debate and inquiry. Some philosophers, such as Plato and Kant, have argued that beauty is an objective property of the world, rooted in universal principles of form and harmony. Others, such as Hume and Nietzsche, have argued that beauty is a subjective and individual experience, shaped by personal preferences, cultural norms, and historical context (Scruton, 2009)

In recent years, some scholars have proposed that beauty is not simply a matter of aesthetics or individual taste but is linked to deeper psychological and biological processes. For example, some studies have shown that exposure to beautiful landscapes or objects can have a calming effect on the mind and body, and may even have physical health benefits. Other studies have suggested that perceptions of beauty may be linked to evolutionary preferences for traits such as symmetry and health (Reber, 2004).

Camille Paglia believes that beauty is a fundamental aspect of human life and culture and that it has both positive and negative effects on our society. According to Paglia, beauty is a universal and objective quality that can be found in all cultures and throughout history. She argues that beauty is not just about physical appearance, but is also present in art, music, literature, and other forms of expression. For Paglia, beauty is an essential part of the human experience, and it has the power to uplift and inspire us (Paglia, 1990).

Paglia also believes that beauty can be a source of conflict and division in society. She argues that our obsession with beauty and appearance can create unrealistic standards and cause people to feel inadequate or inferior. Paglia also suggests that our focus on beauty can distract us from more important issues and prevent us from fully engaging with the world around us (Paglia, 1990)

4.9.6 Price as an encapsulation of energy

Price is a fundamental concept in economics that reflects the value of a product or service in terms of the amount required to obtain it. While price is often thought of as a purely monetary concept, it can also be understood as a form of encapsulation of energy, matter, information, and time, as these elements are all involved in producing and exchanging goods and services that are priced.

Energy is a key component of any economic activity, as it is required to produce and transport goods and services. The energy required to extract raw materials, manufacture products, and transport them to market is reflected in consumers' price for these goods and services. In this sense, the price can be seen as an encapsulation of the energy invested in producing and exchanging a particular product or service.

The matter is another important component of economic activity, as raw materials are transformed into finished products through various manufacturing processes. The cost of these raw materials and the energy and labour required to transform them into finished goods is reflected in the price that consumers pay for these products. In this sense, the price can be seen as an encapsulation of the matter transformed into a particular product or service.

Information is also a key component of economic activity, as it is required to coordinate the production and exchange of goods and services. Information about consumer preferences, production techniques, and market conditions guides the production and distribution of goods and services. This information is reflected in the price that consumers pay for these products. In this sense, the price can be seen as an encapsulation of the information used to produce and distribute a particular product or service.

Time is a crucial component of economic activity, as goods and services are produced and exchanged over time. For example, the amount of time required to produce a particular product and the time required to transport it to market is reflected in the price that consumers pay for these products. In this sense, the price can be seen as an encapsulation of the time invested in producing and exchanging a particular product or service.

The price can be understood as a form of encapsulation of energy, matter, information, and time, as these elements are all involved in the production and exchange of priced goods and services.

4.9.7 Quanta and Qualia for prices

Pricing decisions in the hospitality industry are influenced by a combination of quanta (objective, measurable factors such as room occupancy rates, seasonal demand, and competitor pricing) and qualia (subjective elements like customer experience, brand perception, and emotional responses).

To correlate the price quantitative elements (quanta) with the perception of price (qualia), we need to consider factors that influence perception, such as context, expectations, individual differences, and psychological biases. A formula to start with:

$$qualia = f(quanta, C, E, I, P)$$

Where:

quanta is the actual price offered.

C represents contextual factors (e.g., market conditions, product quality, availability of alternatives).

E represents expectations (e.g., previous experience with prices, brand reputation).

I represents individual differences (e.g., personal income, preferences, price sensitivity).

P represents psychological biases (e.g., anchoring, framing effects).

A more specific functional form look like:

$$qualia = \alpha \cdot quanta + \beta \cdot C + \gamma \cdot E + \delta \cdot I + \epsilon \cdot P + \zeta$$

Where:

α,β,γ,δ,ϵ are coefficients that measure the influence of each factor, and

ζ is an intercept term.

The implementation methodology:

Step 1: Define the Factors

Contextual factors (C):

- Market conditions:

- Cmarket (e.g., high-demand season or off-season).
- Product quality:
- Cquality (e.g., luxury hotel vs. budget hotel).

  Expectations (E):

- Previous experience with prices:
- E prev.
- Brand reputation:
- E brand

Individual differences (I):

Personal income:

- I income
- Preferences:
- Ipref

Psychological biases (P):

- Anchoring effect:
- Panchor (e.g., comparing with other prices seen first).
- Framing effect:
- P frame (e.g., discounts or special offers).

Step 2: Assign Values to the Factors

We'll use a scale from 1 to 10 for each factor, where higher values indicate stronger influence.

Contextual factors (C):

Cmarket=7 (high demand season).

Cquality=8 (luxury hotel).

Expectations (E):

Eprev=6 (previously experienced higher prices).

Ebrand=9 (well-known brand).

Individual differences (I):

Iincome=5(average income).

Ipref=7(preference for luxury).

Psychological biases (P):

Panchor=8(recently saw higher prices).

Pframe =6 (price presented as a discount).

Step 3: Define the Coefficients

We'll assume the following coefficients for the factors (these could be determined through empirical analysis in a real-world scenario):

α=0.5(influence of actual price).

β=0.3 (influence of contextual factors).

γ=0.4 (influence of expectations).

δ=0.2 (influence of individual differences).

ϵ=0.3 (influence of psychological biases).

ζ=10 (intercept term for baseline perception).

Step 4: Calculate the Perceived Price (qualia)

Using the formula: $qualia = \alpha \cdot quanta + \beta \cdot (Cmarket + Cquality) + \gamma \cdot (Eprev + Ebrand) + \delta \cdot (Iincome + Ipref) + \epsilon \cdot (Panchor + Pframe) + \zeta$

Interpretation

If the perceived price is lower than the actual offered price, indicating that the various factors (context, expectations, individual differences, and psychological biases) positively influence the perception, making the price seem more reasonable or attractive to the consumer.

4.9.8 Ulam-Borsuk Theorem to Explain the Relationship Between Quanta and Qualia in Price-Making Decisions in the Hospitality Industry

To model the interaction between quanta and qualia, we can adapt a metaphor based on the Ulam-Borsuk theorem and the idea of balancing delivered outcomes versus expected outcomes. The theorem, a key result in topology, states that on any n-dimensional sphere, there is always at least one pair of antipodal points (points directly opposite each other on the sphere) that lie in the same region for any partition of space. In this framework, we treat quanta and qualia delivered versus quanta and qualia expected as opposing forces in hospitality pricing, rather than two completely separate points. Despite potential differences in what is delivered versus what is expected, these forces must coexist within a unified pricing strategy.

Overview of the Ulam-Borsuk Theorem

The Ulam-Borsuk theorem focuses on partitioning high-dimensional spheres and how pairs of opposing points can still fall within the same region. In pricing, this metaphor suggests that even though delivered quanta and qualia (what the customer actually receives) and expected quanta and qualia (what the customer expects) may seem to represent different forces, they must ultimately align in a comprehensive strategy.

Quanta and Qualia Delivered vs Quanta and Qualia Expected

In the hospitality industry, pricing is influenced by both objective data (quanta) and subjective experiences (qualia). However, there's often a gap between what is delivered to the customer and what is expected.

- Quanta and Qualia Delivered represent the combination of objective data and subjective experience that the hotel provides.
- Quanta and Qualia Expected capture customer expectations, which shape their perceptions of value and influence their satisfaction.

These two elements, though seemingly opposed, are analogous to antipodal points: they must be balanced within a common region to create an effective pricing strategy.

Quanta and Qualia in Hospitality Pricing

Quanta: Objective Data in Hospitality Pricing

Quanta, or the objective, measurable factors, are critical for determining baseline prices. These factors include:

- Occupancy rates: The percentage of rooms filled at any time.
- Seasonality: Fluctuations in demand depending on the time of year.
- Competitor pricing: The rates other hotels charge for comparable rooms.
- Operating costs: Fixed and variable expenses like utilities, staffing, and maintenance.
- Market trends: Broader economic factors affecting demand, such as inflation or global travel trends.

These quantifiable factors are essential for setting data-driven prices.

- Qualia: Subjective Experience in Hospitality Pricing

Qualia refers to subjective elements that influence customer perception and experience, including:

- Customer perceptions of value: Emotional and personal evaluations of a service's worth, often based on ambiance, luxury, or personalized service.
- Brand image: A hotel's reputation, which allows for price premiums.
- Customer experience: The overall guest journey, from booking to post-stay follow-up.
- Psychological pricing: The use of tactics like charm pricing (e.g., 99.99 instead of 100) to influence customer decision-making.

Qualia, though difficult to measure, are vital to shaping customer satisfaction and loyalty, which directly impact pricing strategies.

The Interaction of Quanta and Qualia Delivered vs Expected in Hospitality Pricing

Using the Ulam-Borsuk metaphor, quanta + qualia delivered and quanta and qualia expected can be viewed as opposing, but interrelated, forces. Successful pricing must integrate both to meet customer expectations while maintaining profitability. For instance:

- Quanta delivered might indicate a high demand season, suggesting a price increase, but if qualia expected (e.g., luxury, seamless service) isn't met, the hotel may risk negative reviews and lost customer loyalty.

By analyzing the gap between what is delivered and what is expected, hoteliers can adjust prices dynamically to ensure they meet customer expectations, even if data-driven factors push prices higher.

Balancing Quanta and Qualia in Hospitality Pricing

The balance between delivered and expected outcomes, both in objective data and subjective experience, drives the final pricing strategy.

For example:

- If a hotel's objective data (quanta) suggests a price increase due to high occupancy, but recent customer reviews (qualia) indicate dissatisfaction with service quality, the hotel might opt for a more moderate price increase to reflect this feedback.

This balance ensures that customers perceive value not just in terms of price, but also in their overall experience.

Practical Implications: Integrating Delivered vs Expected Factors

Dynamic Pricing and Market Adaptation

Dynamic pricing, where room rates fluctuate based on demand, primarily relies on quanta (objective factors). However, integrating qualia helps refine this strategy. For example, a hotel might charge a premium for rooms with high customer satisfaction ratings or superior service features, reflecting the qualia expected by future guests.

Brand Loyalty and Customer Perceptions

Qualia such as brand reputation and customer loyalty can allow hotels to maintain higher prices even when objective data (e.g., market trends) suggests otherwise. A hotel with a strong brand and loyal customer base may keep prices stable, knowing that customers value the overall experience (qualia), not just the room price.

Formula for Balancing Quanta and Qualia Delivered vs Expected

To express the interaction between quanta + qualia delivered and quanta and qualia expected mathematically, we can modify the antipodal point model.

General Setup: Delivered vs Expected on a Pricing Sphere

Let's define the relationship between delivered and expected on a unit sphere in R^3, where quanta Q and qualia L are points representing objective and subjective elements. We introduce a balance coefficient $\alpha \in [0,1]$, where:

- α represents the weight given to delivered quanta and qualia.
- $1-\alpha$ represents the weight given to expected quanta and qualia.

Formula for Price:

$$P = \alpha(Qdelivered + Ldelivered) + (1 - \alpha)(Qexpected + Lexpected)$$

Where:

- P is the final price.
- Qdelivered and Ldelivered are the quanta and qualia provided.
- Qexpected and Lexpected represent customer expectations.
- α is the balance coefficient controlling how much weight is given to what is actually delivered versus what is expected.

Example:

Suppose the quanta and qualia delivered indicate that the optimal price should be 200 units based on market conditions. However, customer expectations are higher, and failing to meet them will reduce perceived value. If customer expectations suggest a 50-unit reduction and we decide that 70% of the decision should rely on delivered outcomes, the formula would be:

$$P = 0.7 \times (200) + 0.3 \times (150) = 140 + 45 = 185 units$$

Thus, the final price is adjusted to 185 units, balancing delivered and expected outcomes.

In this way, the interaction of quanta and qualia delivered versus quanta and qualia expected shapes a holistic and adaptive pricing strategy in the hospitality industry

4.9.9 Price Creation as a Dynamic System: A Geometric Framework

This chapter aims to develop a metaphorical framework that connects the mathematical concepts of differential geometry with the dynamics of price creation in the hospitality industry. Specifically, we explore how price formation can be modelled using geometric structures, drawing analogies to manifolds, Ricci flow, homeomorphism, and RGB decomposition to represent the stabilization, segmentation, and organization of pricing strategies. This regression—from a complex manifold representing the pricing landscape to a smooth 3D sphere symbolizing stability, followed by the segmentation of prices into distinct components and containment within a cylindrical structure—offers a systematic approach to understanding price creation and management.

By using these geometric ideas, we build a model to capture the stabilization of complex pricing

1. The Manifold as a Complex Price Space

A manifold is a mathematical space that locally resembles Euclidean space but can have more complex global structures. Manifolds are essential in differential geometry and topology because they allow for the generalization of shapes and surfaces across various dimensions. In the context of pricing, a manifold represents the multidimensional nature of price creation, where each point on the manifold corresponds to a potential price level influenced by factors like demand, competition, and availability.

The manifold's overall shape reflects the complexity of the pricing landscape, while local neighbourhoods on the manifold represent short-term, isolated pricing conditions. These local markets may experience small, predictable price variations, while the manifold as a whole represents the broader, more unpredictable price environment. For example, pricing for a luxury hotel during a peak season may exist on one part of the manifold, while off-season budget pricing for the same hotel might occupy a completely different area.

Mathematical Definition of a Manifold in Pricing

A manifold is a topological space that behaves like Euclidean space locally, allowing small regions of the manifold to map onto familiar geometric forms like planes or lines. Globally, however, the manifold may have curvature or higher-dimensional properties. In the context of pricing, these properties represent the interconnected and evolving nature of the hospitality market, where local pricing behaviours may seem predictable, but the global market is far more complex and multi-dimensional.

Stabilizing Price Fluctuations: Ricci Flow and Homeomorphism

Ricci flow is a mathematical process that smooths out the curvature of a manifold over time, gradually transforming it into a more uniform shape. Introduced by Richard Hamilton (Hamilton, 1982) and applied by Grigori Perelman (Perelman, 2003) to prove the Poincaré Conjecture, Ricci flow serves as a metaphor for the stabilization of price fluctuations. In the hospitality market, prices can start off irregular, reflecting volatility, shocks, or sudden demand surges (e.g., during festivals or holidays). Over time, however, various market forces—such as regulation, market correction, or competitive pricing strategies—act to smooth out these fluctuations, driving prices toward equilibrium.

Ricci Flow

In the hospitality market, Ricci flow can be likened to regulatory actions, corrections, or seasonal adjustments that work to stabilize prices over time. Just as Ricci flow evens out irregularities on a manifold, these forces address price volatility, making the pricing structure more predictable and balanced over time.

Homeomorphism: From Complex to Simple Price Structures

A homeomorphism is a continuous deformation between two topological spaces that preserves their essential properties. In pricing, this represents the transformation from irregular, fluctuating pricing areas to a more ordered and predictable one. Over time, pricing models, which might start off as complex and unpredictable, evolve into a stable and structured system, symbolized metaphorically by a smooth 3D sphere. This process captures how markets can retain their essential dynamics while becoming more predictable and symmetric in their price distributions.

Decomposing the Price Sphere into Segments

After the manifold of price dynamics stabilizes into a 3D sphere, the next step is to decompose it into distinct price segments. This can be visualized using the RGB color model, commonly used in computing to represent images through Red, Green, and Blue channels. Each colour corresponds to a specific pricing tier or category, reflecting the diversity in pricing strategies.

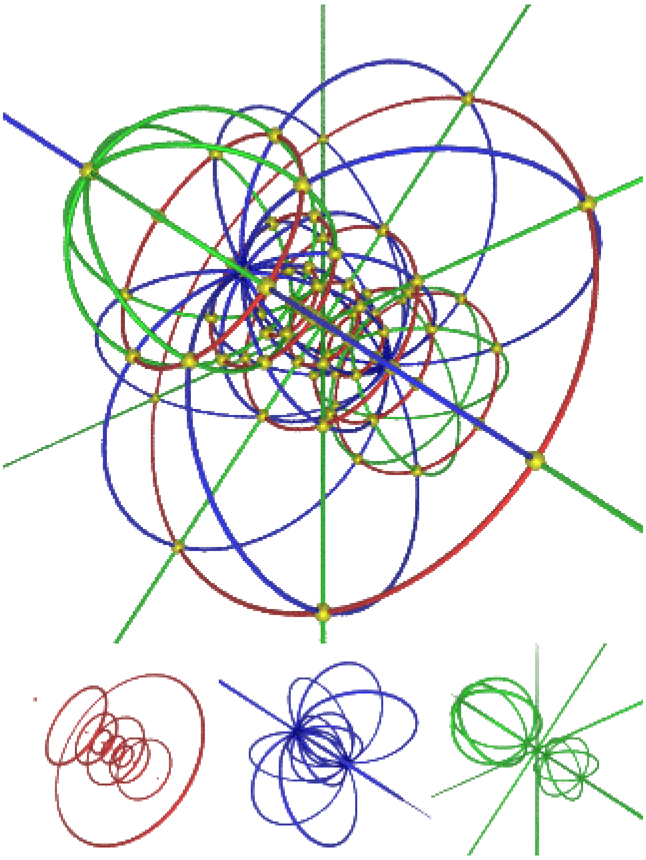

Figure 4 3-sphere. (2024, September 23). In Wikip 1

RGB Splitting: Price Segmentation in Hospitality

In the context of hospitality pricing:

- Red represent price container.
- Green simbolize price quanta,
- Blue represents the price qualia

These segments are distinct but interrelated, forming the complete price structure of a hotel. The RGB model allows for the separation of price elements, where each behaves according to its dynamics, but together they form the overall pricing system.

Conclusion: A Geometric Perspective on Price Creation

This chapter has demonstrated how mathematical concepts such as manifolds, Ricci flow, homeomorphisms, and RGB decomposition can provide a powerful framework for understanding price creation and the sell-buy process. By treating price creation as a complex manifold subject to forces of stabilization and segmentation, we can model how prices evolve from irregular and volatile systems to structured, organized frameworks. The price container represents the controlled environment in which different pricing segments interact.

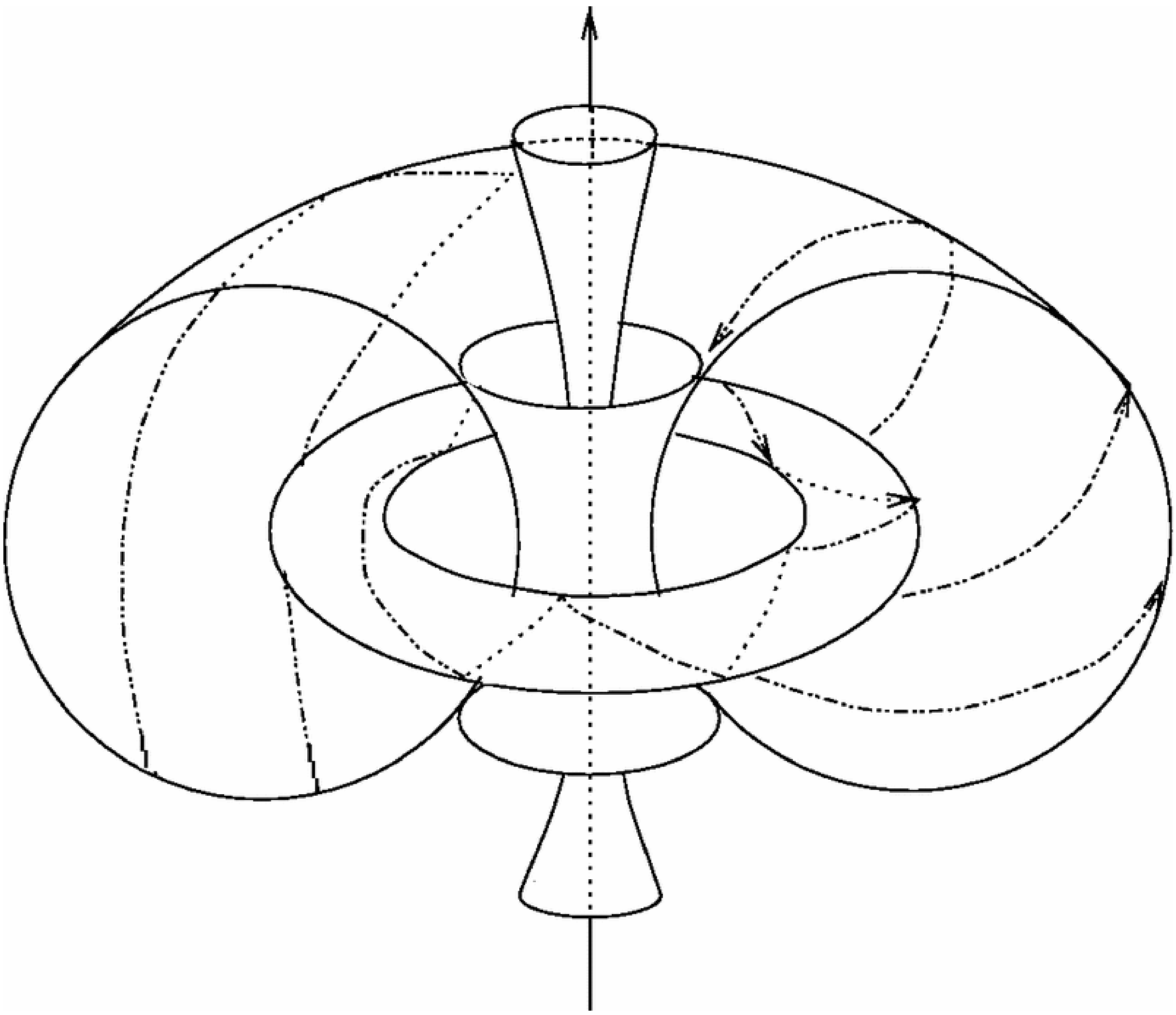

Figure 5 Foliation of a 3-D Sphere 1 (Gibbons, 2008)

Physical Interpretation of the picture: This image represents a physical phenomenon, the sphere might represent a region where interesting dynamics occur, equilibrium states, or regions where forces balance out (e.g., in electromagnetism or fluid dynamics) The 1D vertical line at the centre of the image could be seen as the axis of a *circle* or a cylinder, depending on the perspective.

If we imagine a circle around the line, it would represent the rotation or a cross-section of a cylindrical structure around the axis. In physical and mathematical contexts, such circles symbolize:

- Rotational symmetry: A system where the dynamics (or pricing) revolve uniformly around a central point or axis.
- Equilibrium states: The circle could represent a set of balanced states surrounding the central axis, perhaps analogous to a market price that fluctuates around a central value.
- Concentric forces or fields: In physics, especially in electromagnetism or fluid dynamics, such a configuration might represent forces that radiate outward or inward from a central point, much like a magnetic field around a wire.

We define the circle as a Price Container, the place where buying decision-making collapsed into selling price-making.

4.9.10 All information is in the areas not volumes

The statement that "all the information is in the areas, not in the volumes" is attributed to physicist Gerard 't Hooft. Gerard 't Hooft is a Dutch theoretical physicist and Nobel laureate who made significant contributions to the field of quantum field theory, particularly in the study of gauge theories and fundamental interactions.

The specific quote referring to the information being in the areas, not in the volumes, is often associated with 't Hooft's work on the holographic principle. The holographic principle suggests that the information contained in a higher-dimensional volume can be encoded on its lower-dimensional boundary or surface. ('t Hooft, 1993)

The intersection of a multidimensional space with a plane is a lower-dimensional subspace.

In a multidimensional space, each dimension represents a different variable or parameter. The number of dimensions determines the complexity and dimensionality of the space. A plane, on the other hand, is a two-dimensional flat surface defined by two linearly independent vectors.

The intersection of the multidimensional space with the plane represents the set of points that satisfy the equations or constraints defining both the space and the plane simultaneously. These points lie within the subspace created by the intersection and can be used to analyse and study the relationships between the variables or parameters represented by the dimensions of the space. (Kreyzig, 2018)

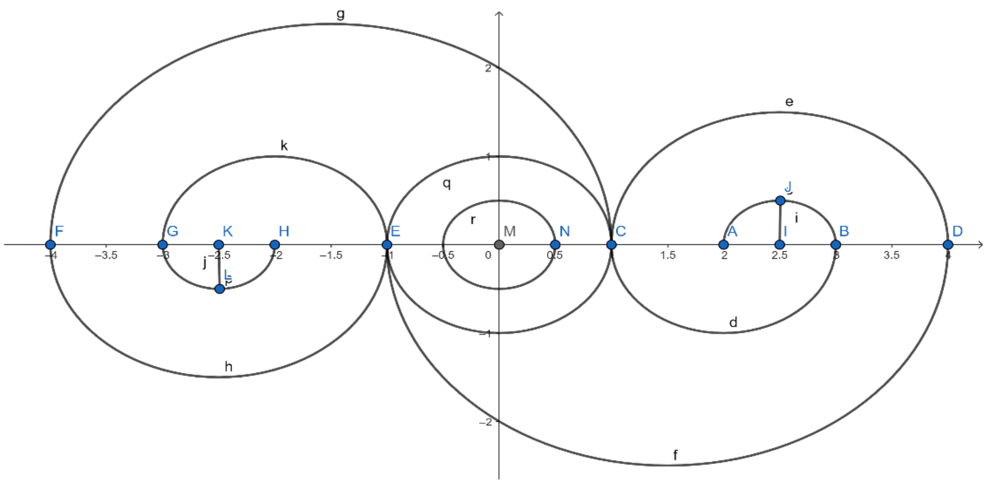

Figure 6 Sell buy process representation

4.9.11 Price container geometry

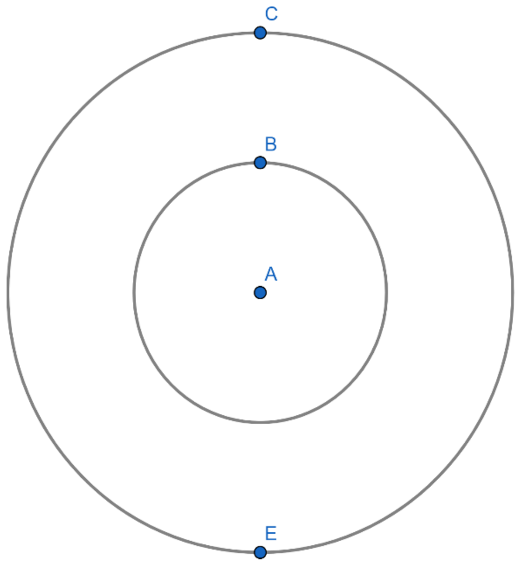

Figure 7 Price container geometry

The Concept and Functionality of Price Containers

Introduction to Price Containers

The concept of a "price container" has emerged as a metaphorical framework for understanding how prices are determined and how they evolve. A price container can be thought of as a structured mechanism that holds various factors influencing the final price of a product or service. These factors include market demand, production costs, competition, and customer perception, among others. Just like a physical container, a price container has boundaries—such as price floors and ceilings—and mechanisms that regulate internal dynamics, such as price elasticity and market conditions.

The idea of a price container is significant in dynamic pricing strategies, particularly in industries where prices are not fixed but fluctuate based on external and internal forces. Understanding this concept is key to comprehending modern price-setting mechanisms, especially in sectors where digital platforms and automation dominate the pricing process.

The Structure and Appearance of a Price Container

A price container, in the metaphorical sense, can be visualized as a flexible but bounded framework that holds the quanta and qualia variables influencing price. It is shaped by several components:

1. Demand Elasticity: This reflects the responsiveness of consumers to changes in price. High elasticity means that small changes in price lead to significant changes in demand, whereas low elasticity indicates that demand remains stable despite price fluctuations.
2. Cost Structure: This refers to the fixed and variable costs associated with producing a product or service. These costs form the base of the container, representing the minimum price level necessary to cover expenses.
3. Competition: The presence of competitors and their pricing strategies creates pressure on the price container, affecting how much room exists for raising or lowering prices. Strong competition often compresses the price range.
4. Market Conditions: External economic factors, such as inflation, government regulation, and supply chain disruptions, impact the flexibility and size of the price container.

"Prices are not just numbers but strategic decisions that require continuous adjustment, shaped by both internal and external pressures" (Smith, 2021). This idea aligns with the concept of a price container, which must adapt to changing market dynamics while retaining a structured form.

The Membrane of the Price Container: Pricing Boundaries and Control

A critical feature of the price container is its membrane, which acts as the boundary controlling the variables inside. The membrane allows for the controlled expansion and contraction of prices based on the interaction of the factors it contains.

- Flexibility and Rigidity: The membrane must balance flexibility and rigidity. Flexible pricing strategies, such as dynamic pricing, allow prices to fluctuate based on real-time data, market demand, and competitor actions. On the other hand, rigid pricing frameworks, like cost-plus pricing, fix the membrane in place, creating more predictable but less competitive prices.

- Pricing Algorithms: In many industries, especially e-commerce and retail, the membrane is controlled by sophisticated pricing algorithms. These algorithms analyze a vast amount of data to determine the optimal price at any given moment.
- Price Floors and Ceilings: These are limits imposed within the price container. A price floor is the minimum price that can be charged, often determined by production costs or else. A price ceiling, on the other hand, caps the maximum price.

By adjusting the price membrane, companies can maintain profitability while reacting to market changes. The strength and elasticity of the membrane are vital for businesses that rely on real-time data to set prices, especially in competitive and fast-changing markets.

The Time Factor in Pricing: Understanding Temporal Dynamics in Price Containers

Price containers are not static; they evolve. The timing of price changes, known as price temporal dynamics, is a key element of modern pricing strategies. In certain industries, price fluctuations occur rapidly, while in others, they follow predictable cycles.

- Dynamic Pricing: In industries like hospitality, prices fluctuate multiple times a day. This is due to real-time demand changes and the perishability of goods or services. "Dynamic pricing reflects the continuous recalibration of the price container, where the internal variables of demand and competition force constant adjustment" (Morris, 2019).
- Price Stickiness: In contrast, some markets experience price stickiness, where prices remain stable despite changes in supply and demand. This often occurs due to long-term contracts, brand reputation concerns, or consumer expectations of price stability. Price stickiness creates a more rigid container, limiting the room for manoeuvring prices even when internal factors suggest change is needed.
- Seasonality: Time also plays a role in pricing through seasonality. Prices for products like clothing, travel, and agricultural goods follow predictable seasonal patterns, influenced by consumer behaviour and supply conditions.

Key Elements of the Price Container

The price container holds several core elements that shape how the final price of a product or service is determined. These include:

1. *Cost of Production*: The base element determines the minimum price threshold. Without covering production costs, a business cannot sustain itself. According to Brown (2022), "Cost-based pricing forms the foundation of most pricing strategies, as it ensures that a company can cover its operational expenses and maintain profitability."

2. *Consumer Willingness to Pay*: This is a reflection of perceived value. The greater the perceived value of a product or service, the more consumers are willing to pay. Psychological pricing tactics, also play a role in manipulating consumer perception within the price container.

3. *Market Trends and Competitive Pricing*: These external forces are dynamic, continuously reshaping the container by creating price pressure from competitors and shifting consumer demand. When competitors lower their prices, businesses must either respond by compressing the price container or differentiate through added value.

4. *Regulatory and Ethical Considerations*: Governments and regulatory bodies often impose restrictions, such as price ceilings on essential goods to prevent price gouging. Ethical considerations can also constrain pricing decisions, as excessively high prices during crises can lead to reputational damage. "Ethics and regulation create artificial boundaries within the price container, ensuring that businesses operate within socially acceptable norms" (Harrison, 2021).

Conclusion

The price container is a robust model for understanding how various factors influence the pricing of goods and services. By visualising price-setting as a dynamic container, businesses can better manage internal and external pressures, ensuring that their prices are competitive yet profitable. The flexible yet bounded nature of the price container allows it to adapt to changing market conditions, consumer behaviour, and regulatory environments. The membrane, time dynamics are core elements of the container work together to shape the final price, creating a structured yet adaptable pricing strategy.

The Time Factor in Pricing: Understanding Temporal Dynamics in Price Containers

Time plays a crucial role in shaping how prices are set and adjusted within a market, which is a critical aspect of the price container concept. Pricing is not just a static decision; it is deeply influenced by temporal factors, which include the frequency and timing of price changes, market cycles, and the timing of consumer demand. These elements create a temporal dimension within the price container, forcing businesses to adapt their pricing strategies to the passage of time and the evolving dynamics of the marketplace.

Several temporal dynamics that influence the behaviour of prices over time, including dynamic pricing, price stickiness, seasonality, and long-term market trends. Each of these elements affects how companies manage the flexibility and structure of their price containers to remain competitive and profitable.

Dynamic Pricing and Real-Time Adjustments

Dynamic pricing refers to a strategy where prices are continually adjusted in response to real-time data on demand, competition, and other market factors.

Dynamic pricing creates a highly fluid price container, where the internal elements such as demand and competition can stretch or compress the container in real time. Algorithmic pricing plays a critical role in this strategy. "Dynamic pricing reflects the continuous recalibration of the price container, where the internal variables of demand and competition force constant adjustment," as Morris (2019) emphasizes.

The key advantage of dynamic pricing is that it enables businesses to maximize their revenue by adjusting to market fluctuations quickly. However, it also requires sophisticated data analysis and technological infrastructure to maintain, as companies need access to accurate real-time information to make effective pricing decisions.

Price Stickiness: Resistance to Change

In contrast to dynamic pricing, businesses experience price stickiness, where prices are slow to change despite shifts in demand or cost conditions. This phenomenon is often observed in markets where long-term contracts, brand reputation, or customer expectations play a significant role.

Price stickiness creates a more rigid price container, where businesses may be hesitant or unable to adjust prices despite external factors suggesting the need for change. According to Taylor (2021), "Price stickiness occurs when businesses, for various reasons—contractual, reputational, or regulatory—cannot adjust their prices immediately to reflect shifts in costs or demand."

This rigidity can be both a strength and a weakness. On the one hand, it provides stability and predictability to consumers, which can enhance customer loyalty. On the other hand, it limits the company’s ability to respond to sudden market changes, potentially leading to missed revenue opportunities or profitability losses.

Seasonality and Cyclical Pricing

Seasonality refers to predictable fluctuations in prices due to changes in consumer demand or supply conditions at different times of the year. This is particularly common in industries such as agriculture, retail, and travel, where demand for goods and services varies depending on the season. For instance, winter clothing tends to be more expensive in the fall and early winter, while travel and hotel prices surge during holiday periods.

In seasonal markets, businesses must expand or compress their price containers based on cyclical trends. As Jones (2020) notes, "The price container for agricultural products expands during harvest seasons when supply is abundant, compressing during off-seasons when supply is limited." Companies in these industries must be proactive in their pricing strategies to ensure they capitalize on high-demand periods while remaining competitive during slower times.

Peak Pricing: During times of high demand, such as holidays or seasonal events, companies often increase their prices to take advantage of consumer willingness to pay higher premiums. This period expands the price container, allowing for more profitable pricing strategies.

Off-Peak Discounts: Conversely, businesses may reduce prices during low-demand periods to stimulate sales, compressing the price container and offering discounts to encourage consumer spending.

Long-Term Price Trends and Inflation

Another important temporal aspect of pricing is the long-term trend of prices, often influenced by macroeconomic factors like inflation, technological innovation, and shifts in consumer behaviour. Over time, prices for certain goods and services tend to rise due to inflationary pressures, while others may decrease as technology reduces production costs or as consumer preferences shift.

The impact of inflation on pricing strategies cannot be overlooked. As Harrison (2021) observes, "Inflationary pressures stretch the boundaries of the price container, forcing companies to either pass on the increased costs to consumers or find ways to absorb them through operational efficiencies." In high-inflation environments, businesses must carefully manage the balance between maintaining profitability and retaining consumer loyalty.

Time-Sensitive Pricing Strategies: Early Bird, Peak, and Last-Minute Pricing

Time-based pricing strategies are often employed to create a sense of urgency and maximize revenue by appealing to different types of consumers. Common strategies include:

Early Bird Pricing: Offering lower prices to customers who purchase early. This strategy rewards consumers who commit to a purchase well in advance and helps companies secure early revenue. It is commonly used in event ticket sales, travel bookings, and membership programs.

Peak Pricing: Charging higher prices during periods of high demand. This is common in utilities, transportation, and event ticketing, where prices surge during peak usage times.

Last-Minute Pricing: Offering discounts to fill unsold inventory or tickets close to the deadline. This is a popular strategy in hospitality and airlines, where businesses prefer to sell at a lower price rather than leaving capacity unsold.

These time-sensitive pricing strategies help businesses optimize their price container by adapting to different consumer behaviors and demand patterns over time.

The Internal Time of Price: *Price Evolution*

The internal time of price refers to the natural evolution of pricing within the boundaries of a price container, influenced by the inherent dynamics of the product lifecycle, also by the internal processes that occur over time as a product or service moves through different stages of its life.

In this section, we explore how the internal time within the price container affects pricing strategies, focusing on the product lifecycle, market penetration, and internal demand cycles.

Product Lifecycle Pricing

Products and services typically move through distinct stages in their lifecycle: introduction, growth, maturity, and decline. At each stage, the internal dynamics of the price container change, forcing businesses to adjust their pricing strategies accordingly.

Introduction Stage: During the introduction phase, companies often employ penetration pricing or premium pricing. Penetration pricing aims to gain market share quickly by offering lower prices to attract early adopters, whereas premium pricing seeks to establish a high price point to position the product as a luxury or exclusive offering. The internal time of price at this stage is marked by high volatility, as the price container must adjust rapidly to consumer reception and competition.

The internal time of price evolves rapidly during the introduction phase," as companies balance the need to recoup initial investments with the goal of gaining market traction" (Anderson, 2020).

Growth Stage: As demand increases and the product gains traction in the market, prices may stabilize or gradually rise due to economies of scale. The price container expands as production costs decrease, and the product becomes more widely accepted. However, increased competition during this stage may compress the container, leading to strategic price reductions or discounts to maintain market share.

Maturity Stage: At maturity, the product reaches peak demand, and prices often stabilize. Companies may optimize pricing by focusing on maximizing profits through volume sales or value-added services. The internal time of price here is relatively stable, as the container becomes less flexible and more focused on maintaining profitability. According to Jones (2021), "During the maturity stage, the price container becomes less sensitive to rapid shifts, as the product reaches equilibrium in terms of consumer demand and market share."

Decline Stage: As demand for the product wanes, companies may reduce prices to clear inventory or maintain a competitive edge. The price container contracts significantly during this phase, with downward pressure as companies try to remain profitable in a shrinking market. This period often leads to price erosion, where prices fall as products become obsolete or are replaced by newer alternatives.

Market Penetration and Price Evolution

The internal time of price is also influenced by how a company approaches market penetration. When a product or service first enters a market, businesses must carefully manage the timing and scale of price adjustments based on market adoption rates and consumer behaviour. In new markets, initial pricing may be aggressive to encourage adoption, but as the product gains a foothold, the price container evolves to allow for price optimization.

"The internal time of price reflects a company's need to balance early revenue generation with long-term market stability, adjusting the price container as market penetration increases" (Martin, 2019).

Internal Demand Cycles

Even within stable markets, internal demand cycles influence how prices change over time. These cycles can be driven by factors such as customer purchasing patterns, product upgrades, or changes in customer behaviour due to evolving trends. For instance, in the technology sector, demand for new models may peak during product launches, followed by a period of lower demand as consumers wait for the next release.

Businesses must adjust their price containers internally to account for these fluctuations. During peak demand cycles, companies may raise prices or reduce discounts, allowing the price container to expand and maximize revenue. During slower periods, price compression may occur through the introduction of sales or promotions to stimulate demand. Managing internal demand cycles is a crucial aspect of the internal time of price, “as businesses must align pricing strategies with fluctuating consumer interest and purchasing behaviour" (Thompson, 2021).

The Role of Internal Pricing Data

Finally, the internal time of price is influenced by a company’s own pricing data and insights. By analysing historical sales data, customer behaviour, and market trends, businesses can better predict when to adjust prices within the container. This data-driven approach to pricing allows companies to optimize their pricing strategies in real time, aligning their internal timeframes with market opportunities.

"Data-driven pricing helps businesses understand the internal time of price, providing insights that allow them to make strategic adjustments based on both historical performance and future projections" (Green, 2022).

Conclusion: The Evolution of Price Within the Container

The internal time of price represents the natural evolution of pricing over time, influenced by product lifecycles, market penetration, internal demand cycles, and data-driven insights. Understanding how prices shift internally allows businesses to better manage the dynamics within the price container, ensuring that their pricing strategies remain adaptable, competitive, and aligned with market realities.

As a product or service progresses through its lifecycle, companies must continuously adjust the boundaries of the price container to reflect changing demand, costs, and competitive pressures.

4.9.12 Price molecules bonds

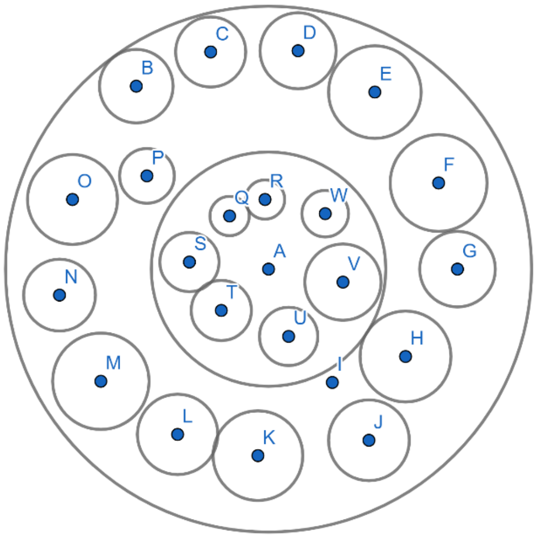

Figure 8 Representation of price units-molecules

In biological molecules, bonds and relationships between atoms and functional groups are essential for maintaining structure, function, and interactions. Various types of chemical bonds and intermolecular forces contribute to the stability and specificity of these molecules. Understanding these bonds is key to appreciating how biomolecules form complex structures and carry out biochemical processes.

These interactions collectively determine the complex three-dimensional structures of biomolecules and enable their diverse functions in biological systems.

These price units are linked together by economic bonds, influenced by internal and external factors, just as chemical bonds in molecules are influenced by their environment.

The Price Molecule Analogy

Just like biological molecules are composed of different atoms connected by bonds, the price units (molecules)are connected by various types of economic forces and relationships. These forces—like cost, supply, demand, and competition—act as bonds between the units.

Types of Bonds in the Price Molecule

1. Supply-Demand Bond (Internal Force)
   - This bond is analogous to covalent bonds in molecules, where the equilibrium between supply and demand forms the core structure of the price. If demand increases while supply remains constant, the bond tightens (price increases). If supply outpaces demand, the bond weakens (price drops). Example: When a product is in high demand but in short supply (like limited edition items), the supply-demand bond tightens, pushing the price up significantly.
2. Cost-Production Bond (Internal Force)
   - This bond represents the production costs that influence the baseline price of the product. Similar to peptide bonds in proteins, it links together the essential components that define the structure of the price molecule, such as raw materials, labour, and overhead. Example: If the cost of raw materials rises (e.g., due to inflation or shortage), the cost-production bond strengthens, leading to an increase in the price.
3. Competitive Bond (External Force)
   - This bond is similar to ionic bonds, where price units are influenced by the competition's pricing strategies. If competitors lower their prices, the competitive bond pulls the price unit downward. Conversely, when competition is scarce, the bond weakens, allowing prices to rise. Example: In a highly competitive market, the competitive bond will pull prices lower as companies compete for market share.
4. Consumer Perception Bond (External Force)

- This is analogous to hydrogen bonds in molecules, which, though relatively weak, significantly affect the overall structure. Consumer perception (brand value, quality perception) creates a bond that can pull prices higher (strong brand perception) or lower (poor brand image). Example: A luxury brand has a strong consumer perception bond, allowing it to price its products higher compared to competitors.

5. Government Regulation Bond (External Force)
   - This bond behaves similarly to external environmental forces that impact molecular structure, such as temperature or pH. Government regulations (such as taxes, tariffs, or subsidies) can alter the strength of price bonds, either raising or lowering the price. Example: A new environmental regulation increasing taxes acts like a force that tightens the price molecule, leading to higher prices.
6. Economic Condition Bond (Macro-Economic Force)
   - This is akin to Van der Waals forces, where macroeconomic conditions like inflation, interest rates, and economic growth subtly but broadly affect the price molecule. This bond fluctuates based on economic trends, causing shifts in pricing across industries. Example: During a recession, the economic condition bond weakens, reducing overall consumer spending and forcing prices to decrease.

We propose a model where circles are used to represent individual pricing units, this conceptual framework visualizes pricing in the hospitality industry as a system composed of interconnected elements, each influencing the overall price structure. Circles serve as an effective geometric tool to convey both the unity and diversity within pricing systems, encapsulating the idea that each pricing unit, like an atom in a molecule, contributes to the overall behaviour and stability of the price.

The units could be defined as the encapsulation of price units and of quanta and qualia with the following features:

Time-based Decay: Each unit has a unique decay function over time. This means the value or influence of each unit diminishes at a different rate, influenced by factors like perishability, depreciation, or demand. The decay could be linear, exponential, or based on other time-dependent patterns.

Space Occupation in a Price Container: These units are visualized as occupying space within price container. The space they occupy could symbolize how much they contribute to the total price or value, with different units potentially varying in "area" or "weight" within this container.

We can use a general equation to calculate the number of 1-unit circles that can be included within a circle of any diameter. Let's denote the diameter of the container circle as D and the number of 1-unit circles as N. The equation can be expressed as:

$$N = floor(D^2)$$

We can calculate the number of 1-unit circles included for various diameters. Here's an updated table:

Container Diameter	Container Area	Number of 1-units Included in the area
120	11309.7336	113
121	11554.4060	116
122	11801.4238	121
123	12050.8049	125
124	12302.5675	128
125	12556.7295	133
126	12813.3090	137
127	13072.3240	142
128	13333.7924	146
129	13597.7323	151

Container Diameter	Container Area	Number of 1-units Included in the area
...	...	...
147	21318.8731	213
148	21696.1376	218
149	22075.9040	222

Figure 9 Table 1 Area vs units

The values in the table are rounded for simplicity, and the equation assumes that the circles are perfectly aligned and do not overlap

Example: Calculate the number of 1-unit circles that can fit within a circle with a diameter of 12.

To do this, we need to calculate the area of the larger circle and then divide it by the area of a single 1-unit circle.

1. Calculate the radius of the larger circle: Radius = Diameter / 2 Radius = 12 / 2 Radius = 6 units
2. Calculate the area of the larger circle: Area = π * Radius^2 Area = 3.14159 * 6^2 Area ≈ 113.097 square units
3. Calculate the number of 1-unit circles: Number of Circles = Area of Larger Circle / Area of 1-unit Circle Number of Circles = 113.097 / (π * 1^2) Number of Circles ≈ 113.097

Therefore, approximately 113 circles with a diameter of 1 unit can fit within a circle with a diameter of 12 units.

This calculation assumes the circles are arranged in a tightly packed manner without any overlapping.

4.9.13 Thermal deformation of a circle

The equation for thermal deformations of a circle can be described using the coefficient of thermal expansion and the temperature change. When a circle undergoes a temperature change, it expands or contracts, resulting in a change in its dimensions.

Let's denote the initial radius of the circle as R and the change in temperature as ΔT. The equation for thermal deformations of a circle can be expressed as:

$\Delta L = \alpha * R * \Delta T$

where: ΔL is the change in the length or diameter of the circle, α is the coefficient of thermal expansion for the material, and ΔT is the change in temperature.

The coefficient of thermal expansion (α)

By multiplying the initial radius (R) of the circle by the coefficient of thermal expansion (α) and the change in temperature (ΔT), we can determine the magnitude of the thermal deformations experienced by the circle.

To calculate the increase in diameter of a circle due to thermal deformation, we can use the formula:

Change in Diameter = (Percentage Change in Area)^(1/2) * Original Diameter

Given that the original diameter of the circle is 120 units, let's calculate the increase in diameter for different percentages of area change:

1. For a 10% increase in area: Change in Diameter = (10%)^(1/2) * 120 = 1.048 * 120 = 125.76 units
2. For a 20% increase in area: Change in Diameter = (20%)^(1/2) * 120 = 1.095 * 120 = 131.4 units
3. For a 30% increase in area: Change in Diameter = (30%)^(1/2) * 120 = 1.155 * 120 = 138.6 units
4. For a 40% increase in area: Change in Diameter = (40%)^(1/2) * 120 = 1.244 * 120 = 149.28 units
5. For a 50% increase in area: Change in Diameter = (50%)^(1/2) * 120 = 1.414 * 120 = 169.68 units

Therefore, the diameter of the circle will increase by approximately 125.76 units for a 10% increase in area, 131.4 units for a 20% increase, 138.6 units for a 30% increase, 149.28 units for a 40% increase, and 169.68 units for a 50% increase.

Deriving a general formula to calculate the number of tangent circles that can be drawn inside a circle with a given area.

Let A be the original area of the circle. Let n be the percentage increase in area. Let N be the number of tangent circles.

The formula to calculate N can be expressed as:

$$N = floor((\pi * (sqrt(A + (n/100 * A)) / 2)^2) / 1)$$

In this formula, we first calculate the new area of the circle by adding the percentage increase to the original area. Then, we calculate the radius of the tangent circles by taking the square root of the new area divided by π, and dividing it by 2 to get the radius. Finally, we square the radius, multiply it by π, and divide by 1 to get the total area covered by the tangent circles. Taking the floor value ensures that we get the integer number of tangent circles.

By plugging the values of A and n into this formula to calculate the number of tangent circles for any given scenario, thus evaluate the dynamics of price.

4.10 Meta benchmark -Pricing in Aviation

Pricing in aviation is a leader in marketing innovation for several reasons. Firstly, the aviation industry operates in a highly competitive market with many different players vying for customers. As a result, airlines have developed sophisticated pricing strategies to attract customers while maximising revenue. These strategies often involve dynamic pricing, changing prices in response to market demand and supply.

Secondly, airlines have access to vast amounts of data on customer behaviour and market trends, which they can use to inform their pricing decisions. For example, airlines may use data on customer demographics, purchasing habits, and travel patterns to develop pricing strategies that target specific customer segments or respond to changes in market demand.

Finally, the aviation industry has been at the forefront of technology adoption, particularly in revenue management systems. These systems use algorithms and machine learning to analyse market data and optimise real-time pricing decisions. As a result, airlines can adjust prices quickly and accurately in response to changing market conditions.

The success of these pricing strategies in the aviation industry has led to their adoption by other industries, such as hotels, car rental, and cruise lines. These industries have realised the value of dynamic pricing and data-driven pricing strategies in maximising revenue and attracting customers.

4.10.1 Seat Prices

The process of determining seat prices for the aviation industry involves various factors, including fuel, maintenance, labour, and competition from other airlines. The following are some of the equations and approaches used in the aviation industry to calculate and forecast seat prices:

Breakeven Load Factor (BELF): This is the percentage of seats that must be filled on a flight for the airline to break even. The equation for calculating BELF is:

BELF = (Total Operating Cost / Revenue per Passenger) / (Number of Seats x Flight Hours)

Yield Management: This pricing strategy optimizes revenue by adjusting seat prices based on demand. The objective is to maximize revenue by filling as many seats as possible at the highest price. The equation for determining optimal seat prices based on demand is:

Price = [(Maximum Revenue per Seat – Variable Costs per Seat) / Load Factor] + Fixed Costs per Seat

Demand Forecasting: This involves using historical data and statistical models to predict future demand for airline seats. The equation for calculating demand forecasting is:

Demand Forecast = $\alpha(Y_{t-1}) + (1-\alpha)Y_{t-2}$

It is the demand for seats in the current period, Yt-1 is the demand in the previous period, and Yt-2 was the demand two periods ago. α is a weight between 0 and 1, used to place more emphasis on recent data.

Regression Analysis: This involves analyzing the relationship between factors affecting seat prices, such as fuel costs, labour costs, and competition from other airlines. The equation for regression analysis is:

$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \varepsilon$

Where Y is the dependent variable (seat price), X1, X2, and X3 are the independent variables (fuel costs, labour costs, and competition), β0 is the intercept, β1, β2, and β3 are the regression coefficients, and ε is the error term.

The aviation industry uses various mathematical models and analytical tools to determine seat prices, forecast demand, and optimize revenue. These equations and approaches constantly evolve as airlines seek to stay competitive and respond to changing market conditions.

Breakeven Occupancy Rate (BEOR)

Similar to the Breakeven Load Factor (BELF) for airlines, hotels need to calculate the minimum occupancy rate to cover costs. The equation can be adapted for hotel rooms as:

$$BEOR = (Total\ Operating\ Cost/Revenue\ per\ Room)/(Number\ of\ Rooms \times Hotel\ Operating\ Days)$$

- Total Operating Cost: Includes the hotel’s expenses (e.g., utilities, staff, maintenance, etc.).
- Revenue per Room: The average revenue generated by a single room.
- Number of Rooms: The total number of rooms available in the hotel.
- Hotel Operating Days: The number of days the hotel is operating in a given period.

This formula gives the percentage of rooms that must be booked to break even.

2. Yield Management

Yield management helps hotels optimize room prices based on demand, aiming to maximize revenue by adjusting prices in real-time. The equation is similar but adapted for rooms:

$$Price = ((Maximum\ Revenue\ per\ Room - Variable\ Costs\ per\ Room)$$
$$/(Occupancy\ Rate) + Fixed\ Costs\ per\ Room$$

- Maximum Revenue per Room: The highest price that a room can be sold for.
- Variable Costs per Room: Costs that change with each room booking (e.g., housekeeping, utilities, guest services).
- Occupancy Rate: The current occupancy percentage.
- Fixed Costs per Room: Costs that do not change with occupancy (e.g., mortgage, fixed salaries).

This equation helps to set optimal prices for hotel rooms depending on demand and the occupancy rate.

3. Demand Forecasting for Hotel Rooms

Hotels can use historical data to predict future demand for rooms. The equation for demand forecasting remains the same:

$$Demand\ Forecast = \alpha(Yt - 1) + (1 - \alpha)Yt - 2$$

- Demand Forecast: The predicted number of room bookings for the current period.
- Yt−1: The demand for rooms in the previous period (e.g., last month).
- Yt−2: The demand for rooms two periods ago (e.g., two months ago).
- α: A smoothing factor between 0 and 1 to give more weight to recent data.

By using this method, hotels can anticipate changes in demand and adjust pricing accordingly.

4. Regression Analysis for Room Prices

This method helps analyse how different factors affect hotel room pricing, just like in the aviation industry. The equation is:

$$Y = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \epsilon$$

Where:

- Y: The dependent variable (room price).
- X1: Independent variable 1 (e.g., seasonal demand).
- X2: Independent variable 2 (e.g., competitor pricing).
- X3: Independent variable 3 (e.g., marketing campaigns).
- β0: The intercept (base price).
- β1,β2,β3: Coefficients representing the impact of each factor on room prices.
- ϵ: Error term representing unexplained variability.

By using regression analysis, hotels can identify the key factors influencing room prices and adjust them based on trends, competitor actions, and other market dynamics.

Summary of Key Factors for Hotel Room Pricing:

1. Operating Costs: Includes fixed and variable costs like staffing, utilities, and maintenance.
2. Demand Patterns: Influenced by seasonality, local events, or market conditions.
3. Competitor Pricing: Room prices must remain competitive with nearby hotels offering similar amenities.
4. Room Availability: Pricing adjusts based on the hotel's occupancy rates and the number of rooms available.
5. Customer Behaviour: Changes in booking behaviour, such as last-minute bookings, can also affect pricing strategies.

By adapting these aviation industry concepts to hotel management, hotels can make informed pricing decisions, forecast demand, and optimize revenue based on current market conditions.

4.11 Fluid Pricing Models and Physics-based Analogies

Fluid pricing in the hospitality market is a dynamic pricing strategy that models price adjustments based on principles from thermodynamics and fluid mechanics. This approach treats prices as fluid entities that continuously respond to changing market conditions, similar to how fluids behave under varying pressure, temperature, and volume in physical systems.

In this context:

Pressure represents external market forces such as demand surges (e.g., during holidays or peak seasons) and competitive actions (e.g., promotions by competitors). High demand increases "pressure," driving prices upward, while low demand releases pressure, causing prices to drop.

Temperature symbolizes the market's volatility or activity level. In times of high uncertainty or rapid change (like during an economic crisis or major events), prices fluctuate significantly, akin to the higher energy and movement of particles in a heated fluid. During more stable periods, prices remain steadier, similar to how fluids calm at lower temperatures.

Viscosity refers to the flexibility or resistance of prices to adjust. In some parts of the hospitality market, such as luxury hotels with fixed pricing structures, prices might be "sticky" and slower to change (high viscosity). On the other hand, budget accommodations or online platforms using revenue management software may adapt prices swiftly based on real-time data (low viscosity), akin to a low-viscosity fluid that flows easily.

Flow rate reflects how quickly prices adjust to market changes. A fast flow rate, like a rapid stream, occurs when prices shift frequently in response to real-time demand and occupancy rates. A slower flow rate indicates more gradual pricing changes, as seen in markets with longer lead times for bookings or less volatile demand.

Drawing on thermodynamic principles, such as the Ideal Gas Law (PV = nRT), fluid pricing in hospitality captures how pricing reacts to variables like demand (pressure), available inventory (volume), and market trends (temperature). For instance, during a high-demand period with limited room availability, prices rise dramatically—similar to an increase in pressure within a confined volume of gas.

Conclusion

Fluid pricing refers to a dynamic pricing strategy where prices are adjusted based on real-time market factors, akin to how fluids change their state and behaviour under varying pressure, volume, and temperature conditions.

4.12 Applying gas laws for hospitality

Modifying hotel room prices can be an innovative way to dynamically adjust prices based on supply and demand. Let's draw parallels between gas laws and hotel pricing strategies:

Boyle's Law (Pressure and Volume)

Boyle's Law, formulated by Robert Boyle in 1662, describes the relationship between the pressure and volume of a gas at a constant temperature. The law states that the pressure (P) of a gas is inversely proportional to its volume (V), which can be expressed mathematically as:

$$PV=k$$

Where K,is a constant for a given amount of gas at a constant temperature. This means that if the volume of the gas decreases, the pressure increases, and vice versa, provided the temperature remains unchanged.

Application of Boyle's Law in Hotel Room Management

While Boyle's Law is primarily a principle in physics and chemistry, its conceptual framework can be metaphorically applied to hotel room management and pricing strategies. Here's how the principles behind Boyle's Law can relate to hotel operations:

Occupancy and Pricing: Just as gas pressure increases when volume decreases, hotel room prices may need to be adjusted based on occupancy levels. For instance, during high-demand periods (low availability), hotels might increase prices to maximize revenue, similar to how increased pressure results from reduced volume in gas.

Revenue Management: Hotels use metrics like Average Daily Rate (ADR) and Revenue Per Available Room (RevPAR) to optimize their pricing strategies. When occupancy rates are low, hotels might lower prices to fill rooms, akin to allowing more volume for gas to reduce pressure.

Dynamic Pricing: The concept of adjusting prices based on demand can reflect Boyle's Law. As demand increases (akin to increasing pressure), hotels can raise rates. Conversely, if demand drops (like increasing volume), they may need to lower rates to attract guests.

Boyle's Law states that at constant temperature, the pressure of a gas is inversely proportional to its volume. In hotel pricing:

- Pressure (P): Can be analogous to the demand for rooms.
- Volume (V): Can be analogous to the number of available rooms (supply).

$$P1V1 = P2V2$$

If demand increases (higher pressure), and the supply (number of rooms) remains constant, the price (analogous to pressure) should increase. Conversely, if there are many available rooms, the price should decrease to attract more bookings.

2. Charles's Law (Volume and Temperature)

Charles's Law states that at constant pressure, the volume of a gas is directly proportional to its temperature. In hotel pricing:

Charles' Law, formulated by Jacques Charles in the late 18th century, states that the volume of a given amount of gas is directly proportional to its absolute temperature when pressure is held constant. This relationship can be expressed mathematically as:

$$\frac{V1}{T1} = \frac{V2}{T2}$$

where V represents volume and T represents temperature in Kelvin. As the temperature increases, the volume expands; conversely, if the temperature decreases, the volume contracts.

Application of Charles' Law in Room Management

In hotel management, Charles' Law can serve as a metaphor for understanding how temperature (representing market conditions) affects room availability and pricing strategies. Here’s how it can be applied:

Demand and Pricing: Just as increasing temperature leads to an increase in volume, rising demand for hotel rooms (e.g., during peak seasons or events) can lead to higher room rates. Hotels can adjust their pricing strategies based on expected occupancy levels, similar to how gas expands with heat.

Capacity Management: Understanding that higher temperatures (demand) require more space (room availability), hotel managers can optimize their inventory by forecasting peak periods and adjusting availability accordingly. For instance, during high-demand periods, hotels might choose to limit discounts or implement minimum stay requirements to maximize revenue.

Dynamic Pricing Strategies: Just as gases expand with increased temperature, hotels can implement dynamic pricing models that adjust room rates in real-time based on current demand. This involves analysing booking patterns and market trends to set competitive prices that reflect both occupancy rates and seasonal fluctuations.

Practical Implementation

Using these analogies, you can develop a dynamic pricing model. A step-by-step approach:

1. Determine Baseline Metrics:
   - Set a baseline price for rooms based on historical data and costs.
   - Identify baseline occupancy rates and demand indicators.
2. Monitor Real-Time Data:
   - Track real-time booking trends, occupancy rates, and external demand factors (e.g., local events, holidays, seasons).
3. Adjust Prices Dynamically:
   - **Boyle's Law**: Adjust prices inversely based on occupancy rates. If the hotel is filling up quickly (high occupancy), increase prices. If there are many vacant rooms, decrease prices to attract more bookings.
   - **Charles's Law**: Adjust prices based on expected demand changes due to seasonal variations or events. Higher prices during high-demand periods, lower prices during low-demand periods.
   - **Gay-Lussac's Law**: Adjust prices directly based on demand indicators. Use data analytics to forecast demand and set prices accordingly.

4.13 Carnot Engine Analogy for Pricing in Hospitality

Introduction to the Carnot Engine Analogy in Pricing

The Carnot engine, introduced by the French physicist Sadi Carnot in 1824, represents an idealized thermodynamic cycle that achieves maximum efficiency by converting heat into work. In thermodynamics, the Carnot engine is seen as the most efficient process for transferring energy, as it operates between two heat reservoirs—one hot and one cold. This concept can serve as a powerful analogy when applied to pricing strategies in the hospitality industry.

Pricing in hospitality is a complex, dynamic process, much like the transfer of energy in a thermodynamic system. By viewing pricing decisions through the lens of the Carnot engine, hospitality managers can approach their strategies with an emphasis on maximizing efficiency, profit, and market competitiveness. The Carnot analogy provides a framework for understanding the interplay between demand (input energy), competition, and profitability (output energy) in the ever-changing hospitality environment

Key Components of the Carnot Engine and Pricing in Hospitality

The Carnot engine operates on four key processes: isothermal expansion, adiabatic expansion, isothermal compression, and adiabatic compression. Each of these processes can be mapped onto the pricing dynamics of hospitality businesses, allowing for a deeper understanding of how price optimization can function similarly to energy optimization in thermodynamics.

1. Isothermal Expansion: Maximizing Demand at Optimal Price

In the Carnot engine, isothermal expansion occurs when the system absorbs heat at a constant temperature, resulting in an increase in volume (or expansion). This phase can be likened to periods of high demand in the hospitality industry, such as during peak seasons, holidays, or major events when customer interest is strong. In this stage, a hotel or restaurant seeks to absorb as much revenue (analogous to heat) as possible by adjusting prices to match the increased demand.

By operating at an optimal price point during times of high demand, hospitality businesses can maximize their revenue intake. This corresponds to the system absorbing energy efficiently, without overextending or underselling. The goal here is to find the pricing "sweet spot," where customer willingness to pay is maximized while maintaining high occupancy or patronage rates.

According to Hayes and Miller (2011), "Strategic pricing during high-demand periods allows businesses to capture maximum revenue potential, provided they understand the elasticity of customer demand."

2. Adiabatic Expansion: Responding to Competition Without External Input

During adiabatic expansion in a Carnot engine, no heat is exchanged with the environment, yet the system continues to do work as it expands. This phase can be compared to situations in the hospitality market where external demand is stable, but competitive pressures force businesses to adjust their pricing strategies without external changes in customer behaviour. In this context, businesses must optimize internal processes—cost management, service quality, and operational efficiency—to stay competitive without simply relying on external demand changes to drive revenue.

For example, during periods of moderate demand, a hotel must adjust its prices to remain competitive while controlling costs and maintaining service standards. The goal here is to "do more with less," much like the Carnot engine continues to expand without absorbing additional heat. Efficient management and lean operations become key to maintaining profitability without having to lower prices drastically.

As noted by Kimes (2010), "Revenue management in hospitality requires balancing competitive pressures and cost control, ensuring that pricing reflects both market conditions and internal capabilities".

3. Isothermal Compression: Reducing Prices to Stimulate Demand

In isothermal compression, the Carnot engine releases heat at a constant temperature while reducing its volume, mirroring the need to lower prices in the hospitality industry during low-demand periods. During off-peak seasons, hospitality businesses often face reduced bookings or foot traffic. To stimulate demand, prices are lowered, representing the release of excess capacity or "heat" from the system to attract more customers.

This stage is crucial for maintaining a baseline level of revenue during periods of low demand. The challenge is to reduce prices in a controlled manner that stimulates demand without severely compromising profit margins. Offering promotions, discounts, or value-added packages can be likened to the isothermal release of energy, ensuring that business operations continue smoothly despite the lower price point.

According to Mauri (2013), "Discounting strategies during low-demand periods can effectively drive occupancy and sales, but they must be carefully calibrated to avoid eroding brand value or long-term profitability.

4. Adiabatic Compression: Preparing for the Next Demand Cycle

Finally, adiabatic compression in a Carnot engine occurs when the system prepares to reabsorb heat for the next cycle, reducing its volume without any external heat exchange. This phase can be equated to the hospitality industry's preparation for the next high-demand cycle, during which businesses recalibrate their pricing and operational strategies in anticipation of the next peak period.

During this phase, hotels and restaurants may not necessarily change their prices, but instead focus on internal improvements—renovations, staff training, marketing campaigns, and operational refinements. These activities help position the business to capitalize on future demand without requiring immediate customer input. Just as the Carnot engine recharges by preparing for the next cycle of energy absorption, hospitality businesses must prepare to capture future demand effectively.

As Enz and Canina (2010) point out, "Effective preparation during low-demand periods can set the stage for capturing market share and driving revenue when demand rebounds.

Theoretical Efficiency and Practical Limitations in Pricing

The Carnot engine is often referred to as the most efficient engine possible, but in practice, no engine can achieve 100% efficiency due to real-world frictions such as energy losses and material limitations. Similarly, in hospitality pricing, perfect pricing efficiency is unattainable due to market unpredictability, customer behaviour, and operational constraints. However, the Carnot analogy helps hospitality managers aim for maximal efficiency by identifying the ideal balance between price, demand, and profitability.

Ideal Pricing and Revenue Management

The theoretical maximum efficiency of a Carnot engine depends on the difference between the temperatures of the hot and cold reservoirs. In pricing terms, this can be likened to the difference between peak demand (the "hot" phase) and low demand (the "cold" phase). The greater the differential, the more potential there is for revenue optimization. In practice, this means that understanding customer behaviour during both peak and off-peak times allows for more strategic pricing adjustments, helping businesses extract the most revenue possible within the constraints of market conditions.

"Revenue management is, in essence, the science of pricing efficiency, optimizing income by understanding the nuances of customer behaviour and market demand" (Kimes, 2009).

Constraints and Operational Limitations

In the real world, however, no business can operate as an ideal Carnot engine. Market constraints—such as unpredictable demand fluctuations, competitor actions, and regulatory pressures—act as friction in the pricing process, reducing the potential for achieving ideal revenue outcomes. Similarly, operational limitations, such as fixed costs, labour availability, and supply chain disruptions, prevent hospitality businesses from responding to demand changes with perfect agility.

As Enz and Canina (2010) noted, "The pursuit of pricing efficiency must be balanced with the realities of market behaviour and operational constraints, requiring continuous adaptation and strategic flexibility."

Practical Application of the Carnot Analogy in Hospitality Pricing

The Carnot engine provides a useful framework for hospitality businesses to analyse and refine their pricing strategies. By mapping the thermodynamic processes of energy transfer to the dynamics of price adjustments, hospitality managers can develop a more structured and scientific approach to pricing. This approach helps businesses identify when to increase prices, how to respond to competitive pressures, and what strategies to employ during low-demand periods to maximize profitability.

Peak Period Pricing: Capturing Maximum Revenue

During peak demand periods (analogous to isothermal expansion), hospitality businesses should focus on optimizing prices to capture as much revenue as possible without exceeding customer willingness to pay. Using data-driven pricing models that factor in real-time demand, customer segmentation, and competitive analysis allows businesses to fine-tune their rates for maximum efficiency.

As Kimes (2010) suggests, "Data-driven pricing strategies enable hospitality firms to adapt to demand fluctuations in real-time, ensuring that they capitalize on every opportunity to maximize revenue.

Off-Peak Pricing: Stimulating Demand Without Sacrificing Profitability

During low-demand periods (isothermal compression), businesses should explore creative discounting strategies, bundled offers, or value-added services to stimulate demand. However, they must do so carefully to avoid eroding long-term brand value or profitability. This phase is about maintaining efficiency by driving occupancy or sales without slashing prices unsustainably.

"Mauri (2013) highlights that 'the key to off-peak pricing is maintaining value perception, ensuring that discounts do not undermine the brand or diminish customer loyalty.'"

Conclusion

The Carnot engine analogy offers a powerful framework for understanding pricing dynamics in the hospitality industry. By viewing pricing as a cyclical process of energy transfer between demand and profitability, hospitality managers can optimize their strategies to maximize revenue during high-demand periods, remain competitive during stable periods

4.14 Price- energy perspective- Dirac

Dirac's Antiparticle Model: A Brief Overview

In physics, Paul Dirac's antiparticle model posits that for every particle (with positive energy), there is an antiparticle with an opposite charge but equal mass. These particles can emerge from the "vacuum" when sufficient energy is introduced. Particles and antiparticles eventually annihilate each other, releasing energy.

- Negative Charge (Antiparticle): Represents the supply side (in our case, service creation).
- Positive Charge (Particle): Represents the demand side (in our case, the act of purchase or consumption).

This model suggests a symbiotic relationship where creation on one side corresponds with consumption on the other, and equilibrium is restored when both interact.

Service Creation as a Negative Charge

In the hospitality industry, the creation of a service—such as offering a hotel stay, a restaurant meal, or a travel experience—can be conceptualized as the creation of a "negative charge." This is akin to the antiparticle in Dirac's model:

- Service Creation: When a hotel creates a room package or a restaurant develops a new dining experience, they generate a form of "negative charge." This is an investment of resources, including capital, labor, and creativity, similar to how energy is used to bring an antiparticle into existence.
- Negative Charge Representation: The service exists as an offering, but it hasn't yet been consumed. It's waiting for a corresponding "positive charge" (a buyer or guest) to complete the interaction. This stage is like the formation of an antiparticle in Dirac’s sea of negative energy (Dirac, 1928).
- Signalling in the Market: Communication of Charges

In Dirac’s theory, particle-antiparticle pairs interact with their surroundings through electromagnetic signals. Similarly, in hospitality, services are made visible to potential customers through signalling mechanisms, such as marketing, branding, and promotions. This signalling is necessary for connecting the "negative charge" (service) with its complementary "positive charge" (demand).

- Market Signalling: Hotels, restaurants, and other hospitality businesses use advertising, reviews, loyalty programs, and social media to signal the existence of their services. These signals can be thought of as energy waves that communicate the availability of the service, much like how particles interact through forces in physics.
- Energy Input: External factors like economic conditions, consumer preferences, and technological advances serve as additional energy inputs, amplifying or diminishing the effectiveness of these signals, influencing how quickly the service (negative charge) meets demand (positive charge).

The Act of Buying as a Positive Charge

In the Dirac model, the particle with positive energy corresponds to the antiparticle's negative energy, and their interaction leads to annihilation, restoring equilibrium. In the context of hospitality:

Buying as Positive Charge: The act of buying a service (e.g., booking a hotel room or reserving a table at a restaurant) is analogous to the appearance of a particle with a positive charge. This demand completes the service creation process, as the consumer injects financial and emotional "energy" into the system by paying for and consuming the service.

Energy Transfer: When a customer buys the service, there is an exchange of value (financial and experiential), similar to the energy released when particles and antiparticles interact. The "annihilation" of the negative and positive charges can be seen as the completion of the transaction: the customer's need is fulfilled, and the business receives compensation.

Equilibrium and Market Balance

In both Dirac's antiparticle model and the hospitality market, equilibrium is a key concept. In the Dirac equation, once the particle and antiparticle annihilate, the system returns to equilibrium. In the hospitality industry:

- Service-Demand Balance: The market reaches equilibrium when there is a balance between service creation (supply) and customer demand. Too much negative charge (overproduction of services) without corresponding positive charge (buyers) leads to an imbalance, similar to an overabundance of antiparticles in a quantum system. Conversely, a surge in demand with insufficient supply creates pricing pressure and unmet needs.
- Market Fluctuations: Changes in economic factors, such as consumer sentiment, disposable income, and travel preferences, can cause fluctuations in this equilibrium, leading to periods of high demand (positive charge) or oversupply (negative charge).

Timeline of Service Creation and Consumption in Hospitality

Using this framework, we can establish a timeline for service creation and consumption, mirroring particle-antiparticle dynamics in Dirac's model:

Stage 1: Service Creation (Negative Charge)

A hotel or restaurant creates a new service offering (e.g., a seasonal dining menu, special event, or vacation package). This represents the formation of a "negative charge," akin to an antiparticle appearing in the quantum vacuum.

Stage 2: Signalling (Energy Interaction)

The business sends signals to the market through advertising, social media, or direct promotions. These signals aim to attract customers (positive charges) to the service (negative charges).

Stage 3: Purchase (Positive Charge)

- When a customer books the service, the "positive charge" interacts with the "negative charge." The demand for the service meets the supply, completing the energy exchange. This is akin to particle-antiparticle annihilation.

Stage 4: Equilibrium and Rebalancing

After the transaction, the market returns to balance, with services delivered and businesses compensated. The system stabilizes until new energy inputs (changes in demand, seasonality, economic factors) create the need for fresh service offerings, restarting the cycle.

Conclusion

The creation of a service in hospitality can be modelled as the generation of a "negative charge," representing the supply side, while the act of purchasing and consuming that service corresponds to a "positive charge." Market signalling plays a critical role in bridging these charges, while the balance between service creation and consumption maintains equilibrium in the market. Much like Dirac's model, where particles and antiparticles interact energetically, the hospitality market operates on dynamic energy exchanges between service offerings and customer demand.

The relevance of Dirac antiparticle model to the hospitality industry, we gain a unique theoretical framework to understand the energetic and dynamic nature of market interactions, where service creation and customer purchasing are seen as complementary forces driving the economic system. This conceptual model can also offer practical insights for improving market efficiency, optimizing supply-demand balance, and strategically aligning service offerings with consumer behaviour in real-time.

4.15 Analogies between fluid properties and the price

An analogy can be drawn between the properties of a fluid and the prices of fluids in the context of economics. Just as a fluid's properties vary based on temperature, pressure, and chemical composition, fluid prices can fluctuate depending on various factors in the market. Let's explore this analogy further:

1. Viscosity: In the realm of fluid prices, viscosity can be likened to the market liquidity or ease with which prices change. Fluid markets with high liquidity experience rapid price changes, similar to fluids with low viscosity that flow quickly. Conversely, markets with low liquidity may have slower price movements, comparable to highly viscous fluids.
2. Density: The concept of density in fluids can be related to price levels. Just as denser fluids exert more pressure on objects, higher prices can create greater pressure on consumers or businesses, influencing their purchasing. On the other hand, lower prices may relieve some of this pressure.
3. Compressibility: The compressibility of fluids aligns with the concept of price elasticity. Highly compressible gases can be compared to goods or services with high price elasticity, meaning their demand is sensitive to price changes. In contrast, less compressible liquids reflect goods or services with low price elasticity, where demand remains relatively stable despite price fluctuations.
4. Surface tension: Analogous to surface tension, pricing dynamics can exhibit resistance to external forces that attempt to disrupt equilibrium. Market prices often resist significant deviations from supply and demand forces, similar to how a fluid's surface tension resists deformations. This stability can be seen in pricing patterns over time.
5. Thermal conductivity: The thermal conductivity of fluids can be related to price transmission and information flow. Just as a fluid's thermal conductivity affects how it transfers heat, efficient price transmission mechanisms allow relevant

information to disseminate quickly across markets, enabling price discovery and efficient allocation of resources.

6. Solubility: Solubility in fluids can be associated with the interaction between prices and other economic factors. The solubility of a fluid affects its chemical and physical behaviour, much like how price changes can interact with factors such as consumer preferences, market competition, and economic policies, leading to varied market outcomes.

Formula that incorporates the influence of viscosity, density, compressibility, surface tension, thermal conductivity, and solubility on prices, we can use a weighted model. Each factor can be assigned a weight representing its influence on the overall price dynamics. Let's denote:

- P as the price
- V as viscosity (market liquidity)
- D as density (price levels)
- C as compressibility (price elasticity)
- S as surface tension (pricing stability)
- T as thermal conductivity (price transmission)
- L as solubility (interaction with economic factors)

We'll use wV, wD, wC, wS, wT, and wL, as the respective weights for each factor.

The formula for price P could be represented as:

$$P = wV \cdot f(V) + wD \cdot g(D) + wC \cdot h(C) + wS \cdot i(S) + wT \cdot j(T) + wL \cdot k(L)P$$

Here f, g, h, i, j,f,g,h,i,j, and k are functions that map each factor to its influence on price. Let’s assume these functions are linear for simplicity:

1. Viscosity (V): f(V)=V
2. Density (D): g(D)=D
3. Compressibility (C): h(C)=C

4. Surface Tension (S): i(S)=S
5. Thermal Conductivity (T): j(T)=T
6. Solubility (L): k(L)=L

Assuming a linear relationship, the formula becomes:

$$P = wV \cdot V + wD \cdot D + wC \cdot C + wS \cdot S + wT \cdot T + wL \cdot LP$$

Interpretation

- Viscosity (V): High market liquidity (low viscosity) leads to rapid price changes, so a higher V would influence prices more.
- Density (D): Higher prices exert more pressure, so D influences overall price levels.
- Compressibility (C): Reflects price elasticity; high C means demand is sensitive to price changes.
- Surface Tension (S): Pricing stability resists significant deviations; higher S means more stability.
- Thermal Conductivity (T): Efficient price transmission mechanisms enable quick information dissemination.
- Solubility (L): Interaction with economic factors; higher L means more significant interactions.

Application

To use this formula, we need to quantify each factor (V, D, C, S, T, L) based on market conditions and apply the weights to calculate the price P. Adjust the weights according to the importance of each factor in your specific context.

This model provides a structured approach to understanding how various factors influence price, integrating concepts from fluid dynamics into economic pricing theory. These analogies highlight how the properties of fluids and fluid prices share similarities in terms of their behaviour and impact. Understanding the diverse properties of fluids can provide insights into the complexities of price dynamics and their effects on economic systems.

4.16 Ideal Gas Equation for Hotels

We are going to adapt the Ideal Gas Law equation PV=nRT for the context of hotel pricing.

Replacements and assumptions:

- V (volume) is replaced by the area of the circle (which represents the price).
- N is replaced by a factor representing hotel internal factor quality, which will be one of the variables:α, β, γ, δ, ϵ, corresponding to 1-star to 5-star hotels respectively.
- P is the "pressure," which represents external factors like demand or time of year or day.
- T is temperature, which can be interpreted as an internal or external factor that influences the rate of price change.

The goal is to come up with a formula that helps us understand the pricing based on these variables.

Formula Derivation:

The Ideal Gas Law is given by:

PV=nRT

Replacing the terms with the hotel pricing analogies:

P remains as a factor representing external pressure over pricing

- V is replaced by the area of the circle (which equals price), which is A= πr^2 where r is the "radius" of the pricing area(something that can increase with hotel internal or external factors).

- n is replaced by the internal factor α,β,γ,δ,ϵ.
- T remains as a factor that represents the influence of seasonal demand or other factors affecting price shifts (analogous to temperature in the gas law).

Modified Equation:

$$\boldsymbol{A = \frac{(\alpha, \beta, \gamma, \delta, \epsilon) \cdot R \cdot T}{P}}$$

Where:

- P = external factors like market demand, competition, etc.
- A= πr^2 the "price" represented as the area of a price container.
- α,β,γ,δ,ϵ = hotel internal variables.
- R = a constant related to the specific location or hotel chain.
- T = a seasonal demand factor that affects the price.

Thus, the Price of a hotel room is influenced by:

1. The internal factor (α,β,γ,δ,ϵ for 1 to 5-star hotels).
2. The seasonal demand factor T.
3. External market pressures P like competition or location.
4. A location-based constant R

- Interpretation:
- If P (market pressure) increases, the price A decreases if all other factors remain constant.
- If T (demand or seasonal factor) increases, price A increases, assuming the market can bear it.
- The hotel internal quality factor α,β,γ,δ,ϵ play a direct role in determining the price. A 5-star hotel (ϵ) will have a higher value, leading to a larger area A (or higher price).

This formula gives us a simplified relationship for calculating the pricing of hotel rooms based on different factors that are analogous to the Ideal Gas Law.

Now, let's assume:

α = 1-star hotel quality = 1.

β = 2-star hotel quality = 2.

γ = 3-star hotel quality = 3.

δ = 4-star hotel quality = 4.

ϵ = 5-star hotel quality = 5.

R = location-based constant = 50.

T = seasonal demand factor = 2.5 (mid-season, moderate demand).

P = market pressure = 1.5 (high competition, lowering prices).

Summary Table:

Hotel Factor (Stars)	Price (Area A)
1-Star (α=1)	83.33 units
2-Star (β=2)	166.67 units
3-Star (γ=3)	250 units
4-Star (δ=4)	333.33 units
5-Star (ϵ=5)	416.67 units

Interpretation:

As the hotel factor increases, the price goes up.

Since the seasonal demand factor T is set to 2.5 (moderate demand), the prices reflect a standard season. In a high-demand season, increasing TTT would further raise the prices.

- The market pressure P=1.5 represents a scenario where competition is driving prices down. If competition were lower (e.g., P=1P = 1P=1), the prices would be higher.

Define New Scenarios:

Scenario 1: High Demand Season (Summer), Reduced Market Competition

T=4T = 4T=4 (high demand).

P=1P = 1P=1 (low competition).

Scenario 2: Low Demand Season (Winter), High Market Competition

T=1.5T = 1.5T=1.5 (low demand).

P=2P = 2P=2 (high competition).

Scenario 3: Moderate Demand, Minimal Competition

T=3T = 3T=3 (moderate demand).

P=1.2P = 1.2P=1.2 (minimal competition).

We'll keep R=50R = 50R=50 (constant, representing the location factor) and the internal factors α=1, β=2, γ=3, δ=4, ϵ=5

Summary Table

Scenario	1-Star	2-Star	3-Star	4-Star	5-Star
High Demand, Low Competition	200 units	400 units	600 units	800 units	1000 units
Low Demand, High Competition	37.5 units	75 units	112.5 units	150 units	187.5 units
Moderate Demand, Minimal Competition	125 units	250 units	375 units	500 units	625 Units

Interpretation:

1. High Demand, Low Competition:
    - Prices are very high across all hotel categories due to the high seasonal demand and low competition. A 5-star hotel costs 1000 units in this scenario.
2. Low Demand, High Competition:
    - Prices are significantly lower across the board. For instance, a 1-star hotel is only 37.5 units, and even a 5-star hotel is only 187.5 units due to both low demand and strong competition.
3. Moderate Demand, Minimal Competition:
    - Prices are moderately high. A 1-star hotel costs 125 units, and a 5-star hotel is priced at 625 units. Minimal competition in this case keeps prices relatively higher despite moderate demand.

Here's the table showing the hotel prices based on the new factors ($\alpha=1.8$, $\beta=2.3$, $\gamma=3$, $\delta=3.5\delta=3.5$, $\epsilon=4.1$) for different demand and competition scenarios:

Hotel Quality (Stars)	**High Demand, Low Competition (T=4, P=1)**	**Low Demand, High Competition (T=1.5,P=2)**	**Moderate Demand, Minimal Competition (T=3, P=1.2)**
1-Star (α=1.8)	360.0 units	67.50 units	225.0 units
2-Star (β=2.3)	460.0 units	86.25 units	287.5 units
3-Star (γ=3)	600.0 units	112.5 units	375.0 units
4-Star (δ=3.5)	700.0 units	131.25 units	437.5 units
5-Star (ϵ=4.1)	820.0 units	153.75 units	512.5 units

Key Observations:

- High Demand, Low Competition (Summer, T=4, P=1):
  - Prices are quite high, with a 5-star hotel costing 820 units, and a 1-star hotel costing 360 units.
- Low Demand, High Competition (Winter, T=1.5, P=2):
  - Prices are much lower due to reduced demand and high competition, with a 1-star hotel costing 67.5 units, and a 5-star hotel costing 153.75 units.
- Moderate Demand, Minimal Competition (T=3, P=1.2):
  - Prices are in between, with a 1-star hotel priced at 225 units, and a 5-star hotel priced at 512.5 units.

Chapter 5: Discussion

The hospitality industry operates as a complex and adaptive system, requiring businesses to continually evolve in response to internal and external influences (4.1 Introduction). This chapter establishes a foundational understanding of the hospitality sector as an open, dynamic entity, emphasizing the need for companies to adapt and innovate to meet shifting consumer expectations and market conditions. The complexities involved necessitate a comprehensive approach that integrates various elements influencing decision-making processes. It provides an answer to the research question nr. 1.

Framing companies as living organisms is crucial to understanding their adaptive, dynamic, and interdependent nature (4.2 The Company as a Living Organism: Adaptive, Dynamic, and Interdependent Systems). This perspective encourages hospitality businesses to recognize the importance of holistic management strategies. Just as biological systems must adapt to survive, hospitality companies must adjust their operations to align with the ever-changing market landscape. The dynamic interactions among organizational components mirror biological systems, highlighting the need for an integrated approach to management that fosters resilience and sustainability. It provides a partial answer to the research question nr. 1.

An exploration of market dynamics reveals the interdependencies between various stakeholders within the hospitality sector (4.3 Markets and Complex Systems: Understanding Dynamics in Hospitality). This understanding is vital for developing effective strategies that respond to fluctuations in consumer behaviour and market conditions. The interconnectedness among market players can significantly influence pricing, marketing, and service delivery strategies. By comprehensively understanding these dynamics, hospitality managers can enhance their strategic decision-making processes. It provides an answer to the research question nr. 1.

A critical aspect of navigating these dynamics involves recognizing the role of folklore in shaping consumer experiences (4.3.1 Open Systems: Folklore). The narratives and stories that resonate with customers can significantly influence their expectations and perceptions. By leveraging these narratives, hospitality businesses can enhance their marketing strategies and create memorable experiences that drive customer loyalty. This emphasis on storytelling illustrates the broader concept of understanding consumer behaviour within the hospitality context. It provides an answer to the research question nr. 1 and 2.

Additionally, acknowledging the path of least resistance highlights a fundamental consumer behaviour (4.3.2 Path of Least Resistance). Consumers often gravitate toward options that require minimal effort, which presents an opportunity for hospitality managers to design services and experiences that align with these tendencies. By streamlining processes and reducing friction points, businesses can enhance customer satisfaction and increase the likelihood of repeat business. It is relevant for price making decision.

Furthermore, the concept of a participatory universe emphasizes the active role consumers play in co-creating their experiences (4.3.3 Participatory Universe). Encouraging collaboration and participation can significantly enhance customer satisfaction and loyalty. By fostering an environment where customers feel involved and valued, hospitality businesses can build lasting relationships and drive innovation through shared ideas and feedback. It provides an answer to the research question nr. 1 and 2.

The ethical considerations surrounding strategic communication are critical, particularly when referencing Edward Bernays' principles of propaganda (4.3.4 Bernays Propaganda). While strategic communication can effectively influence consumer perceptions, hospitality businesses must navigate these ethical waters carefully to ensure that their messaging aligns with their core values and fosters trust among consumers. It provides an answer to the research question nr. 2.

Understanding market forces that operate without resistance is analogous to superconductivity, which can provide insights into identifying and capitalizing on growth opportunities (4.3.5 Superconductivity). Recognizing these forces can enable hospitality managers to adapt their strategies proactively, enhancing their ability to innovate and respond to market changes effectively.It provides an answer to the research question nr. 2.

As technology increasingly drives operations, coping with complexity in software design becomes paramount (4.3.6 Coping with Complexity in Software Design). Implementing user-centred design principles can significantly improve operational efficiency and enhance customer interactions. By prioritizing user experience, hospitality businesses can deliver services that meet customer needs more effectively, ultimately fostering customer loyalty. It provides an answer to the research question nr. 1.

The concept of synthesis proposed by Alexis Carrel encourages the integration of diverse elements to create cohesive experiences (4.3.7 Alexis Carrel on Synthesis). This holistic approach not only enhances operational effectiveness but also improves customer satisfaction by providing seamless experiences that align with consumer expectations. It is a support chapter to justify the methodology.

Abstraction, the ability to simplify complex ideas into actionable insights, is essential for hospitality managers navigating industry intricacies (4.3.8 Abstraction). By mastering this skill, managers can make informed decisions that positively impact their operations and enhance customer experiences. It is a support chapter to justify the methodology.

The metaphorical exploration of “spooky action” and the invisible hand highlights the unseen forces that drive market dynamics (4.3.9 Spooky Action and Invisible Hand). By understanding these forces, hospitality businesses can anticipate changes and adapt their strategies accordingly, thus enhancing their competitive advantage. It provides an answer to the research question nr. 1 also, it is a support chapter to justify the methodology.

The psychological aspects of consumer behaviour play a crucial role in shaping decision-making processes within the hospitality industry (4.4 Consumer Behaviour and Perception in Decision-Making). Understanding how perception influences decision-making allows businesses to tailor their offerings to meet consumer needs more effectively, ultimately enhancing customer satisfaction.It provides an answer to the research question nr. 2.

Visual perception is particularly significant in shaping consumer choices, as visual elements influence customer experiences and purchasing decisions (4..4.1 Visual Perception). This underscores the importance of effective branding and marketing strategies in creating compelling offerings that resonate with the target audience.It provides partial answers to the research question nr. 3 and 2.

The physical aspects of pricing presentation also play a vital role in shaping consumer perceptions (4.4.2 Res Extensa on Prices). Understanding how prices are visually perceived can lead to more effective pricing strategies that align with consumer expectations and enhance perceived value.It provides an answer to the research question nr. 3 and 2.

Additionally, considering consumers as conscious agents emphasizes the active role they play in their decision-making processes (4.4.3 Conscious Agents). This perspective encourages hospitality businesses to engage customers meaningfully and authentically, fostering a more personalized and satisfying experience. It provides an answer to the research question nr. 2.

The complexities of perception, as illustrated by Vervaeke, further highlight the challenges hospitality businesses face in influencing consumer behaviour (4.4.4 Vervaeke on Perception). By understanding these complexities, managers can create more engaging experiences that resonate with their target audience. It provides an answer to the research question nr. 2.

Kahneman and Tversky's insights into cognitive biases illustrate the importance of recognizing these influences on consumer decisions (4.4.5 Kahneman and Tversky: The Role of Perception in Decision-Making). By anticipating customer reactions and adjusting strategies accordingly, hospitality businesses can enhance their marketing effectiveness and improve customer engagement. It provides answers to the research question nr. 3 and 2.

Perception of quality is another crucial element in the hospitality sector, as it varies among consumers (4.5 Perception of Quality). Recognizing the subjective nature of quality can help businesses enhance their offerings to meet diverse consumer expectations, fostering loyalty and satisfaction. It provides answers to the research questions nr. 3, 2 and 6.

Hospitality biases can distort consumer perceptions, influencing decision-making processes (4.6 Hospitality Biases over Perception). This highlights the need for businesses to be aware of these biases and actively work to counteract them, ensuring that customers make informed decisions based on accurate information.It provides an answer to the research question nr. 3 and 2.

The decision-making process in the hospitality industry is multifaceted, influenced by both internal and external factors (4.7 Decision Making). Understanding these influences is essential for creating effective marketing and pricing strategies that resonate with consumers. It provides answers to the research questions no. 4 and 2.

Aligning business offerings with higher consumer values, such as sustainability and social responsibility, can enhance brand loyalty and customer satisfaction (4.7.1 Consumer Higher Values). As consumers increasingly prioritize these values, hospitality businesses must adapt their offerings to meet these expectations. It provides an answer to the research question nr. 6, 5 and 2.

Furthermore, understanding internal values is crucial for shaping consumer decisions (4.7.2 Internal Values). By tailoring messaging and offerings to resonate with their target audience, businesses can foster deeper connections with consumers and improve engagement. It provides answers to the research question nr. 5, 2 and 6.

The probabilistic approach to sales emphasizes understanding customer types and their corresponding likelihood of purchase (4.7.3 Probability of Sales). This insight enables businesses to adopt targeted pricing strategies that optimize sales potential and enhance overall profitability

In exploring the theoretical foundations of money, pricing, and signalling, it becomes clear that understanding these roles is essential for effective pricing strategies (4.8 A Theoretical Exploration of Money, Pricing, and Signaling). Recognizing the evolution of money can inform businesses about effective payment models and pricing strategies (4.8.1 The Nature and Evolution of Money). It provides an answer to the research question nr. 4

The concept of signalling in biological systems offers valuable insights into how hospitality businesses can communicate value and establish trust with consumers (4.8.2 Signalling in Biology). Effective communication remains vital in hospitality, emphasizing the importance of clear signalling in conveying value (4.8.3 Signalling in Communication). It provides an answer to the research question nr. 4

Understanding specific signalling processes unique to the hospitality sector can enhance marketing strategies (4.08.4 The Signalling Process in Hospitality), enabling businesses to convey their value propositions effectively.It provides an answer to the research question nr. 4.

Various pricing systems and theories are critical for understanding effective pricing strategies in hospitality (4.9 Pricing Systems and Theories). Insights into the dynamic process of buying provide valuable information for designing pricing strategies that align with consumer behaviour (4.09.1 Dynamical Process of Buying). It provides an answer to the research question nr. 9.

The distinction between causal and teleological pricing illustrates how different approaches can impact consumer perceptions (4.09.2 Causal vs. Teleological Pricing). Emphasizing the need for dynamic pricing strategies that adapt to market changes and consumer behaviour is essential for competitiveness in the hospitality sector (4.09.3 Price Revival in Hospitality: A Dynamic Approach to Pricing Strategies). It provides an answer to the research question nr. 5.

Understanding the symbolic nature of price tags can also help businesses craft pricing strategies that resonate with consumers (4.09.4 Price Tag as a Symbol). This relationship between beauty and pricing further emphasizes how aesthetics can influence consumer perceptions and willingness to pay (4.09.5 Beauty). It is a support chapter

Framing price as an encapsulation of energy highlights the intrinsic value associated with pricing decisions (4.09.6 Price as an Encapsulation of Energy). The relationship between quantitative and qualitative aspects of pricing offers additional insights into effective pricing strategies (4.09.7 Quanta and Qualia for Prices).

Applying the Ulam-Borsuk Theorem provides a theoretical framework for understanding the interplay between quantitative and qualitative factors in pricing decisions (4.09.8 Ulam-Borsuk Theorem to Explain the Relationship Between Quanta and Qualia in Price-Making Decisions in the Hospitality Industry).

Understanding price creation as a dynamic system can enable businesses to visualize and optimize pricing strategies effectively (4.09.9 Price Creation as a Dynamic System: A Geometric Framework). Additionally, focusing on areas rather than volumes provides a unique perspective on pricing optimization (4.09.10 All Information is in the Areas, Not Volumes).

The exploration of price container geometry offers valuable insights into effective pricing strategies (4.9.11 Price Container Geometry). Understanding the geometric aspects of price containers can inform how businesses present prices, enhancing consumer perceptions of value and encouraging purchasing behaviour. It provides an answer to the research question nr. 8

The concept of price molecules bonds introduces a new perspective on the interconnectedness of pricing decisions (4.09.12 Price Molecules Bonds). This analogy helps illustrate how various pricing strategies and decisions are interrelated, emphasizing the importance of considering these relationships in the broader context of business operations. Unanticipated Insights

Furthermore, the metaphorical exploration of thermal deformation in relation to pricing dynamics illustrates how external factors can influence pricing strategies (4.09.13 Thermal Deformation of a Circle). Just as physical materials respond to thermal changes, pricing strategies must also adapt to fluctuations in market conditions, consumer preferences, and competitive pressures. This adaptability is essential for maintaining relevance and achieving success in a fast-paced industry. Unanticipated Insight.

Moving on to a meta-benchmark comparison, the examination of pricing strategies in aviation provides practical insights for the hospitality industry (4.10 Meta Benchmark - Pricing in Aviation). By analyzing seat prices in aviation, we can draw parallels and lessons that can inform dynamic pricing strategies applicable to hospitality services

(4.10.1 Seat Prices). The aviation sector has long utilized advanced pricing strategies to optimize revenue, providing a valuable model for hospitality managers to consider.

Fluid pricing models and physics-based analogies further expand the discussion on pricing strategies within the hospitality context (4.11 Fluid Pricing Models and Physics-Based Analogies). These innovative perspectives can help businesses understand pricing dynamics through the lens of fluidity and adaptability, emphasizing the importance of being responsive to market changes. It provides an answer to the research question nr. 7.

Applying gas laws to pricing dynamics illustrates the potential for interdisciplinary approaches to inform pricing strategies (4.12 Applying Gas Laws for Hospitality). By leveraging scientific principles, hospitality businesses can develop more effective pricing models that reflect consumer behaviour and market conditions. This approach encourages a deeper understanding of the forces that drive pricing decisions and how they can be optimized. It provides an answer to the research question nr. 7.

The Carnot Engine analogy serves to illustrate the efficiency of pricing strategies in hospitality (4.13 Carnot Engine Analogy for Pricing in Hospitality). Just as the Carnot Engine operates at maximum efficiency, hospitality businesses must strive to optimize their pricing strategies to ensure they are maximizing resources and delivering value to consumers. This analogy reinforces the importance of resource allocation and operational efficiency in achieving business success. It provides an answer to the research question nr. 7.

Exploring the price-energy perspective, particularly through the lens of Dirac, further enhances the understanding of pricing dynamics in hospitality (4.14 Price-Energy Perspective - Dirac). By examining the relationship between pricing and energy dynamics, businesses can uncover insights into how to optimize their pricing strategies for maximum impact. This perspective encourages hospitality managers to think critically about the factors that contribute to perceived value and consumer willingness to pay.

Drawing analogies between fluid properties and pricing strategies provides unique insights into the behaviour of pricing dynamics (4.15 Analogies Between Fluid Properties and Price). This exploration emphasizes the importance of adaptability in pricing strategies, highlighting how fluid pricing models can respond to changes in demand and consumer behaviour. By embracing this flexibility, hospitality businesses can better navigate the complexities of the market and enhance their competitive advantage.

Finally, applying the Ideal Gas Equation to hotel pricing showcases the potential for scientific models to inform pricing strategies and decision-making processes (4.18 Ideal Gas Equation for Hotels). This application highlights how mathematical and scientific frameworks can provide valuable insights into consumer behaviour, enabling businesses to make more informed pricing decisions that align with market demands and enhance overall profitability. It provides an answer to the research question nr. 10.

In conclusion, the discussion of these chapters emphasizes the intricate interplay between various factors that influence pricing and consumer behaviour in the hospitality industry. By adopting an interdisciplinary approach that incorporates insights from biology, psychology, physics, and economics, hospitality businesses can develop adaptive strategies that enhance operational effectiveness and customer satisfaction. The ongoing exploration of these themes underscores the need for continuous learning and innovation, as the hospitality industry navigates an increasingly complex and dynamic landscape.

Chapter 6: Conclusions

In this thesis, we have explored the intricate relationship between pricing dynamics, geometrical representations, and the decision-making processes in fluid pricing models. The investigation provided new insights into how prices can be perceived, shaped, and controlled, particularly within complex and adaptive systems like hospitality markets. Drawing on the analogy of fluid mechanics and physics-based models, we introduced the notion of "price containers" and analysed how their geometric properties, as well as thermodynamic principles, can be applied to better understand market behaviour and price fluctuations.

Fluid pricing, as presented in this study, offers a flexible and adaptive framework to represent the continuously shifting nature of prices in dynamic markets. Unlike other pricing models, fluid pricing embraces the inherent variability found in consumer demand, competition, and external factors. By likening pricing mechanisms to fluid systems, we were able to analyse market behaviour with greater precision, highlighting how prices can flow, expand, and contract in response to both microeconomic and macroeconomic forces. Furthermore, this analogy allowed us to explore complex market phenomena through principles derived from fluid dynamics, such as pressure, temperature, and volume. For example, the ideal gas law's application in hospitality markets helped frame pricing as a function of both volume and temperature (demand volatility). This perspective offers practical applications in industries where demand is sensitive to factors such as seasonality, external shocks, and consumer behaviour, allowing companies to adapt their pricing strategies in real-time based on the state of the market.

One of the key contributions of this research is the conceptualization of price containers and their geometric properties. By treating prices as entities bounded by "containers" with distinct shapes and dimensions, we can analyse how various market elements interact to form, stretch, or compress the price space. The geometric framework reveals that prices are not simply numbers attached to products but complex structures with internal and external bonds influenced by multiple factors such as perception, consumer behaviour, and signalling mechanisms.

The geometrical model presented here also highlights the role of surface areas and boundaries in determining price behaviour. We demonstrated that critical pricing information often resides in the areas or membrane of these containers, rather than their volumes. This suggests that small gaps can occur in the container-filling, and changes at the margins of market perception—such as slight shifts in quality signals, competitive actions, or marketing strategies—can lead to significant membrane adjustments.

Moreover, the use of molecular analogies, such as "price molecules" and their bonds, offered a deeper understanding of how prices interact and aggregate within the market. These interactions can be seen as complex networks where prices are influenced by both internal (product attributes, consumer value perception) and external (market conditions, competition) forces. The notion of thermal deformation of geometric shapes also helped explain how price structures react to micro and macro-economic pressure.

The study's focus on decision-making processes illuminated the role of perception in buying and selling decisions. Drawing on behavioural economics and visual perception theories, we explored how consumers interpret prices not only as a measure of value but as a signal encapsulating various intangible factors such as quality, trust, and reputation. Prices, when viewed through the lens of perception, become symbolic representations that guide consumer behaviour in a much more nuanced manner than traditional models suggest.

The multidimensional framework for the sell-buy process, as developed in this study, has been distilled into a more comprehensive yet accessible model. This framework offers both descriptive and explanatory power while employing a reductionist approach to present complex dynamics in a simplified, more understandable manner. By breaking down intricate market interactions into clearer and more manageable components, the model provides a robust tool for analysing pricing mechanisms and decision-making processes.

Furthermore, the versatility of this framework extends beyond its immediate application in the hospitality industry. Its adaptable nature allows for its integration into a wide array of research contexts. The generalizable principles that underpin the sell-buy dynamics can be applied to other sectors, where pricing models and consumer behaviour similarly fluctuate in response to market signals, competitive forces, and perceptual biases.

Thus, the framework not only clarifies the fluid nature of pricing but also offers a foundation for broader application in academic and industry research.

The hospitality industry, characterized by its complexity and rapid shifts in demand, serves as a compelling case study for applying fluid pricing models. As demonstrated, the dynamic nature of hospitality pricing requires a system that can account for fluctuating demand, consumer perception, and competitive pressures. Fluid pricing models allow hotels, airlines, and other service providers to adjust prices fluidly in real time, ensuring optimal revenue while maintaining market competitiveness.

The incorporation of gas laws and thermodynamic principles further enhanced the understanding of how pricing systems in hospitality respond to external stimuli such as peak seasons, economic downturns, or unexpected events. The Carnot engine analogy provided a useful model for optimizing pricing efficiency, ensuring that energy (in this case, market effort and resources) is used as effectively as possible to generate revenue while minimizing "entropy" or lost potential in mispriced services.

Finally, this research has established a multi-layered framework for understanding fluid pricing through the lenses of physics, geometry, and consumer perception. The fusion of these diverse fields of study has generated a novel approach to pricing that transcends traditional models. By viewing prices as dynamic, fluid, and geometrically complex, we open the door to more sophisticated strategies for market adaptation, consumer engagement, and decision-making in competitive industries.

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Figures and Tables