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Research Article

Examining the Relationship Between Innovative Product Design, Cognitive Ergonomics, and the Effectiveness of Entity Design-system: Focusing on the Environment of Big Data-driven Interface

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ABSTRACT

The evolution of design systems has undergone a transformative shift towards entity-based frameworks. These systems represent a paradigmatic departure from traditional design approaches by structuring design elements around modular, reusable components known as entities. This study examines the elements that affect entity-based design system effectiveness and its effects on computer-related sectors. The study examines how creative product design, cognitive ergonomics, and big data-driven interfaces affect system efficacy. The study also examines how information processing efficiency mediates and technology infrastructure moderates the relationship between design elements and system results. Data was collected from 254 Chinese design system specialists and practitioners using quantitative methods. Participants' design, technology, and system efficacy perceptions were assessed using a standardized questionnaire. AMOS was used for mediation and moderation analyses to evaluate study hypotheses and examine variable correlations. This study found strong correlations between design elements, technology capabilities, and entity-based design system efficacy. Innovative product design, cognitive ergonomics, and big data-driven interfaces had an impact on system results, both individually and together. Information processing efficiency was a key mediator, while technology infrastructure moderated system efficacy. This study adds to the literature by revealing the complex elements that affect entity-based design systems in computer-related sectors. The study improves our theoretical understanding of design systems by investigating the relationship between design factors, technology capabilities, and system results. It also offers practical advice for organizations looking to improve their design processes and user experiences.

Keywords: Entity-based Design Systems, Innovative Product Design, Cognitive Ergonomics, Big Data-driven Interfaces, Information Processing Efficiency.

INTRODUCTION

Entity-based design is widely used in computer systems and these methods organize design into modules, which is different from previous approaches. Entities combine function with elegant design to make workflows adaptable and scalability for operations (Li, 2020). Designers may build, maintain, and iterate systems by reusing design elements. This improves digital product and platform collaboration, standardization, and efficiency. Modularity, abstraction, and standardization help entity-based design solutions scale and standardize user experiences (Zhang, Liang, Sheng, & Shao, 2022). Entities allow designers to swiftly build and customize interfaces to meet changing design needs and maintain interaction design consistency. Design solutions and efficiency improve when designers, developers, and stakeholders reuse innovative product design concepts (Sufi, 2022). Digital business success, user engagement, and brand experiences depend on design. Design skills are needed for customer communication, operational management, and digital product and service innovation (Urbinati, Bogers, Chiesa, & Frattini, 2019). Well-designed interfaces, apps, and digital experiences boost user adoption, loyalty, business differentiation, process speed, and aesthetics. Flexible, intuitive design is needed for smart appliances, wearables, and mobile devices due to their rapid adoption (Fernandes, Sylla, Martins, & Gil, 2023). In this day of information overload and short attention spans, people want straightforward, efficient, and engaging experiences. Design enhances usability, accessibility, utility, boosting user pleasure, productivity, and loyalty.

Design systems have been researched for collaboration, uniformity, modularity, and usability. For design system scalability, adaptability, and maintainability, Pizzuti, Jin, Rossi, Marinelli, and Comodi (2024) advocate modular design. Designing solutions using reusable components enhances both the construction and management processes. This strategy improves digital product and platform system consistency and efficiency. Puglisi, Warzybok, Astolfi, and Kollmeier's (2021) study also shows that consistency increases brand perception and design system user engagement. Coherence and familiarity with consistent fonts, color palettes, and layout patterns aid user navigation and understanding. Interface design, navigation patterns, and information architecture have been studied in academic studies on usability (Ran Wang et al., 2023). UX testing demonstrates that intuitive interfaces, clear information hierarchy, and easy navigation boost user enjoyment and task performance. Communication, documentation, and cross-functional collaboration are also stressed in cooperative design systems (López-Faican & Jaen, 2020). Efficient collaboration tools enhance communication among stakeholders, developers, and designers, leading to iterative design modifications that reduce time-to-market. While design systems are more known, academic research on entity-based design system efficacy is lacking. Examining the concepts of cooperation, consistency, and modularization as discussed by Zuefle and Krause (2023). There is a scarcity of research that investigate the multitude of elements that influence the outcomes of a system. Previous research ignored design systems' holistic interactions with user behaviors and organizational settings, focusing on design principles or technical capabilities (Ogundipe, Sim, & Emmerton, 2023). In addition, early studies used theoretical frameworks instead of scientific findings. Researchers often use controlled lab settings or hypothetical scenarios to ignore the intricacies of design processes in real-world businesses. To evaluate entity-based design systems in a real-world context, empirical research must include design components, technology capabilities, and user behavior.

This study examines the factors that affect computing entity-based design system efficiency. Large statistics-pushed interfaces, creative product design, and cognitive ergonomics affect entity-based design performance. The look at carefully examines the system's core strategies of effectiveness. Research additionally examines how generation infrastructure influences device layout and outcomes and also tests how records processing efficacy mediates this affiliation. This examination's empirical research on laptop-associated companies offers sensible recommendations to enhance entity-primarily based layout structures. The research has main theoretical and sensible outcomes for design systems and computer organizations. This study complements the theoretical expertise of the way era, layout, and consumer behavior interact in entity-based design structures. This look examines how massive information, cognitive ergonomics, and innovative product layout interfaces have an effect on humans. Companies can use the initiative to assemble systems that emphasize client wishes, decorate efficiency, and inspire innovation. This boosts productivity and competitiveness within the ever-converting computing area.

LITERATURE REVIEW

Innovative Product Design and Effectiveness of Entity-based Design System

Innovative product design, intuitive interfaces, and user-centric methods can boost entity-based design system adoption. This research has shown the complex relationships between design attributes, design system efficacy, and consumer satisfaction. Innovative product design enhances entry-based design device usability and client happiness. M. Huang et al. (2020) found that incorporating transparent navigation and consumer-pleasant interfaces complements leisure and efficiency. Designing capabilities that expedite a person responsibilities can enhance the tool's ordinary efficiency. Studies show innovation boosts entity-ordinarily based layout systems' flexibility and extension. Balinado et al. (2021) argue that scalability is critical for effectively responding to converting purchaser expectancies and improvements in generation. Advanced modular and adaptable design techniques allow structures to extend seamlessly across many environments without compromising the disclosure of personal data. Artificial Intelligence (AI) and the Internet of Things (IoT) decorate layout systems through integrating creative product design. Product layout these days makes a speciality of aesthetics and patron delight. Zangara, Ponterio, Filice, and Passarelli (2022) studied how design innovation impacts consumer emotions and perceptions. Creative layout elements that make customers' experience correct and connect emotionally can improve entity-primarily based layout gadget engagement and adoption. Innovative product design can inhibit entity-based total layout. Evaluate user requirements, preferences, and technology constraints in order to develop cutting-edge functionalities (H. Huang et al., 2022). The rapid advancement of technology poses challenges in achieving platform and device compatibility. Prom Tep, Aljukhadar, Sénécal, and Dantas, (2022) advised iterative design and user involvement for these issues. Designers can improve and create new concepts using this strategy. Innovative product design complicates entity-based design systems' technological integration, usability, scalability, and user engagement. Experts can use innovative design concepts and methods to create design systems that meet consumers' needs, create positive feelings, and form lasting relationships.

H1: Innovative product design has a significant impact on the effectiveness of entity-based design system.

Cognitive Ergonomics and the Effectiveness of Entity-based Design System

Cognitive ergonomics improves user performance and well-being through human-computer interaction. Design system efficiency and user experience are greatly affected by it. Cognitive ergonomics influences problem-solving and decision-making in entity-based design systems (Zamudio et al., 2023). Stremersch, Van Hoye, and van Hooft (2021) discovered cognitive load management minimizes mental fatigue and increases decision accuracy. Design systems that alleviate cognitive strain increase decision-making. These solutions include clear navigation signals and enhanced info displays. Cognitive flexibility helps people adapt to new information settings and tasks, according to Spellman, Svei, Kaminsky, Manzano-Nieves, and Liston (2021). Users can navigate complex information and procedures more readily using cognitive flexibility in system design, enhancing performance and user satisfaction. User learning in entity-based design systems is affected by cognitive ergonomics. Cognitive affordances affect intuitive interactions when learning new design tools and interfaces, according to Boy (2023). Design a system that matches users' cognitive schemas and mental models to promote engagement and learning. This will reduce cognitive hurdles to system adoption. Gualtieri et al. (2023) propose cognitive feedback systems that can quickly reveal user behavior and judgments. Design system feedback loops that match users' cognitive processing skills also improve self-regulation and awareness. Interface design must include user diversity and inclusion to accommodate a wide range of cognitive abilities and information processes. Fernandes et al. (2023) suggest personalizing interfaces to cognitive demands and preferences using user-centered design. Real-time prediction and response to users' cognitive states is difficult due to cognitive processes' dynamic nature. AI-driven adaptive interfaces can detect users' cognitive burdens and attention levels to deliver individualized assistance, according to Z. Huang et al. (2023). In conclusion, cognitive ergonomics increases entity-based design system user competency, learnability, and decision-making. Cognitive ergonomics helps professionals create interfaces that increase user cognition and task performance to boost system effectiveness and user happiness.

H2: Cognitive ergonomics has a significant impact on the effectiveness of entity-based design system.

The Big Data-driven Interface and the Effectiveness of Entity-based Design System

Kamble, Belhadi, Gunasekaran, Ganapathy, and Verma (2021) discovered cognitive load management minimizes mental fatigue and increases decision accuracy. Design systems that alleviate cognitive strain increase decision-making. These solutions include clear navigation signals and enhanced info displays. Cognitive flexibility helps people adapt to new information settings and tasks, according to Cherukunnath and Singh (2022). Users can navigate complex information and procedures more readily using cognitive flexibility in system design, enhancing performance and user satisfaction. User learning in entity-based design systems is affected by cognitive ergonomics. Cognitive affordances affect intuitive interactions when learning new design tools and interfaces, according to Sun, Tsai, and Cheng (2023). Design solutions that match users' cognitive schemas and mental models to promote onboarding and learning. This reduces cognitive hurdles to system adoption. Amerstorfer and Freiin von Münster-Kistner (2021) propose cognitive feedback systems can quickly reveal user behavior and judgments. Design system feedback loops that match users' cognitive processing skills may improve self-regulation and awareness. Shoppers may feel confident and informed. Increased cognitive ergonomics in entity-based design systems is tough. Interface design must include user diversity and inclusion to accommodate a wide range of cognitive abilities and information-processing processes. Hunte, McCormick, Shah, Lau, and Jang (2021) suggest personalizing interfaces to cognitive demands and preferences using user-centered design. Real-time prediction and response to users' cognitive states is difficult due to cognitive processes' dynamic nature. According to Jamshidi et al. (2024), AI-driven adaptive interfaces can detect users' cognitive burdens and attention levels to deliver individualized assistance.

H3: Environment of a big data-driven interface has a significant impact on the effectiveness of an entity-based design system.

The Mediating Role of Information Processing Efficiency

Creative product design and system performance depend on information processing efficiency. Cognitive effort, speed, and accuracy determine information processing efficiency. Xie, Zhu, Liu, Zhou, and Huang's (2022) research has shown the complex relationship between design development, cognitive processes, and system results, showing the core mechanisms that affect user interactions and system performance. Information processing efficacy aids user comprehension and decision-making in entity-based design systems. Wunderlich and Gramann (2021) say basic navigation patterns and information hierarchies help consumers understand complicated information faster. Innovative product design decreases cognitive load and biases, boosting system performance and customer satisfaction. An, Luo, Zhang, Zhu, and Lu (2022) say cognitive ergonomics increases design system information processing. The design enhancements optimized user processes and engagements. Information processing impacts user productivity and work performance in entity-based design systems with creative product design and cognitive traits impact creative design user interactions. The researchers examined how design modifications influenced task performance. Effective user interfaces speed up job completion by improving information clarity, task relevance, and workflow optimization. Interactive design user motivation and engagement were studied by Lee (2022).

H4: Information processing efficiency mediates the relationship between innovative product design and the effectiveness of entity-based design system.

Cognitive ergonomics ideas like task relevance and information clarity boost cognition, argued by Yin, Zheng, Li, and Wang (2023). Cognitive ergonomics encourages decision-making and reduces cognitive strain to incorporate users in design systems. Cognitive flexibility to adapt to shifting information contexts and task demands is stressed by Salamah et al. (2022). Cognitive ergonomics improves complicated dataset and workflow management. Information processing efficiency improves user comprehension and decision-making. Cognitive ergonomics improves task performance and cognitive engagement, suggested by Shah et al. (2024). Cognitive ergonomics interfaces improve productivity with information hierarchies, easy navigation and system effectiveness improving. Tuzun (2020) emphasizes the importance of cognitive feedback systems in providing quick insights into user actions and judgments. Cognitive ergonomics increases information processing by raising user awareness and self-regulation in design systems.

H5: Information processing efficiency mediates the relationship between cognitive ergonomics and the effectiveness of entity-based design system.

Burggräf, Wagner, Koke, and Bamberg (2020) say information interfaces impair users' potential to access and analyze complex datasets. Design systems that adapt to records contexts and personal behaviors raise engagement, productivity, and consistency. Big information-driven interfaces have an effect on entity-based totally layout machine scalability and interoperability. Ruijie Wang et al. (2023) examine layout system huge statistics interface professionals and disadvantages and also preserving information consistency and compatibility is harassed. User-centered layout enables configuring interfaces to cognitive capabilities and choices, in line with Hub, Oehl, Hesse, and Seifert (2023). Adjustable interface design is needed considering the fact that cognitive processes are dynamic, in keeping with Subramanian, Canfield, and Shank (2024). These methods permit design systems to dynamically alter to users' cognitive desires and challenge situations to enhance data processing and device efficacy. Information processing reduces the effect of large information-pushed interfaces on entity-based layout machine users' productiveness. Du, Liu, Morente-Molinera, and Herrera-Viedma (2022) assert that they study the user cognitions associated with the layout of large data interfaces.

H6: Information processing efficiency mediates the relationship between the environment of a big data-driven interface and the effectiveness of an entity-based design system.

Moderating Role of Technology Infrastructure

As design systems become more complex and use advanced technologies and infrastructures, knowing how technology infrastructure quality and capabilities affect information processing and system effectiveness is critical. According to Anejionu et al. (2019), large-scale design systems require robust processing and storage. Design systems that manage vast volumes of data and complex computations need scalable cloud infrastructure, rapid computing, and cheap data storage. Xiao (2021) says network architecture aids design system collaboration. A reliable network architecture allows users to access data without latency or connectivity concerns, enhancing system efficiency. Information processing efficiency and technological infrastructure affect entity-based design system user productivity and work performance. Amadi and Wesangula (2023) evaluate design system information processing efficiency optimization pros and disadvantages. Modern computer and parallel processing architectures let interfaces immediately edit and simulate complex data, boosting decision-making and productivity. Dávila, Derchi, Oyon, and Schnegg (2023) examine the impact of technological infrastructure on interactive design and real-time collaboration. A powerful technical infrastructure with enough processing power and network bandwidth enables functions like design collaboration and enhancement to be possible live. Installing and maintaining a reliable infrastructure requires expensive technology, software, and labor. Wu et al. (2023) emphasize strategic planning and resource allocation for design system technological infrastructure development and extension. Changing technology and user needs require flexible infrastructure design and administration. Gao, Gu, Li, and Guo (2024) examine how cloud computing and virtualization might increase design system flexibility and also workload-based resource deployment optimizes infrastructure usage and expenses. Technical infrastructure limits information processing efficiency's influence on entity-based design systems' flexibility and creativity. Li (2020) studied design system scalability and technology and user demands adaption. Containerization and microservices architectures separate and arrange design system components, boosting adaptability and creativity (Gupta, Modgil, Wong, & Kar, 2023). Future technology infrastructure and data integration are underlined flexible and interoperable design encourages creativity and capacity in creating systems that integrate external data, APIs, and AI. Integrating entity-based design systems with information processing involves computing, network, and scalability.

H7: Technology infrastructure moderates the relationship between information processing efficiency and effectiveness of entity-based design system.

Thus, based on the above literature and discussion we developed the following conceptual framework (**Figure 1**).

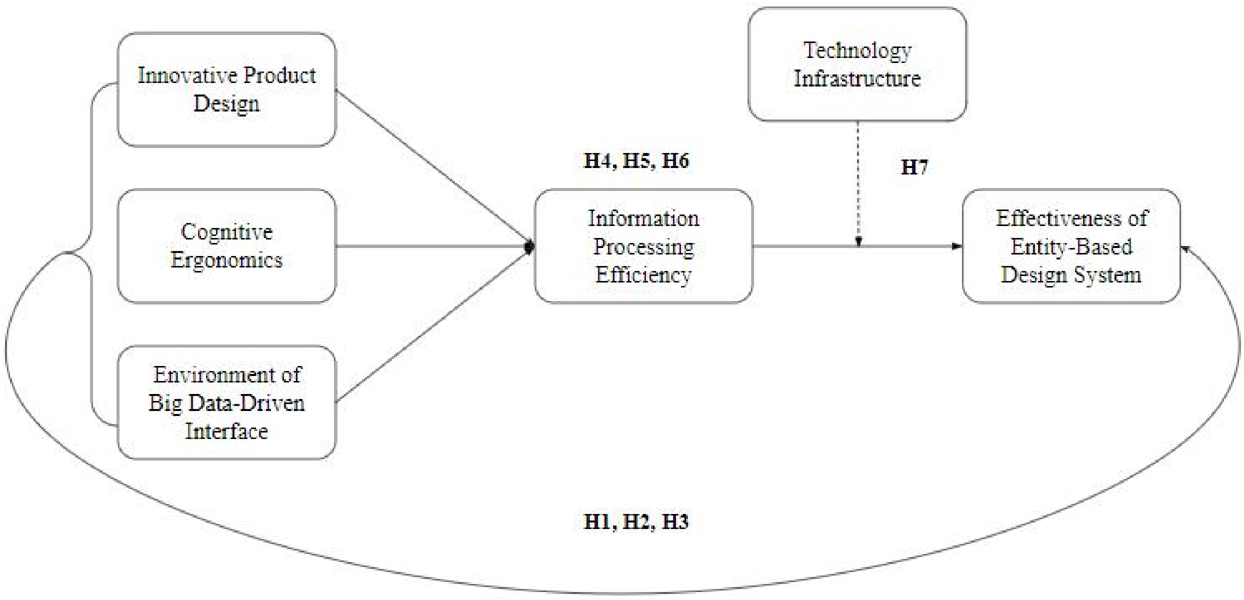

Figure 1. Conceptual Framework

METHODOLOGY

The study used a quantitative research design to collect and analyze numerical data. This method allowed us to study how technical infrastructure moderates the relationship between information processing efficiency and entity-based design system effectiveness. The approach permitted statistical testing on hypotheses. A quantitative method showed the complex relationship between design systems, information processing efficiency, and technology infrastructure. Data patterns, trends, and correlations helped researchers comprehend Chinese entity-based design system utilization.

Participants

The research participants were Chinese with entity-based design system knowledge. These people were chosen based on their active participation and expertise in design system initiatives across a variety of fields, including design, development, engineering, project management, and research. Given the research's focus on technological infrastructure, participants needed to be proficient in design systems technology. There was experience in infrastructure installation, maintenance, and enhancement. Recruiting participants through industry groups, technological infrastructure and design systems forums, and professional networks. Social media and email were used to invite participants. The study has strict inclusion criteria. Participants were expected to have a strong grasp of entity-based design systems. The technological parts of design systems, such as configuration, administration, and infrastructure establishment, were also required. Participants had to have a professional affiliation or residence in China to verify they were either in China or connected to Chinese organizations. This study includes perspectives from people with the requisite experience and understanding of technology infrastructure and design systems in the defined geographic area due to carefully designed inclusion criteria. The participants' diverse vocations and backgrounds supplemented the data, allowing a thorough understanding of the research topic.

Sample Size and Sampling Technique

The researchers calculated the statistical significance of sample size using a method for populations over 1,000. The analysis included confidence, effect magnitude, and response variability. By considering these features, the researchers ensured the sample size was high enough to identify significant correlations and effects. Chinese experts and practitioners who use entity-based design systems were surveyed. Distributing through industry groups and online forums on design systems and technological infrastructure was crucial. The research team sent study invitations via email and social media. This study used 254 completed and returned surveys from 500 distributed. The sample size was 500 questionnaires to offer statistical power and account for partial or non-responses. The study received 254 fully completed surveys, indicating a response rate of over 50% and considerable participant involvement. The sample size of 254 participants was deemed sufficient to provide statistically significant results and extend the findings to Chinese entity-based design systems practitioners and professionals. The sample's different origins and roles guaranteed that the results accurately reflected a wide range of perspectives and experiences on design systems and technological infrastructure efficacy. This study used random sampling, which ensures that every population member has an equal chance of being sampled. This method reduces bias and makes the sample representative of the population. A sample frame that contains the entire population must be created before random sampling. Professionals in China who work with entity-based design systems were sampled. Random sampling techniques were used to randomly select target population members after the sample frame was set. Random sampling reduced selection bias and increased study relevance by ensuring participation. The sample was randomly selected to represent the population of interest. This method yielded more dependable and valid research.

Data Collection Technique

A well-organized online questionnaire was provided to the sample group for data collection. To acquire numerical data, information processing, design systems, and technology infrastructure were extensively surveyed. The survey used a Likert scale and closed-ended questions to measure participants' opinions on research variables, attitudes, and experiences. Participants received clear questionnaire instructions and were ensured confidentiality and anonymity. Emailing and publishing the questionnaire on social media increased data collection nationwide. Participants got six months to finish the survey and the period allowed data collection spanning seasons and work cycles, eliminating temporal biases. The poll measured participant agreement or disagreement with research variable statements using a five-point Likert scale. From "Strongly Disagree" to "Strongly Agree," the scale let respondents express their opinions. This uniform procedure allowed quantifying participants' opinions and statistical analyses like mean comparisons, correlation analysis, and regression modeling easier.

Data Analysis

AMOS assessed structured questionnaire data. AMOS, a powerful structural equation modeling (SEM) software, is ideal for complex correlation studies. Researchers can test hypotheses, analyze direct and indirect effects, and evaluate model efficacy using SEM. AMOS was chosen for numerous reasons. AMOS also offers robust diagnostic tools and output to help scientists evaluate model fit and findings (Malek & Desai, 2022). The study examines how technological infrastructure influences design system effectiveness and information processing efficiency. AMOS assesses mediation and moderation effects. AMOS analyzed data on the Chinese design system, information processing efficiency, and technical infrastructure. The software lets researchers test difficult theoretical models and acquire empirical insights.

RESULTS

Table 1 shows the normality tests and skewness and kurtosis scores for each study variable. Skewness assesses distribution symmetry. Negative values indicate a left-skewed distribution with a left tail. Kurtosis measures a distribution's peak or flatness. Positive values indicate leptokurtic distributions with high peaks. Negative values suggest platykurtic distributions with low peaks. The skewness value of -1.209 and kurtosis value of 1.068 show a significant left-skewness and a minor peak in entity-based design systems' effectiveness distribution. The skewness and kurtosis values of -1.224 and 1.261 indicate a left-skewed distribution with a high peak for innovative product design. Information processing efficiency, technical infrastructure, cognitive ergonomics, and big data-driven interfaces have virtually symmetrical skewness ratings of -0.911 to -1.028. However, the kurtosis values range from 0.354 to 1.153, showing significant peaks. According to normality evaluation, empirical evidence demonstrates that variable distributions are symmetrical and moderate to high-peaked. The variables investigated in this study meet normality assumptions. This boosts trust in statistical analysis and interpretations.

Table 1. Normality Assessment

Variable	Skewness	Kurtosis
Effectiveness of Entity-based Design Systems	-1.209	1.068
Innovative Product Design	-1.224	1.261
Cognitive Ergonomics	-0.911	1.153
Big Data-Driven Interfaces	-0.915	0.363
Information Processing Efficiency	-0.911	0.354
Technology Infrastructure	-1.028	0.822

The outer loading analysis, which measures item-latent variable association, is shown in **Table 2**. The outer loading values show how much each item contributes to concept assessment. Entity-based design solutions have loading values between 0.676 and 0.813, indicating a strong link between elements and variables. EEDS1, EEDS3, and EEDS5 have the highest external loading values, suggesting they are important for measuring entity-based system effectiveness. All creative product design features have outer loading values from 0.746 to 0.828, indicating a high association with the underlying variable. IPD3 and IPD5 have the highest peripheral loading values, emphasizing their importance in evaluating creative product design. Cognitive ergonomics outer loading values range from 0.611 to 0.79, indicating a strong relationship between each item and the latent variable. All items evaluate cognitive ergonomics, however, CE3 and CE5 have higher loading ratings, suggesting they are better for digital interfaces. The outer loading values for big data-driven interfaces vary from 0.668 to 0.773, indicating a significant element-latent variable correlation. BDDI1 and BDDI3 have the highest loading values, making them important for big data interface evaluation. Maximum and minimum outer loading values of information processing efficiency are 0.653 and 0.779. This suggests a strong association between items and the variable. The highest external loading values for components IPE2 and IPE5 show their relevance in measuring design system information processing effectiveness. To conclude, technological infrastructure components have high external loading values from 0.937 to 0.978, showing a strong association with the underlying variable. These results illuminate the reliability and precision of the evaluation instruments and the value of each item in accurately reflecting the variables under inquiry.

Table 2. Outer Loading

Variable	Items	Outer Loading
Effectiveness of Entity-based Design Systems	EEDS1	0.813
	EEDS2	0.676
	EEDS3	0.813
	EEDS4	0.705
	EEDS5	0.744
	EEDS6	0.68
Innovative Product Design	IPD1	0.75
	IPD2	0.746
	IPD3	0.805
	IPD4	0.781
	IPD5	0.828

Variable	Items	Outer Loading
Cognitive Ergonomics	CE1	0.645
	CE2	0.749
	CE3	0.611
	CE4	0.629
	CE5	0.79
	CE6	0.657
Big Data-Driven Interfaces	BDDI1	0.773
	BDDI2	0.668
	BDDI3	0.748
	BDDI4	0.73
Information Processing Efficiency	IPE1	0.747
	IPE2	0.779
	IPE3	0.708
	IPE4	0.653
	IPE5	0.733
Technology Infrastructure	TI1	0.977
	TI2	0.969
	TI3	0.971
	TI4	0.937
	TI5	0.978

The measurement model's fitness index evaluation, which establishes its fit to observed data, is shown in **Table 3** and **Figure 2**. Fitness index is evaluated in three ways: absolute, incremental, and parsimonious. For absolute fit, the Root Mean Square Error (RMSEA) of 0.075 is below the threshold, indicating that the model fits the data well. For incremental fit, the Comparative Fit Index (CFI) score of 0.821 is satisfactory, suggesting that the model performs well compared to a baseline model. For parsimonious fit, the model's Chi-square to degrees of freedom (Chisq/df) ratio of 2.628 passes the criterion, indicating that it fits well. The fitness index evaluation reveals that the measurement model matches the data by effectively capturing the links between observable variables and latent constructs. These findings strengthen the structural model's future analyses and interpretations.

Table 3. Fitness Index Assessment for Measurement Model

Name of Category	Name of Index	Index Value	Comment
Absolute Fit	RMSEA	0.075	The required level is achieved
Incremental Fit	CFI	0.821	The required level is achieved
Parsimonious Fit	Chisq/df	2.628	The required level is achieved

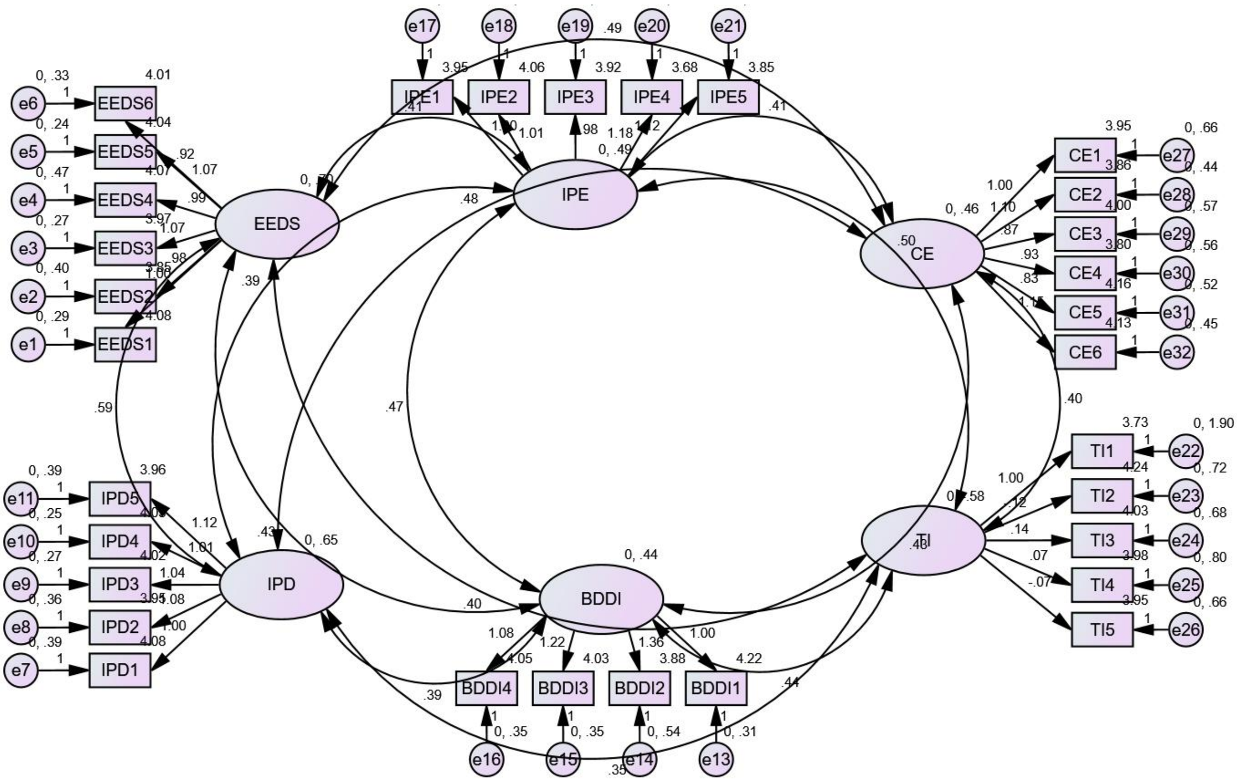

Figure 2. Measurement Model

Table 4 and **Figure 3** show the regression path coefficients for creative product design, cognitive ergonomics, big data-driven interfaces, and entity-based design system efficacy. Beta values are normalized coefficients that measure correlation magnitude and direction. Value significance is determined by T-values and p-values. With a beta value of 0.345, entity-based design techniques appear to be highly effective in creating distinctive product designs. This shows that entity-based design systems improve with product design originality. Its relevance is shown by the extremely low p-value of 0.0001 and the high t-value of 10.208. The beta coefficient of 0.162 shows that cognitive ergonomics improves entity-based design systems (EEDS). Cognitive ergonomics enhancements may improve entity-based design approaches. The t-value of 3.917 and p-value of 0.0001 support this link. The beta value of 0.182 (BDDI -> EEDS) shows a substantial positive correlation between entity-based design systems and big data-driven interfaces. This suggests that big data-driven interface enhancements boost entity-based design systems. The relationship is significant (p-value 0.001 and t-value 3.374). Regression path coefficients support the study assumptions and further explain computer design system efficacy. They demonstrate that creative product design, cognitive ergonomics, and big data-driven interfaces improve entity-based design systems.

Table 4. Regression Path Coefficients

Variable	Beta value	T value	P value	Decision
IPD -> EEDS	0.345	10.208	0.0001	Accepted
CE -> EEDS	0.162	3.917	0.0001	Accepted
BDDI -> EEDS	0.182	3.374	0.001	Accepted

Table 5 shows the study's indirect effects of big data-driven interfaces, cognitive ergonomics, and creative product design on entity-based design systems, using information processing efficiency as the mediating factor. The t-values and p-values define the statistical significance of indirect effects, whereas the standardized beta values indicate size and direction. The mediation route between information processing efficiency, innovative product design (IPD), entity-based design systems, and EEDS has a significant and positive indirect effect with a beta coefficient of 0.145. This shows that innovative product design improves information processing, which boosts entity-based design systems. The low p-value of 0.0001 and large t-value of 4.473 support this indirect influence. The mediation route between cognitive ergonomics, information processing efficiency, and EEDS (CE -> IPE -> EEDS) has a significant and positive indirect influence on entity-based design systems (beta = 0.183).

Cognitive ergonomics improve information processing efficiency, which boosts entity-based design system efficacy. The p-value of 0.0001 and t-value of 2.753 corroborate this indirect influence statistically. The beta value of 0.125 shows a positive indirect effect on the mediation path that links information processing efficiency and entity-based design system efficacy through big data-driven interfaces (BDDI -> IPE -> EEDS). Big data-driven interface improvements raise entity-based design system efficiency by processing information more efficiently. The indirect influence's statistical significance is supported by the t-value of 3.696 and p-value of 0.0001.

Table 5. Mediation Analysis

Variable	Beta value	T value	P value	Decision
IPD -> IPE -> EEDS	0.145	4.473	0.0001	Accepted
CE -> IPE -> EEDS	0.183	2.753	0.0001	Accepted
BDDI -> IPE -> EEDS	0.125	3.696	0.0001	Accepted

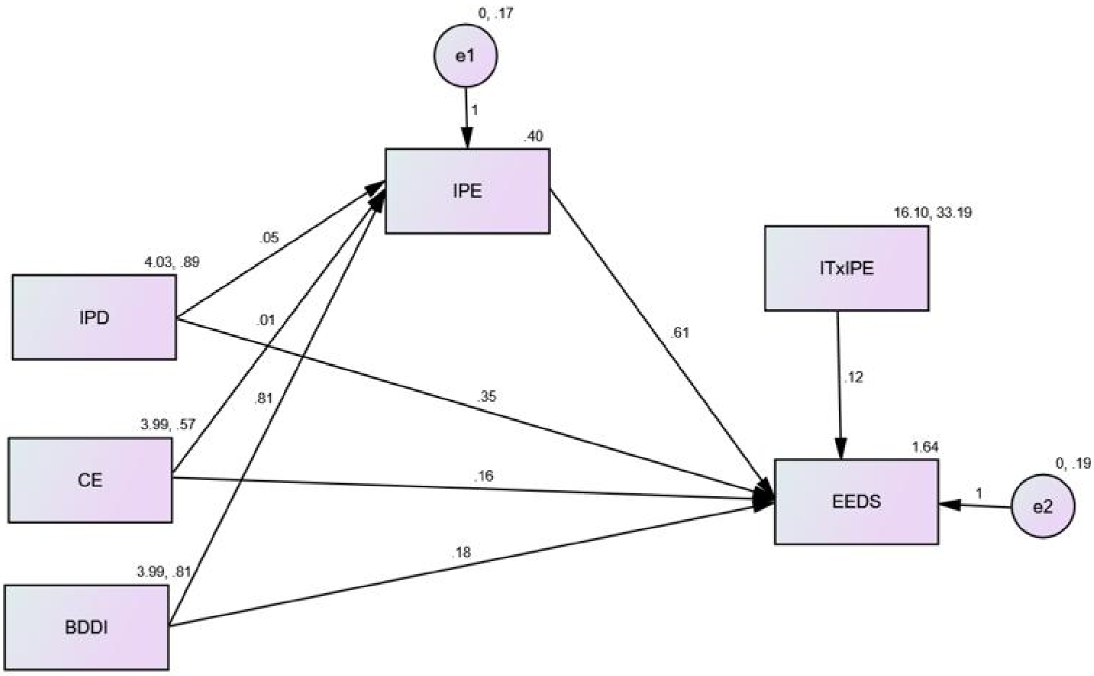

Figure 3. Structure Model

Table 6 shows the moderation findings on how technological infrastructure affects information processing efficiency and entity-based design system efficacy. The beta coefficient reflects the moderating effect's magnitude and direction. The t-value and p-value establish this influence's significance. The investigation discovered a beta value of 0.123, showing that technological infrastructure significantly improves the relationship between entity-based design system efficacy and information processing efficiency. Technological infrastructure boosts information processing efficiency and entity-based design system efficacy. The extremely low p-value of 0.0001 and the large t-value of 5.997 demonstrate the relevance of this moderating impact.

Table 6. Moderation Analysis

Variable	Beta value	T value	P value	Decision
TI x IPE -> EEDS	0.123	5.997	0.0001	Accepted

DISCUSSION

This study analyzes how Chinese technology infrastructure influences entity-based design systems and information processing efficiency in changing technologies. Technologies that combine, analyze, and display massive data sets allow academics to investigate minute patterns and connections, expanding possibilities. Data interface interaction improves user engagement and cooperation, as suggested by M. Huang et al. (2020). Interactive design methods boost communication and decision-making. Balinado et al. (2021) study finds that the restricted interfaces, user expectations, and task requirements balance information density and cognitive strain. Zangara et al. (2022) say user-centered design adapts interfaces to cognitive abilities and preferences. Since cognitive processes are dynamic, Prom Tep et al. (2022) recommend an adjustable interface design. These strategies let design systems dynamically adapt to users' cognitive ergonomics and task situations to improve information processing and system efficacy.

The findings support Hypothesis 2 that cognitive ergonomics improve entity-based design system performance. Cognitive ergonomics combines interface design and cognition to evaluate design system user experiences and outputs. Cognitive ergonomics enhances computer interface interactions, user performance, and enjoyment by addressing task relevance, information organization, and cognitive load. It promotes cognition and decision-making, improves system efficiency, and enhances user engagement in design systems. Key characteristics include information clarity and navigation simplicity, enhancing design system enjoyment and usefulness. Cognitive ergonomics supports system cognitive engineering's goal of imitating human cognition and boundaries. The study supports Hypothesis 3, stating that data-driven interfaces significantly impact entity-based design. Big data technologies improve design systems by understanding client behaviors and trends. Large data-driven interfaces change entity-based design systems, and innovative practitioners and professionals show that external data sources, visualization tools, and predictive analytics enhance system efficiency. Big data-driven interfaces assist users make refined design system decisions, improving design effectiveness and impact, the study found.

This study supports Hypothesis 4, Information processing efficiency mediates the relationship between innovative product design and the effectiveness of entity based design systems research shows that innovative design components improve information processing and system efficiency. According to Xie et al. (2022), digital user satisfaction and productivity depend on information processing efficiency—the speed and accuracy with which design system users collect and interpret information. Research confirms this that the importance of information processing efficiency in designing system user engagement and decision-making and well-designed interfaces on cognition and productivity. Research also shows that information processing efficiency influences creative product design and entity-based design system efficacy. Chinese design systems specialists used user-friendly interfaces and efficient techniques to measure design system satisfaction and utility in quantitative evaluation. The study found that information processing efficiency improves user cognition and task performance, helping entity-based design systems succeed. Wunderlich and Gramann (2021) say that the information processing interfaces allow firms to explore, appraise, and respond to design system information, underlining the importance of efficient information processing in improving design system outputs.

The study significantly supports Hypothesis 5, that cognitive ergonomics improves entity-based design system information processing. Cognitive ergonomics combines interface design and cognition to assess layout gadget user reviews and outputs. Cognitive ergonomics improves virtual person interactions and decision-making, in keeping with Yin et al. (2023). Tuzun (2020) that cognitive ergonomics boosts layout machine consumer involvement and collaboration. The study indicates that data processing overall performance strongly impacts cognitive ergonomics and entity-based design machine efficacy. Clarity and simplicity in cognitive ergonomics improve player pride and design solution application. Improved information processing improves entity-primarily based layout machine consumer cognition and assignment overall performance. Big information technology is converting design methods, giving data-pushed designers new possibilities and difficulties. The necessity of well-designed information collecting, processing, and display interfaces are stressed. Visualisation, predictive analytics, and outside facts integration beautify layout device usability. By providing well timed and applicable data insights, data processing performance improves entity-primarily based layout structures. The observation suggests that hardware, software programs, and networks affect gadget overall performance and user reviews through facts processing efficiency, affecting entity-primarily based layout. Wu et al. (2023) observed that powerful technology boosts virtual statistics processing and device performance. The technical infrastructure is necessary for records processing performance and device outputs, consistent with Xiao (2021). Technical investments enhance online patron delight for advanced infrastructure corporations. Technological infrastructure moderation enhances entity-based total design structures (Amadi & Wesangula, 2023). These attributes affect information processing efficiency, highlighting the need for entity-based design, information processing, and system performance infrastructure enhancements. Improved infrastructure functions that enable effective information processing boost design system user satisfaction and productivity, highlighting the value of technological advances (Zhou, Li, Ma, & Zhang, 2022).

CONCLUSION

Technical infrastructure, product innovation, cognitive ergonomics, a massive data-driven interface, and information processing efficiency affect entity-based design systems. The study explored computer-based design systems. A quantitative study studied Chinese designers and practitioners. Studying impacts theory, practice, and research. Innovative product design, cognitive ergonomics, and large-scale data-influenced interfaces benefit entity-based design systems. Cognitive ergonomics and new interface and system design can boost productivity and satisfaction. Technologies and large data interfaces enable data-driven design advancements. This study shows that information processing efficiency mediates system performance-design. Cognitive ergonomics, big data-efficient interfaces, and unique design affect design system users' results. Streamlining operations, improving interface design, and investing in advanced data processing can improve information processing. Technology infrastructure as a mediator requires effective information processing and system performance frameworks in design systems. Scalable computational resources, secure data storage, and fast networks enable efficient development, collaboration, and innovation.

IMPLICATIONS

Practical Implications

The study emphasizes cognitive ergonomics and innovative product design in computer entity-based design systems. To boost productivity and engagement, firms should invest in user preferences and cognitive ergonomic interfaces. Big data interfaces and technology enable data-driven decision-making and fast insights for design changes. Data visualization, predictive modeling, and advanced analytics enable organizations to understand consumer preferences and trends to make better design decisions. Designing systems requires efficient information processing, creative design, cognitive ergonomics, and big data interfaces to improve user experiences. Implementing data processing technologies, streamlining processes, and boosting data accessibility can boost information processing efficiency. The study emphasizes technology infrastructure's role in information processing and system effectiveness. Choosing technology, training people, and designing for system performance and user experience can improve entity-based design systems. User preferences are essential for designing and executing systems, improving results and satisfaction.

Theoretical Implications

Cognitive engineering improves human-machine interactions by means of matching system layout to human cognitive abilties and obstacles. Integrating large records interfaces and technology also leads to new theoretical studies on how information-pushed insights impact design decisions and device performance. The studies emphasize the significance of facts visualization, predictive analytics, and external records integration in design structures to better apprehend user behaviors, alternatives, and tendencies. This follows data-pushed layout ideas, which emphasize empirical proof-based design development and records-pushed layout selections. The studies additionally emphasize records processing performance's position in machine effectiveness and layout. This has a look at emphasizes the relevance of effective fact processing in person engagement and the challenge of completion in design structures, improving human-computer interplay and information processing expertise. These ideas goal to understand how people process and react to virtual information. In design systems, technology infrastructure facilitates information processing and system performance. Strong technological frameworks including rapid networks, flexible processing resources, and safe data storage are stressed in this study. It expands technology acceptability and infrastructure development understanding. These ideas examine how technical capabilities affect user behavior. The study's theoretical implications help us understand how entity-based design systems work in computer-related context.

LIMITATIONS

This research has certain drawbacks, despite its benefits. Quantitative research may have initially constrained comprehension of the phenomena being investigated. Quantitative methods offer statistical precision and application. They may overlook nuanced user perceptions and experiences in design systems. To better understand user opinions and behaviors, qualitative research methods like focus groups and interviews could be used. However, the research concentrated on Chinese design systems professionals and specialists, limiting its application to many organizational and cultural contexts. Cultural diversity and organizational constraints can affect the success of design systems. Thus, generalizing results to different groups requires caution. Additional research should use a cross-cultural approach to examine how technical advances, design components, cultural considerations, and organizational contexts affect system effectiveness. Because the study used self-reported data, response biases like recall bias and social desirability bias may have skewed the results. Experience with design systems, personal preferences, and the business environment may have influenced participants' responses. Future studies could use objective measurements or triangulation to reduce response biases. The cross-sectional approach also hinders causal connection and temporal change evaluation. Longitudinal studies allow researchers to analyze the evolution and interaction of design parameters, information processing efficiency, and system efficacy over time, improving their understanding. Researchers may also utilize experimental designs to evaluate interventions and identify cause-and-effect linkages. Sampling biases may remain despite careful sampling. The study used convenience sampling, which may have overrepresented certain demographic groups or organizational situations. Stratified sampling should be used in future studies to improve relevance.

FUTURE DIRECTIONS

This work suggests numerous strategies to improve the understanding and deployment of entry-based design systems. Future studies could assess design characteristics and technology progress using longitudinal study approaches. Researchers can study changes in design systems over time, evaluate design interventions, and identify what factors affect their development and adaptation using longitudinal studies. Future studies should evaluate findings from several data sources using mixed-methods approaches because quantitative research cannot capture complicated user experiences. Combining qualitative interviews or observations with quantitative surveys allows researchers to better understand user behaviors, attitudes, and preferences in design systems. Researchers can find hidden insights and assess system success elements by taking a holistic approach. Instead of just professionals and practitioners, future research might include end-users and stakeholders from numerous areas. Researchers can learn about user demands, preferences, and satisfaction with design systems from clients, consumers, and target audience members. Considering the perspectives of executives, managers, and IT specialists to gain an understanding of the organizational factors that affect the adoption and acceptability of design systems. Future research should also study how contextual factors like geography, industry, and culture affect design system efficacy of design systems. Cultural differences, industry restrictions, and organizational standards might unexpectedly affect design system decisions, usage, and outcomes. By addressing context, researchers can better understand how systems succeed in different environments. Future research may examine how blockchain, AI, and AR affect entity-based design systems. Examining how these technologies interact with design aspects and user behaviors can reveal future design systems.

CONFLICT OF INTEREST

No declaration required. Financing: No reporting required. Peer review: Double anonymous peer review.

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