

Investigating the Impact of Digital Games on Managers' Financial Decision-Making Styles: The Mediating Role of Cognitive Biases and the Moderating Roles of Gender and Educational Level



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Abstract: This study aimed to investigate the impact of digital gaming patterns on managers' financial decision-making styles, considering the mediating role of cognitive biases and the moderating roles of gender and educational level. This applied, cross-sectional, descriptive-correlational study was conducted among senior Iranian managers and financial decision-makers in 2025. Using purposive, snowball, and professional-network sampling, 321 valid questionnaires were obtained from chief executive officers, chief financial officers, board members, investment and risk managers, budget managers, entrepreneurs, and senior financial analysts. Data were collected using a composite questionnaire assessing challenge-oriented gaming, immediate reward, social competition, surface progression, cognitive biases, and five financial decision-making styles. The instruments demonstrated acceptable reliability, convergent validity, and discriminant validity. Data were analyzed using SPSS 28 and SmartPLS 4 through Partial Least Squares Structural Equation Modeling, 5,000-resample bootstrapping, mediation analysis, and permutation-based multi-group analysis. Challenge-oriented gaming negatively predicted cognitive biases ($\beta = -.14$, $p = .007$) and positively predicted analytical decision-making ($\beta = .28$, $p < .001$). Immediate reward ($\beta = .31$), social competition ($\beta = .19$), and surface progression ($\beta = .24$) positively predicted cognitive biases (all $p < .001$). Cognitive biases negatively predicted analytical decision-making ($\beta = -.39$, $p < .001$) and positively predicted intuitive ($\beta = .33$), dependent ($\beta = .29$), avoidant ($\beta = .46$), and spontaneous styles ($\beta = .42$; all $p < .001$). Significant indirect effects confirmed mediation through cognitive biases. Multi-group analysis further showed significant gender and educational-level differences in several structural paths. Digital gaming patterns are differentially associated with managers' financial decision-making, with cognitive biases functioning as an important explanatory mechanism and gender and educational level shaping selected relationships.

Keywords: Digital Games; Financial Decision-Making; Cognitive Biases; Managers; Gender; Educational Level

1. Introduction

Financial decision-making by managers is a central component of organizational survival, investment efficiency, risk management, resource allocation, and long-term value creation. Managers are routinely required to make judgments under uncertainty concerning capital budgeting, financing, liquidity, investment selection, pricing, risk exposure, portfolio composition, and strategic expansion, often in environments characterized by incomplete

information, time pressure, ambiguity, and conflicting organizational objectives. Although conventional financial theory assumes that decision-makers process available information rationally and select options that maximize expected utility, research in behavioral finance and behavioral strategy has repeatedly demonstrated that managerial judgments are systematically shaped by psychological tendencies, heuristics, emotions, contextual cues, and individual differences. Behavioral-finance research has consequently shifted attention from the assumption of consistently rational economic agents toward the study of predictable deviations from rational judgment and their consequences for financial behavior [1, 2]. Within organizational settings, such deviations can be particularly consequential because managerial decisions affect not only the decision-maker but also employees, shareholders, creditors, customers, and the broader strategic direction of the firm.

Cognitive biases constitute one of the most important psychological mechanisms through which managerial financial judgments may deviate from normative decision criteria. Biases such as anchoring, confirmation bias, loss aversion, overconfidence, herding, the halo effect, and excessive haste influence how individuals search for information, assign probabilities, evaluate alternatives, respond to uncertainty, and revise previously formed beliefs. Research on investment and financial management has shown that heuristic-driven biases can affect market interpretation, portfolio decisions, perceived risk, and investment efficiency [2]. Overconfidence, for example, may lead managers to underestimate uncertainty, exaggerate the precision of forecasts, and take financial positions that are insufficiently supported by objective information. Evidence from technology-oriented firms has similarly shown that managerial overconfidence can influence corporate liquidity behavior and agency-related financial decisions [3]. Under turbulent conditions, personality characteristics and overconfidence may also shape working-capital decisions, demonstrating that managerial cognition remains relevant even when firms face substantial external constraints [4]. Behavioral biases are therefore not peripheral anomalies but potentially important determinants of the way managers interpret financial information and choose among competing courses of action.

The influence of cognitive bias becomes especially important when decision-making is embedded in broader organizational and strategic contexts. Behavioral strategy research emphasizes that real managers frequently rely on simplified judgment processes rather than fully optimizing calculations, particularly when problems are novel, complex, uncertain, or politically consequential [5]. Empirical evidence from emerging markets has likewise demonstrated meaningful relationships between behavioral biases and strategic decision-making, suggesting that biased cognition can influence the quality, direction, and consistency of managerial choices [6]. Risk perception and cultural context can further alter the behavioral costs of managerial decisions, indicating that judgment is shaped by both cognitive processes and the environments within which those processes operate [7]. Motivated beliefs and social preferences may also affect financial choices under limited liability, implying that seemingly irrational decisions may arise not only from information-processing limitations but also from psychologically motivated interpretations of financial consequences [8]. These findings reinforce the need to investigate not simply whether managers are biased but also which external experiences and behavioral environments may intensify or attenuate such biases.

One increasingly relevant behavioral environment is digital gaming. Digital games have evolved from narrowly defined entertainment products into interactive systems involving strategic planning, rapid feedback, uncertainty, rewards, competition, social comparison, repeated trial and error, resource allocation, simulated risk, and complex decision sequences. The contemporary gaming industry has also become deeply intertwined with entrepreneurship, platform economics, mobile technologies, and digital consumption, making game-related behavioral patterns increasingly relevant beyond entertainment contexts [9]. Gamification principles are now

deliberately applied in domains such as education, finance, energy management, marketing, and organizational learning because game-like structures can influence motivation, persistence, engagement, and choice architecture [10]. Persuasive gaming research similarly shows that game systems can shape attitudes and behavior through their combination of interactive narratives, reward structures, competition, and feedback loops [11]. Consequently, digital gaming can be conceptualized not merely as leisure behavior but as repeated exposure to structured decision environments that may influence habitual cognitive and behavioral responses.

Different features of digital games may plausibly affect financial decision-making in different directions. Challenge-oriented games typically require problem solving, planning, learning from failure, adaptation to changing conditions, and evaluation of delayed consequences. Such repeated engagement may strengthen persistence, strategic thinking, information integration, and tolerance for complex decisions. Game-based learning has already demonstrated value for teaching economic and investment concepts, suggesting that interactive game environments can provide experiential exposure to financial reasoning and trade-offs [12]. Serious games have also been proposed as tools for improving professional decision quality and mitigating cognitive errors. In medical education, for example, serious-game training has been discussed as a potentially useful means of reducing cognitive biases among professionals who regularly make high-stakes decisions under uncertainty [13]. Experimental and training-oriented work in behavioral finance similarly suggests that game-based methods can reduce some financial biases when the game environment is deliberately designed around reflection, feedback, and corrective learning [14]. These findings indicate that exposure to game mechanics involving challenge, reflection, and consequence-sensitive learning may potentially support more analytical forms of judgment.

However, not all game mechanisms are cognitively beneficial. Many contemporary digital games emphasize immediate rewards, rapid reinforcement, status indicators, competitive rankings, badges, levels, visible progression, scarcity cues, and repeated short-cycle decisions. Such design features may encourage attentional narrowing, short-term orientation, reward sensitivity, social comparison, and reliance on salient cues. Research on gamification in financial contexts indicates that behavioral traits can interact with gamified environments to shape financial conduct, making the structure of game-based reinforcement particularly important when analyzing downstream financial behavior [15]. Digital choice environments can also be designed to nudge investment behavior, as demonstrated in experimental work using digital financial-advising and investment-game settings [16]. Although such mechanisms may be used constructively, they also demonstrate that digital interfaces can influence financial preferences and choices without changing the underlying economic information. Algorithmic technologies may additionally influence information exposure through filtering and gatekeeping processes, potentially narrowing the information available to decision-makers and affecting the cognitive foundations on which judgments are formed [17]. The rapid diffusion of artificial intelligence into digital environments adds another layer of complexity, as AI systems increasingly shape recommendations, information visibility, and decision-support processes across modern society [18].

These developments are particularly relevant to financial and accounting decisions because digital technologies can amplify the interaction between trust, automation, information quality, and cognitive bias. Recent research on digital accounting decisions has shown that cognitive bias and trust can jointly influence judgments made in technology-mediated environments [19]. More broadly, the intersection of artificial intelligence and behavioral economics has emerged as a growing research field concerned with how computational systems interact with bounded rationality, preferences, and behavioral responses [20]. Digital environments may therefore either support managerial cognition by organizing information and providing feedback or intensify bias by encouraging

superficial processing, overreliance on automated cues, or excessive confidence in technologically mediated judgments. In a managerial context, this tension is important because executives increasingly operate within data-intensive digital ecosystems while simultaneously being exposed to game-like reward structures in both professional and personal technology use.

Financial decision-making style provides an appropriate behavioral outcome through which these relationships can be examined. Managers differ in whether they approach decisions analytically, intuitively, dependently, avoidantly, or spontaneously. An analytical style emphasizes systematic information gathering, evaluation of alternatives, and deliberate reasoning, whereas an intuitive style relies more strongly on experience, affect, and rapid pattern recognition. Dependent decision-makers seek advice and reassurance from others, avoidant decision-makers tend to postpone difficult choices, and spontaneous decision-makers favor rapid resolution. These styles are not inherently equivalent to good or poor decision-making in every situation, but their relative dominance may have substantial implications when decisions involve financial risk, ambiguity, or long-term consequences. Cognitive biases may alter the balance among these styles by changing how managers perceive information, confidence, losses, social signals, and urgency. For example, herding tendencies may increase dependence on others, overconfidence may facilitate spontaneous choices, and loss aversion may encourage avoidance or excessive caution.

The behavioral-finance literature also indicates that financial decision quality is affected by broader competencies and behavioral tendencies. Financial literacy has become increasingly important in digitally mediated environments where individuals must navigate complex financial products, platforms, and information sources [21]. Research has shown that financial literacy can reduce maladaptive behavioral tendencies in specific decision contexts, including aversion-related responses in debt management [22]. In small and medium-sized enterprises, financial behavior can mediate the effects of literacy and attitudes on business performance and sustainability [23]. Emotional bias has also been associated with financing and performance outcomes among entrepreneurial firms, emphasizing that affective and cognitive processes operate alongside conventional financial knowledge [24]. These findings imply that financial decision-making cannot be fully understood through objective knowledge alone; the behavioral processes through which information is interpreted and acted upon are equally consequential.

The relevance of behavioral bias extends to socially and strategically significant investment contexts. Sustainable-investment research has found that environmental, social, and governance considerations interact with behavioral biases when investors and managers evaluate long-term investment alternatives [25]. Sequential signaling research in equity crowdfunding has likewise highlighted the importance of investors' ability to interpret informational signals correctly, particularly when earlier decisions by others may influence subsequent choices [26]. Such environments are vulnerable to herding, anchoring, and socially reinforced beliefs. Research on free-riding behavior further demonstrates that apparently rational economic behavior can be influenced by strategic expectations regarding the actions and contributions of others [27]. Together, these studies suggest that managerial financial choices often emerge from an interaction between formal information, psychological interpretation, social influence, and situational incentives.

The possibility of reducing or modifying biased financial judgment has therefore attracted increasing scholarly interest. Integrated debiasing research suggests that effective interventions must consider both the origin of the bias and the conditions under which corrective strategies are implemented [28]. Training, structured feedback, reflective reasoning, and decision architecture may all contribute to more calibrated financial judgments, but interventions are unlikely to operate uniformly across individuals. Experimental evidence from behavioral training also suggests

that prosocial and preference-related responses can be influenced through structured learning environments, demonstrating that repeated exposure and training may alter economically relevant behavior [29]. The design of serious games and other interactive learning environments is increasingly being informed by these principles. Work on serious board-game design, for instance, illustrates how emerging technologies can support the creation of interactive systems that facilitate engagement, reflection, and learning [30]. Consequently, digital games may represent both a source of potentially bias-enhancing reinforcement and a medium through which more reflective decision processes can be developed.

Importantly, the relationships among digital gaming, cognitive bias, and financial decision-making are unlikely to be identical across all managers. Gender is a theoretically relevant moderator because research has documented gender-related differences in risk attitudes and financial behavior. Evidence from natural experimental settings indicates that gender can be associated with variation in risk aversion, although the magnitude and direction of such differences are sensitive to context [31]. If men and women differ in sensitivity to competition, reward, loss, or uncertainty, the same gaming characteristics may have different cognitive consequences across gender groups. Educational level may likewise operate as a boundary condition because advanced education can strengthen analytical skills, financial knowledge, information evaluation, and metacognitive awareness, potentially reducing susceptibility to some forms of cognitive bias. At the same time, higher expertise does not guarantee immunity from bias, because confidence associated with expertise may itself generate distortions. Examining educational level as a moderator can therefore clarify whether the relationships between game-related experiences, cognitive biases, and financial decision-making styles are strengthened, weakened, or qualitatively altered as formal educational attainment increases.

The organizational importance of these relationships becomes even greater under contemporary conditions of uncertainty, sustainability pressures, and digital transformation. Managers are increasingly expected to make financial choices while simultaneously considering climate exposure, innovation investments, stakeholder expectations, and technological disruption. Recent research has demonstrated that managerial cognitive limitations, including myopia, can affect corporate financial sustainability and the relationship between managerial awareness and environmentally relevant organizational outcomes [32]. These pressures require managers to integrate immediate financial signals with long-term strategic considerations, creating precisely the kind of decision environment in which cognitive bias and decision-making style may become consequential. Digital games may influence this process because they repeatedly expose users to different temporal structures of reward, competitive signals, risk-response patterns, and feedback mechanisms.

Despite the growing literatures on behavioral finance, gamification, game-based learning, digital decision environments, and managerial cognition, these streams have largely developed independently. Behavioral-finance studies have extensively documented biases in investment and managerial decisions, while game-based research has examined learning, engagement, persuasion, and behavioral change. Gamification studies have begun to explore financial conduct and digital investment choices, yet limited empirical research has examined whether managers' patterns of engagement with digital-game mechanics are associated with their professional financial decision-making styles. Even fewer studies have simultaneously investigated the psychological mechanism that may connect the two domains. This gap is theoretically important because a direct relationship between gaming and financial choice would provide only limited explanatory value; identifying cognitive bias as a mediator can clarify how repeated exposure to particular game environments may become associated with specific decision

tendencies. Furthermore, failing to examine gender and education may obscure important heterogeneity in these pathways.

The present study addresses this gap by conceptualizing digital gaming as a multidimensional behavioral experience rather than a single measure of playing frequency. It distinguishes challenge-oriented gaming, immediate-reward orientation, social competition, and surface progression because these features represent different cognitive and motivational structures. This approach permits the possibility that some gaming patterns may support analytical processing whereas others may increase susceptibility to biased or impulsive judgments. Cognitive bias is positioned as the mediating mechanism connecting these gaming characteristics to managers' financial decision-making styles, while gender and educational level are considered potential boundary conditions that may alter the strength of selected relationships. By integrating concepts from behavioral finance, managerial decision-making, gamification, and cognitive psychology, the proposed framework provides a more differentiated explanation of how contemporary digital experiences may relate to managerial financial behavior.

Accordingly, the aim of this study was to investigate the impact of digital gaming patterns on managers' financial decision-making styles, with cognitive biases as a mediating mechanism and gender and educational level as moderating variables.

2. Methods and Materials

The present study employed an applied, quantitative, cross-sectional, descriptive-correlational research design to investigate the relationships among digital gaming patterns, cognitive biases, and financial decision-making styles among managers, while simultaneously examining the mediating role of cognitive biases and the moderating roles of gender and educational level. The conceptual orientation of the study was informed by pragmatism because the research was primarily directed toward explaining a practically relevant managerial phenomenon and selecting analytical procedures appropriate to the research questions. At the quantitative level, however, the study was principally grounded in a post-positivist perspective, according to which relationships among psychological, behavioral, and managerial constructs can be approximated through systematic measurement and empirical hypothesis testing while acknowledging the fallibility of measurement and human cognition. A cross-sectional survey design was considered appropriate because the proposed conceptual model incorporated relational, mechanistic, and contingent effects that required the simultaneous assessment of direct, indirect, and group-dependent relationships among multiple latent constructs. Although the term "impact" is used conceptually to represent the hypothesized directional relationships among the constructs, the nonexperimental and cross-sectional nature of the study means that the estimated structural relationships should primarily be interpreted as theoretically specified predictive associations rather than definitive experimental causation.

The target population consisted of senior managers and financial decision-makers working in major Iranian industries and financial markets during 2025. Eligible participants included chief financial officers, chief executive officers, board members, investment managers, risk managers, budget managers, entrepreneurs and startup managers, and senior financial analysts who were directly involved in substantial investment, financing, budgeting, risk-management, or resource-allocation decisions. Participants were recruited from strategically important sectors of the Iranian economy, including petrochemicals, automotive manufacturing, basic metals, information and communication technology, banking and insurance, food industries, knowledge-based enterprises, startups, and financial-market institutions. Eligibility was restricted to individuals whose organizational responsibilities involved direct or meaningful participation in financial decision-making so that

responses regarding financial decision-making styles and cognitive tendencies reflected actual managerial experience rather than hypothetical judgments detached from professional practice.

Because no comprehensive sampling frame covering the entire theoretical population of senior financial decision-makers in Iran was available and because access to senior executives is inherently difficult, a multistage non-probability sampling strategy combining purposive, snowball, and professional-network-based recruitment was adopted. Initially, criterion-based purposive sampling was used to identify potentially eligible participants through professional databases, corporate networks, industry associations, financial institutions, and managerial contacts. Personalized invitations were then sent to individuals who fulfilled the inclusion criteria. Subsequently, theory-oriented snowball sampling was employed by inviting participating managers to refer qualified professional colleagues whose job responsibilities met the eligibility criteria. To broaden sectoral coverage and reduce excessive concentration within a limited number of organizations, recruitment was additionally conducted through specialized managerial and financial professional networks and relevant industry and management associations. This combined strategy was considered particularly appropriate for obtaining access to a relatively specialized and difficult-to-reach managerial population.

The required sample size was determined using several complementary criteria relevant to Partial Least Squares Structural Equation Modeling rather than relying on a single sample-size rule. The conventional 10-times criterion, considering the relatively large number of indicators associated with some of the latent constructs, suggested the need for a sample exceeding approximately 240 participants. An a priori statistical power analysis conducted using G*Power, assuming a relatively small-to-medium effect size of approximately $f^2 = 0.10$, a significance level of .05, and statistical power of .95, indicated that approximately 172 observations would be sufficient for detecting the principal structural effects under conventional regression assumptions. More conservative recommendations for PLS-SEM, together with the requirements of mediation testing, bootstrapping, and subgroup comparisons, indicated the desirability of a substantially larger sample. Particular consideration was given to the planned multi-group analyses because adequate representation within gender and educational subgroups was necessary for stable between-group comparisons. Accordingly, a target of approximately 350 usable responses was established before data collection.

Questionnaire invitations were distributed to 680 potentially eligible managers. A total of 410 responses were initially received and subjected to systematic data-quality screening. Responses were excluded when substantial portions of the questionnaire were incomplete, when response patterns suggested straight-lining or random answering, when completion time was implausibly short relative to the length of the instrument, when duplicate responses were detected, or when multivariate response patterns indicated extreme and potentially influential cases requiring exclusion. Responses completed in less than approximately eight minutes were specifically examined as potential indicators of insufficient engagement with the questionnaire. Following data cleaning and eligibility assessment, 321 complete and usable questionnaires remained, representing 78.3% of the initially received responses and an effective response rate of 47.2% relative to the total number of invitations distributed. The final sample size was considered adequate for estimation of the proposed PLS-SEM model, bootstrap analysis of indirect effects, and the planned multi-group comparisons.

Ethical principles were incorporated throughout participant recruitment and data collection. Before accessing the questionnaire, participants were presented with an electronic informed-consent statement explaining the purpose of the study, the voluntary nature of participation, the confidentiality of responses, the intended use of the data, and their right to discontinue participation at any point without adverse consequences. No directly identifying

personal information was required for participation, and analytical datasets were maintained in coded form. The questionnaire was designed to avoid unnecessary psychological discomfort, professional evaluation anxiety, or disclosure of commercially sensitive organizational information. Participation was entirely voluntary, and respondents were informed that results would be reported only in aggregate form. The study procedures were designed in accordance with established ethical principles for research involving human participants, including informed consent, confidentiality, non-maleficence, scientific integrity, and transparent reporting.

Data were collected using a composite self-report questionnaire developed by integrating established international measures of gaming experience, cognitive biases, and decision-making styles with demographic and occupational questions relevant to senior managerial populations. The instrument underwent systematic translation, cultural adaptation, content validation, and psychometric evaluation before structural-model testing. The questionnaire contained four substantive components. The background section comprised 11 items assessing demographic, occupational, and behavioral characteristics, including gender, age, educational level, managerial position, professional experience, sector of employment, and digital gaming behavior. Gender and educational level were particularly important because they were subsequently examined as moderators of the hypothesized relationships. Questions concerning gaming behavior also captured participants' familiarity with and frequency of engagement in digital games to ensure that the independent construct was evaluated within an interpretable behavioral context.

Digital gaming patterns and preferences constituted the principal independent construct and were measured using 16 items adapted from established measures of gaming experience and engagement, including conceptual elements derived from the Game Experience Questionnaire and related game-engagement measures. The construct was operationalized through four theoretically relevant dimensions: challenge, immediate reward, social competition, and surface or visible progression, with four items representing each dimension. These dimensions were selected because they reflect characteristic reinforcement and decision environments embedded in many contemporary digital games. Challenge captures repeated exposure to progressively difficult tasks requiring rapid strategy adjustment and problem solving; immediate reward represents responsiveness to prompt reinforcement and short-term feedback; social competition reflects engagement with comparative performance, rankings, and competitive achievement; and surface progression reflects responsiveness to visible indicators of advancement, such as points, levels, rankings, badges, or other externally represented markers of progress. Items were assessed on a five-point Likert-type scale, with higher scores indicating stronger endorsement or experience of the respective gaming pattern.

Cognitive bias, conceptualized as the mediating construct, was assessed with 24 items representing seven biases that are theoretically relevant to managerial financial judgment: loss aversion, anchoring, confirmation bias, overconfidence, the halo effect, herding behavior, and decision hastiness. Five items assessed loss aversion, three assessed anchoring, five assessed confirmation bias, three assessed overconfidence, three assessed the halo effect, three assessed herding behavior, and two assessed hastiness. Items were adapted from previously developed cognitive and behavioral measures and were rewritten where necessary to situate respondents within managerial and financial decision contexts. Loss-aversion items assessed disproportionate sensitivity to potential financial losses relative to equivalent gains; anchoring items assessed excessive reliance on initially presented values or information; confirmation-bias items evaluated the tendency to favor information consistent with prior expectations; overconfidence items assessed excessive confidence in personal forecasts or judgments; halo-effect items addressed the generalization of salient positive or negative impressions to broader financial evaluations;

herding items assessed the tendency to follow prevailing market or managerial opinions; and hastiness items represented premature decision-making under conditions in which additional information could reasonably be considered. All cognitive-bias items were rated using a five-point Likert-type response format.

Financial decision-making style constituted the principal dependent construct and was assessed using a 20-item instrument based on the General Decision-Making Style framework developed by Scott and Bruce. The measure represented five conceptually distinct decision-making styles: analytical or rational, intuitive, dependent, avoidant, and spontaneous. Five items assessed analytical decision-making, four assessed intuitive decision-making, three assessed dependent decision-making, four assessed avoidant decision-making, and four assessed spontaneous decision-making. The analytical dimension represented deliberate evaluation of information, alternatives, expected outcomes, and financial evidence before making a decision. The intuitive dimension captured reliance on experience, feelings, pattern recognition, and implicit judgment. The dependent dimension represented reliance on advice or guidance from other individuals when making financially consequential decisions. The avoidant dimension reflected postponement or evasion of difficult decisions, whereas the spontaneous dimension captured a preference for making decisions rapidly and with limited deliberation. The wording of the original items was adapted to the managerial-financial context while maintaining the theoretical meaning of the underlying dimensions. Responses were recorded on a five-point Likert scale.

The adaptation of the composite questionnaire followed a multistage procedure designed to maximize linguistic equivalence and contextual validity. Initial English-language items were independently translated into Persian by specialists familiar with cognitive psychology and financial management. The translated items were subsequently reviewed for conceptual rather than merely literal equivalence, and managerial and financial scenarios were adapted to the institutional and economic characteristics of Iran, including the decision environment associated with inflationary uncertainty, financial constraints, market volatility, financing conditions, and organizational structures. A back-translation procedure was then conducted to determine whether the adapted Persian items preserved the intended meanings of the source instruments. Discrepancies between the source and back-translated versions were reviewed collaboratively, and items were revised until satisfactory semantic and conceptual correspondence was achieved.

Content validity was evaluated by two independent panels with complementary expertise. The first panel comprised nine university experts in research methodology, management, finance, or related disciplines, who assessed the necessity, relevance, clarity, and representativeness of the proposed items. Content Validity Ratio and Content Validity Index procedures were applied to support item-level and scale-level decisions. The overall Content Validity Index was 0.92, indicating excellent expert agreement regarding the relevance and clarity of the final instrument. Items that did not demonstrate adequate content validity or that experts considered redundant or ambiguous were reconsidered or removed rather than being retained solely to preserve the original scale length. The second panel consisted of nine senior financial managers with more than 10 years of professional experience. These practitioners evaluated the realism, comprehensibility, and applicability of the items to actual managerial financial decisions. Following the two expert-review stages, four items were eliminated and 12 underwent substantial wording or contextual revisions.

The psychometric properties of the measures were subsequently evaluated using the final analytical sample of 321 managers. The measurement model was assessed in SmartPLS 4 before testing the structural relationships. Indicator loadings were inspected to determine the contribution of individual items to their intended latent constructs. Internal consistency was evaluated through Cronbach's alpha, composite reliability, and related

reliability coefficients, with values of .70 or higher interpreted as satisfactory. Convergent validity was examined using the Average Variance Extracted criterion, with AVE values of at least .50 indicating that the latent construct explained an acceptable proportion of variance in its indicators. Discriminant validity was principally examined using the heterotrait-monotrait ratio of correlations, with HTMT values below .85 treated as evidence that theoretically distinct constructs were empirically distinguishable. The retained constructs demonstrated acceptable internal consistency, convergent validity, and discriminant validity, supporting their use in subsequent structural-model estimation.

Because the main constructs were measured using the same self-report questionnaire at a single point in time, common method variance was explicitly evaluated. Procedural remedies were incorporated during questionnaire development by ensuring respondent anonymity, reducing evaluative wording, separating conceptually different sections of the questionnaire, and using reverse-coded items where appropriate. Statistical examination was first performed through Harman's single-factor procedure. The first unrotated factor accounted for 32.4% of total variance, substantially below the conventional 50% threshold, suggesting that a single method factor did not dominate the covariance structure. Given the limitations of relying exclusively on this diagnostic, an additional common-method-factor assessment was performed by comparing measurement models with and without a common method component. Differences in standardized indicator loadings did not exceed 0.20, providing further evidence that common method bias was unlikely to materially distort the observed relationships. Collectively, the translation, expert validation, psychometric testing, and common-method assessments indicated that the final instrument had adequate measurement quality for testing the proposed mediation and moderation model.

Data analysis was conducted using IBM SPSS Statistics version 28 and SmartPLS version 4. SPSS was primarily used for data screening, descriptive analysis, examination of response distributions, assessment of potential outliers, and preliminary diagnostic procedures, whereas SmartPLS was used to estimate the measurement and structural models. Before hypothesis testing, the dataset was screened for missing values, duplicate cases, implausibly short response times, patterned responses, and extreme observations. Descriptive statistics were then calculated for the demographic and occupational characteristics of the sample and for the primary study variables. Frequencies and percentages were reported for categorical variables, whereas means, standard deviations, skewness, and kurtosis were calculated for continuous or composite variables. Most skewness and kurtosis coefficients fell within approximately ± 1 to ± 1.5 , indicating no severe univariate distributional problems. Nevertheless, Partial Least Squares Structural Equation Modeling was selected because the method does not require strict multivariate normality and is particularly suitable for prediction-oriented models containing numerous indicators, multidimensional constructs, mediation effects, and group-dependent structural relationships.

PLS-SEM was employed to evaluate the proposed relationships among digital gaming patterns, cognitive biases, and financial decision-making styles. The analytical procedure was conducted sequentially by first evaluating the measurement model and then assessing the structural model. For the measurement component, indicator reliability, internal consistency reliability, convergent validity, and discriminant validity were examined using standardized outer loadings, Cronbach's alpha, composite reliability, Average Variance Extracted, and HTMT. Collinearity was also examined using variance inflation factors to ensure that structural estimates were not substantially distorted by excessive predictor overlap. After establishing satisfactory measurement properties, the structural model was evaluated through standardized path coefficients, their statistical significance, coefficients of determination, effect sizes, predictive relevance, and approximate model-fit indices.

The statistical significance of the structural paths was assessed through nonparametric bootstrapping with 5,000 resamples and 95% confidence intervals. Standardized path coefficients were interpreted in conjunction with bootstrap-derived *t* statistics, *p* values, and confidence intervals rather than relying exclusively on statistical significance. The explanatory capacity of the model was examined through R^2 values for endogenous constructs, while Cohen's f^2 was calculated to evaluate the unique contribution of individual predictors to explained variance. Effect sizes of approximately .02, .15, and .35 were interpreted as small, medium, and large, respectively. Model fit was additionally examined using the Standardized Root Mean Square Residual and Normed Fit Index. The estimated SRMR for the overall model was 0.062, which was below the commonly applied threshold of .08 and therefore indicated an acceptable discrepancy between the empirical and model-implied correlation structures.

The mediating role of cognitive biases in the relationship between digital gaming patterns and financial decision-making styles was evaluated by estimating specific indirect effects through the bootstrap procedure. Rather than applying the traditional causal-steps approach, mediation was assessed directly from the magnitude and confidence interval of each indirect effect. An indirect effect was considered statistically supported when its bootstrap 95% confidence interval did not contain zero. Direct and indirect effects were considered simultaneously to determine whether the resulting pattern was compatible with complementary, competitive, indirect-only, or nonsignificant mediation. This procedure made it possible to determine whether exposure to particular gaming patterns was associated with financial decision-making styles partly through systematic differences in managers' cognitive biases.

Gender and educational level were examined as categorical moderating variables through PLS-based multi-group analysis. Before interpreting between-group differences in structural paths, the measurement properties of the relevant constructs were examined to ensure that group comparisons were substantively meaningful. The structural model was then estimated separately for the gender and educational subgroups, and differences in corresponding path coefficients were evaluated using nonparametric permutation-based procedures and PLS multi-group analysis. A statistically significant difference in the magnitude of a structural coefficient across groups, conventionally evaluated at $p < .05$, was interpreted as evidence that the corresponding relationship varied according to gender or educational level. This strategy permitted moderation to be evaluated at the level of theoretically relevant structural relationships rather than merely comparing mean scores across demographic categories.

Predictive relevance was further assessed using the Stone-Geisser Q^2 statistic obtained through blindfolding with an omission distance of 7. Positive Q^2 values were interpreted as evidence that the model possessed predictive relevance for the corresponding endogenous construct. The Q^2 value obtained for financial decision-making style was 0.129, demonstrating meaningful out-of-sample-oriented predictive relevance within the conventional PLS-SEM framework. All statistical tests were evaluated using a two-tailed significance level of .05 unless otherwise specified. Taken together, the analytical strategy allowed simultaneous assessment of measurement quality, direct structural relationships, the indirect mechanism operating through cognitive biases, conditional differences associated with gender and educational level, explanatory effect sizes, and the predictive performance of the proposed model.

3. Findings and Results

The final analytical sample consisted of 321 senior managers and financial decision-makers who met all eligibility and data-quality criteria. Of the respondents, 211 (65.7%) were men and 110 (34.3%) were women. Participants

ranged in age from 27 to 62 years, with a mean age of 42.36 years ($SD = 7.84$). Regarding educational attainment, 61 participants (19.0%) held a bachelor's degree, 194 (60.4%) held a master's degree, and 66 (20.6%) held a doctoral or equivalent professional degree. For moderation analysis, educational level was subsequently classified into two analytically adequate groups consisting of participants with bachelor's or master's degrees ($n = 255$, 79.4%) and those with doctoral-level education ($n = 66$, 20.6%), while supplementary comparisons across the original three educational categories were also inspected descriptively. In terms of organizational position, 48 respondents (15.0%) were chief executive officers or founders, 45 (14.0%) were chief financial officers, 39 (12.1%) were board members, 54 (16.8%) were investment managers, 41 (12.8%) were risk managers, 36 (11.2%) were budget or financial planning managers, 27 (8.4%) were senior financial analysts, and 31 (9.7%) occupied other senior managerial positions with direct financial decision-making responsibilities. Mean professional experience was 15.72 years ($SD = 6.91$), while mean tenure in managerial or senior analytical positions was 9.46 years ($SD = 5.37$). The largest sectoral groups were banking and insurance (22.1%), information and communication technology and knowledge-based firms (18.4%), petrochemicals and basic metals (17.8%), automotive and manufacturing industries (15.3%), food and consumer industries (10.6%), and financial-market or investment institutions (15.9%). With respect to digital gaming exposure, 83.2% of participants reported having played digital games during adulthood, and 61.4% indicated at least occasional current gaming activity. Among current or recent players, the average self-reported playing time was 4.87 hours per week ($SD = 3.76$). Strategy, simulation, competitive, sports, management, puzzle, and multiplayer games were the most frequently reported categories. These demographic and professional characteristics indicated that the sample contained considerable variation in managerial background, education, sector, gaming experience, and decision-making responsibility, providing an appropriate basis for examining the proposed structural relationships.

Table 1. Descriptive Statistics and Correlations among the Main Study Constructs

Construct	Mean	SD	Skewness	Kurtosis	1	2	3	4	5	6	7
Challenge-oriented gaming	3.58	0.73	-0.42	-0.31	1						
Immediate-reward gaming	3.24	0.79	-0.18	-0.47	.46**	1					
Social-competition gaming	3.31	0.82	-0.26	-0.55	.51**	.43**	1				
Surface-progression gaming	3.39	0.76	-0.35	-0.28	.48**	.57**	.49**	1			
Cognitive biases	3.17	0.61	0.21	-0.19	.24**	.49**	.38**	.44**	1		
Analytical financial decision-making style	3.81	0.65	-0.61	0.34	.31**	-.16**	-.08	-.11*	-.36**	1	
Non-analytical financial decision-making style	2.93	0.68	0.29	-0.16	-.09	.38**	.29**	.34**	.57**	-.42**	1

Table 1 presents the descriptive characteristics and zero-order correlations of the principal constructs. Overall, managers reported the highest mean score for analytical financial decision-making ($M = 3.81$, $SD = 0.65$), suggesting that deliberate information processing and systematic evaluation of alternatives were relatively prevalent within the sample. Challenge-oriented gaming also showed a comparatively high mean ($M = 3.58$, $SD = 0.73$), whereas the overall cognitive-bias score was moderate ($M = 3.17$, $SD = 0.61$). Skewness values ranged from -0.61 to 0.29 and kurtosis values ranged from -0.55 to 0.34, indicating no substantial univariate distributional problems. The correlation pattern was broadly consistent with the conceptual model. Immediate-reward gaming was moderately and positively correlated with cognitive biases ($r = .49$, $p < .01$), as were surface-progression gaming ($r = .44$, $p < .01$) and social-competition gaming ($r = .38$, $p < .01$). Challenge-oriented gaming showed a weaker positive association with cognitive biases ($r = .24$, $p < .01$), while simultaneously displaying a positive relationship with analytical decision-making ($r = .31$, $p < .01$). Cognitive biases were negatively associated with analytical decision-making ($r =$

-.36, $p < .01$) and strongly positively associated with the combined tendency toward non-analytical styles ($r = .57$, $p < .01$). Immediate-reward gaming was negatively related to analytical decision-making ($r = -.16$, $p < .01$) and positively related to non-analytical decision-making ($r = .38$, $p < .01$). These preliminary associations suggested that different gaming characteristics could have divergent consequences: cognitively demanding challenge-oriented gaming appeared more closely associated with systematic decision-making, whereas reward-oriented, competitive, and progression-focused gaming patterns were more strongly related to cognitive biases and less deliberative financial decision tendencies.

Table 2. Measurement Model, Reliability, and Convergent and Discriminant Validity Indicators

Construct	Items Retained	Loading Range	Cronbach's α	Composite Reliability	AVE	Maximum HTMT
Challenge	4	.72-.84	.82	.88	.64	.71
Immediate Reward	4	.74-.87	.85	.90	.69	.78
Social Competition	4	.71-.85	.83	.89	.66	.74
Surface Progression	4	.73-.86	.84	.89	.67	.79
Loss Aversion	5	.70-.84	.86	.90	.64	.76
Anchoring	3	.76-.88	.81	.89	.73	.69
Confirmation Bias	5	.71-.86	.87	.91	.66	.81
Overconfidence	3	.77-.89	.83	.90	.75	.73
Halo Effect	3	.72-.85	.79	.87	.69	.77
Herding Behavior	3	.75-.88	.82	.89	.72	.80
Hastiness	2	.82-.89	.75	.85	.74	.67
Analytical Style	5	.73-.87	.87	.91	.67	.74
Intuitive Style	4	.71-.84	.82	.88	.64	.79
Dependent Style	3	.74-.86	.80	.88	.70	.75
Avoidant Style	4	.76-.88	.86	.91	.71	.82
Spontaneous Style	4	.73-.87	.84	.89	.67	.81

The measurement model demonstrated satisfactory psychometric performance across all dimensions. Standardized indicator loadings ranged from .70 to .89, with all retained items meeting or exceeding the commonly accepted minimum criterion of .70 or falling sufficiently close to it while contributing substantively to construct content. Cronbach's alpha coefficients ranged from .75 for hastiness to .87 for confirmation bias and analytical decision-making, whereas composite reliability coefficients ranged from .85 to .91. These findings indicated satisfactory internal consistency without evidence of problematic item redundancy. Average Variance Extracted values ranged from .64 to .75 and therefore exceeded the recommended .50 threshold for every construct, confirming convergent validity. Discriminant validity was also supported because the highest HTMT value observed for any construct was .82, remaining below the conservative criterion of .85. Examination of collinearity showed that all inner variance inflation factor values remained below 3.20, indicating that the estimated structural paths were unlikely to be materially distorted by problematic multicollinearity. Moreover, the common-method assessment conducted before structural testing showed that the first unrotated factor accounted for only 32.4% of total variance and that no indicator demonstrated a loading change greater than .20 after introducing the common method factor. Taken together, the reliability, convergent validity, discriminant validity, and common-method diagnostics confirmed that the measurement model was sufficiently robust for evaluating the hypothesized structural relationships.

Table 3. Structural Model Results for Direct and Indirect Relationships

Hypothesized Relationship	β	SE	t	p	95% CI	f ²	Result
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Challenge → Cognitive Biases	-.14	.052	2.69	.007	[-.239, -.038]	.025	Supported
Immediate Reward → Cognitive Biases	.31	.057	5.44	<.001	[.199, .419]	.112	Supported
Social Competition → Cognitive Biases	.19	.054	3.52	<.001	[.086, .296]	.046	Supported
Surface Progression → Cognitive Biases	.24	.056	4.29	<.001	[.132, .349]	.071	Supported
Challenge → Analytical Style	.28	.050	5.60	<.001	[.181, .376]	.098	Supported
Immediate Reward → Analytical Style	-.11	.048	2.29	.022	[-.205, -.017]	.018	Supported
Cognitive Biases → Analytical Style	-.39	.051	7.65	<.001	[-.488, -.289]	.191	Supported
Cognitive Biases → Intuitive Style	.33	.053	6.23	<.001	[.227, .433]	.132	Supported
Cognitive Biases → Dependent Style	.29	.055	5.27	<.001	[.183, .396]	.097	Supported
Cognitive Biases → Avoidant Style	.46	.049	9.39	<.001	[.365, .555]	.269	Supported
Cognitive Biases → Spontaneous Style	.42	.052	8.08	<.001	[.318, .521]	.224	Supported
Immediate Reward → Cognitive Biases → Analytical Style	-.121	.028	4.32	<.001	[-.180, -.071]	—	Significant mediation
Social Competition → Cognitive Biases → Analytical Style	-.074	.024	3.08	.002	[-.126, -.032]	—	Significant mediation
Surface Progression → Cognitive Biases → Analytical Style	-.094	.026	3.62	<.001	[-.148, -.048]	—	Significant mediation
Challenge → Cognitive Biases → Analytical Style	.055	.023	2.39	.017	[.015, .105]	—	Significant mediation

Table 3 shows that the proposed structural relationships were largely supported. Challenge-oriented gaming was negatively related to cognitive biases ($\beta = -.14$, $p = .007$), suggesting that stronger preference for cognitively demanding and problem-solving-oriented gaming environments was associated with lower susceptibility to systematic judgment distortions after controlling for the other gaming dimensions. In contrast, immediate-reward gaming had the strongest positive relationship with cognitive biases ($\beta = .31$, $p < .001$), followed by surface progression ($\beta = .24$, $p < .001$) and social competition ($\beta = .19$, $p < .001$). Thus, gaming characteristics centered on rapid reinforcement, visible advancement, and comparative performance were associated with greater cognitive-bias tendencies among managers. Challenge-oriented gaming also showed a positive direct association with analytical financial decision-making ($\beta = .28$, $p < .001$), whereas immediate-reward gaming had a smaller negative direct association with analytical style ($\beta = -.11$, $p = .022$). Cognitive biases emerged as an important proximal predictor of financial decision-making style. Greater cognitive bias was associated with lower analytical decision-making ($\beta = -.39$, $p < .001$) and higher intuitive ($\beta = .33$, $p < .001$), dependent ($\beta = .29$, $p < .001$), avoidant ($\beta = .46$, $p < .001$), and spontaneous decision-making tendencies ($\beta = .42$, $p < .001$). The strongest effect was observed for avoidant financial decision-making, followed by spontaneous decision-making, indicating that managers who were more susceptible to systematic cognitive distortions were particularly likely to postpone difficult financial choices or make them rapidly with limited deliberation. The f^2 values indicated that cognitive biases exerted medium effects on analytical, intuitive, avoidant, and spontaneous decision-making and a small-to-medium effect on dependent decision-making. The overall model explained 38.6% of the variance in cognitive biases, 41.8% of the variance in analytical decision-making, 29.7% in intuitive style, 24.2% in dependent style, 36.9% in avoidant style, and 34.1% in spontaneous style. The SRMR value of 0.062 indicated acceptable overall model fit, while the Q^2 value of 0.129 for financial decision-making style indicated meaningful predictive relevance.

The indirect-effect analysis further supported the mediating role of cognitive biases. Immediate-reward gaming demonstrated a significant negative indirect association with analytical decision-making through cognitive biases ($\beta = -.121$, 95% CI [-.180, -.071]), indicating that managers who were more oriented toward immediate gaming rewards tended to exhibit greater cognitive bias, which in turn was associated with less analytical financial decision-making. Similar significant negative indirect effects were observed for social competition ($\beta = -.074$, $p = .002$) and surface progression ($\beta = -.094$, $p < .001$). By contrast, challenge-oriented gaming produced a small but statistically significant positive indirect effect on analytical style through reduced cognitive bias ($\beta = .055$, $p = .017$).

Because the direct path from challenge to analytical style remained significant after inclusion of the mediator, cognitive bias represented partial complementary mediation for this relationship. The direct and indirect effects of immediate-reward gaming were both negative with respect to analytical style, likewise indicating complementary partial mediation. In practical terms, the results showed that digital gaming was not associated with managerial financial decision-making in a uniform direction. Rather, its relationship depended on the psychological reinforcement structure of the gaming experience, with cognitively challenging gaming associated with more systematic decision tendencies and reward-intensive, competitive, and progression-focused gaming associated with greater cognitive bias and less deliberative financial judgment.

Table 4. Multi-Group Analysis of the Moderating Effects of Gender and Educational Level

Structural Path	Group 1 β	Group 2 β	Difference	Permutation p	Moderation
Immediate Reward → Cognitive Biases: Men vs. Women	.36	.22	.14	.031	Significant
Social Competition → Cognitive Biases: Men vs. Women	.25	.10	.15	.024	Significant
Challenge → Analytical Style: Men vs. Women	.24	.35	-.11	.048	Significant
Cognitive Biases → Analytical Style: Men vs. Women	-.36	-.45	.09	.083	Not significant
Cognitive Biases → Spontaneous Style: Men vs. Women	.47	.32	.15	.019	Significant
Cognitive Biases → Avoidant Style: Men vs. Women	.43	.50	-.07	.176	Not significant
Immediate Reward → Cognitive Biases: Bachelor/Master vs. Doctoral	.35	.18	.17	.018	Significant
Surface Progression → Cognitive Biases: Bachelor/Master vs. Doctoral	.28	.11	.17	.021	Significant
Challenge → Analytical Style: Bachelor/Master vs. Doctoral	.24	.39	-.15	.016	Significant
Cognitive Biases → Analytical Style: Bachelor/Master vs. Doctoral	-.42	-.28	-.14	.037	Significant
Cognitive Biases → Avoidant Style: Bachelor/Master vs. Doctoral	.49	.31	.18	.012	Significant
Cognitive Biases → Intuitive Style: Bachelor/Master vs. Doctoral	.34	.29	.05	.294	Not significant

The multi-group results provided evidence that gender and educational level moderated selected relationships within the proposed model rather than exerting uniform moderation across all paths. The positive relationship between immediate-reward gaming and cognitive biases was significantly stronger among men ($\beta = .36$) than women ($\beta = .22$; $\Delta\beta = .14$, $p = .031$). Similarly, the association between social-competition gaming and cognitive biases was stronger among men ($\beta = .25$) than women ($\beta = .10$; $\Delta\beta = .15$, $p = .024$). Conversely, the positive association between challenge-oriented gaming and analytical financial decision-making was stronger among women ($\beta = .35$) than men ($\beta = .24$; $\Delta\beta = -.11$, $p = .048$). Gender also moderated the relationship between cognitive biases and spontaneous financial decision-making; the association was stronger for men ($\beta = .47$) than women ($\beta = .32$, $p = .019$). However, gender differences in the cognitive bias-to-analytical style and cognitive bias-to-avoidant style paths were not statistically significant, indicating that some consequences of cognitive bias were relatively stable across gender groups. Educational level also demonstrated meaningful moderating effects. Immediate-reward gaming had a stronger positive association with cognitive biases among managers with bachelor's or master's degrees ($\beta = .35$) than among managers with doctoral-level education ($\beta = .18$, $p = .018$), and an analogous pattern was observed for surface-progression gaming ($\beta = .28$ versus $.11$, $p = .021$). In contrast, the positive path from challenge-oriented gaming to analytical decision-making was stronger among doctoral-level participants ($\beta = .39$) than among those with bachelor's or master's degrees ($\beta = .24$, $p = .016$). Interestingly, the negative association

between cognitive biases and analytical decision-making was stronger among the bachelor's/master's group ($\beta = -.42$) than the doctoral group ($\beta = -.28$, $p = .037$), and the positive association between cognitive biases and avoidant decision-making was also significantly stronger in the lower-education grouping ($\beta = .49$ versus $.31$, $p = .012$). These results suggest that advanced education may partially attenuate the behavioral consequences of cognitive biases in financial decision-making, although it does not eliminate them entirely. Collectively, the MGA findings support the view that gender and educational attainment operate as contingent boundary conditions for selected gaming-bias and bias-decision relationships.

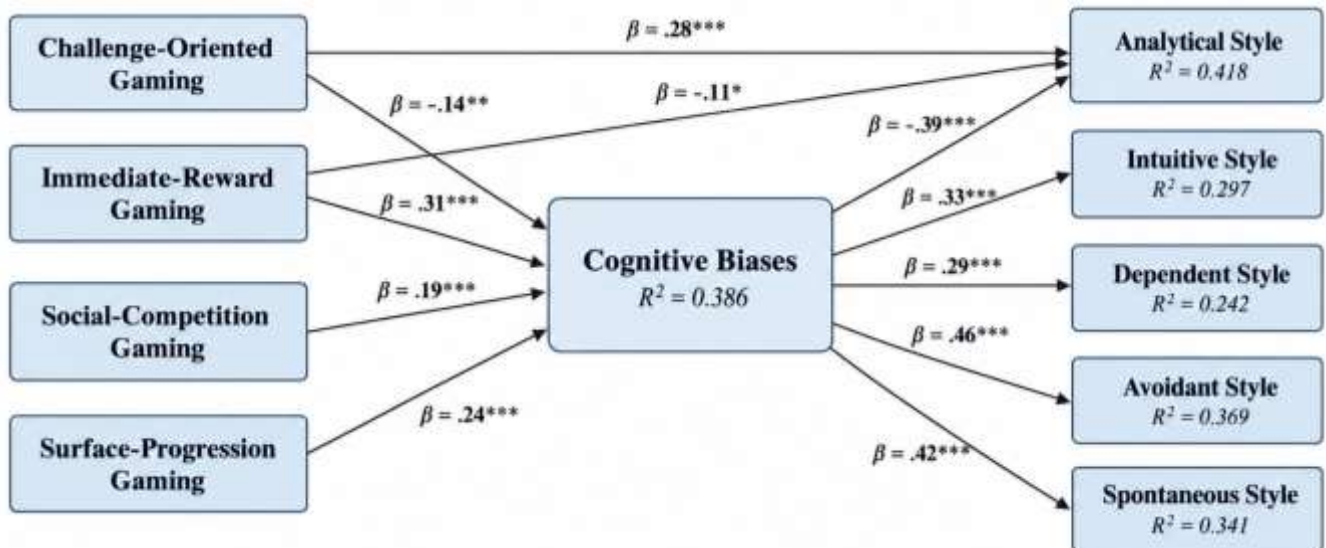


Figure 1. Structural Model of the Relationships among Digital Gaming Patterns, Cognitive Biases, Financial Decision-Making Styles, Gender, and Educational Level

Figure 1 summarizes the final structural model and illustrates the general pattern of relationships identified in the PLS-SEM analysis. The model shows that the four dimensions of digital gaming did not exert equivalent influences on managers' cognitive and financial decision processes. Challenge-oriented gaming was associated with reduced cognitive biases and increased analytical decision-making, whereas immediate reward, social competition, and surface progression were associated with increased cognitive-bias tendencies. Cognitive bias occupied a central mediating position in the model and transmitted a substantial proportion of the association between gaming characteristics and financial decision-making. Higher cognitive bias predicted reduced analytical decision-making and increased intuitive, dependent, avoidant, and spontaneous styles, with the strongest standardized relationships observed for avoidant and spontaneous decision-making. The figure also represents the statistically significant group differences identified through gender- and education-based multi-group analyses. In particular, reward- and competition-related gaming effects on cognitive bias were stronger among male managers, whereas the challenge-to-analytical-style relationship was stronger among female managers. Similarly, the adverse relationships associated with immediate reward, surface progression, and cognitive bias were generally more pronounced among managers with bachelor's or master's degrees than among those with doctoral education. The final model therefore supports a conditional indirect-effects interpretation in which gaming-related behavioral reinforcement patterns are associated with managers' financial decision-making partly through cognitive biases, while the magnitude of selected pathways varies according to gender and educational level. Overall, the findings support the proposed theoretical framework by demonstrating that the relevance of digital gaming to managerial financial judgment is multidimensional, psychologically mediated, and demographically contingent.

4. Discussion and Conclusion

The present study investigated the relationship between digital gaming patterns and managers' financial decision-making styles, with particular attention to the mediating role of cognitive biases and the moderating roles of gender and educational level. The findings indicate that digital gaming is not uniformly associated with financial decision-making in either a positive or negative direction. Rather, the effects depend on the specific psychological and motivational characteristics of the gaming experience. Challenge-oriented gaming was associated with lower cognitive bias and stronger analytical financial decision-making, whereas immediate-reward gaming, social competition, and surface progression were positively associated with cognitive biases. Cognitive biases, in turn, were negatively associated with analytical decision-making and positively associated with intuitive, dependent, avoidant, and spontaneous decision-making styles. The mediation analyses further demonstrated that cognitive biases significantly transmitted the effects of gaming patterns to financial decision-making, while the multi-group analysis showed that selected relationships differed according to gender and educational level. Taken together, these results support a conditional indirect-effect framework in which the behavioral structure of digital gaming influences managerial decision tendencies partly through cognitive processes and with varying strength across demographic groups.

The positive association between challenge-oriented gaming and analytical financial decision-making is consistent with research suggesting that interactive and game-based environments can enhance systematic reasoning, strategic thinking, and learning through repeated problem solving. Challenge-oriented games typically require players to process multiple cues, anticipate consequences, compare alternative strategies, tolerate temporary failure, and adjust behavior based on feedback. Such characteristics closely resemble many of the cognitive requirements of high-quality managerial financial decision-making. Previous research has shown that game-based learning can effectively facilitate the acquisition of economic and investment principles, particularly when learners are required to engage actively with trade-offs and consequences rather than passively receiving information [12]. Serious-game environments have similarly been proposed as tools for improving professional reasoning and reducing biased judgment through repeated exposure to complex decision scenarios [13]. The present findings extend this argument beyond formal training contexts by suggesting that habitual engagement with challenge-based digital gaming may be associated with a stronger preference for analytical processing in professional financial decisions.

The negative relationship between challenge-oriented gaming and cognitive biases also supports the possibility that some forms of gaming may strengthen metacognitive vigilance. Repeated exposure to cognitively demanding gaming environments may require players to update beliefs, abandon ineffective strategies, and distinguish reliable from unreliable cues. These processes may counter tendencies such as confirmation bias, anchoring, or excessive confidence. Prior evidence suggests that game-based training can reduce behavioral-finance biases when participants receive structured feedback and opportunities to recognize errors in judgment [14]. Research on debiasing likewise emphasizes that effective reduction of cognitive bias depends on creating conditions that make decision-makers aware of their reasoning processes and encourage deliberate reconsideration of initial judgments [28]. Although the present study did not experimentally manipulate game exposure, the negative association between challenge-oriented gaming and cognitive bias is theoretically compatible with the idea that repeated strategic feedback may reinforce reflective rather than heuristic processing.

In contrast, immediate-reward gaming emerged as the strongest gaming-related predictor of cognitive biases. Managers who reported stronger orientation toward rapid feedback and immediate rewards were more likely to exhibit biased cognitive tendencies and less likely to use an analytical financial decision-making style. This finding is consistent with the broader literature on gamification and digital choice architecture, which shows that reward structures can influence behavioral responses by directing attention toward immediate reinforcement. Research on gamified financial behavior indicates that behavioral traits interact with game-like reward systems in ways that can meaningfully affect financial conduct [15]. Similarly, experimental evidence from digital financial advising has demonstrated that game-like nudges can alter investment preferences and financial choices even when the underlying economic options remain unchanged [16]. The present findings therefore suggest that repeated exposure to immediate-reward structures may be associated with a stronger tendency to prioritize salient short-term outcomes, potentially increasing vulnerability to cognitive shortcuts in managerial financial contexts.

The positive effects of social competition and surface progression on cognitive biases can be interpreted through similar mechanisms. Competitive gaming frequently emphasizes rankings, relative performance, status signals, and comparisons with other players. These features may strengthen sensitivity to external cues and social proof, making decision-makers more vulnerable to herding, overconfidence, or comparative evaluation. Behavioral-finance research has long demonstrated that investor and managerial decisions are affected by heuristic and socially driven biases [2]. Sequential signaling environments, such as equity crowdfunding, likewise illustrate how the actions of others may shape subsequent financial choices, particularly when decision-makers use observed behavior as an informational signal [26]. The present findings imply that similar dynamics may emerge in gaming contexts, where repeated exposure to rankings and competitive comparisons could reinforce cognitive habits that later become relevant to professional decision-making.

Surface progression was also positively related to cognitive bias. This dimension reflects responsiveness to visible indicators such as points, levels, badges, ranks, or other markers of advancement. Such indicators provide simplified representations of progress and may encourage decision-makers to focus on salient metrics rather than underlying complexity. This interpretation is compatible with research on algorithmic information gatekeeping, which emphasizes that digital systems can shape decisions by selectively highlighting certain signals while suppressing others [17]. In financial settings, overreliance on visible indicators may encourage anchoring, halo effects, or excessive trust in easily interpretable performance measures. The expanding role of artificial intelligence and digital interfaces may intensify this tendency because technological systems increasingly mediate how information is organized and presented [18]. The observed association between surface progression and cognitive bias therefore suggests that simplified digital signals may have broader implications for how managers interpret financial information.

A central finding of the study was that cognitive bias significantly predicted multiple financial decision-making styles. Greater cognitive bias was associated with weaker analytical decision-making and stronger intuitive, dependent, avoidant, and spontaneous tendencies. This pattern is consistent with behavioral-finance research showing that cognitive heuristics influence investment management, risk interpretation, and market judgments [2]. It is also consistent with behavioral strategy research indicating that managers frequently rely on simplified reasoning processes when facing complex and uncertain decisions [5]. The strongest observed relationship was between cognitive bias and avoidant decision-making, followed by spontaneous decision-making. This suggests that biased cognition may not merely change the content of a financial judgment but may also influence whether managers delay decisions or act prematurely.

The strong relationship between cognitive bias and avoidant decision-making is particularly important in managerial contexts. Financial decisions often involve uncertainty, accountability, and potential losses, conditions under which loss aversion and risk perception can encourage postponement or avoidance. Research has demonstrated that managerial risk perception interacts with culture and individual behavioral tendencies to shape the costs of decision-making [7]. Similarly, evidence on managerial overconfidence and working-capital management shows that cognitive characteristics can influence how executives respond to uncertain and demanding financial environments [4]. Avoidance may therefore represent one behavioral manifestation of cognitive conflict, especially when managers perceive possible losses as more salient than equivalent gains.

The positive relationship between cognitive bias and spontaneous decision-making may reflect a different mechanism. Biases such as overconfidence, anchoring, and confirmation bias can reduce perceived need for additional information, thereby increasing the likelihood of rapid decisions. Research on managerial overconfidence has shown that excessive confidence can influence corporate financial policies and cash-holding decisions [3]. Motivated beliefs may also shape financial choices by allowing decision-makers to interpret uncertainty in ways that support preferred outcomes [8]. In this sense, spontaneous financial decision-making may partly arise when managers believe that their first impressions or prior beliefs are sufficiently reliable, even when objective uncertainty remains high.

The mediation results provide further support for the central role of cognitive bias. Immediate-reward gaming, social competition, and surface progression exerted significant negative indirect effects on analytical financial decision-making through increased cognitive bias, while challenge-oriented gaming had a positive indirect effect through reduced bias. These findings suggest that the relationship between gaming and decision-making is not simply behavioral but psychologically mediated. This distinction is important because it implies that digital gaming may influence managerial judgment by shaping habitual modes of information processing rather than directly determining financial behavior. The result is consistent with research showing that behavioral factors mediate the effects of financial knowledge and attitudes on economic outcomes [23]. It is also compatible with evidence that emotional and cognitive biases can influence financing and performance in entrepreneurial contexts [24]. The present study therefore contributes to the literature by identifying cognitive bias as a plausible psychological pathway through which digital gaming characteristics are associated with financial decision styles.

The findings also align with the growing literature on the behavioral implications of technology-mediated decision environments. Cognitive bias and trust have been shown to influence digital accounting decisions, indicating that technology use does not eliminate psychological distortions and may sometimes interact with them [19]. More broadly, the intersection of artificial intelligence and behavioral economics has become increasingly important because digital systems can shape the information, prompts, and recommendations available to decision-makers [20]. The current results suggest that digital games may represent another relevant component of this broader technological ecology. Managers increasingly engage with digital systems not only at work but also during leisure, and repeated exposure to particular interface structures, reward schedules, and competitive environments may contribute to stable cognitive habits.

The moderation results further revealed that gender influenced selected relationships. The positive effects of immediate reward and social competition on cognitive bias were stronger among men, whereas the positive relationship between challenge-oriented gaming and analytical decision-making was stronger among women. These findings are consistent with research showing gender differences in risk attitudes and financial behavior, although such differences are context-dependent rather than universal [31]. The stronger reward and competition

effects among men may reflect greater responsiveness to competitive or status-based gaming cues, whereas the stronger challenge-to-analysis relationship among women may indicate that cognitively demanding gaming experiences are particularly relevant when they reinforce deliberative problem solving. However, because gender did not moderate every path in the model, the results should not be interpreted as indicating broad or deterministic gender differences.

Educational level also moderated several structural relationships. Immediate reward and surface progression had stronger positive associations with cognitive bias among managers with bachelor's or master's degrees than among doctoral-level managers, while challenge-oriented gaming had a stronger positive relationship with analytical decision-making among doctoral-level participants. These findings are compatible with research emphasizing the importance of financial literacy and knowledge in improving financial decision processes [21]. Greater education may strengthen information evaluation, critical reflection, and tolerance for complex reasoning, thereby reducing reliance on salient reward or progression cues. Evidence that financial literacy can reduce maladaptive financial tendencies further supports this interpretation [22]. Nevertheless, advanced education did not eliminate cognitive bias, which is consistent with the broader behavioral-finance literature showing that expertise and knowledge reduce but do not fully remove heuristic distortions [1].

The results also have implications for contemporary managerial challenges involving sustainability and long-term strategic thinking. Behavioral biases have been shown to affect sustainable-investment decisions, including decisions involving environmental, social, and governance considerations [25]. Similarly, managerial myopia can undermine corporate financial sustainability and weaken the translation of strategic awareness into long-term organizational outcomes [32]. The present findings suggest that gaming-related reward structures may be relevant to these issues because immediate-reward orientation is inherently focused on short-term reinforcement, whereas challenge-oriented gaming may cultivate greater tolerance for delayed outcomes and complex problem solving. This distinction may be particularly important in financial decisions requiring managers to sacrifice short-term rewards in favor of long-term strategic value.

The broader implications of the study also extend to organizational learning and managerial development. Serious games and game-based environments are increasingly used to simulate complex decision situations and enhance professional learning [30]. Persuasive gaming research similarly demonstrates that carefully designed game contexts can shape attitudes and behavior [11]. The present findings indicate that organizations should distinguish between game mechanics that promote reflection and those that emphasize rapid reinforcement. This distinction is important because gamification itself is not inherently beneficial or harmful; its effects depend on design. Interactive systems that reward deliberation, scenario comparison, delayed outcomes, and learning from error may strengthen analytical decision processes, whereas systems dominated by immediate rewards, rankings, and superficial performance markers may unintentionally reinforce biased judgment.

The present findings are also consistent with the argument that economically relevant behavior can be modified through training and structured experience. Evidence from behavioral interventions suggests that repeated exposure to carefully designed learning environments can alter preferences and decision responses [29]. Similarly, debiasing frameworks emphasize that interventions are more likely to be effective when they target the cognitive mechanism underlying the error rather than merely providing more information [28]. This has direct relevance to managerial development: if cognitive bias mediates the relationship between gaming patterns and decision style, then interventions should focus on reflective feedback, metacognition, and bias recognition rather than simply discouraging gaming behavior.

The study should be interpreted in light of several limitations. First, the cross-sectional design does not permit definitive causal inference, and although the structural model was theoretically directional, reverse or reciprocal relationships remain possible. Managers who already prefer analytical decision-making may be more attracted to challenge-oriented games, while those who favor rapid decisions may prefer immediate-reward gaming environments. Second, all principal constructs were measured using self-report instruments, which may be affected by recall error, social desirability, or subjective interpretation despite the procedures used to evaluate common method bias. Third, the sample was obtained through purposive, snowball, and professional-network recruitment rather than probability sampling, which may limit generalizability to the full population of Iranian managers. Fourth, some educational subgroups were smaller than others, which may reduce the stability of multi-group estimates. Fifth, the study focused on selected gaming dimensions rather than specific game genres, game duration, platform characteristics, or actual behavioral telemetry. Finally, managers were drawn from several industries, and although this increased heterogeneity, sector-specific financial environments may have introduced unmeasured contextual variation.

Future research should employ longitudinal and experimental designs to clarify temporal order and causal mechanisms. Experimental studies could expose participants to controlled game environments emphasizing challenge, immediate reward, competition, or visible progression and then assess changes in financial judgment, risk perception, and bias. Longitudinal studies could determine whether prolonged gaming patterns predict changes in decision-making styles over time. Future studies should also incorporate behavioral measures, simulated investment tasks, real financial decisions, or digital game telemetry instead of relying solely on self-reports. Replication in other countries and institutional environments would help determine whether the observed relationships are culturally specific or more general. Additional moderators, including age, managerial experience, financial literacy, risk tolerance, personality, digital competence, and organizational culture, could be examined. It would also be valuable to distinguish specific cognitive biases rather than modeling them only as an aggregate construct and to test whether individual biases mediate different gaming-decision pathways. Finally, future studies could compare leisure gaming with intentionally designed serious games and investigate whether carefully structured game-based training can reduce managerial cognitive bias.

From a practical perspective, organizations should avoid treating digital gaming as a uniformly harmful or beneficial behavior and should instead focus on the specific decision structures embedded within gaming experiences. Management-development programs can incorporate serious games that emphasize delayed consequences, scenario analysis, strategic planning, uncertainty management, and explicit reflection on decision errors. Financial managers can also benefit from structured debiasing procedures such as decision checklists, independent review, pre-mortem analysis, delayed confirmation of high-stakes decisions, and explicit comparison of alternative assumptions. Organizations using gamified dashboards or performance systems should be cautious about excessive reliance on rankings, immediate rewards, badges, and simplified progression indicators, especially when these tools are linked to consequential financial choices. Training programs may also need to be tailored according to educational background and gender-related response patterns rather than assuming identical effects across all managers. More broadly, organizations should integrate cognitive-bias awareness into financial governance and decision-support systems so that digital tools reinforce deliberative judgment instead of unintentionally amplifying short-term, socially driven, or heuristic decision tendencies.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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