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Evaluating the Impact of Digital Transformation on the Development of Assessment Measures for Supporting Rehabilitation and Education of People with Disabilities in Iraq

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Abstract

This study evaluates the impact of digital transformation on rehabilitation and educational programs for individuals with mobility disabilities in Iraq. The increasing integration of digital technologies—such as artificial intelligence, virtual reality, wearable devices, and mobile applications—has introduced new opportunities to enhance physical rehabilitation and educational outcomes. A mixed-methods research design was employed, combining quantitative data from structured questionnaires with qualitative insights obtained through semi-structured interviews and observational assessments. The study sample consisted of 100 participants enrolled in rehabilitation and educational programs that utilize digital tools.

The findings indicated that digital technologies contributed to moderate improvements in mobility-related skills and learning experiences, with participants reporting generally positive perceptions regarding usability and overall satisfaction. However, several challenges were identified, including limited accessibility, lack of clear guidance, and technical issues, which reduced the effectiveness of digital tools for some users. The results highlight variability in user experiences and emphasize the importance of customization and user-centered design.

The study concludes that digital transformation holds significant potential to enhance rehabilitation and education for individuals with mobility disabilities. Nevertheless, the effectiveness of digital tools depends largely on their adaptability, accessibility, and alignment with individual needs. Developing tailored digital assessment measures and support systems is essential to maximize benefits and improve long-term rehabilitation and educational outcomes.

1-Introduction

In recent years, the world has witnessed rapid and profound developments in technology and digital transformation, which have significantly influenced various sec-tors, particularly education, rehabilitation, and human development. Digital transformation has become a central component of contemporary systems, contributing to the redesign of curricula, teaching strategies, and evaluation mechanisms in alignment with modern technological ad-vancements and artificial intelligence applications [1–3]. This transformation has created new opportunities for enhancing the effectiveness of educational and rehabili-tation programs, especially for people with

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disabilities, by providing innovative, flexible, and data-driven solu-tions.

Motor disabilities are among the most challenging types of disabilities due to their direct impact on mobility, independence, and participation in educational, social, and professional activities. Individuals with mobility im-pairments often face limitations that hinder their access to traditional educational and rehabilitation services, which are frequently based on conventional methods that may not adequately address individual needs or provide continuous and objective monitoring of progress [4]. Global reports and international conventions emphasize that people with disabilities continue to encounter struc-tural and functional barriers that negatively affect their quality of life and limit their opportunities for inclusion and participation.[9,10]

The integration of digital technologies into rehabilita-tion and education has introduced a wide range of tools, including assistive technologies, digital assessment sys-tems, wearable devices, interactive rehabilitation plat-forms, and intelligent learning environments. These technologies have demonstrated considerable potential in improving motor performance, supporting skill acquisi-tion, enhancing functional independence, and facilitating active participation in learning and rehabilitation pro-cesses [6,11,12]. Moreover, digital systems enable re-al-time feedback, continuous data collection, and objec-tive measurement of progress, which are essential ele-ments for effective intervention planning and outcome evaluation.

Several structured and technology-based systems have been developed to evaluate and promote development in individuals with severe motor disabilities, offering stand-ardized and evidence-based approaches to assessment and rehabilitation planning [5,13]. Such systems contrib-ute to improving decision-making processes for educa-tors, therapists, and policymakers by providing reliable data on individual performance and developmental tra-jectories. However, despite these advancements, many outcome measures currently used in rehabilitation and educational settings were developed prior to the wide-spread adoption of digital technologies and may not fully capture the multidimensional effects of modern, technol-ogy-based interventions.[7,14]

This limitation has raised important concerns regarding the validity, sensitivity, and applicability of existing as-sessment tools in digitally enhanced rehabilitation con-texts. The rapid evolution of digital technologies has outpaced the adaptation of traditional measurement frameworks, resulting in a gap between technological innovation and the tools used to evaluate its effectiveness. Consequently, there is a growing need to develop and adapt assessment measures that are compatible with digi-tal environments and capable of accurately reflecting functional, educational, and psychosocial outcomes for individuals with mobility disabilities.

Furthermore, digital transformation in disability sup-port is closely aligned with global efforts to promote in-clusive education, health equity, and sustainable devel-opment. Digital technologies are increasingly recognized as key enablers for achieving sustainable development goals by enhancing accessibility, participation, and qual-ity of life for people with disabilities [8]. International educational and developmental frameworks further em-phasize the role of digital transformation in building in-clusive and equitable systems that respond to the needs of diverse populations, including individuals with disa-bilities .[15]

Accordingly, this study seeks to examine the effec-tiveness of digital transformation in developing and adapting assessment measures that support rehabilitation and education for individuals with mobility disabilities. It also aims to identify the challenges associated with im-plementing digital assessment tools and propose strate-gies to optimize their use, thereby enhancing inclusive practices and improving the overall quality of life for this population

Study Background:

In recent years, rapid advancements in digital tech-nology have significantly transformed various sectors, including healthcare, education, and rehabilitation. For individuals with mobility disabilities, these technological innovations hold great potential to enhance accessibility, improve rehabilitation outcomes, and provide more in-clusive educational opportunities. Tools such as artificial intelligence (AI), virtual reality (VR), wearable devices, and mobile applications have shown promise in improv-ing physical therapy, learning processes, and daily life activities for people with disabilities.

However, while these digital tools offer many ad-vantages, there is still a need to better understand their actual impact on the specific needs of individuals with mobility impairments. Existing rehabilitation and educa-tional programs often rely on traditional methods and measures that may not be fully equipped to integrate or assess the effectiveness of these emerging technologies. This gap raises important questions about how well digi-tal transformations are addressing the challenges faced by mobility-disabled individuals in their rehabilitation and education journeys.

Moreover, the development of new, adaptive measures that are specifically designed for digital tools is crucial to ensure that these technologies truly benefit individuals with mobility disabilities. As digital transformations con-tinue to reshape the way support is provided, it becomes increasingly necessary to assess

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their effectiveness and explore how they can be optimized to improve both reha-bilitation and educational outcomes. This study seeks to fill this gap by evaluating the impact of digital transfor-mations on the development of measures designed to support individuals with mobility disabilities.

2. Methodology

1 .Research Design

This study adopts a mixed-methods research design, integrating both quantitative and qualitative approaches to assess the impact of digital transformation on rehabilita-tion and educational measures for individuals with mo-bility disabilities. The quantitative component employs a cross-sectional survey, while the qualitative component utilizes case studies and semi-structured interviews to provide an in-depth understanding of participants' expe-riences and the effectiveness of digital tools.

2 .Sample (Participants)

a. Target Population:
Individuals with mobility disabilities who are currently enrolled in rehabilitation programs or educational programs that utilize digital technologies in the State of Iraq.
b. Sample Size:
A total of 100 participants, divided into two groups:
50 participants enrolled in rehabilitation programs
50 participants enrolled in educational programs
c. Sampling Method:
A purposive sampling technique was employed to select participants who have direct exposure to digital tools within their rehabilitation or educational contexts.

3 .Data Collection Tools

a. Questionnaire:
A structured questionnaire was developed to collect quantitative data related to the effectiveness,
accessibility, usability, and satisfaction with digital tools. Responses were measured using a five-point Likert scale (Strongly Agree to Strongly Disagree).
b. Interviews:
Semi-structured interviews were conducted with a subsample of 20 participants to explore personal experiences, perceived benefits, and challenges associated with the use of digital technologies.
c. Observational Checklist:
For participants in rehabilitation programs, structured observations were conducted to evaluate interaction with digital devices and their role in improving mobility, en-gagement, and task performance.

4 .Scientific Measurements (Reliability and Validity)

a. Reliability:
Internal consistency of the questionnaire was assessed using Cronbach's Alpha, with a coefficient of 0.70 or higher considered acceptable.
b. Validity:
Content validity was ensured through expert review by specialists in rehabilitation, education, and disability studies. A pilot study was conducted to refine questionnaire items and interview questions before final data col-lection.

5 .Data Analysis

a. Quantitative Data Analysis:
Descriptive statistics (means, standard deviations, frequencies, and percentages) and inferential statistics (independent sample t-tests and ANOVA) were used to compare responses between rehabilitation and educational groups.
b. Qualitative Data Analysis:
Interview data were analyzed using thematic analysis, allowing the identification of recurring themes, patterns, and challenges related to digital tool usage.

6 .Ethical Considerations

Participants were fully informed about the purpose of the study and provided written informed consent. All data were anonymized to ensure confidentiality, and ethical approval was obtained from the relevant institutional ethics committee prior to data collection.
Statistical Methods
Data were analyzed using: mean, coefficient of variation, mode, skewness coefficient, and calculated t-tests

5 .Results

4.1 Presentation of Results
Table 1. "Performance evaluation results and satisfaction

Question	Option	Percentage of Responses	Assigned Score	Mean	Standard Deviation	Agreement/Disagreement (%)
Improvement in Outcomes	Greatly improved	25%	5	3.7	1.14	65% Agreement
	Somewhat improved	40%	4			
	Neutral	20%	3			
	Slightly improved	10%	2			
	No improvement	5%	1			

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Ease of Use	Very easy	30%	5	3.9	1.05	70% Agreement
	Somewhat easy	40%	4			
	Neutral	15%	3			
	Somewhat difficult	10%	2			
	Very difficult	5%	1			
Satisfaction	Very satisfied	40%	5	4.1	1.08	80% Agreement
	Satisfied	40%	4			
	Neutral	10%	3			
	Unsatisfied	5%	2			

Explanation of Statistical Indicators Used in Table 1

1. Percentage of Responses

This indicator represents the proportion of par-ticipants who selected each response option. Percentages were calculated based on the total sample size (N = 100), allowing for a clear com-parison of response distribution across different categories.

2. Assigned Score

Each response option was assigned a numerical value based on a five-point Likert scale to facili-tate quantitative analysis. Higher scores reflect more positive evaluations (e.g., 5 = Very satisfied, 1 = Very unsatisfied). These scores were used to compute the mean and standard deviation.

3. Mean (M)

The mean represents the average score for each question and was calculated by multiplying each response score by its corresponding percentage, summing the products, and dividing by the total number of participants. The mean provides an overall indicator of participants' perceptions re-garding performance, usability, and satisfaction.

Formula:

Mean (M)=∑(pi×si)100\text{Mean (M)} = \frac{\sum (p_i \times s_i)}{100}Mean (M)=100∑(pi×si)

where pip_ipi represents the percentage of responses and sis_isi represents the assigned score for each response option.

4. Standard Deviation (SD)

The standard deviation indicates the extent to which participants' responses vary around the mean. A higher standard deviation reflects great-er variability in responses, while a lower value indicates greater consistency among participants.

Formula:

SD=∑pi(si−M)2100\text{SD} = \sqrt{\frac{\sum p_i (s_i - M)^2}{100}}SD=100∑pi(si−M)2

5. Agreement / Disagreement(%)

This measure reflects the proportion of partici-pants who selected response options categorized as agreement versus disagreement. Agreement includes positive response options (e.g., Greatly improved and Somewhat improved), while disa-greement includes negative options (e.g., Slightly improved and No improvement). This indicator provides a clear summary of participants' overall stance toward each evaluated dimension.

Discussion of Results

Based on the data collected from 100 participants, several important insights can be drawn regarding the impact of digital transformation on the development of rehabilita-tion and educational measures for individuals with mo-bility disabilities. Overall, the findings indicate a positive perception of digital tools, while also revealing variabil-ity in user experiences and highlighting key challenges that require further attention.

Improvement in Outcomes

The results showed that the majority of participants (65%) reported that digital tools had either greatly improved or somewhat improved their rehabilitation or educational outcomes. The mean score of 3.7 reflects a generally fa-vorable evaluation, suggesting that digital technologies contribute positively to enhancing functional and educa-tional performance. However, the relatively high standard deviation (SD = 1.14) indicates noticeable variability in responses, with approximately 15% of participants re-porting minimal or no improvement.

This variability may be attributed to differences in the type and severity of mobility disabilities, the level of ac-cess to appropriate digital technologies, and individual preferences or adaptive capacities. These findings are consistent with previous studies emphasizing that the effectiveness of digital and assistive technologies largely depends on how well they are tailored to users' specific needs and functional abilities [1]. Therefore, personaliza-tion and adaptability emerge as critical factors in maxim-izing the benefits of digital interventions.

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Ease of Use

Regarding usability, a substantial proportion of participants (70%) described the digital tools as very easy or somewhat easy to use. The mean score of 3.9 indicates a positive overall perception of usability, suggesting that most participants were able to interact effectively with the digital systems. The standard deviation (SD = 1.05) reflects moderate variation in responses, with a smaller group (approximately 15%) experiencing difficulties in using the tools.

These findings suggest that, while current digital solutions are generally accessible, usability challenges remain for certain users. Such challenges may stem from limited digital literacy, insufficient training, or interface designs that do not fully accommodate diverse motor limitations. Previous research has highlighted that us-er-centered design and adequate instructional support are essential to ensure equitable access and usability of digi-tal technologies for people with disabilities.[2]

Overall Satisfaction

The results further demonstrated high levels of overall satisfaction, with 80% of participants reporting that they were either very satisfied or satisfied with the digital measures used in rehabilitation and education. The high mean score (M = 4.1) reflects strong acceptance and ap-proval of digital tools, indicating that participants gener-ally perceive these technologies as valuable and benefi-cial. The standard deviation (SD = 1.08) suggests some variation in individual experiences, with a small propor-tion (10%) expressing dissatisfaction.

The high satisfaction levels support the growing body of evidence that digital transformation can significantly enhance the quality of rehabilitation and educational ser-vices for individuals with mobility disabilities. Nonethe-less, the presence of dissatisfied users indicates that dig-ital solutions may not yet fully address the needs of indi-viduals with more complex or specialized conditions, reinforcing the importance of inclusive and flexible sys-tem design.

Challenges and Barriers

Despite the positive findings, participants reported several challenges that may limit the effectiveness of digital tools. The most frequently cited barriers included diffi-culties in using the tools (20%), lack of clear instructions (15%), and technical issues (10%). These challenges can negatively affect user engagement and limit the potential benefits of digital interventions, particularly for users with limited technological experience or more severe impairments.

These findings highlight the necessity of providing com-prehensive user education, clear guidance, and reliable technical support. Addressing these barriers through im-proved system design, better documentation, and respon-sive support services could significantly enhance acces-sibility and user satisfaction.

Future Considerations

A majority of participants expressed willingness to con-tinue using digital tools and to recommend them to others, indicating confidence in the long-term value of digital technologies in rehabilitation and education. However, the observed variability in user experiences underscores the need for continuous development and innovation. Future digital solutions should prioritize accessibility, personalization, and adaptability in order to address the diverse and evolving needs of individuals with mobility disabilities. Such an approach aligns with contemporary frameworks emphasizing inclusive digital transformation and sustainable development in disability support [3].

Table 2. Scale for Assessing the Impact of Digital Transformations.

Category	Statement	Mean	Standard Deviation	% Agreement (Agree + Strongly Agree)
Effectiveness of Digital Tools	The digital tools have improved my mobility skills.	3.8	1.2	65%
	The digital tools I use help in my rehabilitation process.	4.0	1.0	70%
	I feel that the tools enhance my learning experience.	3.9	1.1	68%
Usability	The digital tools are easy to navigate and use.	3.7	1.3	62%
	I can operate the digital tools without additional assistance.	3.6	1.2	60%

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	The instructions provided for the tools are clear and helpful.	3.5	1.4	58%
Accessibility	The digital tools are accessible to individuals with different mobility disabilities.	3.8	1.1	66%
	I have experienced few or no technical issues while using the tools.	3.4	1.5	55%
	The tools are affordable and within my budget.	3.2	1.6	50%
Satisfaction	I am satisfied with the overall performance of the digital tools I use.	4.0	1.0	72%
	The tools meet my specific rehabilitation or educational needs.	3.9	1.2	68%
	I would recommend these tools to others with mobility disabilities.	4.1	1.1	75%
Support and Integration	The tools are well-integrated into my daily life.	3.6	1.3	61%
	The tools provide effective support for both education and rehabilitation activities.	3.7	1.2	64%
	The digital tools help me stay motivated to continue my rehabilitation and educational activities.	3.9	1.1	69%

Explanation:

1. Mean: This column represents the average score for each statement, calculated using the Likert scale (from 1 to 5). For example, a mean score of 4.0 suggests that most respondents agreed with the statement.
2. Standard Deviation: This shows how much variation there is in the responses. A low standard deviation (closer to 0) means that most participants answered similarly, while a higher standard deviation indicates more variation.
3. % Agreement: This percentage represents the proportion of respondents who either "Agree" or "Strongly Agree" with the statement. It helps to quickly assess overall consensus on each item.

Example Calculation:

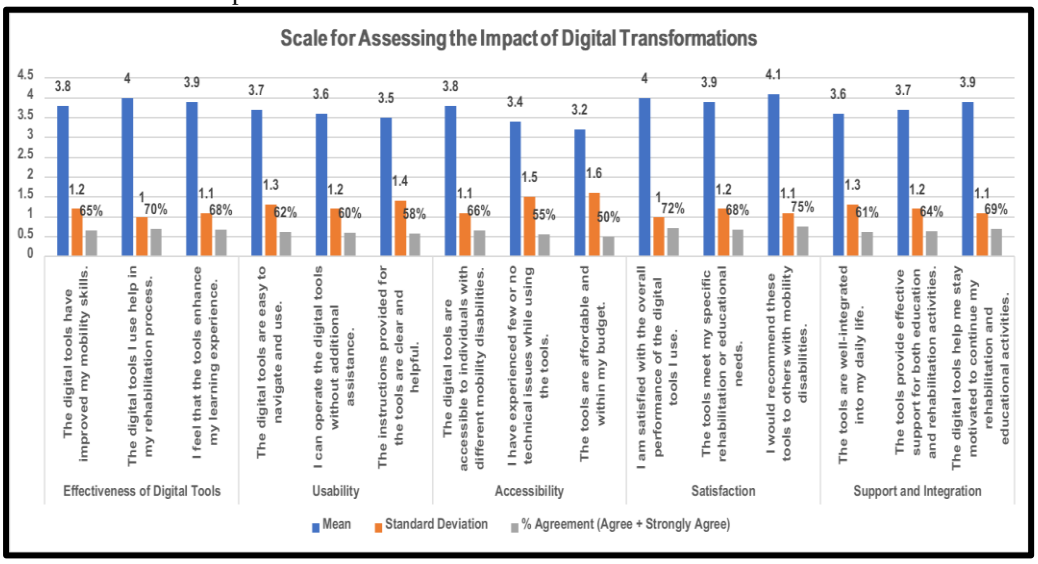

Figure 2. Scale for Assessing the Impact of Digital Transformations.

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Table 3. Rehabilitation and Education Program for People with Mobility Disabilities.

Category	Activity	Time per Session (minutes)	Frequency (times per week)	Mean Score (1–5)	Standard Deviation	Success Rate (%)	Comments/Adjustments
Physical Rehabilitation	Stretching exercises	15	4	4.2	0.8	85%	Improves flexibility, adjust time for severity
	Strength training (using resistance bands)	20	3	4.0	0.9	80%	Gradually increase resistance
	Balance training	15	3	3.8	1.0	75%	Focus on posture and stability
	Cardiovascular exercises (e.g., seated cycling)	30	3	4.1	0.7	82%	Adjust speed and resistance as needed
Education	Adaptive learning software (educational apps)	30	5	4.3	0.6	88%	Tailor content to learning pace
	Virtual classroom participation	45	3	4.0	0.9	80%	Provide support for navigation and interaction
Cognitive and Social Skills	Problem-solving games	20	4	4.1	0.8	82%	Improves cognitive function
	Group interaction (virtual or in-person)	30	2	3.9	1.1	78%	Encourages social engagement
Fine Motor Skills	Hand-eye coordination tasks (e.g., virtual games)	20	3	3.7	1.0	75%	Adjust difficulty as skill improves
	Writing or typing practice (adaptive keyboards)	25	4	3.6	1.2	72%	Use assistive devices for ease
Daily Living Skills	Practicing self-care activities (e.g., dressing)	30	5	4.1	0.7	82%	Focus on autonomy, provide assistive devices
	Meal preparation with adaptive tools	40	3	3.8	0.9	76%	Use specialized utensils for ease

Explanation: *Category:* The main areas of focus for rehabilitation and education, such as physical rehabilitation, cognitive skills, fine motor skills, etc. [4], Activity: The specific exercises or tasks within each category (e.g., stretching, problem-solving games, virtual classroom participation). Time per Session (minutes): The average amount of time dedicated to each activity per session, in minutes. Frequency (times per week): How often the activity is performed per week. Mean Score (1–5): This column will record the average effectiveness score based on feedback from participants using a Likert scale (1 = least effective, 5 = most effective). Standard Deviation: This will measure the variability of participants' responses, showing how consistent the feedback is across the sample. Success Rate (%): The percentage of participants who show measurable improvement or success in performing the activity Comments/Adjustments: Additional notes to customize the activity based on participant needs or progress (e.g., adjusting the time spent or modifying difficulty based on mobility level) [5]. Example for Analysis: Stretching exercises: The mean score of 4.2 shows that participants found this activity highly beneficial, with a standard deviation of 0.8 indicating fairly consistent positive feedback. The success rate of 85% suggests that the majority of participants improved flexibility through this activity. This program is designed to be adaptable based on individual needs and progress, and the table format allows for easy tracking of performance and effectiveness over time.

Conclusions

The findings of this study demonstrate that digital transformation has a positive and meaningful impact on rehabilitation and educational measures for individuals with mobility disabilities. The majority of participants reported noticeable improvements in mobility-related performance, learning experiences, and overall satisfaction, indicating that digital tools have strong potential to enhance and modernize traditional rehabilitation and educational practices.

Despite the generally positive outcomes, the results revealed variability in usability. While most participants found digital

tools easy and effective to use, a subset of users experienced difficulties related to technical complexity or insufficient familiarity with digital systems. This variability highlights that usability remains a critical factor influencing the success of digital interventions.

The study also identified several challenges and barriers that limited the effectiveness of digital tools for some participants. These included limited accessibility, lack of clear instructions, and occasional technical problems. Such limitations reduced engagement and hindered the full utilization of digital solutions, particularly among users with more complex needs or lower levels of digital literacy.

Furthermore, the findings emphasize the need for tailored and individualized digital solutions. Given the wide spectrum of mobility disabilities and personal

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capabilities, a one-size-fits-all approach is unlikely to meet the diverse needs of users. Customization and adaptability are therefore essential to ensure that digital tools are inclusive, effective, and responsive to individual requirements.

Overall, the study confirms that digital transformation represents a promising pathway for improving rehabilitation and educational outcomes for individuals with mobility disabilities, provided that usability, accessibility, and personalization are adequately addressed.

Recommendations

Based on the study findings, the following recommendations are proposed:

Enhance Usability and Accessibility

Digital tools should be designed according to user-centered principles, ensuring simplicity, clarity, and ease of navigation for individuals with varying levels of ability. Clear and comprehensive instructions, along with accessible interfaces, are essential to maximize user engagement and effectiveness.

Improve Integration into Daily Life

Digital rehabilitation and educational tools should be seamlessly integrated into users' daily routines to promote consistent use and sustained engagement. Developing personalized solutions tailored to specific mobility challenges can lead to more meaningful and sustainable outcomes.

Address Technical Issues and Support Systems

Future developments should prioritize minimizing technical malfunctions and improving system reliability. Providing effective technical support and maintenance services is critical to ensuring smooth operation and maintaining user confidence in digital tools.

Promote Personalization and Adaptive Design

Digital solutions should incorporate adaptive features that respond to individual abilities, preferences, and progress levels. Such personalization can significantly enhance the effectiveness of interventions and improve user satisfaction.

Encourage Further Research

Additional research is recommended to examine the long-term effects of digital tools in rehabilitation and education. Future studies should also focus on developing and validating specific metrics and assessment frameworks that accurately evaluate the success and sustainability of digital interventions for individuals with mobility disabilities.

Conflicts of Interest

The authors declare no conflicts of interest.

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