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Comprehensive Framework for Addressing the Challenges of Technology-Enhanced Learning (TEL)

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ABSTRACT: In the context of vocational education in Indonesia, integrating technology-enhanced learning (TEL) is becoming increasingly important to improve the quality of education and prepare students for the demands of the evolving labour market. Five key strategies can be implemented to address the challenges of TEL implementation. This study focuses on polytechnics acting as strategy owners in these endeavours, while environmental constraints included budget limitations, resistance to change and technical challenges, and using 4 of the first stages of SSM. Through the model, polytechnics in Indonesia can holistically address the complexities of TEL to improve vocational education. In integrating TEL, the roles of educators, stu-dents, IT departments, and government are key. In addition, it is important to overcome environmental constraints such as budget limitations and resistance to change to achieve success in TEL adoption and prepare students with relevant skills for the digital age. Thus, these strategies provide a comprehensive view of how to address the challenges and realize the potential of TEL in improving vocational education in Indonesia.

KEYWORDS: Digital Technology, SSM, Technology-Enhanced Learning, Vocational Higher Education.

I. INTRODUCTION

In vocational education, the leading role is practical training as the basis for desveloping the activity-based component of professional competence [1][2]. It is expected to better prepare students for the current and future labour market and society as a whole and make education more at-tractive to students in the hope that fewer students will quit before attaining their qualifications. Yet competency-based education is a container concept, and there is no consensus about what exactly is meant by it, neither in theory nor in practice [3]. The introduction of competency-based education has increased the importance of learning in the workplace and has emphasized the importance of connectivity between learning in an educational setting and the workplace. One of the challenge domains developed by is Technology Enhance Learning (TEL), with six main challenge domains: learning, social and cognitive, policy, or-ganization, and resources [4]. The first three challenges consist of humans (learner and educator), the organizational setting in which the learning takes place, and the interaction between them [5]. The last three challenges were identified by [3] and identified within the seven challenges illustrated in Figure 1; however, the organizational and human aspects have not been deeply investigated [4]

Integrating practical training aims to equip students with skills that resonate in current and future labour markets, thereby increasing the attractiveness of education and reducing dropout rates. This emphasis on prac-tical competence embodies the essence of competency-based education, a concept that, although widely recog-nized, lacks consensus in theory and practice [3]. The move towards competency-based education has increased the importance of workplace learning, creating a crucial link between educational environments and professional settings. The synergy between practical training and technology-enhanced learning (TEL) is paramount in Indonesia's vocational higher education landscape. Integrating practical skills with technology-enhanced pedagogies becomes crucial as the country seeks to prepare its students to excel in today's labour market. Aligning practical experience with digital tools equips learners with real-world skills and fosters their competence to navigate the intricate dynamics of their chosen professions [6]

In Indonesia's vocational higher education landscape, the collaboration between practical training and technology-enhanced learning (TEL) is paramount. As the country seeks to prepare its students to excel in to-day's job market, integrating practical skills with technology-enhanced pedagogies is becoming crucial. Aligning practical experience with digital tools equips learners with real-world skills and fosters their competence to navigate the intricate dynamics of their chosen professions [7][8].

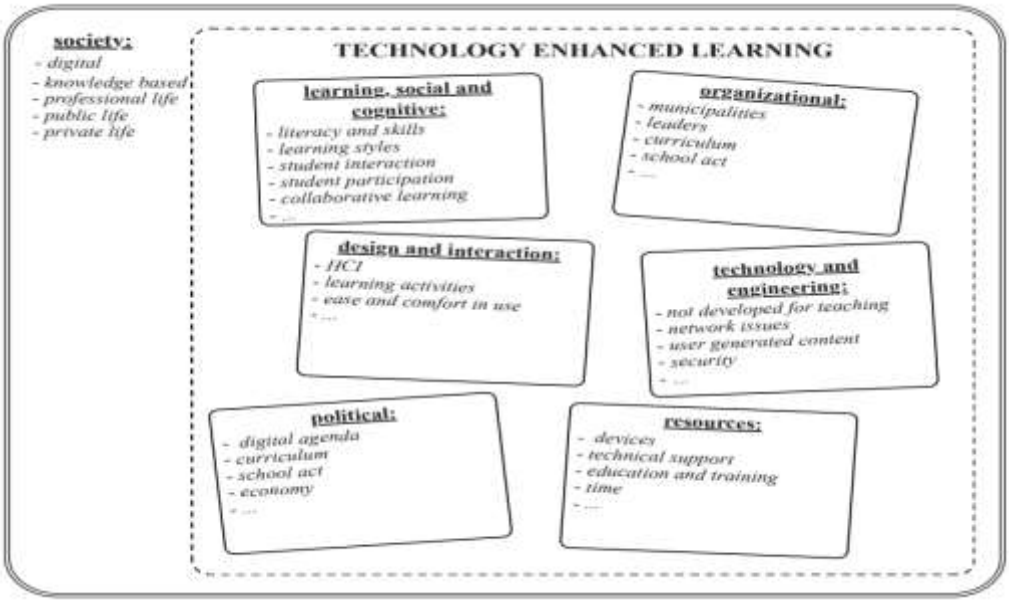

Figure 1. TEL challenge domains

However, addressing the challenges of TEL in vocational higher education requires a holistic approach. Bridging the organizational and human aspects is essential to create a symbiotic learning environment. VHE institutions need to cultivate a seamless fusion of practical exposure and technology integration to ensure that learners are competent in their respective fields and equipped to harness the transformative power of digital tools. This means designing curricula that combine theoretical foundations with practical applications while leveraging digital platforms to enhance engagement, collaboration, and skills development [9][10].

The confluence of practical training and technology-enhanced learning (TEL) is a critical frontier in Indo-nesia's vocational higher education journey [11][12]. By skillfully blending practical experience with digital skills, institutions can produce graduates who are both professionally adept and technologically savvy, positioning them to excel in the ever-evolving professional landscape. Technology En-hanced Learning (TEL) has gained immense importance as the world moves into the digital age. TEL involves integrating technology into the learning process and touches on various aspects of education. This framework addresses the seven challenge areas identified, highlighting the complexity of TEL and its impact on society [4][5]. The framework also considers the role of technology companies in education, the use of digital transformation frameworks, and the application of soft systems methodology (SSM) to address the challenges educators and stakeholders face. This study aims to explore and provide insights into the holistic approach required to navigate the challenges of TEL in vocational higher education in Indonesia, with a focus on bridging organizational and human aspects to leveraging digital platforms, thereby equipping learners with both vocational competence and technological adeptness for success in the dynamic professional landscape.

II. RESEARCH METHOD

Soft System Methodology (SSM) is an approach Peter Checkland developed in systems thinking. It is designed to tackle complex, unstructured, and ill-defined problems involving multiple perspectives and diverse stakeholders. SSM is beneficial when there is no explicit agreement on the problem definition, and the solution is not apparent. In addressing the challenges of Technology-Enhanced Learning (TEL), SSM can provide a structured and systematic way to understand and address the issues educators face when adopting digital technologies. The Complex Problematic Situation Using the Rich Picture technique of Soft Systems Methodology, various entities, actors, roles, relationships, and viewpoints. The evolution of society can be considered the most powerful and influential factor as it influences all aspects of society, from the development of digital technologies to the ways organizations and working life are conducted, organized, and carried out. They are brief sentences that usually begin with CATWOE [13]. To deal with systems problems (exceedingly soft systems problems involving human activities), all stakeholders should become participants [14]. The Complex Problematic Situation Using the Rich Picture technique of Soft Systems Methodology, various entities, actors, roles, relationships, and viewpoints.

The evolution of society can be considered the most powerful and influential factor as it influences all aspects of culture, from the development of digital technologies to the ways organisations and working life is conducted, organised, and carried out. The development of different societies influences all individuals, including educators, students, and prospective educators [4]; Salavati et al., 2021). The primary constructs of SSM are Root definitions (RD) which are succinct descriptions of notional systems of human activity. They are brief sentences that usually begin with CATWOE [13]. The process of SSM is illustrated in Fig. 2.

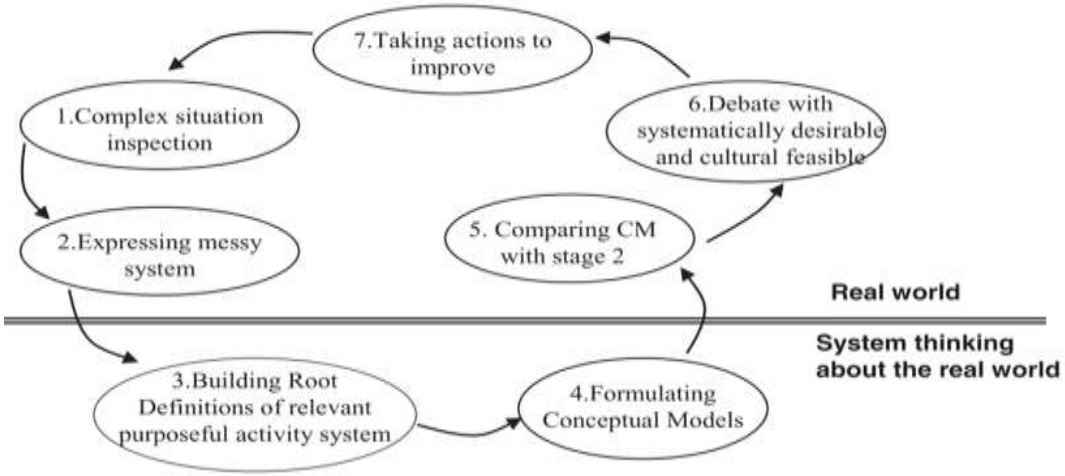

Fig. 2: Seven Steps of SSM [13]

The real-world situation is examined and expressed, often in a "rich picture." Then, a variety of RD/CM pairs are developed from different perspectives. These models are then compared with the appreciation of the actual situation generated in the first stage, and the differences then form the subjects for debate about desirable and feasible changes. However, in this study, the SSM helps address the problems associated with educators' limited understanding and adoption of digital technologies only in the following ways [14][15][16].

1. Structured Problem Analysis: SSM provides a structured framework for analyzing complex problems. It starts with problem identification and definition, allowing educators to clarify the precise nature of the challenges they face in adopting digital technologies.
2. Multiple Perspectives (CATWOE): SSM encourages considering numerous perspectives through the CATWOE analysis. This helps in understanding the problem from various angles, including those of Customers (Educators), Actors (Stakeholders), Owners (Institutions), and others. SSM ensures that the solutions address their specific concerns and needs by involving all relevant parties.
3. Root Definitions: SSM involves creating root definitions that define the boundaries of the problem situation. Doing so helps identify the core issues and constraints related to the limited adoption of digital technologies in education. This can include issues related to training, pedagogical shifts, and perceptions of technology.
4. Conceptual Models: SSM encourages the development of conceptual models to represent the current state of affairs and how different elements interact. In this context, it can mean the educators' current practices, understanding of digital technologies, and their challenges in adopting them.

III. RESULT AND DISSCUSSION

Educators often struggle to understand why they should adopt digital technologies in their teaching, which complicates their daily practices. Current in-service training is insufficient to persuade educators to use digital technology, mainly when it necessitates a shift in their teaching philosophy and is perceived as cumbersome. Educators also face difficulties when digital technologies are perceived as inflexible, awkward, or prone to malfunctions. Concepts like equity and the practical use of digital technologies are unclear and vary in meaning depending on stakeholders' perspectives. Different actors involved in education often attribute conflicting or contradictory meanings to the same concepts, leading to uncertainty in practice. Therefore, this 4-stage SSM has been carried out based on the following stages.

A. *Problem Situation Unfolding*

In this stage, the problem revolves around effectively implementing Technology Enhanced Learning (TEL) in vocational education institutions. In depth interviews with polytechnic scholars, they stated that TEL aims to bridge the gap between traditional teaching methods and technology-driven learning. However, there are chal-lenges in its adoption, and vocational HE institutions are under pressure to prepare students for the modern job market, which increasingly demands digital skills. The central issue pertains to successfully implementing Technology Enhanced Learning (TEL) within vocational education institutions. TEL represents a paradigm shift in educational practices, aiming to integrate technology into learning seamlessly. However, this transition is far from straightforward, as several challenges and complexities emerge.

At its core, TEL seeks to bridge the gap between traditional teaching methods, which often rely on chalkboards and textbooks, and the dynamic landscape of technology-driven learning. In an era where digital tools and re-sources have become integral to daily life, adopting technology in education is advantageous and increasingly necessary. This shift is accentuated by the evolving

demands of the modern job market, which places a premium on digital skills and competencies. Vocational education institutions, in particular, find themselves under con-siderable pressure to equip their students with the practical skills required for employment in a digital age.

However, the challenges in implementing TEL are multifaceted. These encompass issues such as limited fi-nancial resources, the availability of technology infrastructure, and varying levels of digital readiness among educators. Successfully integrating TEL within vocational education requires addressing these practical hurdles and ensuring that digital tools are effectively aligned with the unique learning objectives of vocational programs. Thus, the problem is twofold: enabling access to technology and ensuring its meaningful integration to prepare students for the digital demands of the contemporary job market.

B. *Problem Expressing*

The next stage expresses the problem as the need for vocational institutions to successfully integrate TEL to equip students with practical vocational skills and digital proficiency. Constraints such as limited financial re-sources, the need for technology infrastructure, and educators' varying levels of digital readiness pose significant challenges. SSM encourages considering multiple perspectives through the CATWOE analysis to make it com-prehensive. This helps in understanding the problem from various angles, including those of Customers (Edu-cators), Actors (Stakeholders), Owners (Institutions), and others. By involving all relevant parties, SSM ensures that the solutions address their specific concerns and needs, as explained in table 1 below.

The CATWOE analysis sheds light on the complex web of stakeholders and contextual factors in digital technology adoption in education. Starting with customers (C), it is clear that educators are the core group facing the challenge. They struggle with the fundamental question of why they should incorporate digital technologies into their teaching practices. This lack of understanding is a critical obstacle. The Actors (A) include the edu-cators, the training departments responsible for their development, and the institutions supporting this trans-formation. The transformation process (T) is the epi-center of change, reflecting the shift from conventional teaching methods to the effective use of digital technologies. The Worldview (W) aspect encapsulates the over-arching perspective beyond the classroom and recognizes the broader educational goals that digital technologies can fulfill. Owners (O), typically vocational institutions, take responsibility for providing the necessary support, training, and resources. Finally, Environmental Constraints (E), including limited budgets, resistance to change and financial constraints, set the boundaries within this transformation.

Table 1. CATWOE analysis with the additional points related to the problem expressing

Element	Description
Customers (C)	Educators who struggle to understand why and how they should adopt digital technologies.
Actors (A)	Educators, training departments, and institutions responsible for training and support.
Transformation (T)	The shift from traditional teaching methods to effective use of digital technologies.
Weltanschauung (W)	The overarching perspective recognizes the broader educational objectives of technology.
Owner (O)	Vocational institutions are responsible for providing necessary support, training, and resources.
Environmental (E)	Constraints include limited budgets, resistance to change, financial conditions, and more.

Complementing the CATWOE analysis, the problem statement stage articulates the complexity. The challenge is a broad need for educators to understand the rationale for adopting digital technologies in education. This basic understanding is hampered by educators' resistance to change, a challenge exacerbated by their limited digital literacy. Inadequate professional development programs are the final piece in this complex puzzle, often failing to convince educators of the inherent value of technology-enhanced learning (TEL) and its alignment with broader educational goals. These challenges create a multifaceted problem landscape that requires a holistic approach to bridge the understanding gap and facilitate the effective integration of digital technologies in edu-cation.

C. *Root Definitions*

Vocational institution (owner and client): The VEH institution is both the owner and the customer of the target. As the owner, the institution is responsible for successfully implementing Technology Enhanced Learning (TEL) within its educational framework. As a customer, it seeks improved educational outcomes through the integration of digital technologies to improve the overall quality of the vocational training it provides.

Educators (Actors): Educators are the main actors in this context. They are responsible for implementing TEL strategies in their teaching practice. Their role is crucial in shaping how digital technologies are used and inte-grated into VEH, thus influencing students' learning experiences.

Government (resource and environment): In this scenario, the government acts as both a resource and a background. As a resource, it provides the funding, policies, and support necessary for the successful imple-mentation of TEL in VEH. At the same

time, it acts as an environmental factor by regulating and setting guide-lines for VEH, thereby creating the context in which TEL initiatives operate.

Students (actors and customers): Students are both actors and customers in this context. As Actors, they ac-tively engage with TEL tools and platforms as part of their learning journey. As Customers, they expect a high-quality vocational education experience enriched by digital technologies, ultimately aiming to acquire relevant skills and knowledge for their future careers.

Digital technology (resource): Digital technology is a critical resource required to implement TEL success-fully. It encompasses various tools, platforms, and infrastructure to facilitate compelling digital learning expe-riences in vocational education and training.

These basic definitions provide a deeper understanding of the roles and relationships between key elements in the context of TEL in VEH. They highlight the interconnectedness of VEH institutions, educators, government, students, and digital technology in pursuing improved educational outcomes and advancing VEH practice.

1. Then, in root definitions, we specify the key elements of the problem situation:
2. The "Vocational Institution" serves as the Owner and Customer of the objective, representing vocational education providers.
3. "Educators" are the main actors responsible for implementing TEL.
4. The "Government" acts as a Resource and Environment, as it funds and regulates vocational education.
5. "Students" are both Actors and Customers, as they are the beneficiaries of vocational education.
6. "Digital Technology" is a Resource crucial for TEL implementation.

D. Conceptual Models:

This conceptual model represents the current state of TEL in vocational education and depicts how educators integrate technology, digital resource availability, and the existing curriculum structure. The models should capture educators' varying levels of digital readiness and students' experiences with TEL.

The limited understanding of why digital technologies should be adopted and used is a significant issue that adds to educators' everyday practice complexity. This condition has a substantial impact on educators who struggle with the use of digital technologies. The research shows that in-service training is insufficient to convince educators to use digital technologies. This is particularly the case when it requires a change in educators' pedagogical philosophy and worldview and when the technology is often experienced as inflexible, clumsy, and dysfunctional, in addition to a limited understanding of why; the research also showed that crucial concepts such as equity and natural/practical use of digital technologies are unclear and ambiguous in multiple ways. The ambiguity depends on which stakeholder or actor perspective is considered. Because of the ambiguity identified, there are uncertainties in understanding these key concepts and how they should be implemented. Furthermore, different actors sometimes attribute conflicting or contradictory meanings to the same ideas. Here is the conceptual model synthesized from several stages already passed through.

Table 2. Conceptual Model of TEL Vocational Education

Strategy Name	Customers (C)	Actors (A)	Transformation Process (T)	Weltanschauung (W)	Owner (O)	Environmental Constraints (E)
Professional Development	Educators	Educators, Training Departments	Training programs that emphasize the pedagogical value of TEL	A shift toward a technology-integrated, student-centered education approach	Vocational HE	Limited budget for training resources, resistance to change
Digital Literacy Curriculum	Students, Educators	Educators	Curriculum development to incorporate digital literacy skills	Recognizing digital literacy as a fundamental skill for students' future employability	Vocational HE	Limited time within the curriculum, need for additional resources
Technology Infrastructure Upgrade	Educators, IT Departments	IT Departments	Upgrading technology infrastructure to support TEL	Ensuring that infrastructure aligns with the objectives of TEL	Vocational HE	Financial constraints, technical challenges

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Collaborative Online Projects	Students, Educators	Educators, Administrators	Implementing collaborative online projects as part of coursework	Emphasizing the importance of collaborative skills in the digital age	Vocational HE	Limited access to collaborative tools, training needs
Digital Assessment Tools	Students, Educators	Educators, Assessment Departments	Integration of digital assessment tools	Recognizing the efficiency and objectivity of digital assessments	Vocational HE	Ensuring equitable access, addressing concerns of cheating

In the context of polytechnics in Indonesia, the conceptual model for technology-enhanced learning (TEL) in vocational education is a vital tool to improve the quality of teaching and prepare students for the growing labour market. Five main strategies can be implemented in this context:

1. Professional development: This strategy makes educators the main stakeholders (customers) and key actors (actors). In the transformation process, this strategy involves developing training programmes that emphasise the pedagogical value of TEL. The worldview behind this strategy is a shift towards technology-centred, student-centred education. Ownership of this strategy lies with the polytechnic itself, but environmental constraints such as limited budgets and resistance to change remain a challenge.
2. Digital literacy curriculum: This strategy involves students and teachers as stakeholders (customers and actors). The transformation process focuses on the development of a curriculum that integrates digital literacy skills. The worldview behind this is the recognition of digital literacy as a fundamental skill for the future employability of students. The owner of this strategy is the Polytechnic (Vocational HE), while the environmental constraints include time constraints in the curriculum and the need for additional resources.
3. Technology Infrastructure Upgrade: In this strategy, the stakeholders are the teachers and the IT department, while the main actors are the IT department. The transformation process involves upgrading the technology infrastructure to support TEL. The worldview behind this is the infrastructure that supports the TEL goals. The Polytechnic (Vocational HE) is the strategy owner, but the environmental constraints include financial and technical challenges.
4. Collaborative online projects: This strategy involves students, teachers, and administrators as stakeholders and actors. The transformation consists of implementing collaborative online projects as part of the curriculum. The worldview behind this is the importance of collaborative skills in the digital age. Polytechnics (vocational colleges) have a role as strategy owners, but constraints include limited access to collaboration tools and training needs.
5. Digital assessment tools: This strategy has students, teachers, and the assessment department as stakeholders and actors. The transformation process involves the integration of digital assessment tools. The underlying worldview is the efficiency and objectivity of digital assessment. Polytechnics (Vocational HE) has the role of strategy owner, but the environmental challenges include efforts to ensure equitable access and address issues of cheating.

These five strategies provide a holistic view of addressing TEL challenges in the context of polytechnics in Indonesia, focusing on strengthening the quality of education and preparing students for an increasingly complex labour market.

IV. CONCLUSION AND REOMMENDATION

Soft System Methodology (SSM) offers a structured and holistic approach to understanding and addressing the challenges of Technology-Enhanced Learning. By acknowledging the complexities, ambiguities, and diverse perspectives, educators and stakeholders can collaboratively develop more effective strategies for integrating technology into education while considering the broader societal implications. SSM helps in understanding the complex and interconnected nature of challenges in TEL. It considers the human, organizational, and techno-logical aspects, ensuring that solutions are comprehensive and balanced. By involving diverse stakeholders and their perspectives, SSM provides solutions that are more inclusive and representative of the different needs and concerns of educators, students, administrators, and others. Therefore, this allows for continuous improvement of solutions in the dynamic context of TEL.

In the context of Technology Enhanced Learning (TEL), the limited understanding of why digital technol-ogies should be adopted and used is a critical issue that significantly impacts educators' everyday practices. This challenge adds a layer of complexity to the integration of technology in education, particularly in vocational settings. Let's elaborate on how this issue aligns with the TEL framework. One of the core challenges lies in convincing educators to embrace digital technology as an integral part of their teaching methodology. This often requires a fundamental shift in pedagogical philosophy and educators' worldviews. Traditional teaching methods may have been deeply ingrained in their practices, and adopting digital tools may seem

like a disruptive change. In this context, TEL not only involves the technical aspect of technology integration but also necessitates a profound reevaluation of teaching approaches and beliefs about effective education.

The research underscores that in-service training programs are often inadequate in preparing educators to use digital technology effectively. This inadequacy is particularly pronounced when educators are expected to transition to a technology-enhanced teaching approach. TEL demands more than just technical training; it re-quires educators to understand technology integration's pedagogical value and broader educational objectives. Without comprehensive training addressing these aspects, educators may struggle to navigate the complexities of TEL.

The research also highlights the ambiguity surrounding central concepts in TEL, such as equity and the natural/practical use of digital technologies. These concepts may have different interpretations depending on various stakeholders' perspectives, including educators, administrators, policymakers, and students. This ambi-guity leads to uncertainties in understanding how these concepts should be translated into practical educational practices. Conflicting or contradictory meanings assigned to these concepts can further hinder the cohesive adoption of TEL strategies.

In the TEL framework, addressing these challenges involves providing technical training and comprehen-sive professional development that aligns with educators' pedagogical philosophies. Furthermore, it requires a clear and shared understanding of central concepts like equity and the purpose of digital technologies in educa-tion. By fostering a collaborative environment that supports educators in their journey toward TEL adoption and addressing the philosophical, technical, and conceptual aspects, vocational education institutions can navigate the complexity of TEL and empower educators to leverage digital technologies for enhanced learning experi-ences effectively.

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