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DEVELOPING COMPETENCIES FOR THE IT INDUSTRY:

THE ROLE OF DUAL EDUCATION IN THE DIGITAL ECONOMY

Contents

Summary

This thesis investigates the extent to which dual education—both at the pre-university and university levels—can become a viable instrument for developing human capital for Romania's IT sector. The research analyzes the relevance and effectiveness of partnerships between universities, the private sector, and public authorities; the potential of the dual system to align academic training with the real needs of the labor market; the degree to which emerging skills (including digital and transversal competences) are integrated into Romania's Classification of Occupations (COR); and stakeholders' perceptions of the challenges, risks, and benefits of such an educational model.

To achieve these objectives, the study focuses on: analyzing the theoretical framework on human capital development in the digital economy; investigating the potential of dual education—at both pre-university and university levels—for developing skills demanded by the IT industry; assessing the correlation between university curricula and labor market requirements; identifying the transversal and digital skills required in IT and the extent to which they are integrated into the educational offer; determining IT employers' perceptions of students' preparedness for the labor market; analyzing how emerging skills are reflected in COR; and, finally, identifying the challenges, barriers, and opportunities associated with implementing dual university programs.

A key aim of this research is to propose public policy measures and strategic directions designed to enhance the efficiency of human capital development in IT through the potential of university-level dual education. At the same time, the study offers practical recommendations for improving educational practices in academia, as the evaluation of obstacles in implementing this model provides valuable data for shaping institutional interventions and systemic solutions.

The thesis is structured into seven chapters: analysis of Romania's IT market and human resource development dynamics (Chapter 1), theoretical and conceptual foundations (Chapter 2), research methodology (Chapter 3), the expansion of dual education in the IT sector (Chapter 4), analysis of transversal competences (Chapter 5), assessment of risks and opportunities in implementing the dual model (Chapter 6), and, finally, the formulation of conclusions, identification of limitations, and proposals for future research directions (Chapter 7).

Chapter 1 – Analysis of the Current Situation

This chapter examines the national and international context of dual education in IT, the evolution of the IT market in Romania, and the state of its human resources. It presents models from the USA and several European countries (Germany, Switzerland, Austria, Denmark, the Netherlands), as well as the Romanian legislative framework for both pre-university and university dual education. Statistical data analyzed include turnover and employability levels in IT, highlighting both the sector's potential and the gaps compared to the European average in digital skills.

Over the past two decades, the Information and Communication Technology (ICT) sector has become a strategic pillar of Romania's economy, making a significant contribution to GDP and attracting foreign direct investment. According to Eurostat and National Institute of Statistics (INS) data, Romania ranks among the top EU countries in terms of the share of IT specialists in the total labor force. The sector's evolution reflects both a competitive advantage based on a well-trained

workforce and significant potential for growth amid accelerated global digitalization. Compared to other Central and Eastern European countries, Romania maintains a steady growth rate, but gaps persist in aligning education with the dynamic demands of the IT industry.

In 2024, the IT sector in Romania entered a period of stagnation in terms of GDP contribution. According to INS data, in the first half of 2024, the industry maintained a 7.8% share of GDP formation, the same as in the corresponding period of 2023, without a notable increase. Major differences between individuals with higher education and those with lower education levels indicate a systemic issue in developing basic digital skills across the general population. Given the significant restructuring underway in the IT industry, the education system must prioritize advanced competencies such as artificial intelligence, cybersecurity, and data analytics.

Internationally, dual education in IT is seen as an effective way to prepare a qualified workforce, tailored to local labor market needs and the requirements of technology companies. While approaches differ between the United States and Europe, both models seek to integrate students into relevant professional environments during their studies, thus facilitating a smooth transition to the labor market.

In Romania, a major step in developing this educational model was the adoption of Law No. 199/2023, which, starting in 2024, enabled the launch of 18 dual bachelor's programs in five universities. From the 2024–2025 academic year, institutions including the Technical University of Bucharest, Babeș-Bolyai University in Cluj-Napoca, and Technical University of Timișoara have introduced programs combining theoretical training with professional practice, involving internships in companies from the relevant field. These programs have the same authorization and accreditation as traditional ones, and the degrees awarded are recognized both nationally and internationally, granting graduates the same rights to continue their studies (master's, PhD) and to access the labor market.

Chapter 2 – Theoretical Framework

This chapter explores the interconnections between education, employability, and economic development dynamics in the digital economy. The analysis begins with the concept of investment in human capital, approached from an economic perspective that recognizes education and vocational training as essential drivers of productivity and economic growth, going beyond their role as tools for personal development. The purpose is to provide the theoretical foundation for investigating the role of dual education as a mechanism for aligning competencies with the requirements of Romania's IT industry in the digital economy context.

The structure integrates key theoretical perspectives and relevant empirical studies, including Human Capital Theory (Becker), contributions by James Heckman, the systematic review *Graduate Employability and Competence Development in Higher Education* (Abelha, 2020), and *Skill Dependencies Uncover Nested Human Capital* (Hosseinioun, 2024). The analysis also includes insights into the global and national IT labor markets, highlighting the pace of technological change and the pressure on education systems to adapt to challenges and opportunities generated by artificial intelligence.

Given the constant transformation of the IT industry—driven by AI advancements and labor market restructuring—it is essential to develop a coherent perspective linking education,

employability, and the sector's dynamic demands. This approach allows the research to capture both global trends and Romania's specific challenges, forming a robust basis for recommendations on curriculum adaptation and strategies for graduates' professional integration.

Research objectives:

1. Analyze the potential of dual education in developing relevant IT skills
2. Assess transversal skills essential for employability in the IT industry
3. Identify gaps between employers' actual needs and competencies recognized in COR
4. Investigate employers' perceptions of the added value of the dual system
5. Explore risks and limitations in implementing dual education in the IT sector
6. Evaluate the role of local public administration in operating dual consortia
7. Analyze the dual system's capacity to address challenges from new technologies, especially Generative AI

Chapter 3 – Research Methodology

This chapter presents the mixed methodology used in the research, which combines qualitative and quantitative methods to analyze the relevance of dual education in developing the skills required in the IT industry. The choice of this approach is justified by the complexity of the subject, which requires both exploring the perceptions of stakeholders (employers, university staff, public administration) and quantifying the skills considered essential for employability.

The qualitative dimension includes semi-structured interviews with IT industry specialists, university faculty, and a representative of the public administration. The quantitative dimension is based on a structured questionnaire applied to a sample of 43 IT professionals, designed to provide a clear picture of the skills considered a priority in the field.

The selection of respondents was carried out through purposive sampling, the main criterion being experience in human resources and recruitment in IT. The sample included representatives from large, medium, and small companies in Cluj-Napoca, as well as four faculty members with expertise in training students for the IT sector. The interviews explored graduate preparedness, curriculum relevance, organizational integration challenges, and the potential of the dual system.

In addition, an analysis of the Romanian Classification of Occupations (COR) was conducted to assess the extent to which it reflects the actual requirements of the IT industry, particularly in the area of digital and transversal skills. The results were triangulated between methods to validate the consistency of perceptions and provide an integrated picture of the current labor market requirements.

Chapter 4 – Expanding Dual Education into the IT Sector: A Response to the Skills Gap?

This chapter analyzes the potential of dual education—both at the pre-university and university levels—to address the skills gap in the IT industry. The analysis starts from the structure of roles in IT companies and from the differences between technical roles

(programming, systems administration, testing, cybersecurity) and non-technical roles (project management, sales, customer support).

It discusses recruitment criteria for each category, the relevance of university studies versus practical experience, and controversies regarding the baccalaureate as a filter for access to post-secondary programs. The chapter examines the opportunities for labor market integration of candidates with secondary education, including professional retraining, and highlights employers' perspectives on workforce preparation.

The interviews reveal the real needs of the IT business environment and expectations regarding graduates, emphasizing the lack of full alignment between the skills delivered by the education system and those demanded by industry. Special attention is given to the impact of Generative AI, seen both as a challenge (automation of certain technical tasks, rapid change in requirements) and as an opportunity (creation of new roles and competencies).

The benefits of the dual model—rapid job integration, reduced onboarding time, and development of practical skills—are presented alongside major challenges: insufficient resources, curriculum adaptation, faculty training, and university–company collaboration.

The conclusions of this chapter stress that the success of expanding dual education into the IT sector depends on functional partnerships, active involvement of all stakeholders, and continuous updating of educational content to meet both current and emerging labor market demands.

Chapter 5 – Transversal Skills Required for IT Industry Employees: Relevance and Impact

This chapter examines the transversal skills considered essential for employability in the IT industry, based on results from semi-structured interviews and the questionnaire applied to employers and professionals in the field. The research identifies a core set of critical competencies that support adaptability and long-term performance in dynamic technological contexts.

The analysis shows that critical thinking and problem-solving are indispensable in the face of technological complexity and rapid industry changes. Effective communication, both in technical and interdisciplinary teams, is seen as key to collaboration and project delivery within quality and time constraints. Teamwork and collaboration, especially in international and remote work settings, contribute to professional integration and operational efficiency. Adaptability and flexibility are deemed essential for responding to emerging requirements, while creativity and innovation play a central role in leveraging new technologies. Leadership and time management are also important for coordinating teams and managing resources efficiently.

Comparison with the Romanian Classification of Occupations (COR) reveals significant gaps, especially in the official recognition of advanced digital skills and socio-emotional abilities. University faculty interviewed highlighted the difficulty of integrating these skills into the curriculum due to rigid educational plans and limited resources.

The chapter concludes that a proactive approach to developing transversal skills is necessary, starting from lower levels of education, to ensure a high degree of digital and socio-professional literacy. These skills are not merely professional tools but form the foundation of

adaptability and competitiveness in the digital economy. Their systematic integration into academic training is essential for meeting the real demands of the IT industry.

Chapter 6 – Risks and Opportunities in Implementing the Dual University System

This chapter provides a detailed analysis of the challenges and opportunities associated with introducing dual education at the university level, with a focus on the specific conditions of the IT sector. The analysis covers structural, logistical, cultural, and legislative aspects, aiming to identify factors that can facilitate or hinder the sustainable implementation of this educational model.

On the risk side, the findings highlight significant logistical difficulties, such as inadequate infrastructure, insufficient material resources, and a shortage of personnel trained for work-based learning methodologies. Tensions are noted between the objective of immediately responding to industry needs and maintaining the role of general and critical education, as well as legislative ambiguities that create an unclear governance framework and uneven distribution of responsibilities between universities, companies, and public administration. Another identified risk is the potential economic instrumentalization of the university, with excessive focus on meeting immediate market demand at the expense of its long-term academic mission.

On the opportunity side, it is emphasized that the dual university system can contribute to creating a flexible educational ecosystem capable of responding quickly to technological changes and market demands. Direct involvement of the business sector can stimulate curricular innovation and generate best practices that can be replicated in other domains. Tripartite collaboration between universities, companies, and public administration is seen as a catalyst for improving the quality of training. Although currently limited, the involvement of local public administration represents an opportunity for strategic, logistical, and financial support, including incentives for small and medium-sized enterprises.

The chapter concludes that mitigating risks and capitalizing on opportunities requires adapting the legislative framework, establishing clear governance mechanisms, and making consistent investments in faculty training and educational infrastructure. Such measures could ensure the sustainable and efficient functioning of the dual university model, strengthening its role in developing human capital for the IT industry.

Chapter 7 – General Conclusions

The conclusions of this research confirm the validity of the working hypotheses and highlight the strategic role that dual university education can play in developing the human capital needed for the digital economy. In a context where the IT industry is undergoing accelerated transformations—both in terms of emerging technologies and skills requirements, this form of integrated education, combining theory and practice, emerges as a viable and adaptable solution.

The study shows that employers clearly value dual programs, considering them instrumental in reducing the time required for labor market integration, improving professional

performance, and enhancing employee retention. This value is amplified by the direct involvement of companies in curriculum design, enabling better alignment between training and actual industry needs. Respondents also emphasized that by alternating academic learning with real work experience, students develop not only technical skills but also a solid set of transversal competencies—autonomy, critical thinking, collaboration, and problem-solving—which are highly valued in agile, interdisciplinary work environments.

At the same time, the research highlights a significant gap between the competencies formally recognized in occupational standards (COR) and those actually required by the industry. This discrepancy affects not only the recognition of emerging IT roles but also the state's ability to support the rapid adaptation of educational programs to new technological challenges. The integration of digital and transversal skills into occupational standards remains fragmented, limiting the effectiveness of human resource planning tools.

The chapter on risks and opportunities reveals tensions that could affect the sustainable implementation of the dual university model. These include legislative ambiguities regarding the functioning of dual consortia, the absence of clear and effective governance mechanisms, unequal distribution of responsibilities among partners, and the risk of economic instrumentalization of the university. Additional challenges include ensuring predictable and sufficient funding, lack of coherence in defining the roles of stakeholders (university, company, public administration), and insufficient faculty preparedness for integrating work-based learning into university pedagogy.

On the other hand, the analysis also highlights strategic opportunities that could be leveraged. Dual university education offers the possibility of building a flexible educational ecosystem capable of quickly responding to the evolving needs of the IT industry. It can stimulate curricular innovation, generate student-centered learning models, and foster a culture of lifelong learning. Although currently modest, local public administration involvement could be expanded through institutional support tools (infrastructure, co-financing, incentives for SMEs), thus strengthening the tripartite collaboration essential for the model's success.

An important aspect addressed in the research is the impact of generative artificial intelligence on skill requirements. This technology profoundly transforms not only how work is done but also what is learned. In this context, dual education proves to be a suitable environment for rapidly testing educational content and for developing higher-order competencies: metacognition, adaptability, social responsibility, and autonomous learning. The dual university can become a training ground for an AI-augmented economy in which human–machine collaboration skills are crucial.

The work was initiated during a period of economic expansion and technological optimism (2022) but was revised in 2024–2025 to incorporate structural changes in the IT market. The stakeholders interviewed—representatives of academia, industry, and local administration—confirmed a perception of accelerated transformation and heightened uncertainty, validating the hypothesis of the education system's need for continuous adaptation to technological dynamics.

Another critical finding of the research is the existence of significant differences between educational categories in terms of digital literacy levels, affecting young people's ability to access professional opportunities in the digital economy. This situation calls for early interventions in

lower levels of education to systematically integrate basic digital skills, thereby reducing disparities and promoting equity in training.

In conclusion, the efficient implementation of dual education—both at the pre-university and university levels—constitutes a strategic opportunity for Romania. This educational model can contribute to strengthening the competitiveness of the digital economy, developing adaptable human capital, and fostering sustainable collaboration between universities, companies, and public administration. If coherently regulated and applied, dual education can become not just an alternative educational pathway but a central pillar of public policies for sustainable development, with a tangible impact on economic performance and social cohesion.