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Empowering Curriculum Design Stakeholders with AI in Higher Education

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***Abstract*—In the 21st century, higher education (HE) operates within the context of a VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) environment, characterized by rapid disruptions events across e.g. economic, geopolitical, and social domains, affecting also HE. Among these disruptions, the accelerating advancement and public usage of Generative Artificial Intelligence (AI), initiated after 2020, presents both significant challenges and transformative opportunities for HE institutions. To remain relevant and future-ready, HE must adapt swiftly, forward-looking and strategically by designing and developing curricula that are not only aligned with emerging knowledge and technological trends but also resilient to the uncertainties and futures of the globalized VUCA landscape. This paper proposes a conceptual framework designed to empower stakeholders in their curriculum development and revision processes through AI-enabled collaboration. It emphasizes the integration of AI while promoting stakeholder synergy as a critical component of sustainable curriculum development. Furthermore, this framework underscores the importance of equipping graduates with both technical competencies and essential 21st-century skills to ensure their adaptability in a rapidly evolving VUCA global environment, empowered by a new AI era.**

Keywords—Curriculum Design; Artificial Intelligence; Higher Education; VUCA

I. INTRODUCTION

The 2020 COVID-19 pandemic and rapid technological advancements have disrupted nearly every sector worldwide, including education. Accordingly, somehow, systemic changes have been reinforced in the beginning of the 2020's, a new normal world commonly referred to as the VUCA environment: Volatility, Uncertainty, Complexity, and Ambiguity [1]. In this increasingly unpredictable global context, the ability to respond swiftly and adapt strategically has become a crucial priority for Higher Education (HE) institutions. Planning the future now demands flexible, responsive and pro-reactive methods for curriculum designers, methods that can address rapidly evolving challenges. As a key sector for advancing education, HE must actively integrate 21st-century skills and emerging technologies in the teaching and learning process [2]. This means HE requires a sustained commitment to equipping students with the competencies, skills, and ethical grounding necessary to navigate the complexities of a VUCA-driven world [3]. The realities of the VUCA environment brings opportunities and challenges, pushing HE institutions to consistently reassess and refine their strategies to remain responsive and stay relevant. In these shifting conditions, the quality of graduates remains one of the clearest markers of educational effectiveness. To ensure alignment with both academic and societal needs, curricula must be thoughtfully structured to align course content and learning outcomes, but also character development and practical competencies required by employers. These elements serve to meet coherency of instructional practices with institutional objectives and real-world competency expectations. As graduates capabilities represent the core outcome of higher education, curricular design must emphasize adaptability, flexibility, and future-oriented thinking preparing students not only academically prepared but also capable of contributing meaningfully in an increasingly dynamic global environment.

Today's VUCA landscape is further amplified by the rapid rise of Artificial intelligence (AI) which has demonstrated the potential to transform various aspects in human life through the development of various AI tools such as machine learning, natural language processing, and data analytics [4]. In this evolving context, technological advancements support HE in leveraging the opportunities to improve academic process, particularly in curriculum design. AI today, even if still controversial for the learners usage, can be of great help for educational programme leaders in their more reactive curriculum revisions. A research study by [5] found that the adoption of technology within the education sector progressed slowly between 1985 and 1995, a trend further supported by [6] who observed that HE institutions often lag behind the general public in integrating emerging technologies. There may also be resistance to the integration of AI still in the 2025's, particularly from the stakeholders [7]

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who may view AI as a threat to their traditional roles or fear that it could lead to job displacement.

Nowadays, to overcome this resistance requires proactive approach, clear communication and a focus on the complimentary of human and AI roles, toward these diverse stakeholders of HE. While this cautious approach may have been justifiable in earlier decades, the current educational landscape characterized by increasing accessibility to advanced technologies and the disruptive dynamics of a VUCA environment, demands a more proactive and responsive stance. Strategic opportunities are now in the HE landscape. Emerging collaborations between educators (human expertise) and AI technologies are beginning to define promising strategies for developing curricula that are relevant to present needs and resilient to withstand future disruptions with a central focus on maintaining the quality and relevance of graduates in an increasingly complex and technology-driven landscape. Curriculum design in HE, supported for quality assurance and accreditation processes, requires the active participation of academic and professional stakeholders, whose contributions are essential for continuously revising graduates' competencies [8]. HE has as a must to engage with diverse internal and external stakeholder groups. The internal stakeholders typically include HE leaders, lecturers, faculty staff, and students, while the external stakeholders are more government ministries, alumni, professional associations, society, and industry partners [9]. These stakeholders not only influence institutional priorities but are also influenced by them. They play a significant role in shaping the changes and strategic planning of HE institutions, thus it is crucial for HE to recognize and understand the unique value each stakeholder brings to the curriculum design process for ensuring its relevance at right times [10].

This paper aims to examine the sustainable collaboration between stakeholders and AI in the development of HE curricula within the context of VUCA environments. It explores how AI can empower stakeholders engagement and contribute to the design of curricula that are adaptive, inclusive, and future-oriented to respond effectively to global shifts and unforeseen rapid challenges. The study results in a conceptual framework that fosters strategic interaction between human and technological input across the curriculum development cycle, with the objective of fostering relevance, quality, as resilience in higher education outcomes.

II. LITERATURE REVIEW

A. VUCA Environments and their impact on HE

The last few years, since the COVID crisis, the world is undergoing a significant transformation characterized by unpredictable circumstances. This phenomenon is commonly called the VUCA phenomenon [11]. In the military context in the 1980s, the VUCA characteristics were introduced [12] [13]. This concept has since been applied to various sectors, including HE, where institutions face increasingly dynamic and unstable conditions.

- **Volatility** pertains to turbulent and unpredictable events. In this 21st century, the rise of the digital economy, rapid technological advancements, and increased global competition [14] are critical factors impacting the temporal stability of HE. This volatility compels HE institutions to more rapidly redefine their mission and revise their curriculum in a faster pace, ensuring that graduates possess the skills and abilities required by the job markets [15].
- **Uncertainty** refers to the challenges of forecasting the future events. Nowadays, there are less certainties in the future [16]. This situation is particularly pertinent to HE, where fluctuating national and international economic and employment conditions and fast-changing technology create an unpredictable job market for graduates. As a result, HE institutions and their curricula must not only anticipate change but also equip students with the adaptability and creative problem-solving skills needed to thrive in uncertain environments.
- **Complexity,** as defined by [17], stems from the interplay of numerous internal and external factors that make it challenging to fully understand or resolve specific issues. The volatility and uncertainty of the future heighten this complexity. HE institutions today face growing pressure to navigate these intricate dynamics and systemic cause-chain effects, demanding more agile and responsive approaches to governance and curriculum design [18].
- **Ambiguity** describes a lack of clarity regarding an event's threats, opportunities, or causes associated with a particular phenomenon. In the context of HE, it presents a significant obstacle, especially when institutions must respond to emergent technological or economic developments without definitive clear guidance [19]. Addressing such ambiguity requires a forward-thinking mindset among educators and policymakers, acceptance of unknown unknows, encouraging institutions to remain flexible and proactive in adapting to emerging trends, supported by continuous curriculum revisions and dynamic policy formulation.

In response to the VUCA environment, characterizing the current global landscape, HE institutions must now more than ever critically reassess and clearly articulate their educational mission. Relying solely on the traditional academic models, with long-term accreditation cycles, are no longer adequate to meet the demands of this rapidly evolving environment, leading to a demand for innovative approaches to curriculum development that can foster skills of students [20], but also educational program managers [21]. As such, HE must transition toward a more dynamic framework that addresses the multifaceted challenges posed by VUCA conditions. To realize this new adaptative vision, HE must design, develop and implement curricula that are flexible, adaptive, and future-ready. Such curricula should be responsive to emerging trends, capable of integrating new technologies at pace, and aligned with evolving but unstable industry and labor market demands. Furthermore, when required, curricular reforms must support the holistic development of students and societal readiness, reinforcing not only their intellectual capacities but also their dispositions and character strengths [22].

B. Human-AI Collaboration in HE

Digital technology is one-factor driving in transforming the educational landscape, significantly enhancing the teaching and learning process. Among these technologies, AI has emerged as a prominent and fast-evolving field since

2020, influencing a wide range of sectors including HE. By mimicking certain aspects of human cognition and behavior, even if still several bias, AI systems offer intuitive interaction, thereby promoting more seamless integration and collaboration between human users and intelligent systems. The integration of AI into educational settings has now the potential to significantly enrich learning experiences. In conventional classrooms, student engagement is often limited due to time constraints and restricted educator-student interaction. As noted by [23], tools such as ChatGPT can play a transformative role, particularly in language instruction. In this context, students are able to engage in real-time conversation or written-practice, receiving immediate feedback on grammar and constructive suggestions for improving sentence structure and overall composition.

Generative Artificial Intelligence (GenAI) has also introduced exciting new opportunities for educational innovation. It facilitates personalized learning by adapting content to individual students' learning paces and needs, while also streamlining routine administrative functions [24]. Moreover, to support students by answering questions and clarifying complex concepts, AI-powered systems aid educators in creating quizzes and instructional materials tailored to specific learning objectives [25]. Less investigated from now, in the context of HE, AI presents collaboration to support and enhance engagement among various stakeholders, including institutional leaders, faculty members, and students. More than course design at a micro level mostly considered and tooled the last few years, AI can also empower educational program leaders in their whole curriculum transformations, at a more meso level. AI applications range from administrative optimization to personalized learning environments, positioning it as a catalyst for innovation in educational practice. Although much of the recent literature such as [26] and [27], highlights the challenges and potential disruptions posed by AI, it is also crucial to consider how these technologies can be leveraged to create dynamic and adaptive curricula. This predominantly critical focus may inadvertently slow the adoption of AI within educational contexts temporarily, thereby limiting the ability of HE stakeholders to design curricula that are flexible, adaptive, resilient, and future-oriented. Moreover, despite the growing capabilities of GenAI tools, their integration into educational practice remains limited in their qualitative analysis. As noted by [5] and [6], the education sector, with its inertia, has been cautious in embracing these innovations, often underutilizing their potential to enhance teaching and learning outcomes.

In response to ongoing global disruptions, HE institutions must best consider integrating AI into curriculum design. Doing so enables educators to adapt teaching materials and learning outcomes to better align with the demands of an evolving world and programme leaders to reinforce the adequacy of their curricula. To ensure effective implementation, it is essential to actively engage stakeholders including HE leaders, faculty, students, and industry partners in the feedback process. Their insights can help clarify the appropriate role of AI in shaping curricula that are both responsive and future-oriented.

HE institutions are now more and more accustomed to adopt an iterative approach to curriculum design to stay aligned with evolving global trends and the demands of a rapidly changing world, the CDIO standards are a good example of incremental maturity levels [28]. One widely adopted framework that supports this process is the ADDIE model, which comprises five key phases: Analyze, Design, Develop, Implement, and Evaluate [29].

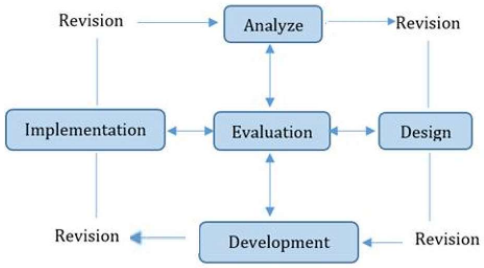

Fig. 1. ADDIE model for curriculum development [29]

The ADDIE model, as shown in Fig. 1, serves as an iterative framework for curriculum development for years in HE, which is even particularly beneficial in the context of a VUCA environment where flexibility is paramount. The **Analysis** phase involves assessing learners' current conditions, including the educational environment, prior knowledge and skills, and the constraints and resources that may influence curriculum development. This is followed by the **Design** phase, during which a comprehensive design document or instructional blueprint is produced, detailing specific learning objectives, assessment instruments, and lesson structure. In the **Development** phase, instructional materials are created in alignment with the established blueprint. The **Implementation** phase marks the deployment of the developed curriculum to the target learners, focusing on establishing clear procedures for facilitators based on the course curriculum, defining learning outcomes, and the selected method delivery. This stage ensures that educational content is delivered effectively and constantly to learners. Ongoing feedback during implementation is essential for maintaining alignment with the desired learning objectives and ensuring responsiveness to learners' needs. The **Evaluation** phase supports continuous assessment and refinement of the program or course structure. Importantly, evaluation is not confined to the final stage of the ADDIE model. Instead, it functions as an iterative component, integrated throughout the development cycle, enabling incremental revisions and iterative improvements based on feedback and observed outcomes. The curriculum engineering process begins with an assessment of the current state of the academic program, which includes a critical review of the existing curriculum and its implementation. Feedback is gathered mainly from students as the active participants in the educational process through structured surveys administered at the end of each semester, but not only (e.g. professional branches or employers views). These surveys collect insights on various aspects, including learning outcomes proficiency levels, classroom learning experiences, the effectiveness of instructional materials, and the perceived relevance of the curriculum to the various needs and trends. Often, similar feedback mechanisms are extended to alumni to evaluate the curriculum's applicability and impact within the job market and professional practice.

III. DESIGNING A CURRICULUM FOR VUCA ENVIRONMENTS USING HUMAN-AI COLLABORATION

A. *Proposed Framework Description*

Building upon the preceding discussion, this paper proposes a framework that emphasizes the active involvement of stakeholders in guiding the integration of AI into curriculum design and benefiting for it in the curriculum adaptation phases.

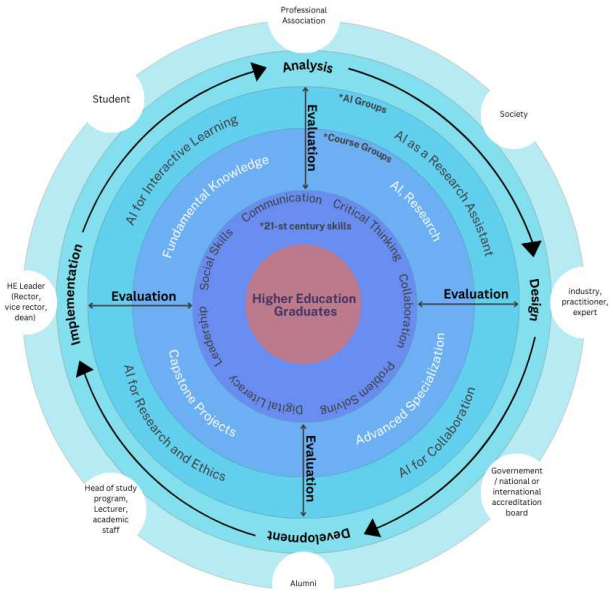

Fig. 2. Conceptual framework of empowering curriculum design stakeholders with AI

The conceptual framework in Fig. 2 outlines a comprehensive, multi stakeholder, AI-integrated approach to curriculum engineering in HE. It is structured across five concentric layers, each representing a critical element in designing, delivering, and evaluating an adaptive and future-relevant curriculum with stakeholders (outer circle of the Figure), all revolving in an iterative loop aligned with ADDIE incremental four phases and evaluation task on each phase. Effective curriculum engineering within this framework involves a sequence of essential processes, design, implementation, and evaluation ensuring that educational programs remain aligned with contemporary trends and evolving industry needs [30]. To illustrate the iterative nature of this process, an outer-layer arrow represents the ongoing cycle of curriculum refinement, drawing conceptually from the ADDIE model of instructional design [29]. We discuss the framework layer-per-layer (from inner to outer layer) as below:

- Core Layer (Layer 0): Higher Education Graduates. At the center of the framework is the Higher Education Graduate, which represents the ultimate objective of curriculum engineering. The curriculum is designed to ensure that graduates are competent in their field of study, adaptive to change, ethical and socially responsible and equipped to contribute meaningfully to society and the global workforce.
- Transversal skills Layer (Layer 1): 21st-Century Skills. Encircling the graduate profile is a set of 21st-century competencies that every student must acquire. These includes Communication, Critical Thinking, Collaboration, Problem Solving, Digital Literacy, Leadership and Social Skills. These competencies are embedded across learning objectives, instructional methods, and assessment strategies. Their integration ensures that learners are not only knowledgeable but also possess the transversal skills needed in complex, real-world settings.
- Course Layer (Layer 2): AI-Enhanced Courses. This layer represents the course group where AI can be integrated. These includes **AI Research** as a curriculum element that engages students in research involving AI or uses AI as a method or tool to conduct research across disciplines. **Advanced specialization** as the learning modules that allow students to develop expertise in niche or emerging areas, often interdisciplinary nature. **Capstone Projects** as the integrative, project-based learning experiences typically undertaken in the final year of study. **Fundamental knowledge** as the core disciplinary content that provides the academic foundation for students within a specific field of study (e.g. mathematics, physics, programming basics).
- AI-components Layer (Layer 3): AI-Enabled Curriculum Components. This layer represents the learning domains and pedagogical tools, where AI is leveraged to enhance educational processes outcomes. The curriculum integrates with following components: **AI as a Research Assistant** which utilizes AI for literature review, hypothesis generation, and reporting. **AI for collaboration** which supports teamwork and co-creation through smart communication tools. **AI for Research and Ethics** which promotes research inquiry and ethical reasoning in digital context. **AI for Interactive Learning** which personalizes content delivery through adaptive learning platforms. These components provide scaffolding for a flexible, student-centered curriculum responsive to both technological innovation and learner diversity.
- Process Layer (Layer 4): Curriculum Development Phases. Surrounding the content layer is the curriculum engineering process, grounded in the principles of iterative design and continuous improvement. This process consists of five core phases as describe in the ADDIE model.
- Stakeholders Layer (Layer 5): Stakeholders in the Curriculum Engineering. The stakeholders are organized based on their respective main concerns and areas of expertise, with each group aligned to a specific phase of the instructional design process to ensure targeted and effective input. The outer stakeholders is categorized into two main groups: external and internal stakeholders. **External stakeholders** encompass professional associations, societies, industry/practitioners/experts, government/national or international accreditation boards, and alumni. These stakeholders play a critical role in contributing domain-specific expertise to compose the curriculum, particularly in areas such as "1) learning outcomes, 2) entry requirements, 3) structure of program, 4) teaching methods, 5) location of teaching and learning, 6) teaching of interpersonal skills, 7) assessment methods, 8) language, and 9) ethno- and socio graphic aspects" as

conceptualized in the curriculum metamodel of the European DECART project in 2024 [31]. **Internal stakeholders** include institutional leadership such as the rector, vice-rector, and dean, as well as heads of study programs, lecturers, academic staff, and students. These individuals play a direct role in shaping the strategic direction, instructional design, and the implementation of AI-integrated curricula within HE institutions.

B. *Discussion of The Framework*

The interconnection between Layer 5 and Layer 4 has significant role to formulize the interconnection of Layer 3, Layer 2 and Layer 1 to achieve the graduates' profile (Layer 0). At the initial phase of curriculum renewal or development (interconnection between Layer 5 and Layer 4), leadership within HE institutions including e.g. the rector, vice-rector, and dean plays a central role in defining the institution's long-term vision, mission and strategic direction. During the analysis phase, these internal stakeholders initiate the development of curriculum guidelines, working collaboratively with academic staff to integrate regulatory requirements and quality benchmarks. These inputs are informed by standards set forth by government authorities and national or international accreditation boards, which function as external stakeholders. A critical component of these guidelines involves clearly articulating the role of AI in HE, specifying its curricular integration, and establishing ethical parameters for its application in teaching and learning contexts. All the stakeholders engage to discuss on current trends as AI and its appropriate integration into the academic curriculum and input recommendations. At this phase, external stakeholder groups include representatives from professional associations, industry practitioners and experts, and alumni. These contributors offer valuable insights into the practical application and evolving role of AI within the industry. Their input is particularly critical during the analysis, design, and evaluation phases of curriculum development, as it ensures alignment between academic content and real-world technological advancements. The expertise of internal and external stakeholders (Layer 5) is vital in evaluating (follow the cycle in Layer 4) four key focus areas within the AI-components (Layer 3) integrated with Course Layer (Layer 2), as follows:

- The first focus is the use of **AI to facilitate interactive learning** in **fundamental knowledge**, aimed at strengthening students' core knowledge which also ensure mastery of fundamental concepts before students engage in advanced or applied learning activities. The AI integration includes AI-curated digital textbooks (e.g., adaptive e-books) personalize content delivery, AI tools (e.g., chatbots) provide instant support and explanations. Diagnostic AI systems assess prior knowledge and guide students through personalized learning paths.
- The second focus involves leveraging **AI as a collaborative tool** in **advanced specialization**, discipline-specific courses, thereby supporting deeper engagement within a student's primary field of study. AI integration role as the recommender systems suggests elective course, certifications, or research areas based on student interests and performance.
- The third area centers on the integration of **AI for research and ethics** in **capstone or project-based courses**, where students synthesize knowledge and skills acquired throughout their academic journey. The integration of AI can be as the tools assist in project scoping, literature reviews, data analysis, and feedback. AI-based project management platforms help students track milestones and collaborative effectively.
- The fourth area position **AI as a research assistant** in specialized **AI courses and research initiatives**, where it serves to augment analytical tasks and support data-driven investigations with supporting of AI ethics frameworks that can be integrated into student work to guide responsible use.

In addition to integrating AI (Layer 3) to enhance students' knowledge and technical competencies, it is equally critical to evaluate essential 21st-century soft skills (Layer 1). These include social skills, critical thinking, communication, collaboration, problem-solving, leadership, and digital literacy [32]. In this way, the framework operationalizes a learning ecosystem wherein AI technologies serve as pedagogical accelerators, the 21st-century competencies serve as learning outcomes, and the graduate profile functions as the strategic vision. The upward scaffolding from AI-enabled domains through skill development to graduate formation (Layer 0) ensures curricular coherence, responsiveness, and long-term relevance in the face of technological, economic, and societal changes. To ensure the effectiveness of the curriculum development process, HE leadership must maintain sustained collaboration with external stakeholders such as collaborative research projects, industry-aligned course assignments, particularly practitioners and alumni help to strengthen the relationship between HE institutions and their broader professional communities. This engagement is vital for the continuous improvement of curricula. In summary, the proposed framework envisions collaborative and iterative curriculum design processes where AI is not a replacement for human input, but a complimentary force.

IV. CONCLUSION

HE institutions must remain responsive to the demands of a VUCA environment by incorporating flexible elements within the curriculum that align with ongoing advancements in knowledge and technology. To achieve this, the inclusion of stakeholders with domain-specific expertise is essential, as their contributions provide valuable insights for curriculum enhancement. AI can somehow be a new stakeholder in the curriculum design and development phases. Importantly, VUCA should not be viewed solely as a challenge but rather as an opportunity to cultivate long-term, collaborative relationships with stakeholders and AI tools, thereby ensuring educational relevance and resilience [33]. This paper proposes a layered framework designed to guide stakeholders (Layer 5) in developing a curriculum using an iterative loop model (Layer 4) to ensure the curriculum remains current. By leveraging the capabilities of AI, we empower stakeholders to create a future-oriented curriculum that incorporates AI as a necessary component of the learning process. The expertise of stakeholders is essential for integrating AI elements (Layer 3) into four key course groups in Layer 2. Both internal and external stakeholders should

focus on defining how to utilize AI to enhance the learning process for each course. This establishes a connection between Layer 3 and Layer 2, particularly through the role of AI as a research assistant, which supports AI and Research courses. Additionally, AI for collaboration enhances Advanced Specialization courses, AI for research and ethics supports Capstone Projects, and AI for interactive learning aids Fundamental Knowledge courses. We have also emphasized that AI technologies serve as pedagogical accelerators to improve 21st-century competencies (Layer 1), which are essential learning outcomes. This equips graduates of higher education (Layer 0) not only with knowledge but also with the transversal skills necessary for navigating complex, real-world situations. Future research should focus on conducting empirical validation of this conceptual framework to measure its effectiveness in empowering stakeholders to select the appropriate tools for enhancing curriculum design and assessing the curriculum's impact on higher education graduates. As AI technologies continue to evolve, subsequent studies should aim to refine existing frameworks by incorporating AI literacy components, enabling stakeholders to enhance their capabilities at each phase of the EDDIE model. This will improve their ability to utilize AI tools or produce effective prompts when using AI.

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