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Identifying the Dimensions of 'Technology Derived Value Proposition' in Apartment Purchase Behavior: An Exploratory Factor Analysis Approach

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ABSTRACT

Background: Real estate decision-making is inherently multi-dimensional, increasingly shaped by the pervasive role of technology in modern consumption patterns. Technology-driven value propositions (TDVPs) have gained prominence due to their impact on customer behaviors, especially in apartment purchasing decisions. Despite existing literature on data-driven marketing, gaps remain in understanding TDVP dimensions and their measurement validity within the real estate context.

Purpose: This study aims to identify and validate the factors influencing technology-derived value propositions in apartment purchasing behavior through exploratory factor analysis (EFA). It integrates work behavior and technology-driven marketing insights to establish a comprehensive assessment of the phenomenon.

Methods: A structured questionnaire, informed by theoretical frameworks and expert opinions, was administered to a diverse sample of 425 participants (179 females, 246 males). Using principal component analysis with varimax rotation, EFA identified latent dimensions of TDVPs. Reliability and validity assessments of measurement items were conducted via SPSS to ensure data adequacy and factor dimensionality.

Results: Twelve key factors were identified as contributors to TDVPs in real estate decision-making. These included market orientation, AI-induced biases, customer work behavior, builder technology usage, and credit availability, among others. The analysis revealed significant correlations between these factors and their influence on shaping customer decisions, supported by high sample adequacy (KMO = 0.845) and significant Bartlett's Test results ($p < 0.001$).

Conclusion: The study highlights the critical dimensions of TDVPs in apartment purchase behavior, emphasizing their theoretical and practical implications. It underscores the transformative role of technology in shaping consumer decisions and offers validated measurement constructs for further research and application in real estate marketing strategies. Future studies could explore additional dimensions, such as augmented reality and machine learning, to further refine the understanding of TDVPs.

1. Introduction

This research focuses on providing a multi-dimensional perspective for data-driven value propositions in apartment purchase behavior that is theoretically rich and empirically robust in nature and scope. Accordingly, both the work behavior and technology-mediated marketing literatures were integrated. In fact, the work behavior transformation-related literature has considerably influenced discussion in 'data-driven value propositions,' and as such, greater value seems to be driven by the rising pervasiveness of technology at work and at home. A major advantage in integrating two diverse sets of literature is the intent to emerge with a composite assessment of research constructs in evolving realities. A technology-guided and technology-derived interpretation of data-driven value propositions in apartment purchase behavior would enable this research to reflect more on the underlying dynamics (Genenig *et al.*, 2018). Thus, in the sections that precede this, more emphasis is being placed on the technology as shaping work, life, home living, and finally the apartment purchase intent development.

2. Theoretical Basis

The inquiry into the 'technology' derived and 'data' driven value proposition formulation (Genenig *et al.*, 2018) revealed the incidence of underplay of multiple agents

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and forces. From the lens of complexity theory, the value proposition formulation entails a focus on managing the chaos in the technologically asymmetric information landscape (Taylor *et al.*, 2020). The technology administered bounding of rationality across human mindsets (customer) finds extensive echo in complexity theory literature (Ooi & Husted, 2021) and across complex adaptive systems approaches (Woodside *et al.*, 2018) (Figure 1). Scholars argue that marketing theology (Key *et al.*, 2020) is more similar to the complex adaptive systems approach than anything else (Goldenberg & Shapira, 2009).

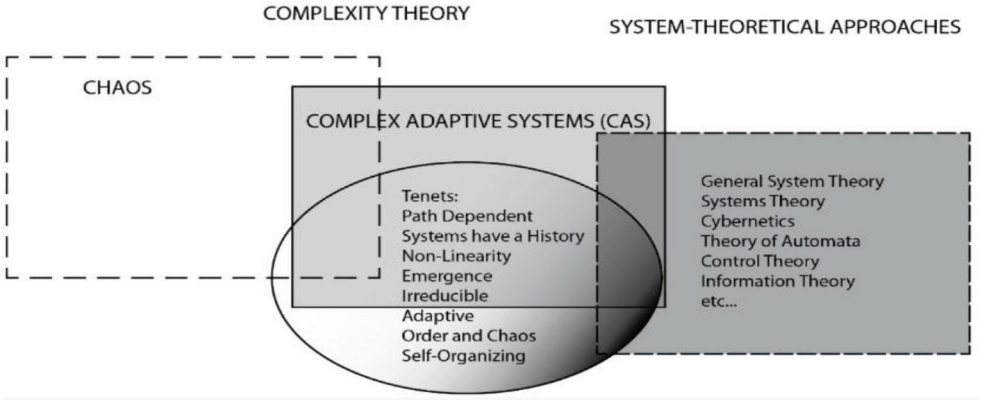

Figure 1: Understanding Value Proposition with Complexity Theory
Source: (Turner & Baker, 2019)

Hence, formulation and execution of data-driven value propositions (Sunder & Modukuri, 2022) in apartment purchases need to leverage complexity theory to interpret the complex entities involved in operational marketing mechanisms from a real estate perspective. The merging enthusiasm for applying the complexity approach in marketing and real estate studies stems from its capacity to elucidate various aspects of a data-driven marketing system in terms of its components, nonlinear relations, hierarchies, boundaries, and interdependencies (Vatankhah *et al.*, 2023). Despite earlier efforts to advance a data-driven value proposition in real estate marketing, especially in regard to apartment purchase behavior, the field is plagued by a lack of precise definition of the term and the phenomenon (Cascio & Montealegre, 2016). Nevertheless, most authors subscribe to the notion that the value proposition in real estate marketing hinges on technology pervasiveness. The rising incorporation of technology into working, work methods, ways of living, lifestyle adherence, and daily chores has altered the notion of all that goes into the interpretation of the value proposition altogether. As evident in the introduction chapter, the relationship between technology intermediation and human consumption transformation has long been set as vital for the successful deployment of technology in apartment purchase funneling. The relationship is, however, not only limited to technology intermediation yet possesses implications for shaping and transforming the resultant value propositions. The ability of technology to inculcate a set of values and enable the interference in apartment purchase decisions seems to matter most (Fernández-Macías & Bisello, 2022).There are evident changes across value propositions across individual value assessment and across builders' value creation impetus (Antretter *et al.*, 2020). The research hence needs to explore the theoretical and conceptual frameworks that reflect on the diverse value creation propositions as influencing the customer's real estate purchase intent and decision-making. The value delivery (Pogodina *et al.*, 2020), value opinion making, and value-derived perceptions regarding decision making, regarding choice making, and regarding choosing a course of action are dually influenced by rising technology intervention (Baur *et al.*, 2023) in the form of algorithms (Antretter *et al.*, 2020), in the form of app and website-based auto suggestions, and in the form of growing reliance on technology for decision making. Though technology (Schepman & Rodway, 2020) cannot replace human agency in decision-making, intervention and interference are grossly on the rise on account of rising technology dependence for personal productivity and time management. The growing usage of technology in organizational work flows (Cascio & Montealegre, 2016) and growing smartphone usage have altered the human decision-making patterns and, respectively, the manner of real estate purchase decisions.

In drawing on these classical works, scholars continue to debate the idea of technology derived value propositions in the real estate industry. The propositions are in line with earlier studies (Ali & Ullah, 2019), (Baptista *et al.*, 2020),

(Jiang & Zhang 2021). Table 1 summarises the approaches to data driven value propositions.

Table 1: Summarizing the Approaches

Approaches to Data Driven Value Propositions	Enablers
Explorative Approaches	Higher incorporation of digital technology and digital transformation capabilities, Consistent alignment between business digital resources and customer's digital assets, Capabilities for value innovation, Extra generative and AI derived cognitions and sense making Experimentation and effectuation for change management, and Knowledge absorptive capacity
Exploitative Approaches	Strategic digital market place reorientation, Adaptation, Local search behavior, Incremental digital innovation,
Hybrid	A mixture of both above mentioned aspects

3. Conceptualization of Data Driven Value Proposition across Proptech

The existing research conceptualizes the 'value proposition' construct in many different ways. The conceptual lenses as adopted in academic literature can be explored with aid of conservation of resources theory, technology determinism perspective (technology as basis for all human activity), technology and transformation of industry, technology-aided bounded rationality, asymmetric information availability and role of technology, human computer interaction, behavioral sciences, information systems perspective, and self-determination theory, as well as cognitive biases. Aizen and Fishbein's theory of planned behavior, technology diffusion, and technology adoption model offer partial insights into the evolution of phenomena, and literature suggests diverse definitions and interpretations of research constructs. However, one of the widely accepted technology-work-human cognitions nexus is being explored under the economic organizing and reframing being carried out under the aegis of technology determinism perspective (Verbeek, 2016). Research shows that 'Proptech' aptly captures the conceptually distinct and causally linked layers, technology interventions, technology pervasiveness (Saull *et al.*, 2020), and embedment in real estate market dynamics (Tagliaro *et al.*, 2021). While conceptualizing value propositions in urban real estate, the value proposition needs to be interpreted as digitally embedded into the informational matrix that shapes and re-shapes the decisional propensity (Gunther *et al.*, 2022). Human propensity (customer's propensity) for decision-making and mindset for decision-making are rendered fragile and change-prone under an unlimited influx of real estate-related information. This indecisiveness and bounding of customers' rationality is evident in digital real estate mechanisms (Zacher, 2017). Proptech mechanisms and conceptualization of dimensions need to ascertain that real estate has transformed into a gradual data-driven market (Braesemann & Baum, 2020). The digital data as lubricant of PropTech players' machinery and technology-driven pervasiveness need to uncover the underlying aspects that are invisible in first perspective (Sisinni *et al.*, 2017). Technologies are becoming central to data generation, and creation and value proposition seem to reside more in digital data management across networks of property technologies (Kauko & Shavrov, 2020). Ongoing 'datafication' of real estate markets, channels, and sales mechanisms and customer acquisition (Ullah *et al.*, 2021) has altered the literature-based classification of contributing aspects (Bilozor *et al.*, 2022). Information frictions are natural in digitalized real estate markets (Broxterman & Zhou, 2023). Scholars argue that information, connection with possible customers, alignment with their work styles, work-based incorporation of technology (Sepasgozar *et al.*, 2018), and posturing across a customer's life style-technology mix (Lopes, 1999) could be meaningful in interpreting the antecedent aspects (Tan & Miller, 2023). The dimension identification hence derives strength from recent literature and frameworks reflecting on the phenomenon (Bailetti & Tanev, 2020). The literature on the subject, especially from an Indian perspective (Ferreira *et al.*, 2023) regards the phenomenon as involving aspects of the economics of information in real estate, evolving individual work attributes, and contingent technological changes (Bailetti & Tanev, 2020).

4. Instrumentation

Keeping in view the behavioral and cognitive roots of phenomena, psychometric procedures as mentioned in literature were absorbed in designing the questionnaire. The development of the questionnaire and the types of information sought in the questionnaire were reflective of the study's conceptualizations and hypotheses. In line with the research objectives of the current academic study, the existing literature was examined to locate suitable Likert scales that measured the dimensions of customer work behavior, builder-based

technology usage, and data-driven value propositions in real estate and apartment purchase perspectives. In addition to the literature review and key work search, the informal opinion was sought from industry experts as part of the focus group exercise to ensure the inclusion of relevant factors. Table 2 summarizes the factors considered.

Table 2: Summarizing the Considered Factors

Aspects	**Explanation and Inclusions**
Customer work behavior	AI Induced Biases
(Technology determinism as shaping the penchant for technology usage at work, probable consequences for leaving decision making to technology, extent of automation decision making)	Technology Driven Work Styles
Builder technology usage	Technology Orientation
(Extent to which the builder and real estate marketer is leveraging and harnessing the potential of technology in reaching out to the prospective customers in age of technology driven life styles)	Market Orientation
Ecosystem derived influences from broker technology, credit availability, and social change	Broker
	Credit Availability
	Social Change
Data driven value propositions	Data driven Value Propositions
Purchase intention and actual purchase	Purchase intention and Actual Purchase
Socio-economic standing	Socio-Economic Standing
Socio-demographic aspects	Socio-demographic attributes

5. Methods and Approaches

The responding sample comprises the cross-gender participation in the research. The study attracted 179 female participants and 246 male participants. The study exhibited the participation of respondents from diverse age groups and income groups. EFA (extractive factor analysis) figures as the most appropriate analytical approach for the initial item selection. This is a multivariate statistical test that enables the researchers to identify the lateral structure within a set of observed measures. Factor analysis facilitates the determination of interrelationships among a set of variables in the process of defining the construct. The EFA as a data reduction technique reduces the large sets of variables to select a few underlying dimensions, and these dimensions are referred to as 'factors'. The factor in analytical terms pertains to an interdependent set of related items. The related items that essentially load on factor in a manner that maximizes the variance within the data are dually explained by the concerned factor. Reflective scale development methodologies have widely been advocated in the skilling and vocational assessment and entrepreneurial assessment studies. Prior to estimation of measurement models through confirmatory factor analysis, traditional measure of scale (that is, Cronbach's alpha) and exploratory analysis were conducted in order to establish the data set's reliability and the variable's subsequent uni-dimensionality validity. These aforesaid tests were undertaken in SPSS 24.0. The results from exploratory factor analysis were compared to the a priori construct model in order to ascertain the factor composition of the constructs. Then the subsequent measurement models were established on the basis of confirmed factors.

6. Analysis

The adequacy of the data was ascertained with the review of factor structure and values of the respective indicator's correlation matrix. The correlation matrix examines the Person coefficient across the pairs of indicators. The correlation assessment seeks to provide the essential insight across the data sample as being appropriate for the subsequent conduct of extractive factor analysis. The presence of significant correlation points to the prevalence of statistically significant dimensions across each assumed factor or dimension. The extensive correlation across the dimensions (correlations as greater than 0.5 and less than 0.99) in turn points to sample appropriateness and signaling the usage of data for the extractive factor analysis. The respective sample adequacy or adequacy of data collected from Likert forms was further assessed for the inverse correlation in SPSS. The literature signals data adequacy when the inverse correlation matrix is a diagonal matrix. The values of the non-diagonal aspects should, however, be as close to zero as possible. As most of the observed values in the inverse matrix are close to zero or less than zero, the correlation and data adequacy stand vindicated. The Bartlett's signifies another assessment for the ascertainment of data adequacy while the observations are illustrated herein. This particular attribute refers to the

degree to which the data refer to each other. The respective measures of sampling adequacy project KMO assessment are vital to sampling size adequacy determination. (Table 3)

Table 3: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.845
Bartlett's Test of Sphericity	Approx. Chi-Square	55069.747
	df	1275
	Sig.	0.000

The subset-wide factor classification is essential for the perusal of research and achievement of the predefined research objectives. The factors, as mentioned above, have been classified on the basis of reviews of existing literature and academic studies on the subject matter. The studies on the subject matter call for the operationalization of the phenomenon across individual and contextual aspects. All the loading subscale items representing the dimensions of customer work behavior and builder's technology usage orientation were run in a single EFA to ascertain their respective factor loadings. The principal component analysis method with varimax rotation was devised for the aforesaid task. In a nutshell, the factor market orientation' contributed to 35 percent cumulative variance across scale elements, and the factor of data-driven value propositions exhibited a maximum evident variance of 17 percent. The respectively deduced factors as identified from EFA were AI-induced biases (11 percent variance), customer work behavior biases (5.3 percent variance), broker ecosystem (3.7 percent variance), technology orientation (3.5 percent variance), actual purchase (2.8 percent variance), credit availability (2.6 percent variance), technology work style biases (2.0 percent variance), purchase intention biases (1.7 percent variance), builder technology usage biases (1.5 percent variance), and social change biases (1.3 percent variance) exhibiting eigenvalues as equal to or greater than one Table 4.

Table 4: Factor Variance Mapped

Total Variance Explained							
Component	**Initial Eigenvalues**			**Extraction Sums of Squared Loadings**			**Rotation Sums of Squared Loadings**[a]
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**
Factor 1=Market Orientation	18.270	35.824	35.824	18.270	35.824	35.824	4.080
Factor 2= Data driven value propositions	8.738	17.133	52.957	8.738	17.133	52.957	10.380
Factor 3=AI induced Biases	5.670	11.118	64.075	5.670	11.118	64.075	8.900
Factor 4=Customer Work Behavior	2.752	5.396	69.471	2.752	5.396	69.471	6.335
Factor 5=Broker Ecosystem	1.901	3.728	73.199	1.901	3.728	73.199	10.273
Factor 6= Technology Orientation	1.816	3.560	76.759	1.816	3.560	76.759	7.595
Factor 7=Actual Purchase	1.462	2.868	79.627	1.462	2.868	79.627	5.242
Factor 8= Credit Availability	1.362	2.670	82.297	1.362	2.670	82.297	4.819
Factor 9= Technology work style	1.269	2.096	84.393	1.269	2.096	84.393	8.829
Factor 10= Purchase Intention	1.254	1.753	86.147	1.254	1.753	86.147	8.972
Factor 11= Builder Technology Usage	1.250	1.568	87.714	1.250	1.568	87.714	9.664
Factor 12= Social Change	1.196	1.364	89.078	1.196	1.364	89.078	7.153
Extraction Method: Principal Component Analysis.							
a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.							

7. Item selection with EFA

The factor extraction formed the next crucial stage. This is essential to ascertain the factor weightage that each factor occupies across scale composition. This enables the research to comprehend the variance that is exhibited by each scale constituent. The factor 'AI-induced biases' was represented by loading subscale items, namely AB1, AB2, AB3, AB4, AB5, AB6, AB7, and AB8. The factor 'value propositions' was represented by loading subscale items VP3, VP4, VP5, VP6, VP7, VP8, VP9, and factor customer work behavior was represented by CW1, CW2, CW3, CW4. The factor technology orientation was represented by loading items: TO1, TO2, TO3, TO4. Extraction Method: Principal Component Analysis. Rotation Method: Oblimin with Kaiser Normalization. Rotation converged in 14 iterations

Table 5: Pattern Matrix: Exploratory Factor Analysis

Sub Scale Dimensions as extracted with EFA	Item	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
I let AI influence me in my everyday decisions	AB1			.905									
I cannot prevent an AI from influencing me in my everyday decisions	AB2			.851									
I cannot realize if artificial intelligence is influencing me in my everyday decisions	AB3			.875									
I cannot keep control over feelings like frustration and anxiety while doing everyday things with AI	AB4			.916									
I cannot handle it when everyday interactions with AI frustrate or frighten me	AB5			.916									
I cannot control my euphoria that arises when I use artificial intelligence for everyday purpose	AB6			.936									
I am interested in using artificially intelligent systems in my daily life	AB7			.949									
I would like to use Artificial Intelligence in my own job	AB8			.926									
The use of Marketer's apps and virtual tours and media options helps me to gain social approval	VP3		.873										
Marketer's apps and virtual tours and media options helps to make a positive impression on other people	VP4		.914										
The use of marketer's apps and virtual media changed the way that apartments perceived by customers	VP5		.907										
After using marketer's apps and virtual tours, I feel like a smarter person	VP6		.968										
I have seen others availing the benefits of marketer's apps and virtual tours	VP7		.825										

I would use marketer's apps and virtual tours more often if better promotional incentives were offered	VP8		.819										
I'm very particular about the quality and safety of place where I intend to reside	VP9		.793										
It is increasingly rare to have enough time for work tasks	CW1				.982								
The time between the more intense work phases has decreased	CW2				.947								
One has more often to do two or three things at once (such as eating lunch, writing emails, and talking on the phone)	CW3				.981								
Ever more work has to be completed by fewer and fewer employees	CW4				.913								
Utilizes up-to-date technology in business operation	TO1						.730						
Uses technology to put ahead of the competitors	TO2						.816						
Pioneers the use of new technology	TO3						.815						
Allocates financial resources to adopt the latest technology	TO4						.766						
Builder seems to make strategic decisions with respect to products and technologies based on how current competitors will react to competitive actions	MO2	.517											
Builder seems to observe developments at adjacent markets in order to predict the entry of potential competitors early	MO3	.466											
In order to be ahead of competition builder seems to proceed offensively-minded when developing and implementing competitive actions	MO4	.599											
Builder's top management seems to regularly discusses competitors' strategies	MO7	.562											
My responsibilities force me to continually use available technological tools (cell phone, email, chat, video conferencing)	TW2									.916			
I have downloaded work-related applications on my personal mobile devices	TW3									.847			
It is expected that I will always be connected to work issues beyond my workday	TW4									.803			

My colleagues contact me about work issues after my workday through my available mobile devices	TW5									.917			
Builder is actively introducing digital marketing innovation (Managerial innovativeness)	BT3											-.855	
Builder uses digital channels (such as online, social media, and mobile) to market its products and services (Customer experience)	BT4											-.723	
Builder's technological innovations have enabled customers to interact with our operational processes in the new ways(Improving operation)	BT5											-.620	
Builder has launched a new business model based on/using digital technology (Reinvention of business model)	BT6											-.596	
Regular real estate product (apartment) support services	BE3					.906							
Online real estate product (apartment) decision making services	BE4					.952							
Advanced real estate (apartment) service provision models	BE5					.785							
Data-driven real estate services	BE6					.914							
Real estate customers are made to engage in the innovation processes, promoting customer autonomy and collaboration through surveys, forums, direct meetings, etc.	BE7					.750							
A variety of financial options will prompt my decision to buy. For example, paying in installments	CA3								.664				
I think there will be a good return on investment in	CA4								.856				
Prices greatly influence my property buying decisions	CA5								.750				
I enjoy spending time becoming acquainted with a new technical system	SC3												.771
I try to understand how a technical system exactly works	SC4												.705
I try to make full use of the capabilities of a technical system.	SC5												.576
The excellent location allows me to avoid the noise and bustle	AP4							-.730					
Buying a property in a desirable location will make my life convenient	AP5							-.715					

Compared with the traditional housings, I would prefer to	PI1										-.837		
The next time I purchase a house, I would give priority to	PI2										-.864		
I would like to recommend friends to purchase	PI3										-.737		

The review of dimensions categorically exhibits the categorical imprint of technology and technology derived determinism on the aspects and variables that seemingly exert impact on the ethos and determination of phenomenon. Apartment purchase is thus empirically forecasted to rely on.

8. Scree Plot Determination

The scree plot is a plot of the eigen values (and corresponding factors) of the full correlation matrix and the maximum number of factors as indicated by the point before the plot levels off, which in other terms corresponds to the point preceding the elbow. Beyond this point in the graph, the factors seem to experience negligible variance in statistical terminology. The plot of the eigen values of the reduced correlation matrix was also examined as the focus of the current research. The first factor as extracted represents the largest amount of variance as exhibited by the constituent scale factors. (Figure 2)

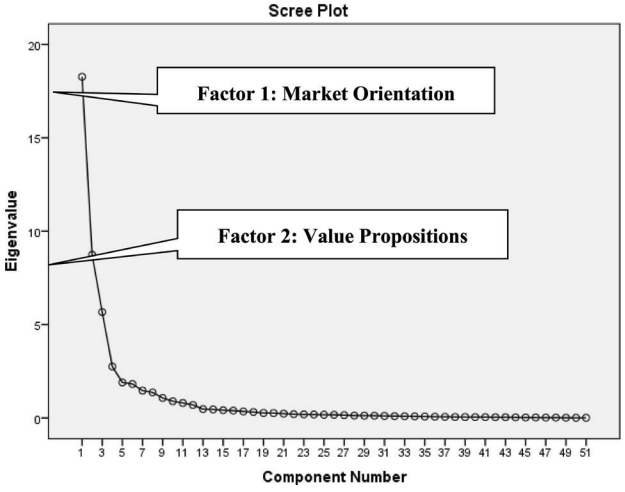

Figure 2: Scree Plot

9. Conclusion

To sum up the discussions, the research objectively identified the factors that contribute to data-derived decision-making with regard to real estate decision-making (an apartment purchase in this case). The results indicated that customer work behavior along with builders' technology orientation collectively shape the data-driven value proposition formulation. Factor validity was assessed with the aid of exploratory factor analysis and was conducted on account of uncertainty about the dimensionality of factors that were involved in measuring the phenomenon. Consequently, it was found that AI-induced biases, technology-driven work styles, customer work behavior, technology orientation, market orientation, builder technology usage, social change, broker ecosystem, and credit availability shaped and determined the phenomenon. In simpler terms, these factors loaded successfully into the factor determination in pattern matrix.

10. Implications

The theoretical implications revolve around the study-based introduction of a novel approach to the study of leverage of digital technologies in aiding human decision-making with regard to real estate decision-making. Unlike the prior real estate marketing studies, throughout this research study, respondents are continuously reminded to focus on the behaviors of their technology determinism, technology-induced AI biases, marketers's and builders's usage of technology, and prospective shaping of data-driven value propositions. This research practice has enabled this study to develop and technology-aided decision-making measures of technology in real estate marketing and value proposition creation. The measures that were developed can be argued to apply specifically to real estate marketing organizations's behaviors. This identifies as an important improvement on existing studies on the subject that tend to unknowingly or knowingly rely more on the technology-based moderating or mediating role on real estate marketing in contemporary situations. At the specific level of 'customer work behavior' and 'builder technology usage', data related to these factors could be strategic resources who are seeking competitive advantage development. Furthermore, results show that a pursuit of regular reviews of AI-induced biases and technology-driven work styles of customers will definitely give valid insights into the understanding of customer work behavior.

11. Directions for Future Research on Dimension Identification

Further research can be conducted with new dimensions of technology, especially machine language, virtual reality, augmented reality, and the other data-embedded technologies that possess the potential to change real estate decision-making.

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All the authors have contributed to all the sections.

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Conflict of Interest

The author declares no conflict of interest.

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