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Plithogenic Hypothesis on the Influence of Electronic Commerce on Retail Sales Dynamics in Shopping Centers

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Abstract. The present research addresses the growing argument on the ways in which e-commerce is changing dynamics in shopping centers by offering a plitogenic hypothesis that looks into the intricacies between the two worlds. The present research goes into duality of these selling environments and their coexistence in a backdrop of challenging traditional models of buying which digital platforms are. Despite the rich literature on electronic commerce and retail, most of the studies have isolated perspectives on the subject, avoiding interrelations that properly emerge from online commerce and physical shopping centers. The study attempts to fill that theoretical gap by applying an innovative approach to analyzing how these two selling models interact while at the same time interacting in a world that changes quickly in customer behavior. In a mixed-method approach, that is, it combines both qualitative and quantitative analysis, this paper uses a plitogeni [c] approach, done to capture the complexities and contingencies of decisions involving consumer purchases. This indicates that the two do not really oppose each other but are two realities that exist in relation to the other; sometimes they negate each other and sometimes they do not under the conditions of convenience or experience. It is one research study that extended not only the theoretical understanding of the relationships between these two worlds of retail but gave tremendous practical implications, such as the design of hybrid strategies using the strengths of both channels. In short, the paper highlights the importance of rethinking business dynamics in a setting dominated by hybridity of platforms, with the ultimate aim being increasing effectiveness both online and at the point of physical sale.

Keywords: E-commerce, sales dynamics, shopping malls, Plithogenic hypothesis, interaction, sales models, consumer behavior , Falsifiability of a Hypothesis, Multivalued Logics, Plithogenic Statistics.

1. Introduction

E-commerce has profoundly altered the dynamics of global retail, impacting both physical stores and shopping centers. In the last ten years, the rapid growth of online sales platforms has transformed the dynamics among consumers, items, and retailers. In this context, investigating the impact of e-commerce on conventional retail sales is crucial for comprehending how shopping malls can adjust to the contemporary digital landscape. Notwithstanding the significance of this subject, prior research has predominantly been disjointed and constrained, resulting in a substantial void in the examination of the interconnections between the two sales models. This study aims to bridge the conceptual and empirical gap by examining the influence of e-commerce on sales dynamics in shopping malls, specifically on hybrid consumption patterns that integrate both physical and digital experiences.

Historically, shopping malls have been seen as the nucleus of retail, representing an evolution of standalone establishments that enabled consumers to procure a diverse array of things in a single location. In recent decades, e-commerce has emerged as an alternative to this model, originally concentrating on the sale of technological and electronic products. Nonetheless, the emergence of platforms like

Amazon, Alibaba, and other retail behemoths has expanded digital commerce to include a broader array of products, ranging from apparel to food, so transforming the in-store shopping experience. The reactions of shopping malls have been diverse; some have embraced digital trends by introducing mobile applications and online shopping services, whereas others persist in their difficulties to remain pertinent amid virtual competition. Nevertheless, research to far has been inadequate in examining the interaction and mutual influence of online and physical sales modes, particularly with customer purchase decisions.

This research aims to examine the impact of e-commerce boom on sales dynamics in shopping malls. Some research indicate that e-commerce may diminish physical sales, while others propose that both models can survive complementarily. The absence of unanimity in the literature prompts a critical inquiry: how does e-commerce influence purchasing decisions at shopping malls, and to what degree do customers embrace a hybrid shopping experience that integrates both physical and digital elements? The significance of this issue is to its implications for the viability of the traditional shopping mall model and its capacity to adapt to contemporary consumer needs. The primary aim of this study is to investigate the correlation between e-commerce and conventional retail sales in shopping malls, using a plithogenic hypothesis to elucidate the interaction between these two channels. Through quantitative and qualitative research, we aim to comprehend the variables that drive customers to amalgamate both purchase models, as well as the techniques employed by shopping malls to integrate the physical and digital realms. Secondly, the study seeks to offer strategic advice to assist shopping centers in adapting to this evolving landscape, fostering synergy between both sales channels and enhancing the consumer experience [4][5].

This study will utilize the concepts of platform hybridization and retail adaptability to demonstrate how shopping malls can evolve into hybrid locations where online and physical commerce are complimentary rather than opposing elements. As consumers get increasingly adept at utilizing technology in their purchasing decisions, expectations for the integration of both channels rise, necessitating an inventive response from merchants to sustain relevance in a saturated market.

This study's results will offer a novel perspective on the evolution of retail malls, emphasizing the tactics that optimally align the confluence of two realms. This study will specifically analyze the impact of technologies such mobile commerce, online ordering systems, and the incorporation of shopping platforms into the physical shopping mall experience [7]. These studies aim to make a substantial contribution to retail theory and business practice by suggesting methods to enhance competitiveness in this evolving scenario. This study aims to analyze the impact of e-commerce on physical sales dynamics and to provide shopping malls with tangible solutions to reformulate their business approaches and maintain competitiveness in a progressively digital market. This study's findings are anticipated to enhance the academic discourse on the future of retail and provide a foundation for subsequent research in the sector.

2. Preliminary

2.1. Electronic Commerce in Sales Dynamics

E-commerce has profoundly influenced worldwide sales dynamics, providing unparalleled ease and altering the manner in which retailers interact with their audiences. The proliferation of the Internet, the ascendance of mobile devices, and enhancements in logistics have resulted in a transformation of consumer behavior and purchase patterns. The ease of internet purchasing has drawn millions of consumers, compelling companies to modify their product marketing techniques. Nonetheless, e-commerce poses obstacles, including intense online competition, necessitating businesses to allocate resources towards digital marketing methods such as personalization, audience segmentation, and recommendation systems[8].

Consumer trust is essential in e-commerce, necessitating that firms invest in secure platforms and data protection protocols to guarantee the security of customer transactions. The emergence of e-com-

merce has influenced conventional retail patterns, resulting in a transition towards omni-channel purchasing experiences[9,10].

E-commerce has democratized access to global markets, enabling small and medium-sized firms (SMEs) to expand their audience and foster innovation. Nonetheless, logistics, an essential element of e-commerce, poses issues for enterprises. E-commerce has facilitated the emergence of novel monetization models, including subscription services, digital goods sales, and affiliate platforms[11].

Digital marketing, augmented by social media, influencers, and tailored content, has transformed the sales environment, enabling organizations to engage with their target audience more directly and accurately. This shift in purchasing behavior necessitates that companies adjust to a more discerning and knowledgeable consumer demographic that prioritizes quality, sustainability, and brand integrity[11].

2.2. Plithogenic Probability

Neutrosophic data, also known as indeterminate, are defined by their lack of clarity and incomplete nature, which makes them prone to the presence of partial unknowns and contradictory information [12-15]. These data can be classified as quantitative (metric), qualitative (categorical), or a combination of both. A relevant aspect of this type of data is plithogenic variables [16], which are used to describe relationships or correlations between neutrosophic variables.

On the other hand, a neutrosophic variable [17, 18], whether a function or operator, has the ability to handle neutrosophic data in its values, its arguments, or both. This type of variables is essential when facing complex problems, which, due to their multidimensional nature, require several measurements and observations. This need is particularly highlighted in scientific research, where obtaining data from diverse sources is crucial. Furthermore, neutrosophic variables can exhibit different types of relationships, such as dependence, independence, partial dependence, partial independence, or partial indeterminacy, common phenomena in many scientific fields [19].

A Plithogenic Set [20, 21] is a non-empty set Pwhose elements within the domain of discourse U($P \subseteq U$) are characterized by one or more attributes $A_1, A_2, \cdots, A_m$, where m is at least 1. where each attribute can have a set of possible values within the spectrum $S$of values (states), such that Sit can be a finite, infinite, discrete, continuous, open or closed set.

Each element $x \in P$is characterized by all possible values of the attributes found within the set $V = \{v_1, v_2, \cdots, v_n\}$. The value of an attribute has a degree of membership $d(x, v)$to an element $x$of the set.P, based on a specific criterion . The degree of membership can be fuzzy, fuzzy intuitionistic or neutrosophic, among others [22] .

That means,

$$\forall x \in P, d: P \times V \rightarrow \mathcal{P}([0,1]^z) \quad (1)$$

Where$d(x, v) \subseteq [0,1]^z$ and $\mathcal{P}([0,1]^z)$is the power set of $[0,1]^z$.$z = 1$ (the diffuse degree of belonging), $z = 2$(the intuitionistic diffuse degree of belonging) or $z = 3$ (the neutrosophic degree of belonging).

Plithogenic [23,24], derived from plithogenic variable analysis , represents a multidimensional probability (" plitho " meaning "many" and synonymous with "multi"). It can be regarded as a probability comprised of subprobabilities, each of which delineates the behavior of a particular variable. The event being analyzed is presumed to be affected by one or more variables, each characterized by a probability distribution function (PDF).).

Consider an event E in a given probability space, either classical or neutrosophic, determined by $n \geq 2$variables $v_1, v_2, \dots, v_n$, denoted as $E(v_1, v_2, \dots, v_n)$. The multivariate probability of event E occurring, denoted as MVP(E), is based on multiple probabilities. Specifically, it depends on the probability of event E occurring with respect to each variable: $P1(E(v_1))$for variable v_1, $P2(E(v_2))$for variable v_2, etc.

It is therefore $MVP\big(E(v_1, v_2, \dots, v_n)\big)$ represented as $\Big(P1\big(E(v_1)\big), P2\big(E(v_2)\big), \dots, Pn\big(E(v_n)\big)\Big)$. Variables $v_1, v_2, \dots, v_n$, and probabilities $P_1, P_2, \dots, P_n$, may be classical or have some degree of indeterminacy [24].

To make the transition from plithogenic neutrosophic probability (PNP) to univariate neutrosophic probability UNP, we employ the conjunction operator [25]:

$$UNP(v_1,\ v_2, \dots,\ v_n) = v_1 \wedge_{i=1}^{n}\ v_n \quad (2)$$

$\wedge$ In this context, it is a neutrosophic conjunction (t-norm). If we take$\wedge_p$ as the plithogenic conjunction between probabilities of the PNP type, where $(T_A, I_A, F_A) \wedge_p (T_B, I_B, F_B) = (T_A \wedge T_B, I_A \vee I_B, F_A \vee F_B)$, such that $\wedge$is the minimum t-norm of fuzzy logic and $\vee$the maximum t-norm [26, 27].

a. Formulate the hypothesis
   Start by explicitly stating the hypothesis you intend to examine. Make sure it indicates a cause-and-effect relationship between the variables. For example, "More study time leads to higher test scores."
b. Identify key variables

   Determine the independent variable, representing the cause, and the dependent variable, denoting the effect, inside your hypothesis. This facilitates the precise targeting of your study inquiries towards the specific link to be examined.Formulate specific research questions
   Break the hypothesis down into precise research questions phrased as "Does X cause Y?" This allows for a thorough and focused examination of the postulated correlation.
c. Perform sentiment analysis on scientific literature.

   To perform sentiment analysis on a research paper and quantify the occurrences of “Yes”, “Possibility/Indeterminacy”, and “No”, a sentiment analysis tool for scientific statements is needed. In this instance, we employ Consensus Meter methods to classify the assertions into three unique categories: Positive (affirmative), Indeterminate (possibility or indeterminacy), and Negative (negative).
d. Formulate neutrosophic probabilistic hypotheses

   Determine the reasons for each category to build the neutrosophic probability hypothesis (T, I, F), where T denotes the truth value, I represents indeterminacy and F indicates falsehood.
e. Calculate the plithogenic neutrosophic probability (PNP)

   Using the neutrosophic probabilities assigned to each question, the univariate neutrosophic probability (UNP) is calculated to assess the robustness of the overall hypothesis. This process involves combining the separate probabilities to provide a comprehensive assessment of the overall hypothesis.

   $$UNP(v_1,\ v_2, \dots,\ v_n) = (Min(t_1,\ t_n, \dots, t_n),\ Max(i_1,\ i_n, \dots, i_n),\ Max(f_1,\ f_n, \dots, f_n)) \quad (3)$$

   Where:

   $T_1, T_2, \dots, T_n$: are the probability values of truth for each question.
   $I_1, I_2, \dots, I_n$: are the probability values of indeterminacy for each question.
   $F_1, F_2, \dots, F_n$: are the probability values of falsehood of each question
   a. Analyze the validity of the general hypothesis.

In this case, the negation of NPH is represented as [28]:

$$(T, I, F) = (F, I, T) \quad (4)$$

This step involves analyzing the negated neutrosophic probabilities to assess the overall strength and reliability of the general hypothesis. By assessing the levels of falsity, uncertainty, and veracity, one can determine the degree to which the hypothesis is valid, ambiguous, or incorrect based on the scientific literature.

3. Case study

The method used in the study is based on [25]. In today's digital age, e-commerce has disrupted various industries, changing the way consumers interact with brands and retailers. Shopping malls, traditionally physical sales locations, have had to adapt to new market trends. The introduction of e-commerce platforms in these shopping malls is changing retail sales dynamics, affecting both customer interaction and the operational efficiency of stores. This research focuses on analyzing the influence of e-commerce on these dynamics, using a plithogenic approach to assess the probabilities surrounding the implementation of online sales platforms in shopping malls.

The plithogenic hypothesis proposed for this study is that e-commerce, when implemented in shopping malls, influences the frequency of purchases, consumer behavior, and the operational efficiency of retail stores. This phenomenon can be explained through neutrosophic and plithogenic variables that describe the correlations between various variables, such as the accessibility of online platforms, the level of consumer satisfaction, and the increase in sales.

Hypothesis Statement:

The implementation of e-commerce significantly influences retail sales dynamics within shopping malls, improving both product availability and consumer accessibility to more diverse options. This study seeks to assess how e-commerce affects purchasing decisions in shopping malls, considering the impact of factors such as competitiveness, convenience, and product exclusivity.

Key Variables:

- **Independent Variable (Cause):** Implementation of electronic commerce in shopping centers.
- **Dependent Variable (Effect):** Retail sales dynamics in shopping centers.

Research Questions:

- **Q1:** Does the increased implementation of e-commerce increase sales within shopping malls?
  - *Variable:* Sales volume in shopping centres.
- **Q2:** Does e-commerce improve accessibility and convenience for consumers in shopping malls?
  - *Variable:* Accessibility and convenience in the purchasing process.
- **Q3:** Does e-commerce create greater competition between brands within shopping malls?
  - *Variable:* Level of competitiveness between brands in the shopping center.
- **Q4:** Does the presence of e-commerce in shopping centres allow for greater exclusivity in the products offered?
  - *Variable:* Exclusivity of products available in shopping centers.

Sentiment Assessment on Research Questions:

Consensus Meter is used to assess the positions of the scientific literature regarding each of the research questions. The articles are classified into three categories: Positive, Indeterminate and Negative, and a neutrosophic probability is assigned to each of the questions.

Ask	Positive	Indeterminacy	Negative	Neutrosophic Probability
P1	[26, 27, 28]	[29]	[30]	(0.80, 0.10, 0.10)
P2	[31, 32]	[33]	[34]	(0.75, 0.15, 0.10)
P3	[35,36]	[37, 38]	[39]	(0.70, 0.20, 0.10)
P4	[40,42,43]	[44]	[45]	(0.77, 0.13, 0.10)

Calculation of the Univariate Neutrosophic Probability (UNP):

Now, we calculate the univariate neutrosophic probability (UNP) using the neutrosophic probabilities of each of the investigated questions.

Where the neutrosophic probabilities of each question are as follows:

- **P1:** (0.80, 0.10, 0.10)
- **P2:** (0.75, 0.15, 0.10)
- **P3:** (0.70, 0.20, 0.10)
- **P4:** (0.77, 0.13, 0.10)

The calculation of the univariate neutrosophic probability (UNP) is performed as follows:

UNP (v1 , v2 , … , vn) = (min (t1 , t2 , … , tn) , max (i1 , i2 , … , in) , max (f1 , f2 , … , fn))

UNP=(min(0.80,0.75,0.70,0.77),max(0.10,0.15,0.20,0.13),max(0.10,0.10,0.10,0.10))

Given:

- **t** : t1=0.80,t2=0.75,t3=0.70,t4=0.77
- **i** : i1=0.10,i2=0.15,i3=0.20,i4=0.13
- **f** : f1=0.10,f2=0.10,f3=0.10,f4=0.10

Steps:

1. **First value (minimum of t)** :
   min (0.80,0.75,0.70,0.77)=0.70
   Second value (maximum of i) :
   max (0.10,0.15,0.20,0.13)=0.20
2. **Third value (maximum of f)** :
   max (0.10,0.10,0.10,0.10)=0.10

Bottom line:

UNP =(0.70,0.20,0.10)

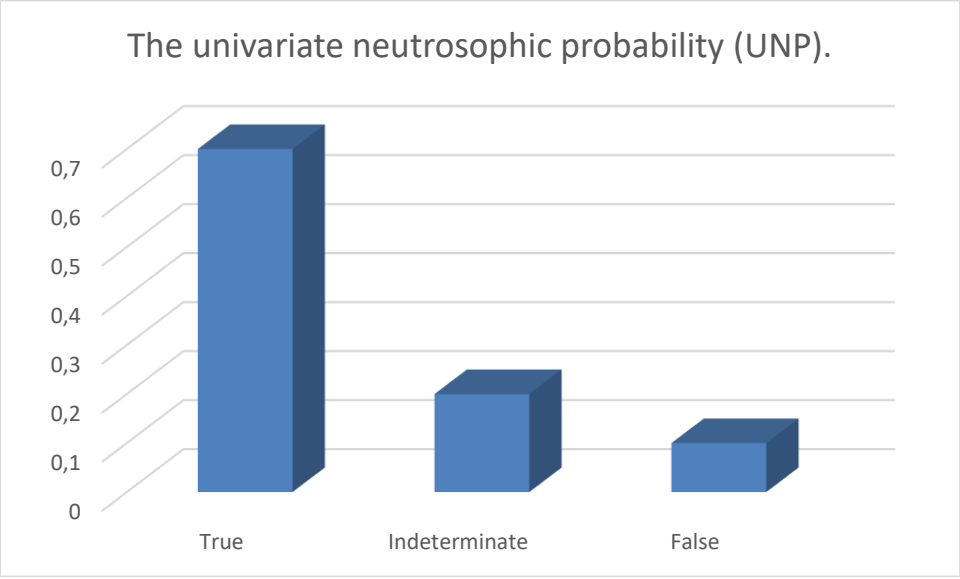

Figure 1: Univariate neutrosophic probability (UNP).

Interpretation of the Result:

- **0.70:** There is a 70% probability that the hypothesis is true, suggesting a high probability that e-commerce will positively influence sales dynamics in shopping centers.
- **0.20:** There is a 20% probability that there is uncertainty about the relationship between e-commerce and retail sales. This value reflects the uncertainty about the total impact of the factors involved, such as competition and accessibility.
- **0.10:** There is a 10% chance that the hypothesis is false, which indicates that, although low, there is a small possibility that e-commerce will not have significant effects on the sales dynamics of shopping centers.

Denial of the Hypothesis:

For the negation of the hypothesis, we calculate the negative neutrosophic probabilities, which results in the values:

(T,I ,F)=(0.10,0.20,0.70)(T, I, F) = (0.10, 0.20, 0.70)(T,I,F)=(0.10,0.20,0.70)

Interpretation of Denial:

- **0.10:** There is a 10% chance that the negation of the hypothesis is true, implying that excluding e-commerce would not have a significant impact on retail sales.
- **0.20:** There is 20% uncertainty about the validity of the denied hypothesis, reflecting the presence of uncertain factors affecting sales dynamics.
- **0.70:** There is a 70% probability that the negation of the hypothesis is false, which implies that it is highly likely that e-commerce will influence retail sales dynamics in shopping malls.

Detailed Analysis of the Results:

This research indicates that e-commerce substantially enhances shopping mall sales, with a 70% likelihood that the initial hypothesis is valid. Nonetheless, there exists a 20% uncertainty over specific aspects that may fluctuate based on the deployment of e-commerce in each particular mall, including consumer adaption and competition with local shops.

The negation of the hypothesis, however, possesses a substantial falsehood value of 70%, hence reinforcing the notion that e-commerce, overall, positively impacts sales dynamics. The 20% indeterminacy indicates that not all retail centers would see uniform benefits due to differences in their characteristics and marketing strategy.

In conclusion, while the hypothesis demonstrates a significant likelihood of accuracy, additional study encompassing diverse situations and varieties of shopping centers is advisable to mitigate uncertainty and elucidate the impact of e-commerce on retail sales.

4. Conclusion

The results of this study suggest that, overall, e-commerce seems to have a positive impact on sales within shopping centres, with a considerable probability that the original hypothesis is true. While 70% of the data supports this idea, it cannot be denied that there is a degree of uncertainty of 20% that could be related to unpredictable factors, such as the particularities of each shopping centre, variations in consumer behaviour or local competition. In any case, the results are still interesting and open many doors to explore how e-commerce continues to influence the sales landscape. From a practical perspective, this finding is important for retailers and designers of commercial strategies, as it could imply that investing in digital solutions is not only a viable option, but a necessity to remain competitive in an increasingly digitalised market. However, as with everything, there are nuances. Perhaps the impact of e-commerce is not the same in all contexts, and integration strategies must be careful and adapted to local circumstances. What works in a shopping center with a very young and connected audience might not be as effective in one with a more traditional customer base.

One of the major contributions of this study is the application of a neutrosophic probability approach to analyse such complex and variable phenomena as e-commerce. Although this is not a new methodology, its use in this specific context provides a useful framework for understanding the uncertainty inherent in situations of high variability. This undoubtedly brings something new to the field of study and offers researchers more sophisticated tools to address similar problems. However, like any analysis, this study is not without limitations. Although the results indicate a clear trend, the small margin of indeterminacy (20%) shows that we do not yet have a definitive answer. Differences between shopping centres, types of consumers and business models may influence the results, limiting the widespread applicability of the findings. Furthermore, the approach used could benefit from a more detailed analysis of contextual variables. For future research, it would be interesting to explore the influence of e-commerce in shopping centres in different regions, with different demographic and economic profiles. Furthermore, incorporating complementary methodologies, such as Big Data analytics or real-time behavioral studies, could offer deeper and more accurate insight into how e-commerce is truly transforming retail sales. All in all, this field has a lot to offer and it seems like we are just scratching the surface of what could be an even more fascinating and revealing area of study.

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