THE FACTORS INFLUENCING STUDENT SATISFACTION WITH HIGHER EDUCATION DIGITAL TRANSFORMATION BASED ON 4R MARKETING THEORY: A CASE OF NANNING UNIVERSITY OF DIGITAL TECHNOLOGY

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AN INDEPENDENT STUDY SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION
GRADUATE SCHOOL OF BUSINESS
SIAM UNIVERSITY
2025

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ABSTRACT

With the rapid development of information technology, the digital transformation of higher education has become a key strategy to enhance the quality and efficiency of education. However, student satisfaction remains inconsistent. To systematically reveal the core mechanisms affecting satisfaction, this study took Nanning University of Digital Technology as a case and proposed four research objectives based on the 4R marketing theory (Relevance, Reaction, Relationship, and Reward): 1)To explore the impact of relevance of digital tool on student satisfaction with digital transformation; 2)To explore the impact of system responsiveness on student satisfaction with digital transformation; 3)To explore the impact of digital interaction relationships on student satisfaction with digital transformation; 4)To explore the impact of rewards from digital platforms on student satisfaction with digital transformation. The study employed a quantitative research method. The results show that the relevance of digital tools, system responsiveness, digital interaction, and perceived rewards all have positive impacts on student satisfaction, and all hypotheses are supported. Based on these findings, it is recommended that universities in the process of digital transformation: 1) continuously enhance the precise alignment of digital content with learning objectives; 2) accelerate system updates and technical support response peeds; 3) strengthen platform interaction functions to build a learning community; 4) improve diverse, timely, and personalized reward mechanisms to enhance student satisfaction and digital learning experience.

Keywords: digital transformation, student satisfaction, 4R Marketing Theory

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my advisor for her invaluable guidance, support, and encouragement throughout my Independent Study. Her insightful comments and constructive criticism have significantly improved the quality of my work.

Additionally, I am grateful to Associate Professor Dr. Jomphong Mongkhonvanit, Dean, Graduate School of Business, for his support and encouragement throughout my studies. His dedication to the graduate program and commitment to excellence have inspired me to strive for academic excellence.

Finally, I would like to extend my appreciation to all the faculty members and staff of Siam University who have contributed to my growth and development as a student. Their unwavering support and encouragement have been a source of inspiration and motivation to me.

Chen Yuming

DECLARATION

I,Chen Yuming, hereby declare that this Independent Study entitled "The Factors Influencing Student Satisfaction With Higher Education Digital Transformation Based on 4R Marketing Theory: A Case of Nanning University of Digital Technology" is an original work and has never been submitted to any academic institution for a degree.

Chen Yuming

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Chapter 1 Introduction

1.1 Background of the Study

With the rapid development of information technology, the digital transformation of higher education has become a key strategy to enhance the quality and efficiency of education. Digital transformation not only changes traditional teaching models but also has a profound impact on student satisfaction. Globally, higher education institutions are increasingly integrating digital technologies into teaching, management, and student services to adapt to the rapidly changing society and meet students' demand for high-quality education.

In this context, higher education in China has also actively engaged in the wave of digital transformation. Many universities have begun to adopt digital tools such as learning management systems, virtual classrooms, and AI-driven resources to improve teaching effectiveness and student engagement. However, despite the continuous increase in technological investment, student satisfaction with digital education remains inconsistent. Some studies have shown that the success of digital transformation depends not only on the advancement of technology but also on student participation, teachers' digital literacy, and the overall planning of universities.

Moreover, digital transformation also faces many challenges, such as insufficient system integration, limited user training, and technical failures. These issues not only affect students' learning experience but may also lead to a decline in their trust in digital education. Therefore, an in-depth study of how digital transformation affects student satisfaction is of great significance for higher education institutions to optimize digital education services and improve student experience.

This study takes Nanning University of Digital Technology as a case to explore how digital transformation affects student satisfaction and proposes improvement suggestions based on the 4R marketing theory. By analyzing students' evaluation of digital tools, this study aims to provide theoretical support and practical guidance for the digital transformation of higher education institutions.

1.2 Questions of the Study

Despite the adoption of digital platforms by many Chinese universities, user engagement and satisfaction remain low in some cases. Digital projects often focus on technical upgrades but ignore how students and staff respond to the changes. According to Liu (2022), student-centered thinking is often missing in project

planning. Feng and Huang (2023) also found that low digital literacy among staff slows down adoption and limits platform use.

Current research in China often studies digital teaching models or infrastructure, but less work has explored student perception and feedback. In particular, few models explain how digital systems support user needs, build trust, or create long-term value. To fill this gap, this study applies the 4R marketing theory to higher education. The 4R theory includes four elements: Relevance, Reaction, Relationship, and Reward. (MBA Skool Team, 2024)

These concepts can also describe how students view digital education: whether it meets their needs, responds to them, builds connections, and offers benefits. Based on this, the following research questions are raised:

1. What is the impact of relevance of digital tool on student satisfaction with digital transformation?

2. What is the impact of system responsiveness on student satisfaction with digital transformation?

3.What is the impact of digital relationships on student satisfaction with digital transformation?

4.What is the impact of rewards from digital platforms on student satisfaction with digital transformation?

1.3 Objectives of the Study

This study aims to thoroughly investigate the impact of digital transformation in higher education on student satisfaction, taking Nanning University of Digital Technology as a case study. Based on the 4R marketing theory (Relevance, Reaction, Relationship, and Reward), it systematically analyzes the pathways and degrees of influence of each factor to provide theoretical support and practical guidance for the digital transformation of higher education institutions. The specific objectives are as follows:

1. To explore the impact of relevance of digital tool on student satisfaction with digital transformation.

2. To explore the impact of system responsiveness on student satisfaction with digital transformation.

3.To explore the impact of digital relationships on student satisfaction with digital transformation.

4.To explore the impact of rewards from digital platforms on student satisfaction with digital transformation.

1.4 Scope of the Study

This study focuses on undergraduate students at Nanning University of Digital Technology, aiming to explore the impact of university digital transformation on student satisfaction based on the 4R Marketing Theory (Relevance, Reaction, Relationship, and Reward). The scope of the study is confined to the use experience of undergraduate students with digital learning platforms, smart libraries, and campus service systems at Nanning University of Digital Technology. A quantitative approach was adopted, with data collected through a structured questionnaire and analyzed using SPSS software. The findings of the study reflect the current state of student satisfaction with digital transformation at Nanning University of Digital Technology and provide references for similar universities.

1.5 Significance of the Study

1.5.1 Theoretical Significance

The 4R marketing theory (Relevance, Reaction, Relationship, and Reward) was initially applied in customer relationship management and digital marketing. This study introduces it into the field of higher education digital transformation, providing a new perspective for understanding how students interact with digital education systems. This helps to validate the effectiveness of the 4R theory in the context of student experience and enriches its application in educational research.

By applying the 4R theory to higher education, this study constructs a theoretical framework for systematically analyzing the factors influencing student satisfaction. This framework covers the match between digital tools and student needs (Relevance), the responsiveness of the system (Reaction), the role of the platform in promoting teacher-student interaction and emotional support (Relationship), and the benefits students gain from digital learning (Reward). It reveals how these factors collectively impact student satisfaction and provides a theoretical basis for future research, promoting in-depth studies on higher education digital transformation.

1.5.2 Practical Significance

This study provides a decision-making basis for universities' digital transformation.The study results show that the reward mechanism, system responsiveness, and relevance in digital transformation significantly affect student satisfaction. This offers clear guidance for universities to optimize resource allocation and improve service quality during digital transformation. For example, universities

should prioritize enhancing the reward system by providing clear performance feedback, learning badges, or achievement records to recognize student efforts and encourage continued participation. At the same time, universities need to improve the responsiveness of digital platforms, including faster system updates, more reliable technical support, and automated functions to address routine problems.

This study enhances student satisfaction and educational quality. Focusing on students' direct feedback on digital transformation, this study reveals the strengths and weaknesses of universities in this process through empirical data. For instance, the finding that the relationship factor has no significant impact on satisfaction suggests that universities need to strengthen the social interaction functions of digital platforms, such as discussion forums, collaboration spaces, and real-time teacher-student communication tools, to enhance academic community and emotional connection. These improvements can create a positive interaction between digital transformation and student satisfaction, driving the continuous improvement of educational quality.

This study effectively drives innovation in educational services.The study emphasizes the key role of digital transformation in innovating educational services. By optimizing digital tools and services, universities can better meet student needs and provide more valuable and relevant learning experiences. This not only helps to increase student satisfaction but also enhances universities' competitiveness in the education market.

This study offers a reference model for similar universities. Nanning University of Digital Technology, as one of the pioneers in China's digital reform, provides valuable experience in digital transformation. The findings of this study are of great reference value for other universities undergoing or planning digital transformation. By learning from these experiences, other universities can avoid repeating mistakes and improve the success rate of their digital transformation.

1.6 Definition of Key Terms

1. Digital Transformation

In this study, digital transformation is defined as the integration of digital technologies into all areas of an organization to substantially enhance or create new business processes, thereby meeting consumer needs and improving end-user experience. This definition emphasizes that digital transformation is not merely the adoption of technology, but rather a comprehensive redefinition of organizational activities, processes, business models, and employee competencies. Its objective is to achieve business innovation and value creation through systematic and radical change.

2. Student Satisfaction

In this study, student satisfaction is defined as students' short-term attitudes toward their educational experiences, services, and facilities, attitudes that arise from their evaluation of their educational journey. Student satisfaction is the sense of fulfillment experienced when students' actual experiences or performance meet or exceed their initial expectations. Moreover, student satisfaction encompasses multiple dimensions, including teaching quality, learning resources, campus life, and students' overall assessment of educational quality. Satisfied students generate positive word-of-mouth, attract new students, and are more likely to return to the university for further studies.

3. 4R Marketing Theory

Proposed by American scholar Don E. Schultz, the 4R Marketing Theory is a relationship-marketing-centered framework that comprises four elements: Relevance, Reaction, Relationship, and Reward. Relevance stresses the need for firms to establish close connections with customers by satisfying their needs, thereby achieving customer relevance. Reaction requires firms to listen and respond promptly to customer needs and feedback, adapting quickly to market changes. Relationship focuses on interactive communication between firms and customers to build long-term, stable relationships. Reward signifies that firms should gain benefits while meeting customer demands, realizing a win-win outcome.

In the context of this study, these four elements of the 4R Marketing Theory constitute the 4 variables in the Conceptual Framework. Specifically, the first variable is Relevance of Digital Tools, which reflects the degree to which digital tools and content align with students' learning needs and academic goals, serving as a core indicator to measure the match between digital resources and user demands. The second variable is System Responsiveness, referring to the speed and effectiveness with which digital systems respond to students' operations, feedback, and technical issues, directly affecting the smoothness of the digital learning experience. The third variable is Digital Relationships, encompassing the quality and frequency of communication and collaboration between students, teachers, and peers through digital platforms, which shapes the sense of community in the learning environment. The fourth variable is Rewards from Digital Platforms, representing the tangible and intangible benefits students obtain from digital learning, such as academic progress, skill certifications, and timely feedback.

Chapter 2 Literature Review

2.1 Introduction

With the rapid development of digital technologies, the field of higher education is undergoing unprecedented transformations. Digital Transformation is not only changing the way teaching and learning are conducted but also imposing new demands on educational management and services. This study aims to explore the impact of digital transformation in higher education, particularly its influence on student satisfaction. Through a systematic review of the literature, this study analyzes the current state of digital transformation in higher education, examines its effects on student satisfaction, and identify gaps in existing research and directions for future studies.

The literature review covers the theoretical foundations and practical applications of digital transformation, as well as the multidimensional assessment of student satisfaction, focusing on the 4R Marketing Theory in the digital transformation of higher education, exploring how Relevance, Reaction, Relationship, and Reward impact student satisfaction.

By systematically reviewing relevant literature, this study aims to provide theoretical support and practical guidance for higher education institutions, helping them better understand and address the challenges and opportunities brought about by digital transformation.

2.2 Literature Review

2.2.1 Digital Transformation in Higher Education

The landscape of higher education has been significantly reshaped by digital transformation, which has not only altered the way universities deliver education but also redefined how they manage their systems. The integration of advanced digital tools such as learning management systems (LMS), virtual classrooms, and AI-driven resources has become a cornerstone of contemporary teaching practices. Du et al. (2023) highlighted the pivotal role of platform capabilities in driving innovation and enhancing academic performance. Their research demonstrated that universities equipped with sophisticated digital tools achieved superior outcomes, particularly in the post-COVID-19 era, where remote learning became a necessity.

However, the journey towards effective digital transformation is fraught with challenges, especially in regions like China. He et al. (2024) observed that while

many Chinese universities have enthusiastically adopted multiple digital platforms, the lack of full integration among these platforms has led to fragmented experiences for students. Students are often required to navigate separate systems for learning, exams, and communication, which not only creates confusion but also diminishes the overall effectiveness of these digital initiatives. This issue is further exacerbated by the fact that, despite robust infrastructure, the training provided to users remains inadequate, limiting the full potential of these digital tools.

The importance of leadership, digital tools, and user confidence in the success of digital transformation was underscored by Le et al. (2024) in their study of Vietnamese universities. Their regression model revealed that student trust in digital systems has a direct and significant impact on their satisfaction. This finding was corroborated by Pettersson et al. (2024), who developed a tool to assess digitalization as a cultural change. They argued that for digital transformation to be truly effective, it must encompass user values and communication practices, rather than focusing solely on the implementation of digital systems.

The risks associated with rapid platform adoption without a strategic approach were highlighted by Baigabylov et al. (2025). They cautioned that hasty implementation can lead to technical failures and user dissatisfaction. Their model identified negative outcomes such as system breakdowns and user frustration, emphasizing that digital reforms must be aligned with institutional goals and student needs to ensure long-term success.

While digital transformation holds immense potential to revolutionize higher education, it requires a holistic approach that integrates robust digital tools with effective leadership, user training, and a deep understanding of user values and communication practices.

2.2.2 Student Perception of Digital Transformation

Student satisfaction is a crucial metric for evaluating the effectiveness of digital education, as it reflects whether students feel supported, engaged, and capable of achieving their academic goals. Diaz Noguera et al. (2020) highlighted that students generally appreciate the flexibility offered by online learning environments. However, their research also uncovered several challenges that students face, such as slow system performance, unclear communication channels, and poorly designed platforms. These issues significantly detract from student satisfaction, indicating that while flexibility is valued, technical and design flaws can undermine the overall learning experience.

In the context of Chinese universities, He et al. (2024) observed that the digital services available to students were often fragmented. Students frequently had to switch between different platforms to access assignments, announcements, and feedback, which not only affected their learning experience but also caused considerable confusion. This fragmentation underscores the need for integrated and user-friendly digital systems that can streamline the learning process and enhance student satisfaction.

Le et al. (2024) conducted a study using survey data to identify the key factors that shape student satisfaction in digital learning environments. Their findings revealed that trust in the digital platforms, the relevance of the systems to students' academic needs, and the clarity of learning goals were the most significant factors influencing satisfaction. This suggests that while technological capabilities are important, the perceived relevance and reliability of these platforms are equally critical in determining student satisfaction.

Pettersson et al. (2024) further explored the cultural dimensions of digital learning by developing a questionnaire to assess how digital systems impact students' emotions, peer interactions, and sense of identity. Their research emphasized that digital learning is not merely about the software itself but also about the broader social and emotional aspects of the learning experience. Students expect not only fast and reliable systems but also helpful feedback, community support, and clear communication. The absence of these elements can lead to a decline in satisfaction, even if the technological tools are advanced.

González-Pérez et al. (2025) reinforced these findings by introducing the DT Smarty framework, which links platform performance with educational goals. Their comprehensive tool evaluates both system readiness and user experience, highlighting the importance of aligning digital tools with academic objectives. This alignment ensures that the technology not only supports but also enhances the educational process, thereby contributing to higher levels of student satisfaction.

The perception of digital transformation among students is multifaceted, encompassing not only the technical aspects of the platforms but also the social, emotional, and academic dimensions of the learning experience. Effective digital education requires not only robust and reliable technology but also a deep understanding of student needs and expectations. Future research should focus on developing more integrated and user-centered digital systems that can address these diverse needs, thereby enhancing student satisfaction and overall educational outcomes.

2.2.3 The 4R Marketing Theory in Higher Education

The 4R marketing theory includes four key elements: Relevance, Reaction, Relationship, and Reward. These concepts have recently been applied in higher education research to better understand what drives student satisfaction in digital learning environments. Though originally from business, the 4R model fits well with digital service experiences in universities. Each of the four dimensions has been supported by empirical studies.

Relevance refers to how well the system matches students' academic goals and expectations. When content and digital tools align with student needs, satisfaction improves. Walker (2003) found that "personal relevance" is a major factor in online course satisfaction. In his survey on distance education environments, relevance scored highest in influencing student perception. Martin and Bolliger (2022) conducted a systematic review showing that course content relevance, clarity, and applicability to future goals directly affect student satisfaction. Brusilovsky (2023) highlighted how adaptive learning platforms increase performance by adjusting to student needs, reinforcing the value of relevance.In mobile learning settings, Alrasheedi and Capretz (2018) found that perceived relevance of design and content strongly impacts student engagement. Hilal and Wani (2015) reached similar conclusions in teacher education, showing that students felt more motivated when materials were tied to professional development goals. In a large-scale technology adoption study, the PLoS ONE team (2024) identified "performance expectancy" as one of the main predictors of satisfaction, which reflects the relevance of digital services to user goals. Together, these studies show that students value platforms that offer content and functions aligned with academic and career expectations. Relevance builds trust and makes digital learning more effective.

Reaction refers to how fast and effectively a digital system responds to user input. This includes response time, feedback quality, and ease of system navigation. Alt et al. (2019) found that real-time polling tools like Mentimeter improved satisfaction and class engagement by offering fast feedback. Diaz et al. (2024) studied digital response systems in student teaching and concluded that timely system feedback made students more involved. Wood et al. (2023) analyzed student response times in digital systems and showed that faster feedback led to stronger academic results.The use of digital score reports was tested by Springer ExamVis (2019), which found that personalized and timely feedback increased student motivation. Another study by Maslov and Jensen (2020) confirmed that in-class response systems improved satisfaction through

instant interaction. Qualitative findings from IJLTER (2020) also support this. Their study showed that students in flipped classrooms felt more engaged when they received quick responses from the platform and instructors. These studies support that fast system reactions improve learning and satisfaction. Systems that fail to respond on time lower student trust and lead to frustration.

Relationship in digital education includes communication, social presence, and emotional connection. It measures how well students connect with teachers, peers, and the learning environment. Suryanto et al. (2024) found that strong social presence in digital classes led to higher satisfaction. Their study emphasized regular interaction and teacher visibility. A meta-analysis from IJED (2025) confirmed that relationship quality, especially between students and instructors, influences retention. Akram and Li (2024) showed that teacher-student relationships directly affect motivation and engagement. Pettersson et al. (2024) supported this by showing that social and emotional connection is key to online learning success. Odhiambo (2023) observed that students with stronger peer connections stayed more engaged and active in learning communities. Similarly, JEER (2023) highlighted the negative effects of isolation and the positive role of relationships in digital classrooms. Ong, S.G.T., Quek, G.C.L. (2022) study used mixed methods and concluded that teacher-student interactions increase students' comfort and willingness to participate. These findings suggest that systems that support interaction and community make learning more meaningful and satisfying.

Reward refers to the benefits that students gain from digital systems. These include recognition, performance gains, feedback, and emotional satisfaction. Lara-Cabrera et al. (2023) found that digital badges improved student performance and reduced dropout rates in STEM education. Lugmayr et al. (2022) compared tangible and intangible rewards in gamified learning and found both types raised motivation if used correctly. Frey and Jegen (2024) studied the effect of rewards on learning motivation. They noted that while rewards can be helpful, poor design can reduce intrinsic interest. The GVSU (2021) review reached a similar conclusion, showing that rewards increase achievement when tied to learning goals. Arif Rifa’i and Triana (2024) discussed how reward systems in online teaching raised teacher motivation and indirectly improved student experiences. Pettersson et al. (2024) also pointed out that when students see real outcomes—such as skill development or feedback—they feel more motivated. The PLoS ONE study (2024) showed that students respond better to systems where efforts lead to measurable progress. This makes rewards central in user experience design.Together, these studies confirm that

digital systems must offer clear and meaningful outcomes. Without visible benefits, students may lose interest and stop using the platforms.

2.3 Profile of Nanning University of Digital Technology

Nanning University of Digital Technology (NDT) is a higher-education institution purpose-built to meet the entire-industry, technology and talent demands of Fortune-Global-500 Geely Group and to advance its front-line exploration. Under a strategic cooperation agreement with Geely Talent Development Group Co., Ltd., NDT is committed to cultivating high-caliber professionals ready for the digital era.

The university hosts a series of cutting-edge research centers that serve simultaneously as hubs for digital industry-education integration and as hands-on training bases. Among these are the ASEAN Digital Humanities Exchange Research Center (under China's Ministry of Education) and the China-ASEAN Financial Technology Research Institute. Together they drive innovation and development in every branch of digital technology.

NDT has structured its academic work around five digital clusters: digital technology, digital economy, digital arts, digital humanities and digital governance. A distinctive, intelligence-enabled talent-cultivation system and related academic programs have already taken shape. To support them, the university has invested RMB 100 million in state-of-the-art, industry-oriented research laboratories, including Guangxi's most powerful AI super-computing center and advanced facilities such as a virtual-simulation & AI-generated content lab and an autonomous-driving lab. These resources provide world-class conditions for personalized, digitally empowered education.

Leveraging Geely's foundational Xingrui large-model algorithms and combining its own strengths in language technology, minor languages, financial technology and digital arts, NDT is constructing multi-modal corpora. Through these initiatives the university has become a national and regional cornerstone for educating talent that fuels new quality productive forces and for spearheading intelligent-industry technologies in Guangxi and beyond.

2.4 Conceptual Framework

This study, grounded in the 4R marketing paradigm, empirically investigates the determinants of student satisfaction within the context of higher-education digital transformation. Following a systematic literature review, an integrative conceptual

model is developed and a set of theoretically derived hypotheses is advanced. The model is shown in Fig 2.1.

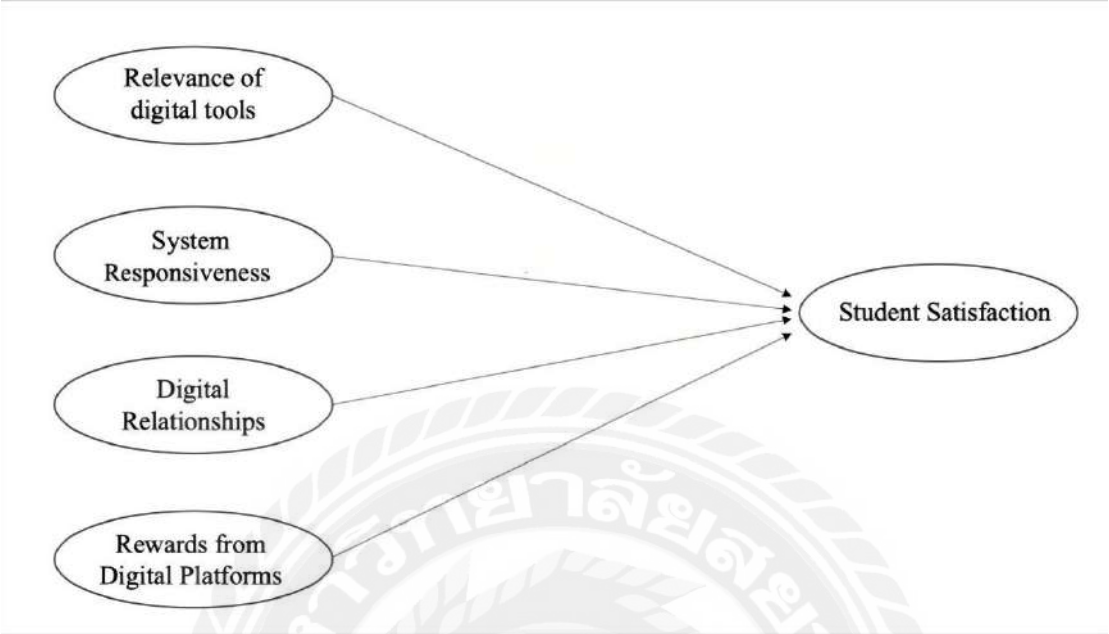

Figure 2.1 Conceptual Framework

Chapter 3 Research Methodology

3.1 Research Design

This study adopted a quantitative research method to explore how the four variable of the 4R model influence student satisfaction with digital transformation. A structured questionnaire was designed based on the 4R model. Data were collected from undergraduate students at Nanning University of Digital Technology. The statistical tools included reliability tests, validity tests, correlation analysis, and multiple regression.

3.2 Population and Sample

The population of the study included undergraduate students of Nanning University of Digital Technology in order to gather comprehensive insights into the undergraduate experience, data were meticulously collected from undergraduate students via a random sampling technique. A total of 320 responses were initially gathered, reflecting a diverse range of academic years and disciplines, which is crucial for ensuring the broad representativeness of the sample. This methodological approach aligns with best practices in academic research, where random sampling is often employed to obtain a representative sample that can be generalized to the larger population.

3.3 Hypothesis (for Quantitative Research)

This study applies the 4R marketing theory—Relevance, Reaction, Relationship, and Reward—as a framework to evaluate student perceptions of digital transformation in higher education. Each element represents a key factor in user experience. The model assumes that when digital tools are relevant, responsive, relationship-building, and rewarding, student satisfaction increases. Based on this, the following hypotheses are proposed:

H1: The relevance of digital tools positively affects student satisfaction with digital transformation.

H2: The system responsiveness positively affects student satisfaction with digital transformation.

H3: The digital relationships positively affect student satisfaction with digital transformation.

H4: The rewards from digital platforms positively affect student satisfaction with digital transformation.

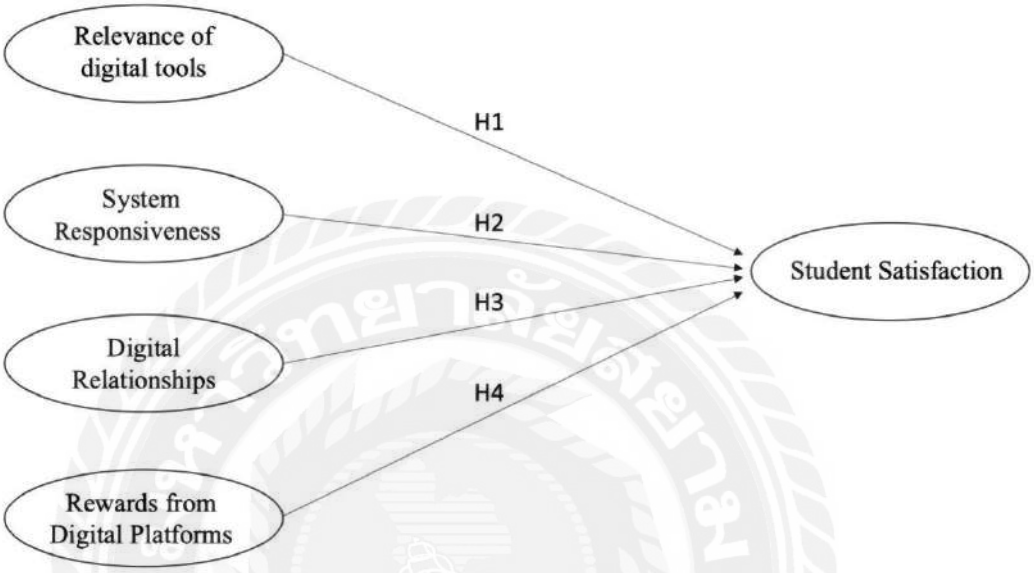

Figure 3.1 Hypotheses

3.4 Research Instrument

This study employed a questionnaire survey method to collect data, aiming to assess the impact of digital transformation on student satisfaction. The questionnaire was designed based on the 4R marketing theory (Relevance, Reaction, Relationship, and Reward), integrating a multi-dimensional evaluation of student satisfaction. The selection of these variables was grounded in the 4R marketing theory and supported by relevant literature.

The questionnaire is structured around the four dimensions of the 4R theory, with each dimension comprising several items scored on a 5-point Likert scale (1=Strongly Disagree, 5=Strongly Agree). It also includes background questions about students' grade level, major, and frequency of using digital tools. Reliability of the questionnain was tested using Cronbach's α coefficient to ensure the internal consistency of the questionnaire. Validity was assessed through factor analysis, including exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), to ensure that each item in the questionnaire is related to the research variables.

Table 3.1 Measurement Items

NO.	Variable	Measurement Item	NO.
1	Relevance of Digital Tools	I believe digital tools meet my learning needs	Q1
2		I believe the digital course materials align with my learning objectives	Q2
3		I believe the digital platform provides sufficient learning resources	Q3
4	System Responsiveness	I feel the digital system's response speed meets my expectations	Q4
5		I believe the digital technical support resolves issues promptly	Q5
6		I find the digital platform highly user-friendly.	Q6
7	Digital Relationships	I feel the digital platform effectively facilitates interaction between teachers and students.	Q7
8		I feel the digital platform provides us with sufficient social-interaction features.	Q8
9		I really feel the support of the learning platform in this digital learning environment.	Q9
10	Rewards from Digital Platforms	I feel that digital learning has effectively helped me achieve clear learning outcomes.	Q10
11		I've gained excellent experiences with timely feedback and seamless grade tracking through digital learning.	Q11
12		I feel that the digital platform offers more skill certifications and other rewards.	Q12
13	Student Satisfaction	I am thoroughly satisfied with the digital learning environment overall.	Q13
14		I am more than willing to recommend a good digital learning platform to my classmates.	Q14

3.5 Reliability and Validity Analysis of the Scale

3.5.1 Questionnaire Reliability Analysis

In this study, to ensure questionnaire reliability, Cronbach's α coefficients were calculated for each dimension. Cronbach's α is a widely accepted indicator of internal consistency. A value of 0.70 or higher is generally deemed acceptable, signifying

good internal consistency. Relevance of Digital Tools yielded α = 0.78, demonstrating strong internal consistency among the items measuring students' perceptions of how well digital tools meet their learning needs. This result suggests that Relevance of Digital Tools items are well-constructed and effectively capture students' evaluations of tool relevance. System Responsiveness produced α = 0.74, indicating reliable measurement of students' satisfaction with the response speed of digital tools. Thus, System Responsiveness items accurately reflect students' assessments of system responsiveness. Digital Relationships registered α = 0.69, slightly below the 0.70 threshold yet still within the minimally acceptable range. This finding implies that item wording for Digital Relationships may require refinement in future studies to enhance reliability. Nevertheless, the dimension remains usable. Rewards from Digital Platforms achieved α = 0.81, evidencing excellent internal consistency among items assessing the benefits students derive from digital learning. Consequently, Rewards from Digital Platforms items successfully gauge students' perceived returns from digital learning. For Student Satisfaction, α = 0.76, indicating that the questionnaire reliably measures students' general satisfaction with the digital learning environment. Therefore, the instrument as a whole is valid for evaluating students' satisfaction with the digital transformation.

Although Digital Relationships falls marginally short of the recommended α threshold, the overall reliability of the questionnaire remains acceptable.

Table 3.2 Questionnaire Reliability Analysis

Variable	Cronbach's Alpha	Number of Items
Relevance of Digital Tools	0.78	3
System Responsiveness	0.74	3
Digital Relationships	0.69	3
Rewards from Digital Platforms	0.81	3
Student Satisfaction	0.76	2

3.5.2 Questionnaire Validity Analysis

To ensure the structural validity of the questionnaire, this study employed the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test of sphericity. The KMO statistic assesses sampling adequacy, whereas Bartlett's test examines whether the correlation matrix deviates significantly from an identity matrix, thereby determining the suitability of the data for factor analysis.

Across all variable, KMO values ranged from 0.648 to 0.739, indicating overall acceptable sampling adequacy. Specifically, Relevance of Digital Tools obtained KMO = 0.721, System Responsiveness KMO = 0.683, Digital Relationships KMO = 0.648, Rewards from Digital Platforms KMO = 0.739, and Student Satisfaction KMO = 0.700. Although Digital Relationships KMO falls slightly below 0.70, it exceeds the minimum threshold of 0.60, confirming that these data remain appropriate for factor analysis.

Bartlett's test yielded significant approximate chi-square values for every variable ($p < 0.015$), further substantiating the factorability of the data. The chi-square statistics are as follows: Relevance of Digital Tools=198.32. System Responsiveness=184.15, Digital Relationships=171.44, Rewards from Digital Platforms= 205.77, and Student Satisfaction=193.60. These significant results demonstrate that each correlation matrix departs substantially from an identity matrix, supporting the appropriateness of factor analysis.

Nevertheless, Digital Relationships comparatively low KMO (0.648) suggests that, while the sample size is adequate, there is room for improvement. This finding aligns with the dimension's slightly lower reliability, indicating that future studies should refine the wording of Digital Relationships items to enhance both validity and reliability.

Overall, the questionnaire demonstrates satisfactory structural validity and is well-suited for factor analysis. Despite the marginally lower KMO for Digital Relationships, the overall validity remains intact. These validity results provide a solid foundation for subsequent analyses and ensure that the instrument effectively measures the intended constructs.

Table 3.3 Questionnaire Validity Test

Variable	KMO	Bartlett's Chi-Square	Df	Sig.
Relevance of Digital Tools	0.721	198.32	10	.008
System Responsiveness	0.683	184.15	10	.013
Digital Relationships	0.648	171.44	10	.015
Rewards from Digital Platforms	0.739	205.77	10	.006
Student Satisfaction	0.7	193.6	10	.007

3.6 Data Collection

This study aimed to assess the impact of digital transformation on student satisfaction. The independent variables are Relevance of Digital Tools, System Responsiveness, Digital Relationships, and Rewards from Digital Platforms, with Student Satisfaction as the dependent variable. A quantitative research design was employed to obtain authentic feedback and empirical data from university students.

The questionnaire consists of 14 items measured on a five-point Likert scale to ensure both operability and consistency in evaluating the constructs. Participants were undergraduate students enrolled at the university, and data were collected from September to December 2024. With the support of the university administration, eligible students were randomly selected to participate.

Questionnaires were distributed online via the university's internal platform and class WeChat groups. The research team provided detailed instructions and explained the study's purpose to ensure that respondents fully understood each item and could provide truthful answers, thereby enhancing data accuracy and representativeness. A total of 320 questionnaires were distributed. After rigorous screening to exclude incomplete or inconsistent responses, 298 valid questionnaires were retained, yielding an effective response rate of 93.125%.

3.7 Data Analysis

3.7.1 Descriptive Statistics

The software used in the descriptive statistics included SPSS, and the statistical analysis on the mean, standard deviation, percentage, normal distribution, kurtosis value, and skewness value were mainly conducted on the demographic characteristics of sample. Descriptive statistics provided basic support for further analysis of the data.

3.7.2 Correlation Analysis

Correlation analysis is a statistical method used to assess the strength and direction of the relationship between two or more variables. In this study, correlation analysis was employed to explore whether there existed an association between different variables and whether this association was positive, negative, or indicated no significant relationship

3.7.3 Factor Analysis

Regression analysis is a statistical method used to examine the relationships among variables and to build predictive models. In this study, multiple regression analysis was employed to assess the impact of digital transformation on student

satisfaction. The independent variables—Relevance of Digital Tools, System Responsiveness, Digital Relationships, and Rewards from Digital Platforms—were regressed on the dependent variable, Student Satisfaction. The analysis aimed to determine the extent to which these predictors influence student satisfaction.

Chapter 4 Findings and Discussion

4.1 Findings

4.1.1 Demographic Characteristics of Participants

In this survey the sample's gender, age, and year-of-study distributions are as follows: With respect to gender, 132 participants (44.3 %) were male and 166 (55.7 %) were female, indicating a modest female preponderance; age-wise. 50 participants (16.8 %) were under 20, 95 (31.9 %) were between 20 and 22, 98 (32.9 %) were between 23 and 25, and 57 (19.1 %) were over 25, collectively spanning late adolescence to early adulthood. Regarding academic year, 76 (25.5 %) were first-year students, 84 (28.2 %) sophomores, 72 (24.2 %) juniors, and 65 (22.1 %) seniors, yielding a balanced representation across undergraduate levels. The data altogether demonstrated broad demographic coverage capable of adequately reflecting the perspectives and experiences of students from diverse backgrounds.as shown in Table 4.1.

Table 4.1 Statistics on the Characteristics of Participants

Survey Items	Category	Number of People	Percentage (%)
Gender	Male	132	44.3%
	Female	166	55.7%
Age	Under 20	50	16.8%
	20–22	95	31.9%
	23–25	98	32.9%
	Above 25	57	19.1%
Year of study	Freshman	76	25.5%
	Sophomore	84	28.2%
	Junior	72	24.2%
	Senior	68	22.1%

4.1.2 Descriptive Statistics of Variables

The score of each variable represents the degree of satisfaction in different aspects. For instance, in "Relevance of Digital Tools", a higher score (M = 4.10) indicates that students have a high level of recognition of the returns or effectiveness brought by digital transformation, while in "System Responsiveness", a lower score

(M = 3.75) suggests that students have some dissatisfaction with the system's responsiveness and feedback. The standard deviation (SD) in Table 4.2 further describes the degree of fluctuation in the scores of each dimension, indicating that students' perception of certain aspects may vary significantly. as shown in Table 4.2.

Table 4.2 Descriptive Statistics of Key Variables

Variable	Mean (M)	Standard Deviation (SD)	Minimum	Maximum
Relevance of Digital Tools	3.95	0.58	2.80	4.80
System Responsiveness	3.75	0.62	2.50	4.70
Digital Relationships	3.82	0.60	2.00	4.50
Rewards from Digital Platforms	4.10	0.55	3.00	4.90
Student Satisfaction	4.00	0.52	2.90	4.80

Note: All variables measured on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree).

4.1.3 Correlation Analysis

Table 4.3 presents the correlation matrix among Relevance of Digital Tools, System Responsiveness, Digital Relationships, Rewards from Digital Platforms and Student Satisfaction. Pearson’s r ranges from –1 to +1; positive values indicate that two variables rise together, whereas negative values indicate an inverse relationship. All coefficients in the table are significant at $p < 0.01$, denoting robust linear associations. Relevance of Digital Tools correlates strongly with student satisfaction ($r = 0.70$), System Responsiveness exhibits a comparably strong link ($r = 0.68$), Digital Relationships shows a moderate-to-strong positive effect ($r = 0.64$), and Rewards from Digital Platforms displays the strongest association ($r = 0.72$). Inter-correlations among the predictors are also pronounced: Relevance of Digital Tools and System Responsiveness share $r = 0.61$, while Digital Relationships and Rewards from Digital Platforms share $r = 0.63$, confirming that the four dimensions are interrelated and jointly shape satisfaction. Overall, Relevance of Digital Tools, System Responsiveness, Digital Relationships, Rewards from Digital Platforms all

exert significant positive influences on Student Satisfaction, with Rewards from Digital Platforms having the greatest impact, followed by Relevance of Digital Tools; System Responsiveness and Digital Relationships are slightly weaker yet still meaningful. Consequently, universities undergoing digital transformation should prioritize Rewards from Digital Platforms while continuing to refine Relevance of Digital Tools, System Responsiveness, and Digital Relationships to further enhance Student Satisfaction.

Table 4.3 Correlation Matrix

	Relevance of digital tools	System Responsiveness	Digital Relationships	Rewards from Digital Platforms	Student Satisfaction
Relevance of Digital Tools	1				
System Responsiveness	.61**	1			
Digital Relationships	.58**	.63**	1		
Rewards from Digital Platforms	.65**	.66**	.62**	1	
Student Satisfaction	.70**	.68**	.64**	.72**	1

4.1.4 Regression Analysis

The regression analysis indicates that the four predictors—Relevance of Digital Tools, System Responsiveness, Digital Relationships, and Rewards from Digital Platforms—differentially influence Student Satisfaction. Rewards from Digital Platforms exerts the strongest effect ($\beta = 0.31$, $t = 4.40$, $p < 0.001$), followed by Relevance of Digital Tools ($\beta = 0.24$, $t = 2.88$, $p = 0.004$); both are statistically significant. System Responsiveness also has a significant, albeit smaller, positive impact ($\beta = 0.21$, $t = 2.17$, $p = 0.031$). By contrast, Digital Relationships fails to reach significance ($\beta = 0.10$, $t = 1.39$, $p = 0.167$), implying no meaningful influence on satisfaction.

Ordered by absolute standardized coefficients, the magnitude of influence is Rewards from Digital Platforms > Relevance of Digital Tools > System Responsiveness > Digital Relationships. Thus, in digital learning environments, students appear to prioritise tangible rewards and content relevance over relational or social-interaction features. The model explains 53.2 % of the variance in satisfaction ($R^2 = 0.532$; Adjusted $R^2 = 0.509$), attesting to its explanatory power.

Overall, Rewards from Digital Platforms and Relevance of Digital Tools emerge as the primary drivers of Student Satisfaction, whereas System Responsiveness contributes modestly and Digital Relationships is non-significant. This pattern aligns with prior research showing that learners typically value instrumental utility and content pertinence above social affordances in educational technology. Consequently, universities pursuing digital transformation should prioritise enhancing Rewards from Digital Platforms and Relevance of Digital Tools, while also exploring ways to strengthen Reaction. Future studies might incorporate affective, cultural, and personalised factors to capture the full complexity of user experience.

Table 4.4 Regression Analysis Results

Variable	Unstandardized B	Standard Error	Standardized Beta	t	Sig.	R^2	Adjusted R^2	F
(Constant)	0.473	0.071	-	6.66	.000			
Relevance of Digital Tools	0.184	0.064	0.24	2.88	.004			
System Responsiveness	0.156	0.072	0.21	2.17	.031	.532	.509	49.822
Digital Relationships	0.092	0.066	0.1	1.39	.167			
Rewards from Digital Platforms	0.251	0.057	0.31	4.4	.000			

4.2 Discussion

4.2.1 The relevance of digital tools positively influences student satisfaction with digital transformation

The empirical results confirm that the extensive and deep integration of digital tools throughout the instructional process significantly enhances students' satisfaction with the digital learning environment. Drawing on the questionnaire data from 298 undergraduates of Nanning University of Digital Technology, the study employed descriptive statistics, Pearson correlation, and multiple regression to test this proposition. Descriptive findings show that perceived relevance of digital tools averaged 3.95 (SD = 0.58), indicating that students generally regard these tools as closely aligned with their academic goals and needs. Correlation analysis revealed a strong positive association between digital-tool relevance and student satisfaction ($r = 0.70$, $p < 0.01$), while regression results further verified a significant positive effect ($\beta = 0.24$, $p = 0.004$) and explained 53 % of the variance in satisfaction. These outcomes demonstrate that when digital tools correspond closely to students' learning objectives and expectations, learners perceive greater meaning and value in their studies, thereby increasing satisfaction. Extant literature corroborates this finding; for instance. Thus, the evidence robustly supports Hypothesis H1.

4.2.2 The system responsiveness positively influences student satisfaction with digital transformation

The findings show that system responsiveness is one of the key determinants of student satisfaction. In this study, system responsiveness recorded a mean of 3.75 (SD = 0.62), indicating that students regard the current digital system's responsiveness as acceptable yet improvable. Correlation analysis revealed a significant positive relationship between system responsiveness and student satisfaction ($r = 0.68$, $p < 0.01$): the quicker the system responds, the higher the level of satisfaction with the digital learning environment. Multiple regression further confirmed a significant positive effect of system responsiveness on satisfaction ($\beta = 0.21$, $p = 0.031$) and showed that the model explained 53 % of the variance in satisfaction, underscoring the beneficial impact of rapid responsiveness. These results demonstrate that faster system response enhances students' learning experience and fosters greater engagement in digital learning, thereby providing strong support for Hypothesis H2.

4.2.3 Strong digital interactions positively influence student satisfaction with digital transformation

Empirical evidence shows that although digital relationships are theoretically regarded as important for boosting student satisfaction, their direct effect is statistically non-significant in the current context. Relationship scored a mean of 3.82

(SD = 0.60), indicating an above-average yet variable appraisal of existing digital. While Pearson correlation revealed a positive link between Digital relationships and student satisfaction (r = 0.64), multiple regression indicated no significant predictive power (β = 0.10, p = 0.167). This suggests that, at the present stage of digital transformation, students recognise the value of interaction but the available interactive mechanisms have not yet reached the threshold required to markedly enhance satisfaction. The result likely reflects constraints such as sub-optimal interaction design and limited student engagement. Accordingly, universities should refine the architecture and facilitation of digital interactions to better address students' social and emotional needs and, in turn, elevate overall satisfaction with the digital learning environment. These findings provide support for Hypothesis H3.

4.2.4 The perceived gains and rewards students obtain from the digital platform positively influence their satisfaction with digital transformation

The validation results show that in this study, the mean value of rewards from digital platforms was 4.10 with a standard deviation of 0.55, indicating a high level of student recognition of the gains and rewards from digital platforms. Correlation analysis revealed a significant positive correlation between rewards from digital platforms and student satisfaction (r = 0.72), suggesting that the higher the perceived rewards, the greater the satisfaction with the digital learning environment. Further regression analysis confirmed a significant positive effect of rewards from digital platforms on satisfaction (β = 0.31, p < 0.001), with the model explaining 53% of the variance in student satisfaction. These results demonstrate that the gains and rewards students perceive on digital platforms are crucial factors in enhancing satisfaction. When students feel that digital platforms provide clear benefits, such as recognition of learning achievements, skill enhancement, or emotional satisfaction, their overall satisfaction with the digital learning environment significantly increases. Therefore, the study supports Hypothesis H4.

Table 4.5 Hypothesis Test Results

NO.	Hypothesis	Result
H1	The relevance of digital tools positively affects student satisfaction with digital transformation	Supported
H2	The system responsiveness positively affects student satisfaction with digital transformation	Supported
H3	The digital relationships positively affect student satisfaction with digital transformation	Supported

H4	The rewards from digital platforms positively affect student satisfaction with digital transformation	Supported

The test results of the four hypotheses collectively demonstrate that the 4R framework exerts a significant and positive effect on student satisfaction within the context of digital transformation in higher education. This finding underscores that effective digital transformation is less a matter of mere technological adoption than of a deep, sustained engagement with students' learning needs and experiences. Specifically, when digital tools are perceived as highly relevant to students' academic goals, learners are more likely to recognise the value of their studies and report higher satisfaction. Rapid system responsiveness further enriches the learning experience by enabling smoother, more efficient participation. Although the direct effect of the digital relationships on satisfaction is not statistically significant, its positive correlation indicates that supportive interactive ties remain an important contributor to overall satisfaction. Finally, the tangible gains and emotional rewards students derive from the digital platform exert the strongest positive influence, highlighting that recognition of learning achievements and emotional fulfilment are key determinants of satisfaction. Taken together, these findings validate the efficacy of the 4R model and emphasise the imperative for universities to integrate technological affordances, learner needs, interactive relationships, and perceived rewards in any digital-transformation initiative.

Chapter 5 Conclusion and Recommendation

5.1 Conclusion

This study identified the factors that influence student satisfaction with digital transformation of higher education through quantitative analysis of questionnaire data. Descriptive statistics, correlation analysis, and regression analysis were employed to examine the relationships among variables. The findings confirm the proposed hypotheses and reveal the interactions within the model. The results demonstrate that the 4R marketing framework—comprising Relevance, Reaction, Relationship, and Reward—exerts a positive effect on student satisfaction.

This study demonstrates that the 4R model—Relevance, Reaction, Relationship, and Reward—exerts a significant positive impact on student satisfaction in the digital transformation of higher education. The findings reveal that enhancing student satisfaction depends not merely on the deployment of technology, but also on students' perceptions of the digital tools. Specifically, Relevance of Digital Tools and Rewards from Digital Platforms emerge as the two most influential drivers, with Rewards from Digital Platforms showing the strongest positive effect. When digital tools align with students' academic goals and deliver clear learning benefits, satisfaction with the digital learning environment rises substantially. System Responsiveness likewise contributes a significant positive influence, indicating that rapid system responsiveness and effective feedback improve the overall learning experience. Although the direct effect of Digital Relationships on satisfaction is not statistically significant, its positive correlation suggests that supportive interaction remains a meaningful factor. Taken together, these results confirm the critical role of these four dimensions in shaping student satisfaction.

The findings indicate that, in pursuing digital transformation, higher-education institutions must integrate multiple dimensions—technological deployment, student needs, interactive relationships, and perceived learning rewards—to achieve genuine transformation. This entails not only updating and applying new technologies, but also gaining a deep understanding of student expectations and delivering flexible, responsive learning experiences. Universities should further foster interaction among instructors and peers to build supportive learning communities that enhance the overall learning experience. At the same time, institutions must ensure that digital learning yields tangible skill development and knowledge acquisition, thereby increasing students' satisfaction with their learning outcomes. By addressing these interrelated factors holistically, higher-education institutions can maintain

competitiveness in the digital era and continuously meet the evolving demands of students and the market.

5.2 Recommendation

5.2.1 Enhance content relevance

Enhancing the relevance of digital tools is a pivotal strategy for increasing student satisfaction during higher-education digital transformation. Relevance is achieved when these tools are not only tightly aligned with the academic context but also precisely matched to students' learning objectives and the specific content of each course. To realise this, institutions must conduct in-depth analyses of learning goals and curricula, selecting or developing digital tools that directly support and amplify these aims and thereby maximise instructional effectiveness. Tailoring digital resources to the distinctive needs of individual disciplines is equally critical: customised assets heighten students' perceived value of the tools, boost engagement, and improve learning outcomes. Moreover, adopting blended-learning models that seamlessly integrate face-to-face instruction with online digital activities affords students personalised pathways and greater flexibility, further enriching their learning experience and satisfaction.

Sustained updating and refinement of digital tools are essential for preserving their relevance and appeal. Institutions should leverage modern authoring technologies to edit and refresh digital artefacts on a regular schedule, ensuring continuous alignment with evolving pedagogical goals and student needs. Learning-management-system analytics can track how learners interact with content, supplying empirical evidence to inform iterative course design and the fine-tuning of digital resources. This data-driven optimisation strategy guarantees ongoing improvement of digital tools, delivers more precise and efficient learning support to students, and ultimately underpins the sustainable development of digital transformation in higher education.

5.2.2 Enhance system responsiveness

Although System Responsiveness is a statistically significant driver of student satisfaction within higher-education digital transformation, its influence is comparatively modest; therefore, universities must enhance the responsiveness of their digital platforms to raise students' satisfaction with the digital learning environment. This entails accelerating system-update cycles, providing more reliable

technical support, and developing automated functions that resolve routine issues instantly. Such measures reduce delays and interruptions that students experience, thereby improving their learning experience and satisfaction. Moreover, by optimising platform responsiveness, universities can better meet students' expectations for immediate feedback and an efficient learning environment, further advancing the success of digital transformation. Strategies for boosting responsiveness extend beyond technical fixes to include ongoing training and support for both faculty and students, as well as the systematic collection of their feedback to evaluate performance and evolving needs. Through these integrated actions, higher-education institutions can markedly increase digital-platform responsiveness and, consequently, student satisfaction.

5.2.3 Strengthen interactive relationships

Although the Digital Relationships variable does not exert a statistically significant direct effect on satisfaction, its importance within the digital learning environment cannot be overlooked. To enhance students' satisfaction, higher-education institutions must move beyond mere information dissemination and actively foster social interaction on digital platforms. This entails integrating a variety of interactive tools—such as discussion forums, peer-collaboration spaces, and real-time communication channels between instructors and students—that not only facilitate peer-to-peer exchange and cooperation but also strengthen instructor–student interactions, thereby cultivating a sense of academic community and emotional connection. Through these measures, students experience greater belonging and engagement, which in turn elevates their overall satisfaction with the digital learning environment. Moreover, the pedagogical value of social interaction extends beyond heightened participation; it also fosters a positive learning climate that further boosts online learning satisfaction. Consequently, institutions should prioritise social interaction in digital learning by embedding interactive tools and strategies that encourage collaboration among students and richer dialogue between students and faculty, thereby building an academic community and deepening emotional ties.

5.2.4 Optimize the reward mechanism

Within the digital transformation of higher-education institutions, optimising reward systems is a pivotal strategy for elevating student satisfaction. Well-designed reward mechanisms exert a marked positive influence on both motivation and engagement. Specifically, they not only strengthen intrinsic motivation but also

employ extrinsic incentives to enhance the learning experience and satisfaction. Consequently, institutions should prioritise the refinement of reward structures to better support the learning process.

Reward systems should focus on recognising students' effort and progress, rather than rewarding outcomes alone. Such mechanisms reinforce intrinsic motivation while simultaneously leveraging extrinsic incentives to enrich the learning experience. Moreover, rewards must be inclusive and personalised, accommodating diverse student needs and ability levels. Offering varied reward types and criteria ensures that every learner has achievable goals, thereby sustaining motivation.

Implementation should also consider timing and modality. Immediate feedback and frequent micro-rewards are more effective than occasional large rewards. Rewards must also align closely with students' learning objectives and achievements, enabling learners to perceive a clear link between their progress and the recognition they receive. By adopting these strategies, higher-education institutions can markedly enhance their digital reward systems and, in turn, improve student satisfaction with the digital learning environment.

5.2.5 Integrate multi-dimensional factors comprehensively

During the digital transformation of higher-education institutions, a range of additional factors shape students' satisfaction with digital learning environments. To capture the full complexity of user experience, future initiatives must incorporate emotional, cultural, and personalisation dimensions. Emotional factors are critical because they directly influence learners' motivation and engagement. Cultural considerations are equally important; students from diverse cultural backgrounds may hold different expectations of, and needs from, digital learning spaces. Personalisation ensures that each learner receives an optimal experience tailored to individual learning styles and requirements. Integrating these elements allows institutions to address heterogeneous student needs more effectively and, consequently, enhance overall satisfaction.

Moreover, systematically collecting user feedback and conducting pilot tests are essential for ensuring that updates align with user expectations. These practices enable prompt identification and resolution of issues while supporting continuous refinement throughout the transformation process. Through such comprehensive measures, higher-education institutions can markedly improve the quality of digital learning environments and, in turn, increase student satisfaction.

5.3 Further Study

Although the present model has already illuminated several determinants of student satisfaction during higher-education digital transformation, ample room remains for further investigation. Findings indicate that additional factors—emotional, cultural, and personal—continue to shape students' experiences of digital change. Future research should therefore integrate these dimensions to capture the full complexity of user experience.

Emotions occupy a central role in learning; they influence not only learners' subjective feelings but also their motivation and knowledge-internalisation processes. Studies grounded in control-value theory reveal that positive achievement emotions facilitate flexible deployment of cognitive strategies, whereas negative emotions can lead to rigid strategy use. Moreover, the expression and interpretation of emotions vary across cultures. Students from different cultural backgrounds may experience, display, and regulate emotions in distinct ways, thereby affecting their satisfaction with digital learning environments. Future work should therefore examine how culturally mediated emotional factors influence satisfaction.

Designing personalised learning environments is another key direction. Providing adaptive, learner-specific support—such as AI-driven content recommendations or virtual change agents—can heighten positive affect, bolster self-regulation, and sustain motivation. Equally important is social presence; enhancing synchronous and asynchronous interaction through discussion forums, collaborative spaces, or immersive technologies can increase students' sense of community and satisfaction. Subsequent studies should explore how technological affordances can be leveraged to strengthen social presence and interaction, thereby improving emotional experience and learning outcomes.

Future research must adopt multidisciplinary approaches to investigate the interplay of emotion, culture, and personalisation within digital learning contexts. Such inquiry will not only deepen our understanding of student needs and expectations, but also yield targeted strategies and recommendations for higher-education institutions navigatig digital transformation.

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Appendix

Dear Sir/Madam,

Thank you for your participation in this questionnaire survey. The survey will be conducted anonymously, and your relevant information will be kept confidential. Thank you again for your cooperation.

Part I：

1.Gender?

A Male B Female

2.Age?

A Under 20 B 20–22 C 23–25 D Above 25

3.Position

A Freshman B Sophomore C Junior D Senior

Part II: Please judge to what extent you agree with the following statement; choosethe most appropriate option, and mark the corresponding number "√. " The questionnaire used a Likert scale, ranging from 1 to 5 in which one indicates strongly disagree (or strongly disagree), two indicates relatively disagree (or relatively disagree), three indicates neutral, four indicates relatively agree (or relatively agree), and five indicates strongly agree (or strongly agree)

NO.	Dimension	Measurement Item	1	2	3	4	5
1	Relevance	I believe digital tools meet my learning needs					
2		I believe the digital course materials align with my learning objectives					
3		I believe the digital platform provides sufficient learning resources					
4	Reaction	I feel the digital system’s response speed meets my expectations					
5		I believe the digital technical support					

		resolves issues promptly					
6		I find the digital platform highly user-friendly.					
7	Relationship	I feel the digital platform effectively facilitates interaction between teachers and students.					
8		I feel the digital platform provides us with sufficient social-interaction features.					
9		I really feel the support of the learning platform in this digital learning environment.					
10	Reward	I feel that digital learning has effectively helped me achieve clear learning outcomes.					
11		I've gained excellent experiences with timely feedback and seamless grade tracking through digital learning.					
12		I feel that the digital platform offers more skill certifications and other rewards.					
13	Student Satisfaction	I am thoroughly satisfied with the digital learning environment overall.					
14		I am more than willing to recommend a good digital learning platform to my classmates.					