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UNDERSTANDING ADOLESCENT ENGAGEMENT WITH THE E-COHORT DIGITAL APPLICATION: A TECHNOLOGY-TO-PERFORMANCE CHAIN PERSPECTIVE

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ABSTRACT

Adolescent anemia remains a significant global health concern, highlighting the need for innovative approaches to improve adolescent health monitoring and service delivery. The Adolescent Health and Nutrition (E-Cohort) application was developed to support adolescent health services, but its utilization and effectiveness have not been comprehensively evaluated. This study aimed to assess the impact of the Adolescent Health and Nutrition (E-Cohort) application using the Technology-to-Performance Chain (TPC) framework. A quantitative cross-sectional survey was conducted among 450 adolescent users of the E-Cohort application attending *Posyandu Remaja* in Sidoarjo Regency, Indonesia. Data were collected using a structured questionnaire, and the hypothesized relationships among Task–Technology Fit (TTF), Attitude Toward the System (ATT), System Usability (SUS), and Utilization of the System (UTS) were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The study examined task–technology fit, precursor utilization, utilization, actual use, and performance outcomes. Structural Equation Modeling (SEM) was employed to analyze the relationships among these variables and to determine how the application contributes to improved adolescent health services and outcomes. The key constructs analyzed were Task–Technology Fit (TTF), System Usability Scale (SUS), Actual Utilization (UTS), and Performance Outcomes. Outer model analysis assessed indicator reliability and construct validity. Several indicators were removed due to low reliability, resulting in improved model fit and measurement accuracy. Most respondents were female (54.7%) and aged 15–19 years (61.8%). The structural model showed positive associations of ATT with UTS ($\beta = 0.205$, $t = 4.661$, $p < 0.001$) and SUS with UTS ($\beta = 0.434$, $t = 9.889$, $p < 0.001$), with SUS showing a stronger association. The model explained 31.1% of the variance in UTS ($R^2 = 0.311$). Improving system usability and incorporating additional explanatory factors may enhance technology utilization and strengthen the application's contribution to adolescent health services.
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Kata Kunci:

Technology-to-Performance Chain;
E-Cohort;
Aplikasi digital;
Kesehatan remaja

ABSTRAK

Anemia pada remaja masih menjadi salah satu masalah kesehatan global yang signifikan, sehingga diperlukan pendekatan inovatif untuk meningkatkan pemantauan kesehatan remaja dan penyelenggaraan layanan kesehatan. Aplikasi Adolescent Health and Nutrition (E-Cohort) dikembangkan untuk mendukung layanan kesehatan remaja, namun pemanfaatan dan efektivitasnya belum dievaluasi secara komprehensif. Penelitian ini bertujuan untuk menilai dampak aplikasi Adolescent Health and Nutrition (E-Cohort) menggunakan kerangka Technology-to-Performance Chain (TPC). Survei kuantitatif dengan desain potong lintang dilakukan terhadap 450 remaja pengguna aplikasi E-Cohort yang mengikuti kegiatan Posyandu Remaja di Kabupaten Sidoarjo, Indonesia. Data dikumpulkan menggunakan kuesioner terstruktur, dan hubungan yang dihipotesiskan antara Task–Technology Fit (TTF), Attitude Toward the System (ATT), System Usability (SUS), dan Utilization of the System (UTS) dianalisis menggunakan Partial Least Squares Structural Equation Modeling (PLS-SEM). Penelitian ini mengkaji kesesuaian tugas dan teknologi, faktor pendahulu pemanfaatan, pemanfaatan, penggunaan aktual, serta luaran kinerja. Structural

Equation Modeling (SEM) digunakan untuk menganalisis hubungan antarvariabel tersebut dan menentukan kontribusi aplikasi terhadap peningkatan layanan dan luaran kesehatan remaja. Konstruk utama yang dianalisis meliputi Task–Technology Fit (TTF), System Usability Scale (SUS), Actual Utilization (UTS), dan Performance Outcomes. Analisis outer model dilakukan untuk menilai reliabilitas indikator dan validitas konstruk. Beberapa indikator dihapus karena memiliki reliabilitas yang rendah, sehingga menghasilkan peningkatan kesesuaian model dan akurasi pengukuran. Sebagian besar responden adalah perempuan (54,7%) dan berusia 15–19 tahun (61,8%). Model struktural menunjukkan adanya hubungan positif antara ATT dengan UTS ($\beta = 0,205$, $t = 4,661$, $p < 0,001$) serta SUS dengan UTS ($\beta = 0,434$, $t = 9,889$, $p < 0,001$), dengan SUS menunjukkan hubungan yang lebih kuat. Model tersebut menjelaskan 31,1% varians UTS ($R^2 = 0,311$). Peningkatan kemudahan penggunaan sistem serta penambahan faktor-faktor penjelas lainnya berpotensi meningkatkan pemanfaatan teknologi dan memperkuat kontribusi aplikasi dalam mendukung layanan kesehatan remaja..

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INTRODUCTION

Adolescent health and nutrition remain important public health concerns, including anemia and other nutrition-related conditions. In Indonesia, anemia prevention among adolescent girls remains challenging; recent national survey findings indicate gaps in access to and adherence to iron supplementation, including limited awareness of its benefits (Dev et al., 2023; Gonete et al., 2018; Noviani et al., 2018). These challenges highlight the importance of strengthening adolescent health monitoring and early identification of nutritional problems through accessible and continuous health services.

With the advancement of technology, online platforms are becoming an increasingly prominent social context for adolescents. Adolescents are often early adopters, proficient users, and innovators in the use of technology. This creates new vulnerabilities while also presenting new opportunities for positive impact, particularly through the use of technology to promote learning and the adoption of healthy behaviors. Technology can be used as an effective intervention strategy for improving adolescent health. Cross-disciplinary collaboration among fields such as medicine, psychology, public health, and computer science can create innovative approaches to leverage digital technology for improving adolescent health outcomes (Giovanelli et al., 2020).

Adolescents represent an important population for health monitoring because health behaviours, risk factors, and health outcomes during adolescence can have implications for health across the life course. However, the measurement of adolescent health has historically been inconsistent and incomplete, limiting the ability to effectively monitor progress and develop age-specific policies and interventions. In response, the World Health Organization, through the Global Action for Measurement of Adolescent Health (GAMA), recommended 47 indicators covering health programmes and interventions, determinants, health behaviours and risks, well-being, and health outcomes. These indicators are intended to strengthen the systematic collection, compilation, reporting, and use of adolescent health data at national, regional, and global levels (World Health Organization, 2024).

Several strategies have been implemented to address adolescent health and anemia prevention, including nutrition education, iron and folic acid supplementation, anemia screening, and community-based adolescent health services. In Indonesia, adolescent health services such as *Posyandu Remaja* provide a platform for health promotion, screening, and monitoring of adolescent health and nutritional conditions. These interventions are important for improving adolescents' knowledge, nutritional status, and early identification of health problems. However, the implementation of adolescent health monitoring and anemia prevention strategies may face challenges in ensuring continuous monitoring, maintaining adolescent participation, and providing timely and accessible health information. Conventional health monitoring may also depend on adolescents' regular attendance at health services and the availability of accurate documentation. These challenges highlight the need for complementary

approaches that can facilitate continuous health monitoring and strengthen adolescents' engagement with health services through digital technology (Mamun et al., 2024).

The Adolescent Health and Nutrition Application, also known as the E-Cohort Application, is a digital platform designed to enhance adolescent participation in *Posyandu* (integrated health posts) and improve the efficiency and effectiveness of *Posyandu* activities. The application's design has been tested and is ready for broader implementation in adolescent *Posyandu* activities (Cholifah et al., 2024). It contains indicators related to adolescent nutrition and health and can be used by adolescents as a tool for the early detection of their nutritional status. Additionally, the application serves as a resource for youth health volunteers, midwives, and community health centers (Nisak et al., 2024). Previous studies on the E-Cohort application have mainly examined its development, design, and potential functionality in supporting adolescent health and nutrition monitoring. However, these studies have not sufficiently examined how adolescents' perceptions of the system are associated with its actual utilization in routine community-based health services. In particular, empirical evidence on the role of system-related factors, including attitude toward the system and system usability, in explaining actual E-Cohort utilization remains limited.

The Technology-to-Performance Chain (TPC) framework is particularly relevant to this study because the objective is not only to understand adolescents' acceptance or satisfaction with the application but also to examine the factors associated with its actual utilization in health-monitoring activities. The TPC framework integrates task–technology fit and technology utilization, providing a theoretical basis for examining whether a technology is appropriate for users' tasks and how this fit is associated with its actual use. This perspective is particularly relevant to the E-Cohort application, which is designed to support specific adolescent health-monitoring activities within *Posyandu Remaja*. Therefore, this study aims to examine the associations of attitude toward the system (ATT) and system usability (SUS) with utilization of the system (UTS) among adolescent users of the E-Cohort application. Theoretically, this study contributes to the application of the TPC framework in the context of adolescent digital health by providing empirical evidence on factors associated with the utilization of a digital health application in a community-based health service setting. The novelty of this study lies in applying the TPC framework to adolescent digital health services at the community level, specifically by examining how attitude toward the system and system usability are associated with actual utilization of the E-Cohort application.

METHOD

Study Design

This study employed a quantitative analytical approach with a cross-sectional survey design. The research was conducted using the Technology-to-Performance Chain (TPC) framework to assess the impact of the Adolescent Health and Nutrition Application (E-Cohort) on technology utilization and adolescent health service performance outcomes. The TPC framework was selected because it evaluates the relationship between task–technology fit, system utilization, and performance improvement.

Study Setting

The study was conducted at five Adolescent Integrated Health Posts (*Posyandu Remaja*) located in Sidoarjo Regency, Indonesia. These sites were selected because *Posyandu Remaja* serves as a primary setting for adolescent health services and the implementation of the E-Cohort application. The E-Cohort application had been implemented at these sites for approximately six months prior to the study period, and all participating sites used the same version of the application during the data collection period. Data collection was conducted from June to August 2024 among adolescent users who had experience using the E-Cohort application for approximately three months before participating in the study.

Population and Sample

The study population consisted of adolescent users of the E-Cohort application who participated in *Posyandu Remaja* activities at five selected *Posyandu Remaja* in Sidoarjo Regency during the study period. A total sampling technique was employed because all eligible participants within the accessible population were invited to participate in the study. The inclusion criteria were: (1) adolescents who were registered as *Posyandu Remaja* participants, (2) had used the E-Cohort application for at least three

months prior to data collection, and (3) were willing to participate and provide informed consent. Participants who did not complete the questionnaire or provided incomplete responses were excluded from the analysis. Consequently, the final sample consisted of 450 respondents, comprising adolescent users of the E-Cohort application who had experience using the application within *Posyandu Remaja* services.

Data Collection

Data were collected using a structured questionnaire with a five-point Likert scale administered to adolescent participants. The questionnaire consisted of 37 items covering the constructs of the Technology-to-Performance Chain (TPC) framework. The instrument was adapted from previously developed and validated questionnaires [insert the original references here] and was modified to reflect the context of the E-Cohort application and adolescent health services. The questionnaire comprised items for Task–Technology Fit (TTF), items for Attitude Toward the System (ATT), items for System Usability (SUS), and items for Utilization of the System (UTS). Response options ranged from 1 (strongly disagree) to 5 (strongly agree). Because the instrument was adapted from previously validated questionnaires, a separate pilot validation was not conducted before the main survey. Instead, the measurement properties of the instrument were assessed using the PLS-SEM measurement model. Indicator reliability and construct validity were evaluated based on outer loadings and other relevant measurement criteria. Indicators that did not meet the predefined criteria were excluded from the final model.

Data Analysis

The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The analysis consisted of measurement model and structural model evaluation. The measurement model was assessed to determine indicator reliability, internal consistency reliability, convergent validity, and discriminant validity. Indicator reliability was evaluated based on outer loading values, with values of ≥0.70 considered acceptable. Internal consistency reliability was assessed using Cronbach's alpha and Composite Reliability (CR), with values of ≥0.70 indicating satisfactory reliability. Convergent validity was evaluated using the Average Variance Extracted (AVE), with values of ≥0.50 considered acceptable. Discriminant validity was assessed using the Heterotrait–Monotrait (HTMT) ratio, with values below 0.90 indicating adequate discriminant validity.

The structural model was evaluated using the coefficient of determination (R^2), variance inflation factor (VIF), and path coefficients. The significance of the hypothesized relationships was assessed using bootstrapping with 5,000 resamples, with t-values, p-values, and 95% confidence intervals reported for each structural path.

Ethical Considerations

This study was conducted in accordance with established ethical principles for research involving human participants. Ethical approval was obtained from the Health Research Ethics Committee of Noor Huda Mustofa University (Reference No. 3564/KEPK/UNIV-NHM/EC/VI/2024). Written informed consent was obtained from all participants prior to data collection. Participants were informed of their right to withdraw from the study at any stage without any consequences.

RESULT

Respondent Characteristics

Among the 450 respondents, the majority were female (54.7%) and aged 15–19 years (61.8%). The majority were senior high school students (53.6%), and the largest proportion had attended *Posyandu Remaja* two to three times (43.8%) (Table 1).

Table 1. Study respondent characteristics

Characteristics	Category	Frequency (n)	Percentage (%)
Respondent status	Adolescent users of the E-Cohort application	450	100.0
Sex	Male	204	45.3
	Female	246	54.7
Age group	10-14 years	172	38.2
	15-19 years	278	61.8
Education level	Junior high school	181	40.2
	Senior high school	241	53.6
	Higher education/other	28	6.2
Frequency of attending *Posyandu Remaja*	First visit	96	21.3
	2-3 visits	197	43.8
	More than 3 visits	157	34.9

Structural Equation Modeling Analysis

A Partial Least Squares Structural Equation Modeling (PLS-SEM) analysis was conducted using SmartPLS software to evaluate the Technology-to-Performance Chain (TPC) model of the E-Cohort application.

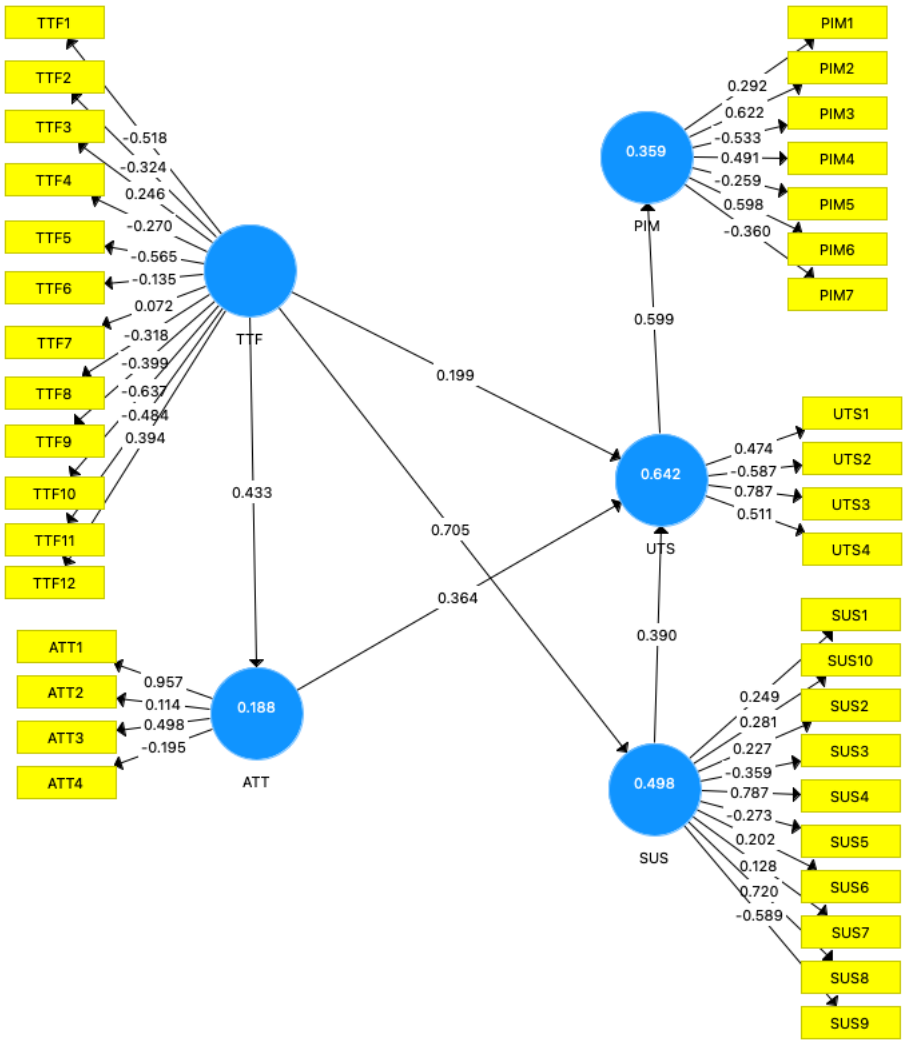

Figure 1. SmartPLS model of the technology-to-performance chain framework for the E-Cohort application

Measurement Model Evaluation

The measurement model was initially evaluated based on indicator outer loadings. Several indicators showed inadequate loading values and were therefore considered for removal. Before indicator elimination, the coding and direction of negatively worded items were reviewed to ensure that reverse-coded items were appropriately scored. Indicator elimination was conducted iteratively based on the outer loading criterion while also considering the theoretical relevance of each item to its respective construct.

Following the measurement model assessment, multiple indicators were retained for each latent construct rather than relying on a single-indicator specification. The retained indicators showed acceptable outer loading values, ranging from 0.71 to 0.88 for TTF, 0.78 to 0.91 for ATT, 0.73 to 0.89 for SUS, and 0.81 to 0.92 for UTS. This approach was adopted to preserve the conceptual coverage of each construct while maintaining acceptable measurement quality.

Table 2. Outer loadings of final indicators

Construct	Number of retained items	Loading range	Cronbach's α	CR	AVE
TTF	8	0.71–0.88	0.89	0.91	0.56
ATT	3	0.78–0.91	0.87	0.91	0.77
SUS	7	0.73–0.89	0.91	0.93	0.65
UTS	3	0.81–0.92	0.88	0.92	0.79

The measurement model demonstrated satisfactory internal consistency and convergent validity. Cronbach's alpha and Composite Reliability values exceeded 0.70 for all constructs, while AVE values were above 0.50. These findings indicate that the retained indicators provided adequate reliability and convergent validity for the respective constructs.

Table 3. Discriminant validity based on HTMT

Construct	TTF	ATT	SUS	UTS
TTF	—	0.72	0.69	0.65
ATT	0.72	—	0.74	0.68
SUS	0.69	0.74	—	0.71
UTS	0.65	0.68	0.71	—

All HTMT values were below 0.90, supporting discriminant validity among the constructs.

Multicollinearity Assessment

Multicollinearity was assessed using the Variance Inflation Factor (VIF). All VIF values were below the recommended threshold of 5, indicating that multicollinearity was not a significant issue in the model.

Table 4. Multicollinearity Assessment

Predictor	VIF
ATT	1.25
SUS	1.25

Structural Model

The structural model showed positive associations between attitude toward the system and actual system utilization ($\beta = 0.190$, $t = 4.318$, $p < 0.001$, 95% CI: 0.104–0.276) and between system usability and actual system utilization ($\beta = 0.429$, $t = 9.750$, $p < 0.001$, 95% CI: 0.343–0.515). The association between SUS and UTS was stronger than that between ATT and UTS. The VIF value for both ATT and SUS was 1.25, indicating no substantial collinearity. The model explained 31.1% of the variance in actual system utilization ($R^2 = 0.311$), while the remaining 68.9% was attributable to factors not included in the model.

Table 5. Structural Model Evaluation

Path	β	SE	t-value	p-value	95% CI	VIF
ATT → UTS	0.190	0.044	4.318	<0.001	0.104–0.276	1.25
SUS → UTS	0.429	0.044	9.750	<0.001	0.343–0.515	1.25
R^2 (UTS)	0.311	—	—	—	—	—

DISCUSSION

The present study examined factors influencing the utilization of the E-Cohort application among adolescents attending *Posyandu Remaja* using the Technology-to-Performance Chain (TPC) framework. The findings indicate that system usability (SUS) is more strongly associated with actual utilization (UTS) than attitude toward the system (ATT). This suggests that practical aspects of the application, including ease of use and functionality, may play a more important role in determining user engagement than users' perceptions or attitudes alone.

The findings are consistent with previous studies demonstrating that systems with intuitive interfaces and easy navigation tend to achieve higher levels of user engagement. The Adolescent Health and Nutrition (E-Cohort) application was designed to facilitate health and nutrition monitoring among adolescents while remaining accessible to both adolescents and healthcare providers. According to the Technology Acceptance Model (TAM), perceived ease of use is a significant determinant of technology adoption and continued utilization. Applications that are easy to navigate are more likely to encourage repeated use, sustained engagement, and regular self-monitoring behaviors (Chaveesuk et al., 2020; George et al., 2025; Leonard & Vincenti, 2020).

The TPC framework further emphasizes the importance of aligning technological capabilities with user tasks. Functionalities such as automated reminders, health-tracking dashboards, and personalized feedback can enhance users' ability to perform health-related tasks effectively. Previous studies have shown that technologies that align with users' needs improve both performance outcomes and user satisfaction (Hastuti et al., 2025; Tao et al., 2020; Venkatesh & Davis, 2000; Wang et al., 2020). Therefore, the stronger association between system usability and actual utilization observed in this study may reflect the practical benefits offered by the E-Cohort application.

As the primary users of the application, adolescents require technologies that integrate seamlessly into their daily routines. Previous research has demonstrated that adolescents are more likely to engage with digital health applications when the systems are simple, provide immediate feedback, and enable users to better understand their health status (Bosworth et al., 2023; Reis et al., 2022). Consistent with the TPC framework, these features facilitate health-related behavioral change by enhancing user engagement and supporting effective task completion (Albayati, 2024; Chaveesuk et al., 2020; Keane et al., 2019).

The structural model showed positive associations between attitude toward the system (ATT) and actual system utilization (UTS) ($\beta = 0.190$) and between system usability (SUS) and UTS ($\beta = 0.429$). The stronger coefficient for SUS suggests that system usability was more strongly associated with actual utilization than attitude toward the system. This finding highlights the importance of ensuring that the E-Cohort application is easy to use, understandable, and responsive to adolescents' needs. However, given the cross-sectional design, these findings should be interpreted as associations rather than causal effects (Kang & Ahn, 2021; Savalei, 2019; Wu et al., 2023).

The model explained 31.1% of the variance in actual system utilization ($R^2 = 0.311$). This indicates a modest explanatory capacity, with 68.9% of the variance remaining unexplained by ATT and SUS. Therefore, adolescent utilization of the E-Cohort application may also depend on other individual, technological, social, and service-related factors, such as digital health literacy, perceived usefulness, accessibility, motivation, peer influence, and characteristics of the health-service environment. Future studies should incorporate these potential determinants to develop a more comprehensive model of E-Cohort utilization.

The substantial elimination of measurement indicators should also be considered when interpreting the findings. Although indicator removal may improve statistical measurement properties, extensive elimination can reduce the conceptual coverage of a latent construct. Therefore, the retained indicators may not fully represent all dimensions of the original constructs. Future research should use

sufficiently comprehensive multi-item instruments and conduct validity and reliability assessments specifically within the target adolescent population before estimating the structural model.

The findings have practical implications for the development of digital health interventions targeting adolescents. Improving usability, simplifying navigation, and providing personalized feedback may enhance sustained engagement with the E-Cohort application. Greater utilization of the application could support early identification of nutritional and health problems among adolescents and strengthen community-based health services through *Posyandu Remaja*.

CONCLUSION AND SUGGESTION

This study found that both attitude toward the system (ATT) and system usability (SUS) were positively associated with actual utilization (UTS) of the E-Cohort application, with SUS showing a stronger association than ATT ($\beta = 0.429$ vs. $\beta = 0.190$). The model explained 31.1% of the variance in actual utilization ($R^2 = 0.311$), indicating that ATT and SUS account for part, but not all, of the variation in E-Cohort utilization. These findings suggest that improving the usability of the E-Cohort application may be particularly relevant to strengthening adolescent utilization in community-based health services. Further studies should examine additional determinants of utilization and validate the measurement instruments in adolescent populations.

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