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# Designing an Intelligent and Human-Centered Learning Environment for University 5.0

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## ABSTRACT

The emergence of Industry 5.0, characterized by the synergistic collaboration between human intelligence and advanced digital technologies, has created new expectations for higher education and highlighted the need to redesign university learning environments. Accordingly, this study investigates the key dimensions and components required for designing intelligent and human-centered learning environments in fifth-generation universities. The research adopts a qualitative approach based on library research and narrative literature review. Relevant scholarly sources on smart learning environments, human-centered learning, artificial intelligence (AI) in education, learning analytics, and higher education transformation were examined and synthesized. The findings indicate that such environments are shaped by several interrelated components, including intelligent and personalized learning platforms, interactive technologies such as augmented and virtual reality, flexible and collaborative learning spaces, and mechanisms that support students' self-efficacy, creativity, and problem-solving skills. The study contributes by integrating intelligent technologies with human-centered educational principles and by proposing a conceptual framework to guide the design of learning environments aligned with Industry 5.0 requirements.

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## 1. Introduction

In today's world, no organization or business operates in a vacuum; all organizations and economic enterprises, like a dynamic, organic system, exist within an environment in which they interact with other components. They influence and are influenced by each other. Organizations take from the environment raw materials, human resources, capital, knowledge, facilities, and equipment, produce a product or service, and then supply it back to the environment. All of these exchanges take place within the framework of rules and regulations that maintain the environment's ability to continue. As long as a system or economic enterprise wishes to continue in this manner, it must adhere to these regulations; otherwise, according to the principle of "survival of the fittest," the environment will only preserve those organizations or systems that can adapt to environmental conditions. Customers and clients, suppliers and providers of raw materials, technology providers, educational institutions, human resource supply institutions, partners, competitors, trade unions, labor unions, human rights groups, peace groups, green groups, environmental protection groups, organizations supporting consumers, supervisory institutions, the laws and regulations of governments, international organizations, and the infrastructures of cultural, economic, social, and popular beliefs are among the components that form the environment (Daft, 2016; Scott & Davis, 2015; Ullah, 2011).

Industry 5.0, with its "Technology for Humanity" slogan, is considered a turning point in the digital transformation process. This paradigm, beyond reliance on mere automation and efficiency in Industry 4.0, emphasizes the intelligent integration of advanced technologies with human capacities and values. This issue requires rethinking all dimensions of human interaction with the surrounding environment, including learning spaces (Daugherty & Wilson, 2018; European Commission, 2021). As the primary institutions for education and research, universities are at the forefront of this transformation. They must design their learning environments so that they not only transfer the knowledge and skills required for the Industry 5.0 era, but also foster creativity, critical thinking, human responsibility, and collaboration. This necessitates moving from traditional education models toward "intelligent and human-centered learning environments" (Salmon, 2019).

Rapid technological developments and changes in patterns of education, research, and industry have made the need to reconsider the role of universities clearer than ever. In this context, the concept of the "Generation Five University," as one of the new approaches in higher education, emphasizes the formation of a human-centered, intelligent university—one in which advanced technologies are used not to replace humans but to empower learners, instructors, and society. In fact, the Generation Five university is a combination of intelligent technologies, human-centered principles, and deep and problem-based learning. It seeks to create an environment in which the real needs of society and industry shape education, research, and innovation. In this model, technology serves humanity, and tools such as artificial intelligence, the Internet of Things, data analytics, and intelligent educational systems are used to enhance the quality of learning, research, and decision-making. Learning is also designed in a personalized and adaptive manner, tailoring each individual's learning pathway to their cognitive, behavioral, and emotional characteristics (Holmes et al., 2019; Stacey, 2011). On the other hand, human–machine collaboration is presented as one of the essential components of the Generation Five university, in which humans serve as creative decision-makers and technology serves as an empowerment tool (Nahavandi, 2019). Moreover, the Generation Five

university emphasizes building a deep connection among the university, industry, and society, transforming it from a purely educational institution into a "learning organism" connected to real-world issues (Etzkowitz & Zhou, 2017).

The importance of paying attention to Generation Five universities becomes more apparent when we examine it in relation to the developments in the Generation Five industry. Unlike previous generations—whose focus was mostly on automation and productivity—the Generation Five industry emphasizes intelligent interaction between humans and technology, creativity, flexibility, and social responsibility (European Commission, 2021; Nahavandi, 2019). Therefore, universities, as the most important institutions for training human resources, must not only transfer specialized knowledge but also provide opportunities to cultivate competencies such as critical thinking, creativity, problem-solving, collaboration, and human skills (Holmes et al., 2019; Salmon, 2019). Under such circumstances, moving toward a Generation Five university is no longer an option; it is an unavoidable necessity to meet future societal and labor-market needs.

In Iran as well, although universities have taken steps in recent years toward digital transformation and the transition to Generation Five, this process still faces numerous challenges. In general, it can be said that Iranian universities are about 30 to 40 percent on the path to realizing a Generation Five university. This movement is most evident in technology and digitalization. At the same time, other important dimensions—such as intelligent human-centeredness, personalized learning, and the formation of innovation ecosystems—have been less realized. Some leading universities, such as the University of Tehran, Sharif University of Technology, Amirkabir University, University of Science and Technology, Ferdowsi University of Mashhad, and several medical universities, have made significant progress in areas such as smart education, the use of learning management systems, collaboration with industry, the establishment of innovation centers, and conducting interdisciplinary research (Etzkowitz & Zhou, 2017; Holmes et al., 2019). They have even, in limited cases, used artificial intelligence and data analysis. However, even these universities are still far from achieving a complete model of a Generation Five university, because fully personalized learning has not been implemented broadly; administrative structures remain bureaucratic and influenced by second- and third-generation patterns; data-driven decision-making is carried out only to a limited extent; and human and soft skills, compared with technology, have received less attention. In addition, a real and continuous connection among universities, industry, and society has not yet reached the desired level.

A review of the overall status of higher education in Iran shows that about half of the universities still operate within the framework of second- and third-generation universities and follow mainly traditional education-oriented or research-oriented approaches. In contrast, about 35 percent of universities have moved toward the fourth generation, focusing on innovation, entrepreneurship, industry connections, and digital education. However, fewer than 10 percent of universities have demonstrated features of a Generation Five university—such as smartification, human-centeredness, adaptive learning, networking, and the development of an innovation ecosystem. Therefore, studying and examining the requirements, challenges, and solutions for realizing Generation Five universities in Iran is of particular importance. The key point is that the most important barrier preventing Iranian universities from moving toward the fifth generation is not simply a lack of technology, but rather weakness in network governance, organizational culture, structural flexibility, and the effective linkage of universities with industry and society—an issue that further underscores the need for scientific and applied research in this field (Etzkowitz & Zhou, 2017; Holmes et al., 2019).

Despite the growing discourse on digital transformation in higher education, current literature on the 'Generation Five University' remains heavily skewed toward the technological and automated dimensions of educational processes, often neglecting the systemic requirements for fostering an 'anthropocentric' paradigm. A critical research gap persists: a comprehensive operational framework that effectively integrates smartification, personalized learning, and the cultivation of soft skills within a unified learning ecosystem remains lacking. This study aims to bridge the theoretical-practical divide by proposing a novel framework for Designing Intelligent and Human-Centered Learning Environments. Utilizing a Design-Based Research (DBR) methodology, this research establishes a structural bridge between emerging technologies and human-centric pedagogical approaches. The fundamental distinction of this study lies in its shift from a 'technology-driven' perspective toward an 'ecosystem-centric' and human-oriented paradigm, redefining the university not merely as an educational institution but as an 'intelligent learning organism' embedded within the complex Industry 5.0 network. Consequently, this research extends the higher education management literature by offering an operational roadmap for transitioning from bureaucratic structures to resilient, intelligent, and socially-integrated models—a transformation essential for meeting the demands of the innovation ecosystem in Iran.

Therefore, this article examines the components and frameworks required to achieve this goal. The main aim of the research is to provide a model for designing these learning environments that can effectively establish interaction between advanced technologies (such as artificial intelligence, augmented/virtual reality, and learning data analytics) and human-centered educational approaches. This study, using the design-based research (Design-Based Research) method and conceptual analysis, identifies key components of these environments: first, providing tools for adaptive and personalized learning that align with each student's learning pace and style; second, creating physical and virtual spaces that encourage collaboration, dialogue, and active learning; and third, prioritizing the development of soft and human skills that are especially important in the era of Industry 5.0 (Demir et al., 2021). Finally, this article offers an operational framework for creating learning environments that prepare students to face the challenges and opportunities of the future and to play an effective role in the Industry 5.0 ecosystem.

## 2. Literature Review

The rapid advancement of digital technologies and artificial intelligence has significantly transformed higher education. Universities are increasingly required to adapt to complex, dynamic, and technology-driven environments to remain innovative and competitive. In this context, the concept of intelligent and human-centered learning environments has emerged as a critical component in the development of next-generation universities. These environments integrate advanced digital technologies, artificial intelligence, and data-driven systems while simultaneously emphasizing human values, creativity, collaboration, and learner well-being.

Theoretical foundations for understanding such transformations can be traced to organizational and strategic management literature. The dynamic capabilities perspective emphasizes the ability of organizations to sense environmental changes, seize opportunities, and reconfigure resources to sustain competitive advantage in turbulent environments (Teece et al., 1997; Eisenhardt & Martin, 2000). These capabilities are particularly relevant for universities facing rapid technological change and evolving educational demands. Similarly, knowledge creation theory highlights the importance of collaborative knowledge generation and organizational learning processes in fostering innovation and adaptability (Nonaka & Takeuchi, 1995).

Parallel to these organizational perspectives, the field of educational technology has increasingly focused on developing smart learning environments. Smart learning environments are technology-enhanced ecosystems that leverage adaptive systems, learning analytics, artificial intelligence, and context-aware technologies to deliver personalized, flexible learning experiences (Chen et al., 2018; Hwang, 2014). These environments support continuous feedback, adaptive learning pathways, and data-informed decision-making, enhancing both teaching effectiveness and student learning outcomes.

The integration of artificial intelligence in higher education has further accelerated the transformation of learning environments. AI technologies enable intelligent tutoring systems, predictive analytics, automated assessment, and personalized learning recommendations (Popenici & Kerr, 2017; Zawacki-Richter et al., 2019). These capabilities have the potential to improve learning efficiency and educational accessibility significantly. However, scholars emphasize that technological advancement alone cannot ensure effective educational transformation. Ethical considerations, human agency, and learner-centered pedagogies must remain central to the design of intelligent educational systems (Holmes et al., 2019; Ifenthaler & Yau, 2020).

In recent years, the emergence of Industry 5.0 and Society 5.0 paradigms has further strengthened the emphasis on human-centered technological systems. Unlike previous industrial paradigms that focused primarily on automation and efficiency, Industry 5.0 highlights the collaboration between humans and intelligent technologies, aiming to create resilient, sustainable, and human-oriented systems (Nahavandi, 2019; Xu et al., 2021). These developments have important implications for higher education institutions, which must prepare learners for complex socio-technical environments while fostering creativity, critical thinking, and interdisciplinary innovation.

Consequently, universities are increasingly expected to evolve toward innovation-driven ecosystems that integrate technological intelligence with human-centered educational values (Carayannis & Morawska-Jancelewicz, 2022). Such transformation requires redesigning learning environments, governance models, and institutional capabilities to support adaptive, collaborative, and technology-enhanced education. Despite the growing body of literature on artificial intelligence, smart learning environments, and digital transformation in higher education, existing studies often address these themes separately and lack an integrated conceptual framework for designing intelligent and human-centered learning environments within the context of fifth-generation universities.

To contextualize the current study, a comprehensive review of the existing literature is essential to synthesize key theoretical perspectives and identify major gaps in current research. Table 1 provides a chronological summary of seminal studies regarding intelligent learning environments, AI in education, and the transition toward Industry 5.0 in higher education. Furthermore, Table 2 maps these existing studies against the identified research gaps, positioning our study as a bridging framework.

**Table 1.** Comprehensive Literature Review on Intelligent and Human-Centered Learning Environments for Fifth-Generation Universities

| Authors | Year | Focus of Study | Method | Key Findings | Research Gap |
|---|---|---|---|---|---|
| Teece et al. | 1997 | Dynamic capabilities in rapidly changing environments | conceptual framework | Organizations need sensing, seizing, and reconfiguring capabilities to adapt to environmental change | Application of dynamic capabilities in higher education learning ecosystems |

| Authors | Year | Focus of Study | Method | Key Findings | Research Gap |
|---|---|---|---|---|---|
| | | | | | remains underexplored |
| Eisenhardt & Martin | 2000 | Nature of dynamic capabilities in organizations | conceptual analysis | Dynamic capabilities help organizations integrate, build, and reconfigure competencies in turbulent environments | Limited discussion of digital learning environments and universities |
| Schreyögg & Kliesch-Eberl | 2007 | Capability dynamization and organizational adaptability | conceptual model | Organizations require dual processes for capability development and renewal | Lack of focus on smart universities and learning innovation |
| Chen et al. | 2018 | Smart learning environments | systematic literature review | Smart environments integrate sensing technologies, adaptive systems, and personalized learning support | Human-centered aspects and ethical considerations need further exploration |
| Popenici & Kerr | 2017 | Artificial intelligence in higher education | conceptual analysis | AI can transform teaching, assessment, and student support | Need for human-centered AI integration in learning environments |
| Zawacki-Richter et al. | 2019 | AI applications in higher education | systematic review | AI mainly used in profiling, prediction, adaptive systems, and assessment | Limited research on holistic intelligent learning ecosystems |
| Nahavandi | 2019 | Industry 5.0 and human-centric systems | conceptual study | Industry 5.0 emphasizes collaboration between humans and intelligent technologies | Implications for higher education and learning environments are insufficiently explored |
| Demir et al. | 2021 | Future of higher education in Industry 5.0 | conceptual framework | Universities must integrate digital technologies, interdisciplinary learning, and human-centric innovation | Lack of concrete models for intelligent learning environments in universities |
| Carayannis & Morawska-Jancelewicz | 2022 | Society 5.0 and future universities | conceptual analysis | Universities must evolve toward innovation ecosystems | Limited operational models for implementing human-centered |

| Authors | Year | Focus of Study | Method | Key Findings | Research Gap |
|---|---|---|---|---|---|
| | | | | integrating technology, society, and sustainability | smart learning systems |
| Ifenthaler & Yau | 2020 | Learning analytics in education | Empirical review | Learning analytics can improve decision-making and personalized learning | Ethical, privacy, and human-centric design challenges remain |
| Holmes, Bialik & Fadel | 2019 | Artificial intelligence in education | conceptual framework | AI can support adaptive learning and intelligent tutoring systems | Need for integration of pedagogy, ethics, and human agency |
| Xu et al. | 2021 | Evolution from Industry 4.0 to Industry 5.0 | Conceptual study | Shift toward human-centric, resilient, and sustainable systems | Higher education transformation models still limited |

The literature indicates a growing interest in intelligent learning environments, artificial intelligence in education, and the transformation of higher education within the context of Industry 5.0. However, existing studies primarily focus on technological capabilities or organizational adaptability in isolation. Limited research has integrated these perspectives into a comprehensive framework for designing intelligent and human-centered learning environments in fifth-generation universities. Therefore, this study aims to develop a conceptual model that combines intelligent technologies, human-centered design principles, and dynamic capabilities to support adaptive and sustainable learning ecosystems in next-generation universities.

**Table 2.** Identified Research Gaps in Previous Studies

| Research Area | Existing Focus in Literature | Identified Gap | Contribution of the Present Study |
|---|---|---|---|
| **Artificial Intelligence in Education** | Adaptive learning, automation, tutoring systems | Overemphasis on technology rather than human-centered learning | Integrates AI with human-centered educational design |
| **Smart Learning Environments** | Context-aware and digital learning systems | Lack of holistic ecosystem perspective | Proposes an integrated intelligent learning ecosystem |
| **Industry 5.0** | Human-machine collaboration in industries | Limited application in higher education | Extends Industry 5.0 principles to universities |
| **Dynamic Capabilities** | Organizational adaptability and resilience | Rarely linked to university learning systems | Applies dynamic capability theory to educational transformation |
| **Learning Analytics** | Personalized feedback and prediction | Ethical and emotional dimensions neglected | Includes ethics, well-being, and learner empowerment |
| **Digital Transformation** | Technology integration in universities | Fragmented conceptual approaches | Develops a comprehensive conceptual framework |
| **Human-Centered Education** | Student engagement and participation | Limited integration with AI technologies | Combines intelligent systems with human-centered pedagogy |

| Research Area | Existing Focus in Literature | Identified Gap | Contribution of the Present Study |
|---|---|---|---|
| **Fifth-Generation Universities** | Innovation and entrepreneurship ecosystems | Lack of operational learning environment models | Designs a practical framework for Generation Five universities |
| **Educational Sustainability** | Resilient and sustainable learning systems | Weak connection with intelligent technologies | Integrates sustainability with intelligent educational ecosystems |
| **University Ecosystems** | Innovation networks and knowledge management | Limited adaptive and smart governance models | Proposes adaptive and intelligent governance structures |

The review of prior studies demonstrates that existing research has independently investigated artificial intelligence, smart learning environments, digital transformation, and Industry 5.0. However, the integration of these dimensions into a unified framework for fifth-generation universities remains limited. Most studies emphasize technological advancement while paying insufficient attention to human-centered values, ethical considerations, learner well-being, and adaptive institutional capabilities. Therefore, the present study seeks to bridge this gap by proposing an intelligent and human-centered learning environment framework that integrates AI technologies, dynamic capabilities, sustainability principles, and human-centered educational design within the context of fifth-generation universities.

## 3. Methodology

### 3-1 Research Design

This study adopted a qualitative research design based on library research and a narrative literature review. The purpose of this methodological approach was to identify, analyze, and synthesize existing scholarly knowledge related to intelligent and human-centered learning environments in the context of Fifth-Generation Universities and Industry 5.0. This design was selected because the research topic is conceptual and interdisciplinary, requiring an interpretive synthesis of theoretical and empirical studies rather than primary data collection.

### 3-2 Literature Search Strategy

The literature search was conducted in major academic databases, including Scopus, Web of Science, ERIC, and the ACM Digital Library. To ensure comprehensive coverage of the relevant literature, a set of keywords and keyword combinations was used, such as "smart learning environments," "human-centered learning," "Industry 5.0 in education," "artificial intelligence in education," "learning analytics," "higher education transformation," and "fifth-generation university." These terms were searched individually and in combination to capture studies that address both the technological and pedagogical dimensions of the topic.

### 3-3. Selection of Sources

The initial search identified a broad range of publications (2015-2026). The retrieved studies were then screened for relevance to the present study. Sources were included if they met the following criteria:

- They addressed the design, implementation, or evaluation of technology-enhanced or human-centered learning environments.
- They were situated within higher education or closely related educational contexts.
- They were peer-reviewed journal articles, books, or conference papers.

- They provided conceptual, theoretical, or empirical insights relevant to intelligent learning environments, learning analytics, artificial intelligence in education, or Fifth-Generation Universities.

Priority was given to recent publications and foundational works that were conceptually significant to the development of the study framework. Sources that were unrelated to higher education, did not address the study's central constructs, or lacked sufficient scholarly relevance were excluded.

### 3-4 Data Analysis and Synthesis

After selection, the literature was analyzed through an iterative synthesis process. The sources were examined to identify recurring themes, theoretical perspectives, and design components related to intelligent and human-centered learning environments. The analysis focused on extracting the main dimensions underlying Fifth-Generation Universities, including technological infrastructure, learner personalization, collaboration, ethical considerations, and human-centered pedagogy. These themes were then integrated into a conceptual framework that reflects the interplay between digital intelligence and human values in higher education.

## 4. Theoretical Framework

### 4-1 Organizational Environment

#### 4-1-1 Concept of the Organizational Environment

In organizational studies, the concept of the organizational environment has received significant attention because it influences organizational behavior, performance, and survival. The organizational environment generally refers to the set of internal and external conditions that shape organizational activities and influence individuals' behavior within the organization. These conditions create relatively stable patterns that distinguish one organization from another and influence employees' work attitudes, behavioral orientations, and interactions within the workplace (Al Sharbin, 1997; Daft, 2016).

From a systems perspective, organizations are not isolated entities but operate within a broader context composed of multiple interacting elements. Jones (2010) defines the organizational environment as the set of forces and conditions operating outside an organization's boundaries that influence its ability to acquire resources and create value. Similarly, Ohmae (2014) conceptualizes the organizational environment as the overall pattern of internal and external conditions that shape an organization's development and survival, creating both opportunities and threats that influence organizational performance.

Scholars have also emphasized the role of stakeholders in shaping the organizational environment. Robbins et al. (2014) define the organizational environment as the domain in which an organization interacts with external actors, including customers, competitors, governments, labor unions, suppliers, communities, and the media. These actors, often referred to as stakeholders, directly or indirectly influence organizational decision-making and strategic actions. From an institutional perspective, Guo (2013) argues that the organizational environment is shaped by the norms, expectations, and values of key stakeholders, including investors, professional associations, governing bodies, and strategic partners. In this sense, the organizational environment can be understood as a network of relationships and interactions that influence organizational legitimacy, performance, and long-term survival (Darna & Nana, 2018; Guo, 2013).

In the literature, the organizational environment is often classified into different dimensions to facilitate analysis. One common classification distinguishes between the task environment

and the general environment. The task environment refers to the sectors with which an organization interacts directly and that have an immediate impact on its ability to achieve its goals. These sectors typically include customers, suppliers of raw materials, competitors, and labor markets. Because these actors directly affect operational processes, organizations must closely monitor and manage their relationships within the task environment (Daft, 2016; Robbins et al., 2014).

In contrast, the general environment encompasses broader societal conditions that indirectly influence organizational activities. These include economic, technological, political, legal, social, and cultural factors. Although these factors may not directly affect daily operations, they shape the broader context within which organizations operate and can significantly influence long-term strategies and organizational development (Jones, 2010).

In addition to these two dimensions, globalization has led scholars to emphasize the role of the international environment. Advances in global communication technologies, international investments, cross-border trade, and the rapid diffusion of innovation increasingly influence organizational contexts. Consequently, organizations must also consider international dynamics when analyzing their environmental conditions (Ohmae, 2014).

The influence of the environment on organizations is generally reflected in two major organizational needs: the need for information and the need for resources. Organizations depend on their environments for critical resources such as capital, labor, knowledge, and technology. At the same time, they require accurate, timely information about environmental changes to make effective strategic decisions (Daft, 2016).

Another key concept discussed in the literature is environmental uncertainty, which arises when decision-makers lack sufficient information about environmental conditions or cannot accurately predict environmental changes. High levels of environmental uncertainty increase decision-making risks and complicate strategic planning and cost estimation processes (Robbins et al., 2014). Closely related to uncertainty is the concept of environmental complexity, which refers to the number and diversity of external factors that influence an organization. In complex environments, numerous interrelated external forces affect organizational activities. In contrast, in simpler environments, only a limited number of external elements are influential (Jones, 2010).

The degree of environmental stability also plays a crucial role in shaping organizational strategies. Stable environments are characterized by relatively predictable conditions that remain constant over time. In contrast, unstable environments experience rapid and unpredictable changes, often driven by technological innovation, market competition, and shifting consumer demands (Stacey, 2011).

The literature also distinguishes between internal and external organizational environments. The internal environment refers to factors within the organization that managers can largely control, such as organizational culture, structure, technological capabilities, human resources, and physical facilities. These internal elements shape the organization's capabilities and influence its overall performance (Purwanti & Fattah, 2010). According to Hubies and Najib (2014), the internal environment comprises the organization's resources, capabilities, and competencies that determine its competitive position.

In contrast, the external environment consists of forces outside the organization that influence managerial decisions and organizational performance but are typically beyond direct managerial control. These forces include economic conditions, technological developments, political regulations, and social changes (Astuti, 2011; David, 2005). Because of its complexity and dynamic nature, continuous monitoring and analysis of the external environment is essential for effective strategic management.

The external environment is commonly divided into two levels: the micro (task) environment and the macro environment. The micro environment includes actors that directly affect organizational operations, such as customers, suppliers, competitors, and financial institutions. The macro environment, on the other hand, refers to broader contextual forces such as economic trends, technological change, political systems, and social transformations that shape the overall conditions under which organizations operate (Daft, 2016; Handoko, 2011).

Overall, the literature highlights that organizations must continuously analyze both their internal and external environments to maintain competitiveness and ensure long-term sustainability. Environmental analysis enables managers to identify opportunities, anticipate threats, and develop strategies that align organizational capabilities with environmental demands (Daft, 2016; Robbins et al., 2014).

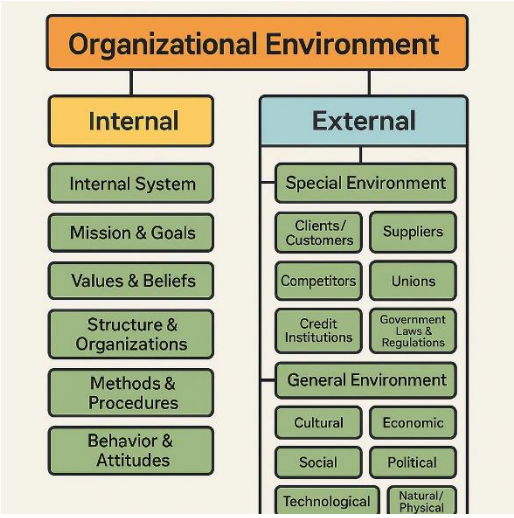



**Figure 1.** Types of Organizational Environments

### 4-1-2 Organizational Environmental Factors in Organizations 5.0

In contemporary organizational theory, particularly within the context of *fifth-generation organizations*, environmental factors play a critical role in shaping organizational performance, adaptability, and innovation capacity. Fifth-generation organizations—often associated with human-centric, intelligent, and digitally integrated systems—operate in highly dynamic environments characterized by rapid technological change, complex stakeholder relationships, and knowledge-driven economies. Consequently, understanding organizational environmental factors is essential for analyzing how such organizations function and sustain competitiveness (Daft, 2021; Nahavandi, 2019).

### 4-1-3 Organizational Factors

Organizational factors refer to the internal structural and managerial conditions that shape employees' understanding of organizational roles, relationships, and work processes. These factors influence how individuals perceive organizational situations and determine the tasks expected from them as members of the organization, as well as the opportunities and rewards they may receive in return for fulfilling their responsibilities. In knowledge-intensive and innovation-driven organizations, these factors significantly affect employee engagement, collaboration, and productivity (Mintzberg, 2009; Robbins & Judge, 2022).

Key organizational elements, commonly identified in the literature, include organizational structure, span of control, workload distribution, leadership style, communication patterns, and decision-making processes. Flexible structures, participatory leadership, and decentralized

decision-making mechanisms are particularly important in fifth-generation organizations because they support creativity, interdisciplinary collaboration, and adaptive problem-solving in complex environments (Daft, 2021; Nahavandi, 2019).

#### 4-1-4 Material and Moral Factors in the Organizational Environment

Material and moral factors serve as motivational stimuli that encourage individuals to engage in behaviors aligned with organizational objectives. These factors serve as incentives for individuals when their actions meet organizational expectations. In organizational behavior literature, incentives are generally categorized into material (extrinsic) rewards and psychological or moral (intrinsic) rewards (Armstrong & Taylor, 2020).

Material factors refer to tangible rewards that address employees' economic and physical needs, such as salaries, bonuses, financial benefits, and job security. In contrast, moral or psychological incentives involve non-material rewards, such as recognition, professional development opportunities, social appreciation, and career advancement. Studies show that intrinsic rewards are particularly important in knowledge-based and innovation-oriented organizations because they foster intrinsic motivation, creativity, and organizational commitment (Deci et al., 2017; Ryan & Deci, 2020).

Incentives can also be classified as positive or negative. Positive incentives encourage desirable behaviors through rewards, recognition, and opportunities for growth. In contrast, negative incentives discourage undesirable behaviors through penalties or disciplinary measures. Effective organizational environments typically emphasize positive reinforcement to foster employee motivation and engagement (Armstrong & Taylor, 2020).

#### 4-1-5 Psychological Factors in the Organizational Environment

Psychological factors originate from employees' perceptions, attitudes, motivations, and emotional responses to their work environment. Organizational psychology emphasizes that employee behavior is influenced not only by material incentives but also by psychological needs such as achievement, belongingness, autonomy, and self-realization (Ryan & Deci, 2020).

These psychological needs may include affiliation, influence, power, recognition, and personal development. When organizations provide supportive environments that address these needs, employees tend to demonstrate higher levels of commitment, innovation, and job satisfaction. In fifth-generation organizations—where creativity, collaboration, and knowledge sharing are essential—psychological empowerment and employee well-being are considered key drivers of organizational effectiveness (Deci et al., 2017; Robbins & Judge, 2022).

#### 4-1-6 Environmental Factors Affecting Organizations

Organizations are also influenced by broader macro-environmental forces that shape their strategic choices and operational capabilities. These environmental influences are commonly categorized into political, economic, social, technological, and environmental dimensions. This framework, widely known as PEST or PESTEL analysis, provides a systematic approach for evaluating external factors that may create opportunities or threats for organizations (Johnson et al., 2020; Rothaermel, 2021).

Political and legal factors include government policies, regulatory frameworks, and legal systems that influence organizational operations. Economic factors encompass variables such as inflation, economic growth, labor markets, and financial stability. Social factors include demographic trends, cultural values, and societal expectations. In contrast, technological factors encompass technological innovation, digital transformation, and information infrastructure.

Environmental or ecological considerations are increasingly important due to sustainability challenges and growing societal expectations regarding environmental responsibility (Rothaermel, 2021).

**4-1-7 Specific (Task) Environment**

The specific environment, also referred to as the task or microenvironment, includes the external actors that directly influence an organization's ability to achieve its objectives. These actors interact frequently with the organization and exert immediate effects on its performance and strategic decisions (Daft, 2021; Robbins & Colter, 2022).

The specific environment typically includes customers, suppliers, competitors, governmental regulatory agencies, labor unions, financial institutions, and professional associations. Each organization has a unique specific environment depending on its organizational domain, which refers to the range of products or services it provides and the markets it serves. Changes in the organizational domain—such as entering new markets or expanding product lines—can significantly alter the structure of the organization's task environment (Daft, 2021).

Some scholars also describe the specific environment as the microenvironment, consisting of stakeholders with whom the organization regularly interacts. These stakeholders may include customers, suppliers, competitors, government agencies, local communities, advocacy groups, labor unions, and financial intermediaries (Freeman et al., 2020).

**4-1-8 Stakeholders and Interorganizational Networks**

Modern organizations operate within complex stakeholder networks that influence their operations and long-term sustainability. Stakeholders include individuals, groups, or institutions that can affect or are affected by organizational activities. These actors may include customers, employees, investors, suppliers, competitors, regulatory authorities, community organizations, and media institutions (Freeman et al., 2020).

Organizations continuously interact with these stakeholders to obtain resources such as capital, labor, knowledge, technology, and infrastructure. In addition, organizations must maintain relationships with customers and markets where their products or services are consumed. Other important environmental actors may include distributors, strategic partners, trade associations, and governmental regulatory bodies.

Stakeholder theory distinguishes between a narrow definition of stakeholders—those whose support is essential to organizational survival—and a broader definition that includes any actor who influences or is influenced by the organization. Managing these relationships effectively is critical for achieving organizational legitimacy, access to resources, and long-term sustainability (Freeman et al., 2020; Hatch & Cunliffe, 2018).

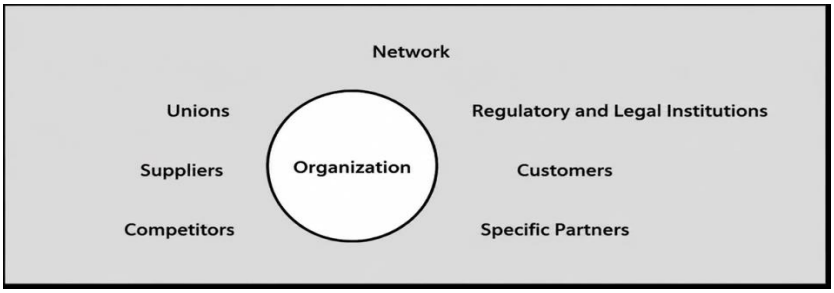



**Figure 2.** Organization at the Center of an Interactive and Competitive Network

**4-2 Environmental Uncertainty in the Context of Fifth-Generation Universities and Industry 5.0**

From an organizational perspective, environments vary significantly in the level of environmental uncertainty they impose on institutions. Environmental uncertainty refers to the extent to which decision-makers lack sufficient information about environmental conditions, making it difficult to predict external changes and their potential impact on organizational performance (Daft, 2021). In the context of Fifth-Generation Universities (5G Universities) and Industry 5.0, environmental uncertainty has become more pronounced due to rapid technological advancement, globalization of knowledge, evolving labor market demands, and the increasing integration between academia, industry, and society.

Some organizations operate in relatively stable environments where changes occur gradually, technological disruptions are limited, and competitive pressures remain predictable. However, universities and organizations operating within the Industry 5.0 ecosystem increasingly function in highly dynamic environments characterized by rapid technological transformation, frequent regulatory adjustments, emerging digital platforms, and continuously evolving societal and industrial needs (Robbins & Colter, 2022; Nahavandi, 2019). Fifth-generation universities, which emphasize innovation, entrepreneurship, societal impact, and strong university–industry collaboration, are therefore required to operate in complex, rapidly changing environments.

Stable environments generally produce lower levels of uncertainty because environmental trends are predictable and easier to monitor. In contrast, dynamic environments create greater uncertainty, making planning, forecasting, and strategic decision-making more challenging. Within Industry 5.0—where technologies such as artificial intelligence, advanced robotics, big data, and cyber-physical systems evolve rapidly—organizations and universities must continuously adapt their strategies, structures, and capabilities to remain relevant and competitive (Carayannis & Campbell, 2012; Daft, 2021).

According to *contingency theory,* effective organizational structures must align with environmental conditions. The classic research by Burns and Stalker (1961) demonstrated that organizations operating in dynamic, uncertain environments tend to adopt more flexible, adaptive structures than those operating in stable environments. Their work introduced the distinction between *organic* and *mechanistic* organizational systems.

Organic organizational structures are characterized by flexibility, decentralized authority, horizontal communication, knowledge-based influence, and extensive information sharing across organizational units. Such structures facilitate innovation, interdisciplinary collaboration, and rapid responses to environmental change. These characteristics are particularly important for fifth-generation universities, which operate within innovation ecosystems involving industry partners, research institutions, government agencies, and entrepreneurial networks. In contrast, *mechanistic structures* are associated with stable environments and emphasize formalization, centralized decision-making, rigid hierarchical control, and clearly defined organizational roles (Burns & Stalker, 1961; Daft, 2021).

Burns and Stalker (1961) further argued that organic structures are especially advantageous in unstable environments where continuous innovation and adaptability are necessary for survival. In the context of Industry 5.0, organizations must rely on highly skilled teams capable of integrating human creativity with advanced technologies and responding quickly to emerging challenges. Similarly, fifth-generation universities must cultivate interdisciplinary teams, collaborative research networks, and innovation-driven cultures that enable them to anticipate and respond effectively to environmental change (Hatch & Cunliffe, 2018; Nahavandi, 2019).

Within *modernist organizational theory*, the environment is viewed as an external domain beyond the organization's boundaries, imposing constraints and opportunities that influence

organizational survival. Organizations depend on environmental resources such as capital, technology, knowledge, and skilled labor. However, the availability and stability of these resources are often uncertain. In the context of fifth-generation universities, this dependency is particularly evident in collaborative innovation ecosystems, including universities, industries, governments, and civil society actors (Carayannis & Campbell, 2012; Hatch & Cunliffe, 2018).

**4-2-1 Environmental Change and Environmental Complexity**

Two major dimensions used to analyze environmental uncertainty are *environmental change* and *environmental complexity*. Environmental change refers to the rate and unpredictability of change within the organizational environment, ranging from stable environments with minimal change to highly dynamic environments characterized by rapid, continuous transformation (Daft, 2021).

In the era of Industry 5.0, environmental dynamism has increased significantly due to accelerated technological innovation, digital transformation, global competition, and evolving societal expectations. Consequently, fifth-generation universities must continuously adapt their educational programs, research agendas, and innovation activities to align with emerging technological trends and labor market demands.

Environmental complexity refers to the number and diversity of external actors and factors that influence organizational operations. In relatively simple environments, organizations interact with a limited number of homogeneous stakeholders. However, in complex environments, organizations must engage with numerous heterogeneous actors, including regulatory bodies, industrial partners, research networks, funding agencies, and community organizations (Robbins & Colter, 2022).

High levels of environmental complexity often lead organizations toward *decentralized decision-making structures,* enabling different organizational units to monitor environmental signals more effectively within their specific domains. In fifth-generation universities, this decentralization is often reflected in the establishment of innovation hubs, technology transfer offices, research centers, and science parks that facilitate collaboration between academia and industry. Such structures enhance the university's capacity to interpret complex environmental signals and respond effectively to the challenges and opportunities presented by the Industry 5.0 ecosystem (Carayannis & Campbell, 2012; Daft, 2021).

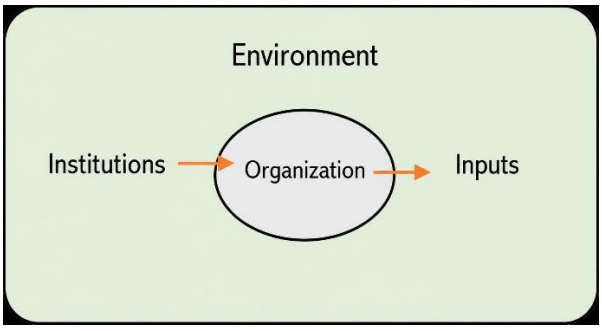



**Figure 3.** Organizational Position within the Environment

### 4-3 Environmental Theories in the Context of Fifth-Generation Universities and Industry 5.0

#### 4-3-1 Resource Dependence Theory

Resource Dependence Theory (RDT), developed by Pfeffer and Salancik (1978), provides an important framework for understanding the relationship between organizations and their external environments. The central premise of this theory is that organizations depend on external actors for critical resources, and this dependence creates power relationships between organizations and the entities that control those resources. In modern innovation ecosystems, organizations must actively manage these dependencies to maintain autonomy and strategic flexibility.

Within the context of Industry 5.0 and Fifth-Generation Universities, resource dependence becomes even more pronounced. Fifth-generation universities operate within complex innovation ecosystems, relying on multiple external stakeholders, including governments, technology firms, venture capital investors, research networks, and community organizations. These actors provide essential resources including funding, technological infrastructure, data, expertise, and collaborative opportunities. As a result, universities must develop strategic partnerships and collaborative networks to secure access to these resources and reduce vulnerability to environmental pressures (Carayannis & Campbell, 2012; Pfeffer & Salancik, 1978).

Resource dependence analysis therefore begins by identifying the critical resources required by an organization and then examining the external actors capable of supplying them. In Industry 5.0 ecosystems, universities, and organizations increasingly participate in innovation networks, research alliances, and knowledge ecosystems to manage resource dependencies and strengthen their strategic positioning within the broader environment (Hatch & Cunliffe, 2018).

#### 4-3-2 Population Ecology Perspective

The population ecology perspective, often referred to as the natural selection approach, emphasizes the role of environmental selection in determining organizational survival. According to this perspective, the environment selects organizations whose structures and strategies best align with environmental conditions. In contrast, organizations that fail to adapt effectively are eventually eliminated (Hannan & Freeman, 1989).

Population ecology theory is built upon three key assumptions. First, analysis focuses on organizational populations—groups of organizations operating within a particular industry or sector—rather than individual organizations. Second, organizational effectiveness is typically equated with survival; organizations that persist over time are considered effective because they have successfully adapted to environmental pressures. Third, environmental forces are viewed as the primary determinants shaping organizational structures and outcomes (Robbins & Colter, 2022).

In the context of Industry 5.0, technological turbulence, digital transformation, and global competition create intense selection pressures within organizational populations. Similarly, fifth-generation universities must continuously adapt their structures, research agendas, and innovation strategies to remain relevant within rapidly evolving knowledge ecosystems. Universities that successfully integrate interdisciplinary research, entrepreneurial activities, and industry collaboration are more likely to survive and thrive within this competitive environment (Etzkowitz & Zhou, 2017).

**4-3-3 Institutional Theory**

Institutional theory emphasizes that organizations adapt not only to economic and technical pressures but also to social norms, cultural expectations, and institutional rules embedded within their environments. According to institutional theorists, organizations seek legitimacy by aligning their structures, practices, and behaviors with widely accepted social and institutional expectations (Scott, 2014).

In modern knowledge economies, organizations compete not only for financial resources and market share but also for institutional legitimacy and social recognition. Institutional environments impose two primary categories of demands. The first consists of technical and economic requirements, which compel organizations to produce goods and services efficiently. The second consists of social and cultural expectations, which encourage organizations to conform to societal norms, ethical standards, and regulatory frameworks (Hatch & Cunliffe, 2018).

In the context of Industry 5.0, institutional pressures increasingly emphasize sustainability, human-centric innovation, ethical technology development, and social responsibility. Fifth-generation universities are therefore expected to address societal challenges, promote sustainable development, and contribute to regional innovation ecosystems. By aligning their missions and practices with these institutional expectations, universities enhance their legitimacy and gain improved access to funding, partnerships, and public support (Carayannis & Campbell, 2012; Scott, 2014).

**4-3-4 Environment from the Perspective of Complex Adaptive Systems**

The complex adaptive systems (CAS) perspective views organizations as dynamic systems composed of multiple interacting components that continuously adapt to changing environmental conditions. In this perspective, organizations are embedded within broader social, technological, and economic systems characterized by nonlinear interactions, feedback loops, and emergent behaviors (Stacey, 2011).

Industry 5.0 environments—characterized by advanced digital technologies, cyber-physical systems, artificial intelligence, and human-machine collaboration—exhibit strong characteristics of complex adaptive systems. Organizations operating within such environments must therefore develop the ability to adapt quickly to technological change, market fluctuations, and evolving stakeholder expectations.

From the CAS perspective, adaptation becomes an integral part of organizational processes. Instead of relying solely on rigid long-term planning, organizations must develop flexible strategies, learning capabilities, and collaborative networks that enable continuous adjustment to environmental changes. Fifth-generation universities, for example, function as knowledge hubs within complex innovation ecosystems, interacting with industries, governments, entrepreneurs, and civil society organizations (Carayannis & Campbell, 2012; Stacey, 2011).

Complexity theory also suggests that modern organizations require more flexible and adaptive organizational designs. Because complex systems consist of numerous interconnected components linked through feedback mechanisms, small environmental changes can produce large, unpredictable organizational effects. Consequently, universities and organizations must adopt adaptive governance structures, encourage experimentation, and foster interdisciplinary collaboration to remain resilient in complex environments (Hatch & Cunliffe, 2018).

**4-5 External Environment and Strategic Management in Industry 5.0**

The external environment represents one of the most critical dimensions of strategic management in contemporary organizations. Organizations do not exist in isolation; their

identity, legitimacy, and long-term success emerge through interactions with their external environments. These environments include social systems, cultural norms, government policies, regulatory frameworks, markets, suppliers, competitors, and global economic dynamics (Stacey, 2011).

In the era of Industry 5.0, organizations must carefully analyze external environmental factors to identify opportunities and threats. Strategic environmental analysis enables organizations to develop strategies that support survival, growth, and competitiveness within highly dynamic technological and market conditions (Rothaermel, 2021).

For fifth-generation universities, the external environment includes industries, entrepreneurial ecosystems, governmental agencies, global research networks, and knowledge-intensive firms. Effective strategic management therefore requires continuous engagement with these stakeholders and active participation in regional and global innovation systems.

Moreover, creating supportive organizational environments has become increasingly important for enhancing employee well-being, creativity, and productivity. Industry 5.0 emphasizes human-centric innovation, meaning that organizational environments should promote collaboration, safety, motivation, and professional development. Universities that create such environments are better positioned to develop innovative research, entrepreneurial initiatives, and impactful societal contributions.

#### 4-5-1 Environmental Dynamism and Sensing Capability

In highly competitive global environments, technological opportunities, customer preferences, and competitive dynamics evolve continuously. According to Teece (2007), organizations must develop sensing capabilities to identify emerging opportunities and threats within such dynamic environments.

Sensing capability involves activities such as environmental scanning, information gathering, interpretation, and opportunity recognition. In Industry 5.0 ecosystems, organizations must monitor technological developments, including artificial intelligence, advanced robotics, big data analytics, and smart manufacturing systems.

For fifth-generation universities, sensing capabilities include identifying emerging research fields, recognizing industry needs, monitoring technological trends, and detecting new opportunities for collaboration and commercialization of research outcomes.

#### 4-5-2 Opportunity-Seizing Capability and Environmental Dynamism

Once opportunities are identified, organizations must be able to seize them by developing new products, services, technologies, or business models. Opportunity-seizing capability involves investment decisions, resource allocation, and the design of appropriate organizational structures to exploit emerging opportunities (Teece, 2007).

Within Industry 5.0, technological and market turbulence creates numerous opportunities for innovation. Universities and organizations must therefore invest in research and development, technology transfer activities, startup incubation, and collaborative innovation initiatives. Fifth-generation universities often establish innovation centers, entrepreneurship programs, and technology transfer offices to support the commercialization of research and the creation of knowledge-based enterprises.

### 4-5-3 Reconfiguration Capability and Environmental Dynamism

Sustaining competitive advantage in dynamic environments requires organizations to reconfigure their resources and capabilities continually. According to Eisenhardt and Martin (2000), dynamic capabilities enable organizations to adapt their resource bases and organizational routines to environmental changes.

In Industry 5.0 ecosystems, technological disruption and rapidly changing market conditions require organizations to adapt their processes, technologies, and structures continuously. Fifth-generation universities must also reconfigure their educational programs, research priorities, and organizational structures to align with evolving societal and technological needs. Research suggests that organizations operating in turbulent environments often engage in experimentation, improvisation, and continuous learning to remain competitive. Similarly, disruptive technological developments or major shifts in market demand may require organizations to transform their core competencies and develop new strategic capabilities (Zahra et al., 2006).

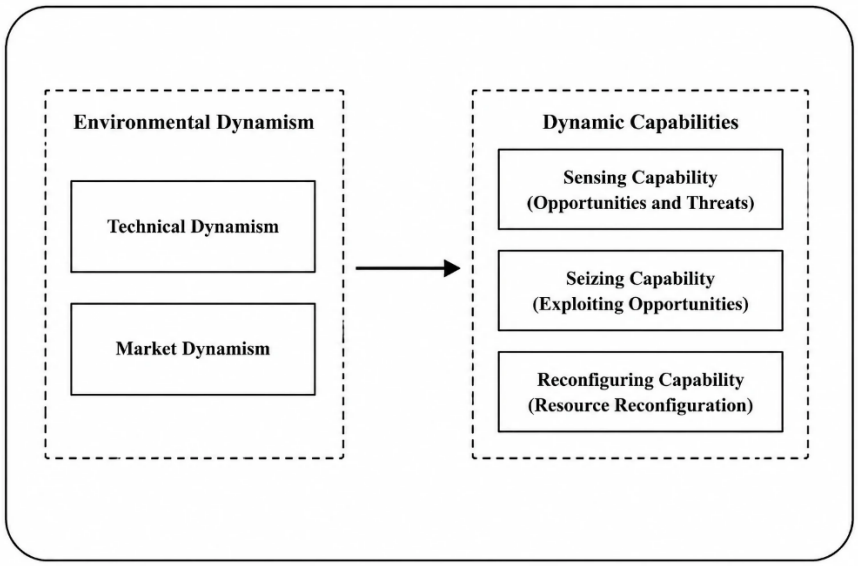



**Figure 4.** Environmental Dynamism–Dynamic Capabilities Relationship (Nekouizadeh et al., 2015)

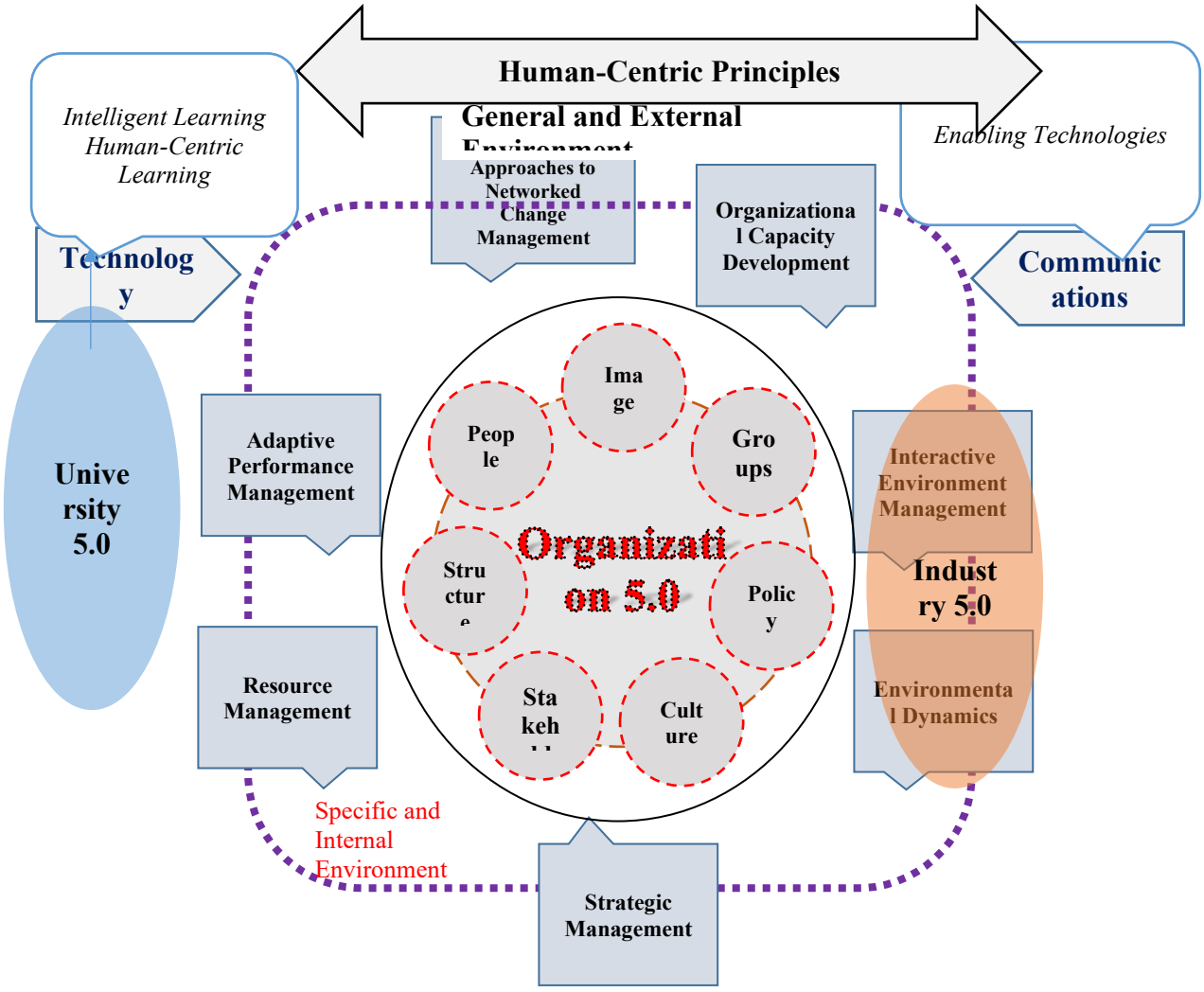
## 5. Findings

The conceptual framework, illustrated in Figure 5, offers a distinct departure from existing models in the higher education and organizational literature. As evidenced in Table 1, traditional organizational studies (e.g., Eisenhardt & Martin, 2000; Teece et al., 1997) have primarily emphasized 'dynamic capabilities' within commercial or bureaucratic contexts. While these foundational models correctly identified the need for sensing and reconfiguring, they often treated technology as an exogenous variable or a neutral tool.

In contrast, our proposed 'Human-Centered Network Organization' model integrates technology as an endogenous, co-evolving element. By situating 'intelligent and human-centered learning' alongside 'enabling technologies' at the core of the framework, this study addresses the research gap identified in Table 2, where previous literature (e.g., Chen et al., 2018; Popenici & Kerr, 2017) struggled to bridge the dichotomy between technical automation and pedagogical humanization.

Furthermore, compared to Industry 5.0 literature, which often focuses on industrial manufacturing processes (Nahavandi, 2019; Xu et al., 2021), the present framework redefines the university as an intelligent learning organism. This model shifts the focus from purely adaptive performance—often cited in conventional organizational theory—to a more holistic, integrated knowledge ecosystem. Specifically, while Ifenthaler and Yau (2020) highlighted the potential of learning analytics for personalized feedback, our model operationalizes this within a broader network structure that incorporates organizational culture, shared mental models, and adaptive governance.

Ultimately, this framework demonstrates that the evolution toward a Fifth-Generation University requires more than the additive integration of digital tools. It necessitates a systemic transformation in which dynamic capabilities are not merely used for resource management but for fostering human-centric resilience and sustainable innovation. This repositioning of the organization as a collaborative, interconnected network represents a significant theoretical advancement over the isolated, top-down structures prevalent in current higher education management discourse. The framework illustrates the synergy between intelligent learning, enabling technologies, and dynamic organizational capabilities within a collaborative knowledge ecosystem (Figure 5).



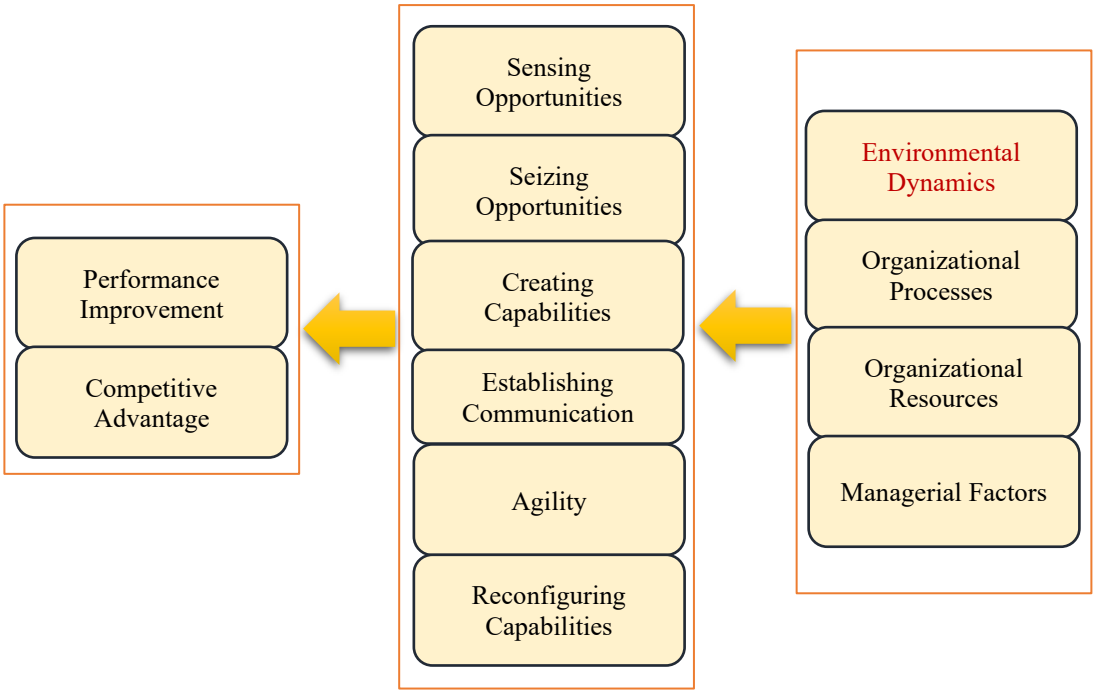



**Figure 5.** The Conceptual Framework of the Fifth-Generation Organization: An Integrated Human-Centered Network Model

## 6. Discussion

This study examined the design and significance of intelligent and human-centered learning environments in fifth-generation universities within the context of Industry 5.0. The findings indicate that the effective integration of advanced technologies—such as AI, the Internet of Things, and learning analytics—with human-centered pedagogical approaches is essential for developing adaptive, personalized, and inclusive learning environments. While intelligent technologies enable data-driven personalization and real-time feedback, human-centered perspectives emphasize social interaction, collaboration, ethical awareness, and learners' well-being as core elements of meaningful educational experiences. Recent studies also emphasize that the transformation of higher education in the era of digitalization and Industry 5.0 requires the development of intelligent learning ecosystems that combine technological innovation with human-centered educational values (Carayannis & Campbell, 2012; Huang et al., 2019; Luckin et al., 2016). Similarly, research on smart learning environments highlights the role of artificial intelligence and learning analytics in enabling adaptive and personalized learning while supporting collaborative and participatory learning processes (Holmes et al., 2019; Zawacki-Richter et al., 2019). In the context of Industry 5.0, which emphasizes collaboration between humans and intelligent systems, higher education institutions must establish a balanced integration of technological capabilities and human values. Learning analytics, for example, can provide valuable insights into students' learning processes and support evidence-based instructional decision-making. However, the use of such technologies requires careful attention to ethical issues, including privacy protection, responsible data governance, and transparency in algorithmic decision-making.

The findings suggest that learning environments in fifth-generation universities should function as integrated educational ecosystems that combine intelligent digital infrastructures with human-centered educational principles. Such environments can support personalized learning pathways, promote collaboration and social engagement, and strengthen students'

creativity, problem-solving abilities, and self-efficacy. Consequently, instructional design in higher education must evolve toward flexible and technology-enhanced learning spaces that simultaneously foster innovation and human development. From an academic perspective, the results highlight the importance of investing in educational technology infrastructure, strengthening faculty professional development in designing hybrid and intelligent learning environments, and rethinking both physical and virtual learning spaces. The study contributes theoretically by integrating the concepts of intelligent technologies and human-centered learning and by proposing a conceptual perspective for designing learning environments aligned with the demands of Industry 5.0. Despite these contributions, this study has several limitations. First, the research is based on a qualitative literature review and conceptual analysis; therefore, the proposed framework has not been empirically tested in real educational settings. Second, the study focuses primarily on higher education contexts and may not fully capture the diversity of learning environments across different institutional or cultural settings.

Navigating the landscape of Industry 5.0 in higher education requires university leadership and policy-makers to look beyond mere hardware acquisition and adopt a more strategic, holistic perspective. Based on our findings, we identify three critical imperatives for successful institutional transformation. First, universities must transition toward holistic infrastructure investment. Rather than focusing solely on isolated digital tools, leadership should prioritize the development of intelligent infrastructures that emphasize robust data governance, ensure ethical AI transparency, and foster seamless integration between virtual systems and human collaborative spaces. Second, the shift toward a fifth-generation university necessitates a fundamental rethink of faculty roles, demanding proactive faculty capability development. Institutions must invest in comprehensive professional development programs designed to equip educators with the skills to orchestrate hybrid learning environments. In these settings, AI-driven insights should be leveraged as a support mechanism to facilitate, rather than replace, human-centric pedagogical practices. Finally, leaders must implement adaptive governance to sustain these educational ecosystems. This requires a shift toward flexible, responsive administrative structures that can effectively manage the intersection of physical and virtual learning spaces. Crucially, this governance must be underpinned by evidence-based instructional decision-making, while maintaining an unwavering commitment to data privacy and the highest ethical standards. Collectively, these actions provide a pathway for universities to transform into resilient, learning-oriented organizations capable of thriving in the complex, technology-infused environments of the modern era. Future research can address these limitations by conducting empirical studies to evaluate the effectiveness of intelligent and human-centered learning environments in improving learning outcomes and student engagement.

Additionally, comparative studies across universities and educational systems may provide deeper insights into the contextual factors influencing the implementation of such environments. Further investigation is also needed to explore the ethical, social, and governance challenges associated with the use of artificial intelligence and learning analytics in higher education. These directions can contribute to the development of more sustainable, responsible, and effective learning ecosystems for the evolving Industry 5.0 landscape..

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