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INVESTIGATING THE DETERMINANTS OF ONLINE LEARNING SUCCESS AMONG COLLEGE STUDENTS

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Abstract - *To prevent the rapid transmission of the viruses among students and staff during the COVID-19 epidemic, on campus classes have been cancelled at colleges and institutions throughout the world. Due to this unexpected disruption in face-to-face learning, pedagogical methods were changed, and colleges quickly accepted online instruction. Both university lecturers and professors as well as university students were impacted by the advent of online learning. The student's performance is what determines how well online learning works. Students' performance is affected by the course material, how a teacher teaches them, and a variety of other factors. So, the study's focus is to investigate the effect of numerous elements e.g. instructor-student interaction, peer interaction, social media use, family support, and technical support on College students' engagement and performance. The population of this study consist of undergraduate and postgraduate students. Data were collected from 320 under-graduate students who belong to the Zone 1 Engineering Colleges. Data were analyzed using LISREL after conducting validity, reliability, exploratory, and confirmatory factor analysis. Our findings show that Instructor-Student Interaction, Use of social media, Family as well as Technical support have a positive relationship with Students' Learning Performance through Students Engagement. It was also shown that peer interaction had a minor influence on learners' performance. All the observed Indices are within the threshold limits.*

Key Words: Online learning, Student Engagement, Confirmatory Factor Analysis (CFA), LISREL, Educational Technology, Digital Literacy, Instructor Competence.

1. INTRODUCTION

The advent of digital technology has revolutionized the landscape of education, offering unprecedented opportunities and challenges in the realm of online learning. This transformation became more significant during global disruptions that required remote learning solutions. Among these solutions, online learning has emerged as a pivotal educational modality, providing access to learning opportunities for students worldwide, irrespective of geographical constraints. The thesis titled "Investigating the Determinants of Online Learning Success among College Students" seeks to delve into the intricate web of factors that influence the efficacy of online education for university-level learners.

This investigation is grounded in the context of the rapidly evolving digital education landscape, where the effectiveness of online learning is contingent upon a myriad of variables ranging from technological infrastructure to the individual characteristics of learners. The core premise of this research is that understanding these determinants is crucial for optimizing online learning environments to enhance educational outcomes and student satisfaction.

The study is motivated by the observation that while online learning offers significant benefits, including flexibility, accessibility, and a broad array of resources, its effectiveness varies widely among different populations of learners. Several factors, such as technological proficiency, learning styles, motivation, engagement strategies, and the quality of instructional design, play pivotal roles in shaping the online learning experience. Furthermore, the impact of external factors, such as socio-economic status and access to a conducive learning environment, cannot be overlooked.

This thesis integrates CFA to systematically identify and validate the measurement items associated with these constructs, thereby laying a solid foundation for evaluating the determinants of online learning success among college students. Confirmatory Factor Analysis is employed as a hypothesis-testing technique that allows researchers to test the theory-driven expectation of how data reflects the underlying structure of latent constructs. These constructs represent unobservable variables inferred from measurable indicators, such as students' satisfaction, engagement levels, technological accessibility, and instructional quality. In the context of online learning, these latent factors are crucial, yet they cannot be directly measured. Instead, they are assessed through various observed variables that serve as their manifestations.

By employing CFA, this research aims to rigorously determine the latent constructs that significantly influence the success of online learning and to establish a reliable and valid framework for their measurement. This approach not only enriches the theoretical understanding of online learning dynamics but also provides practical insights for educators and policymakers in enhancing the design and implementation of online learning environments. Through this analytical lens, the study endeavors to contribute to the optimization of online education, ensuring it meets the diverse needs and preferences of college students, thereby enhancing their educational outcomes and overall learning experience.

2. LITERATURE REVIEW

2.1 Online Learning Satisfaction and Performance

Studies have identified several factors that influence online learning effectiveness, including course structure, instructor support, learner motivation, technology accessibility, and student engagement. Eom and Wen (2006) found that course structure, self-motivation, instructor facilitation, interaction, and feedback significantly affected student satisfaction. Similarly, Sun et al. (2008) reported that course quality, flexibility, perceived usefulness, and ease of use were critical determinants of learner satisfaction.

2.2 Student Engagement and Interaction

Research has consistently highlighted the importance of engagement and interaction in online learning environments. Dixson (2010), Molinillo et al. (2018), and Qureshi et al. (2021) found that instructor-student interaction, peer communication, and social presence positively influence student engagement, collaborative learning, and academic performance.

2.3 Technology Adoption and Online Learning Readiness

Several researchers have emphasized the role of technology readiness and self-efficacy in online learning adoption. Yakubu and Dasuki (2019), Wei and Chou (2020), and Aguilera-Hermida (2020) demonstrated that self-efficacy, technology acceptance, motivation, and perceived usefulness significantly influence learning performance and course satisfaction.

2.4 Research Gap

Although previous studies have examined factors such as motivation, engagement, technology readiness, instructor competence, and course design, limited research has investigated these determinants simultaneously using a comprehensive CFA/LISREL framework among university students in the Indian context. Therefore, this study aims to examine the factors influencing students' online learning performance and satisfaction.

3. CONCEPTUAL MODEL

In evaluating the on-line learning factors that affect learning performance of students a conceptual model is designed. In this study Confirmatory Factor Analysis (CFA)is implemented using LISREL8.8. The aim of this study is to better understand the influence of various factors that influence learning performance of students. The proposed model is through the model comprises of latent variables (measurement models) that define the relationships between latent indicators and their manifest variables. The conceptual model explicated the relationships between the latent variables and their related manifest variables. The five dimensions considered were called exogenous latent constructs such as the Instructor Competence and Engagement (IC), Technology Access and Digital Literacy (TA), Student Motivation and Self-discipline (SM), Course Design and Delivery (CD) and Social Interaction and Peer Support (SI) are consisted. The study developed the following hypotheses
Learning performance of degree level students are influenced by the four major constructs.

The study hypotheses are as follows:

Hypothesis 1 (H1): Instructor Competence and Engagements significantly impact Learning Performance

Hypothesis 2 (H2): Technology Access and Digital Literacy significantly impact Learning Performance

Hypothesis 3 (H3): Student Motivation and Self-discipline significantly impact Learning Performance

Hypothesis 4(H4): Course Design and Delivery significantly impact Learning Performance

Hypothesis 5(H5): Social Interaction and Peer Support significantly impact Learning Performance

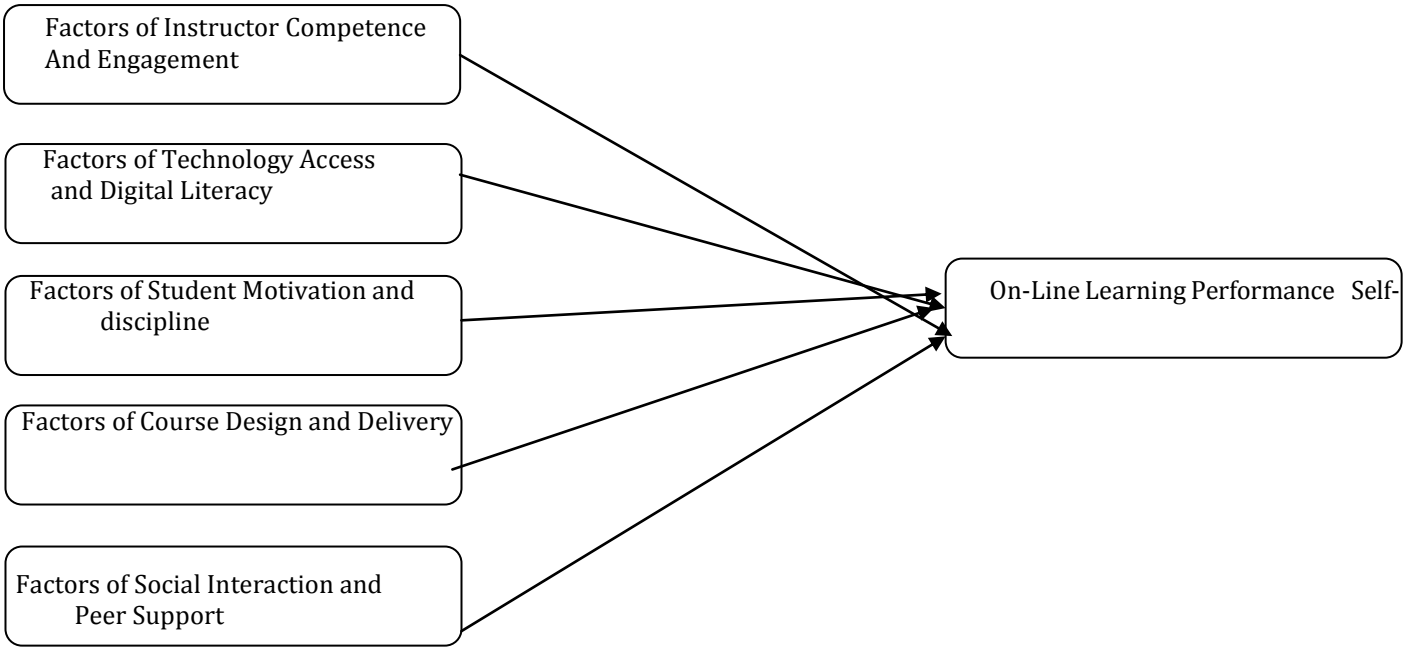

Fig 1: Conceptual Model

4. METHODOLOGY

The methodology adopted in this study involves identifying the critical factors affecting online learning performance through an extensive literature review. Based on the identified factors, a structured questionnaire was developed and administered to undergraduate engineering students. The collected data were analyzed using Confirmatory Factor Analysis (CFA) in LISREL to validate the measurement model. Subsequently, the CRITIC method was employed to determine the relative importance of the identified factors. The overall research procedure is presented in Figure 2

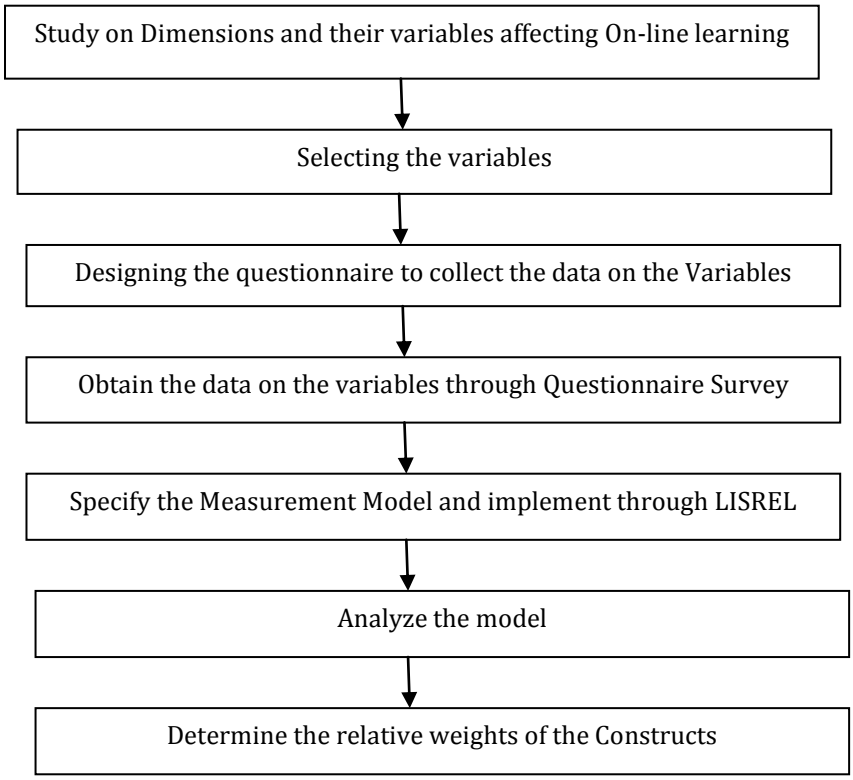

Fig 2: Flowchart of Critical Variables for On-Line Learning performance

4.1 Selection of Variables

The variables considered in this study were identified through an extensive review of the literature on online learning and student academic performance. Previous studies were examined to identify significant factors influencing online learning effectiveness. Based on the findings, five key constructs comprising twenty-five measurement items were selected for empirical analysis. Data were collected from students enrolled in fifteen private engineering colleges. The selected constructs were Instructor Competence and Engagement (IC), Technology Access and Digital Literacy (TA), Student Motivation and Self-Discipline (SM), Course Design and Delivery (CD), and Social Interaction and Peer Support (SI).

4.1.1 Instructor Competence and Engagement (IC)

Instructor competence and engagement play a crucial role in determining the effectiveness of online learning. Competent and actively engaged instructors enhance student satisfaction, improve learning outcomes, and contribute to overall course quality. This construct was measured using five dimensions: Instructor Competence, Use of Technology, Instructional Design, Instructor Engagement, and Availability and Support.

4.1.2 Technology Access and Digital Literacy (TA)

Technology access and digital literacy are essential prerequisites for successful online learning. Adequate access to technological resources, combined with the ability to effectively utilize digital tools, enables students to participate actively in online educational activities. This construct was assessed through five dimensions: Technology Access, Internet Connectivity, Digital Navigation Skills, Digital Information Literacy, and Digital Communication Proficiency.

4.1.3 Student Motivation and Self-Discipline (SM)

Student motivation and self-discipline are critical determinants of academic success in online learning environments. Since online learning requires a high degree of autonomy, motivated and self-disciplined learners are more likely to remain engaged and achieve their learning objectives. This construct included five dimensions: Student Motivation, Goal Orientation, Intrinsic Motivation, Self-Discipline, and Persistence.

4.1.4 Course Design and Delivery (CD)

Effective course design and delivery contribute significantly to meaningful online learning experiences. Well-structured courses, interactive learning activities, accessible resources, and effective use of technology facilitate student engagement and knowledge acquisition. This construct was measured using five dimensions: Clarity and Organization of Course Content, Engagement and Interactivity, Accessibility of Materials, Instructor Presence and Support, and Effective Use of Technology.

4.1.5 Social Interaction and Peer Support (SI)

Social interaction and peer support enhance student engagement and foster a collaborative learning environment. Meaningful interaction among students and instructors promotes knowledge sharing, motivation, and a sense of belonging within the online learning community. This construct was evaluated using five dimensions: Quality of Social Interaction, Opportunities for Collaboration, Peer Support Network, Sense of Community, and Effectiveness of Communication Tools.

4.2 Determination of Relative Weights

After validating the measurement model, the relative importance of the measurement items within each construct was determined using the CRITIC (Criteria Importance Through Inter-Criteria Correlation) method proposed by Diakoulaki et al. (1995). The CRITIC method is an objective weighting technique that determines criterion weights based on the variability of data and the degree of conflict among criteria.

The procedure involves five steps. First, a decision matrix was constructed using students' responses to the measurement items. Second, the standard deviation of each criterion was calculated to measure the contrast intensity of the criterion. Third, the correlation matrix among criteria was computed to determine the degree of conflict between criteria. Fourth, the information content of each criterion was estimated by combining its standard deviation and correlation values. Finally, objective weights were obtained by normalizing the information content values so that the sum of all weights equals one.

The CRITIC method enables the determination of criterion importance by simultaneously considering both the variability and interrelationship among the criteria, thereby providing an objective basis for weighting the factors influencing online learning performance.

Formula 1: Measure of Conflict

$$\sum_{i=1}^{m}(1-l_{jk})$$

l_{jk} denotes the linear correlation coefficient between criteria j and k.

Formula 2: Information Content

$$C_j = \sigma_j \sum_{k=1}^{m}(1-l_{kj})$$

Formula 3: Objective weights

$$w_j = \frac{c_j}{\sum_{i=1}^{m} c_i}$$

The objective weights are obtained by normalizing the information content values, and the sum of all weights is equal to one.

4.3 Data Collection

Data were collected through a structured questionnaire survey administered to undergraduate students from various engineering colleges in Andhra Pradesh, India. A total of 320 students were selected using a random sampling approach and invited to participate in the survey.The questionnaire consisted of two sections. Section I included 25 measurement items related to the five constructs of the study, namely Instructor Competence and Engagement, Technology Access and Digital Literacy, Student Motivation and Self-Discipline, Course Design and Delivery, and Social Interaction and Peer Support. Responses were recorded on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Section II collected demographic information such as gender, age, year of study, and academic program.

Out of 320 questionnaires distributed, 285 valid responses were received, resulting in a response rate of 89%. The respondents possessed adequate experience with online learning environments, enabling them to provide meaningful and reliable responses for the study. The constructs and their corresponding measurement items identified through the literature review are presented in Table 1.

Table 1: List of factors

Main Constructs	Items
Instructor Competence and Engagement (IC):	Instructor Competence(IC1)
	Use of Technology(IC2)
	Instructional Design(IC3)
	Instructor Engagement(IC4)
	Availability and Support(IC5)
Technology Access and Digital Literacy (TA)	Technology Access(TA1)
	Internet Connectivity(TA2)
	Digital Navigation Skills(TA3)
	Digital Information Literacy(TA4)
	Digital Communication Proficiency(TA5)
Student Motivation and Self-discipline (SM)	Student Motivation(SM1)
	Goal Orientation(SM2)
	Intrinsic Motivation(SM3)
	Self-discipline(SM4)
	Persistence(SM5)
Course Design and Delivery (CD)	Clarity and Organization of Course Content(CD1)
	Engagement and Interactivity(CD2)

	Accessibility of Materials(CD3)
	Instructor Presence and Support(CD4)
	Effective Use of Technology(CD5)
Social Interaction and Peer Support (SI)	Quality of Social Interaction(SI1)
	Opportunities for Collaboration(SI2)
	Peer Support Network(SI3)
	Sense of Community(SI4)
	Effectiveness of Communication Tools(SI5)

4.3.1 Demographic Characteristics

The demographic characteristics of the respondents are presented in Table 2. The table summarizes the distribution of respondents based on their branch of study and type of institution. The sample consisted of students from various engineering disciplines, providing a diverse representation of undergraduate engineering students.

Table 2: Summary of the demographic characteristics

Feature	Name of the Branch	Frequency	Percentage
Branch	Civil	45	15.79
	Electrical & Electronics	42	14.24
	Electronics & communication	53	18.60
	Computer	72	25.26
	Mechanical	45	15.79
	Others	28	9.82
Type of Institution	Government	2	20
	Private	8	80

Table 3 provides descriptive statistics such as mean, standard deviation.

Table 3: Mean and Standard Deviation Calculation.

Item	Mean	Stdev	Item	Mean	Stdev
IC1	2.92	1.42	SM4	2.97	1.37
IC2	3.02	1.40	SM5	2.95	1.42
IC3	2.87	1.41	CD1	3.00	1.43
IC4	3.11	1.40	CD2	3.03	1.42
IC5	3.05	1.46	CD3	3.04	1.41
TA1	2.93	1.43	CD4	3.03	1.41
TA2	2.88	1.43	CD5	3.02	1.44
TA3	3.09	1.49	SI1	2.91	1.46
TA4	3.08	1.42	SI2	2.93	1.39
TA5	2.98	1.47	SI3	2.97	1.42
SM1	3.02	1.39	SI4	3.00	1.44
SM2	2.87	1.43	SI5	2.95	1.47
SM3	2.91	21.45			

5. RESULT AND ANALYSIS

The statistical analysis was performed using LISREL 8.8 to examine the relationships between the observed variables and their corresponding latent constructs influencing online learning performance. LISREL is widely used for confirmatory research and has been extensively applied in social science and engineering studies for multivariate analysis. In the present study, measurement model assessment and structural model analysis were carried out using LISREL 8.8.

5.1 Measurement Model

The measurement model was evaluated to assess the reliability and validity of the observed variables and their corresponding latent constructs. Reliability assessment was performed using factor loadings and Composite Reliability (CR), while convergent validity was evaluated using the Average Variance Extracted (AVE).The reliability of individual observed variables was assessed through standardized factor loadings. Factor loadings greater than 0.60 are considered acceptable for establishing indicator reliability. The results indicated that the factor loadings of all measurement items ranged from 0.68 to 0.70, exceeding the recommended threshold value and confirming satisfactory indicator reliability.

Construct reliability was evaluated using Composite Reliability (CR). The results presented in Table 4 indicate that the CR values ranged from 0.8350 to 0.8740, exceeding the recommended threshold value of 0.70 and demonstrating satisfactory reliability and internal consistency of the measurement scales. Convergent validity was assessed using the Average Variance Extracted (AVE). An AVE value greater than 0.50 indicates that a latent construct explains more than 50% of the variance in its associated indicators. The AVE values for all constructs ranged from 0.5032 to 0.5815, exceeding the recommended threshold value of 0.50. Therefore, the results confirm adequate convergent validity and demonstrate that the measurement model possesses good reliability and validity. The results of factor loadings, Composite Reliability, and Average Variance Extracted are presented in Table 4.

Table 4: Composite Reliability and Average Variance Extracted of the Constructs

Main Constructs	Items	Loadings	Error Loading	CR	AVE
Instructor Competence and Engagement (IC):	IC1	0.77	0.41	0.8612	0.5543
	IC2	0.77	0.41		
	IC3	0.68	0.54		
	IC4	0.76	0.42		
	IC5	0.74	0.45		
Technology Access and Digital Literacy (TA)	TA1	0.79	0.38	0.8740	0.5815
	TA2	0.75	0.43		
	TA3	0.74	0.45		
	TA4	0.79	0.37		
	TA5	0.73	0.46		
Student Motivation and Self-discipline (SM)	SM1	0.71	0.5	0.8350	0.5032
	SM2	0.69	0.52		
	SM3	0.74	0.46		
	SM4	0.71	0.5		
	SM5	0.7	0.51		
Course Design and Delivery (CD)	CD1	0.75	0.43	0.8635	0.5587
	CD2	0.75	0.43		
	CD3	0.74	0.46		
	CD4	0.74	0.46		
	CD5	0.76	0.43		
Social Interaction and Peer Support (SI)	SI1	0.78	0.4	0.8577	0.5471
	SI2	0.72	0.48		
	SI3	0.76	0.43		
	SI4	0.75	0.44		
	SI5	0.69	0.52		

5.1.2 Model Evaluation Criteria

The goodness-of-fit indices obtained from the Confirmatory Factor Analysis (CFA) are presented in Table 5. The model exhibited satisfactory fit with $\chi^2/df = 1.99$, which is below the recommended threshold of 3.0. The absolute fit indices, including GFI (0.871), AGFI (0.841), SRMR (0.0746), and RMSEA (0.0591), indicated an acceptable model fit. Similarly, the relative fit indices, namely NNFI (0.9812), NFI (0.960), CFI (0.979), and RFI (0.954), exceeded the recommended threshold values, demonstrating a good fit between the proposed measurement model and the observed data. Therefore, the measurement model was considered statistically acceptable and suitable for further analysis.

5.2 Relative Weights of items under respective constructs

Relative weights of the items under respective construct are determined as discussed in section.

Correlation Matrix:

Ics	IC1	IC2	IC3	IC4	IC5
IC1	1.000	0.663	0.560	0.512	0.629
IC2	0.663	1.000	0.474	0.577	0.617
IC3	0.560	0.474	1.000	0.536	0.416
IC4	0.512	0.577	0.536	1.000	0.481
IC5	0.629	0.617	0.416	0.481	1.000

Measure of Conflict:

Criteria	IC1	IC2	IC3	IC4	IC5
Measure of Conflict	1.636	1.669	2.014	1.894	1.857

Relative Weights:

Relative weights of the items under the constructs are determined and presented in the following table

Items	Relative weights	Items	Relative weights	Items	Relative weights
IC1	0.1804	SM1	0.2017	SI1	0.1932
IC2	0.1819	SM2	0.1971	SI2	0.1954
IC3	0.2207	SM3	0.2051	SI3	0.1925
IC4	0.2061	SM4	0.1935	SI4	0.1997
IC5	0.2108	SM5	0.2027	SI5	0.2191
TA1	0.1907	CD1	0.2063		
TA2	0.2050	CD2	0.1960		
TA3	0.2095	CD3	0.2066		
TA4	0.1869	CD4	0.1975		
TA5	0.2079	CD5	0.1936		

6. CONCLUSION

This study investigated the determinants of online learning performance among engineering students using Confirmatory Factor Analysis (CFA) and the CRITIC method. The findings revealed that instructor competence and engagement, technology access and digital literacy, student motivation and self-discipline, course design and delivery, and social interaction and peer support significantly influence online learning performance. The results highlight the importance of providing effective instructional support, reliable technological infrastructure, and a well-designed online learning environment to enhance student learning outcomes.

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