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Maribel Guerrero
Marina Dabić *Editors*

Re-Building University Capabilities

Public Policy and Managerial Implications to Innovation and Technology

Springer

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Preface

Over the last decades, higher education systems have been exposed to multiple pressures from "public policy agendas," "stakeholder needs," and "socio-economic challenges." Although most universities could be considered bureaucrat organizations, external pressures have internally transformed/reconducted their core functions (teaching and research) by incorporating new ones (e.g., high-quality teaching, scholarly impacts on diversity, equality, accountability, sustainable applied innovation, and management of new digital technologies), configuring the "third university mission." The accumulated literature has provided theoretical and empirical insights into what the "third university mission" means. However, management and public policy researchers have highlighted the need for more theoretical/empirical studies to understand university managers' abilities behind each university's transformation, as well as the emergence of university capabilities.

Inspired by this academic conversation, this book provides a better understanding of how university managers have re-built multiple capabilities to adjust university missions in response to demands from public policy agendas and stakeholders (e.g., development of sustained applied innovation and management of new technologies). Concretely, this book (1) theoretically addresses the university manager's view for re-building university capabilities in response to public policy agendas demands and (2) empirically addresses the experiences and strategies adopted by universities in different contexts to achieve public policy agendas.

We expect to inspire researchers, university managers, stakeholders, and policymakers to understand the interplay between higher education societal demands, new university capabilities/missions, and recent university managers' abilities. We also encourage higher education actors to actively participate in the legitimization of how universities' outcomes strongly contribute to achieving economic, societal, technological, and sustainable public policy agendas worldwide. We also encourage

readers to rethink how universities are expanding equal opportunities related to high-quality higher education and innovative/entrepreneurial graduates' options and contributing to sustainable societal advance and well-being.

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The authors are very grateful to Professor Tugrul U. Daim for inspiring us to move this research project forward as part of the Applied Innovation and Technology Management Series. We also want to thank the young scholars who collaborate on this book. They represent a new generation of social science scholars interested in exploring the role of universities in society.

Last but not least, the authors are extremely grateful to Nitza Jones, Kirthika Selvaraju, and Ben Ingraham from Springer for their continuous support in the editorial process.

About the Book

This book is about how university managers must re-build multiple university capabilities due to public policy agendas and stakeholders' demands (e.g., high-quality teaching, scholarly impacts on diversity, equality, accountability, sustainable applied innovation, and management of new digital technologies). Concretely, this book (1) theoretically addresses the university manager's view for re-building university capabilities due to the public policy agendas demands and (2) empirically addresses the experiences and strategies adopted by universities in different contexts to achieve public policy agendas.

The first part of the book provides an overview of how public policy frameworks have influenced the re-building of numerous university capabilities (Chap. 1), as well as how university managers have adopted entrepreneurial, innovative, sustainable, and technological approachs behind the re-building of numerous university capabilities due to the external pressures (Chap. 2).

The second part of the book proposes a theoretical framework based on a review of a decade of publications about the re-building of entrepreneurial capabilities (Chap. 3) and provides empirical insights based on semi-structured interviews with actors involved in the universities' re-building of entrepreneurial capabilities allocated in Europe, South America, and Africa (Chap. 4).

The third part of the book provides a literature review of a decade of publications about the re-building of innovation capabilities (Chap. 5) and empirical insights about how the European Union's innovation capacity-building programs have contributed to European universities' re-building of innovative capabilities (Chap. 6).

The fourth part of the book evidences the theoretical progress of the literature about the re-building of digital capabilities over the last decade, especially due to the COVID-19 pandemic, (Chap. 7) and provides empirical insights into the university's digital capabilities based on a benchmarking analysis between Latin American and Caribbean (LAC) economies' and European economies' digital capabilities (Chap. 8).

The fifth part of the book reviews the literature over the last decade to understand the research evolution of sustainable capabilities within universities (Chap. 9) and provides empirical insights into the university's sustainable capabilities in a Latin-American university (Chap. 10).

The last part of this book presents the concluding remarks of this research (Chap. 11).

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Dr. Guerrero has published several scholarly international publications in academic journals (*Research Policy*, *Journal of Management Studies*, *Journal of Technology Transfer*, *Technovation*, *Technological Forecasting and Social Change*, *Journal of Knowledge Management*, *Small Business Economics*, *Journal of Small Business Management*) and several special issues and books regarding entrepreneurial universities and technology transfer. She is part of the editorial board of the *Small Business Economics* (Editor), *Journal of Technology Transfer* (Associate Editor), *Journal of Small Business Management* (Associate Editor), *Technology Forecasting and Social Change* (Advisor Board), *Research Policy* (Advisor Board), and *Entrepreneurship: Theory and Practice* (Reviewer Board).

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She was the editor of books published by Routledge, Springer, and De Gruyter. Jointly with Professor Tugrul Daim, she is the editor of the book series: Applied Innovation and Technology Management, Springer. Professor Dabić has prepared a background report for OECD/EC HEInnovate for Croatia. Since 2017 she is a reviewer for Horizon 2020 projects. Over her career, she has achieved success and acclaim in various projects, such as HORIZON 2020 RISE, ERASMUS +, LLL Leonardo da Vinci, Tempus, and EC Interreg. Professor Dabić received the Phi Beta Delta Award for International Scholars at CSU, Georgia, USA, where she was a Visiting Professor.

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Abbreviations

AASCU	American Association of State Colleges and Universities
AASHE	Association for the Advancement of Sustainability in Higher Education
ABS	Association of Business Schools
AI	Artificial Intelligence
ANID	Agencia Nacional de Investigacion y Desarrollo en Chile
ANVUR	Agency for the Evaluation of the University and Research System
AOM	Academy of Management
ARWU	Academic Ranking of World Universities
BDA	Bayh-Dole Act
BID	Banco Interamericano de Desarrollo
CONACYT	Mexican Council of Science and Technology
EC	European Commission
ECA	The European Consortium for Accreditation in Higher Education
EHEA	European Higher Education Area
ERA	European Research Area
EU	European Union
EUA	European University Association
Eurostat	European Commission Statistic
HEPI	Higher Education Policy Institute
GDP	Gross Domestic Product
GEM	Global Entrepreneurship Monitor
GREST	Grupo de Investigación en Gestión Responsable para la Sostenibilidad Territorial
GUESSS	Global University Entrepreneurship Spirit Students' Survey
ICT	Information and Communication Technology
IPR	Intellectual Property Right
KPIs	Key Performance Indicators
LAC	Latin America and the Caribbean
MOOCs	Massive Open Online Courses
NACIE	National Advisory Council on Innovation and Entrepreneurship

NASPA	National Association of Students Public Affairs
NGO	Non-governmental Organizations
OECD	Organization for Economic Cooperation and Development
PPA	Public Policy Agenda
PSED	Panel Studies of Entrepreneurial Dynamics
R&D	Research and Development
RAE	Research Assessment Exercise
REF	Research Excellence Framework
RRM	Recovery and Resilience Mechanism
SDGs	Sustainable Development Goals
SMEs	Small and Medium Size Enterprises
SMS	Strategic Management Society
STEM	Science, Technology, Engineering, and Mathematics
T2S	Technology Transfer Society
THE	Times Higher Education
TTO	Technology Transfer Offices
UUK	Universities United Kingdom
USAID	The United States Agency for International Development
WOS	Web of Science
US	United States
UK	United Kingdom

Part I
Re-building University Capabilities

Chapter 1
Public Policy Implications to Innovation and Technology

Maribel Guerrero and Marina Dabić

1.1 Introduction

Over the last decades, higher education systems have been exposed to multiple "public policy reforms" due to restrictions of public funds, stakeholder pressures, educational trends, and socioeconomic shakeouts. Pioneer studies about public policy and higher education have provided an in-depth analysis of complex state policies and their affectation on university strategies and communities, especially those oriented toward enriching students learning conditions (John et al., 2018). Regarding innovation and technology, since the 1980s, studies have evidenced the significant advance of public policies oriented to reinforce technology transfer within higher education (Guerrero & Urbano, 2021a; Crow et al., 2020), as well as the replication of successful transformation legislative patterns across the globe (Gores & Link, 2021; Guerrero & Urbano, 2021b). However, the link between public policy agenda and university managers' strategies demands more information to clarify the innovative and technological outcomes (NACIE, 2011). Indeed, the COVID-19 pandemic forced public authorities to engage in immediate adjustments to a wide range of higher education policies. The immediate policy action most often taken by governments was to allocate additional research funding to priority research areas

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associated with the pandemic (OECD, 2021, p. 21), affecting the discovery process with universities (Siegel & Guerrero, 2021). This chapter analyses how public policies have redirected the way universities develop core functions, access public resources, collaborate with local/international actors, and generate value for society. Directly or indirectly, this analysis provides interesting insights into the emergence and evolution of university capabilities.

The remainder of this chapter is organized as follows. Section 1.2 highlights the higher education public policy that has influenced both evolution and emergence of university managers' abilities and university capabilities. Section 1.3 introduces some higher education sector trends. Section 1.4 highlights the discussion, and we conclude by outlining policy implications.

1.2 Higher Education Public Policy

1.2.1 The United States

In the 1980s, the Bayh–Dole Act was the most significant public policy that enforced the development and management of university inventions and technological advances (Guerrero & Urbano, 2019; Crow et al., 2020). The result was multiple inventions and technological discoveries across American universities. It was unsurprising that adaptative transformation legislative patterns were implemented worldwide, aiming to foster the socioeconomic contribution of universities via educational, technological, innovative, and entrepreneurial outcomes (Gores & Link, 2021; Guerrero & Urbano, 2021b). This legislative act was the starting point of university managers' entrepreneurial and innovative abilities regarding university innovative and technological outcomes—consequently, the development of entrepreneurial and innovative capabilities within North-American universities (Siegel & Phan, 2005; Phan & Siegel, 2006). After fourthly years, this legislation has continued impacting the technological and innovation advances and university managers' abilities to manage knowledge and intellectual property (Guerrero & Urbano, 2021b; Dabić et al., 2016, 2022). It has promoted the emergence of entrepreneurial and innovative capabilities among university managers, university students, and university professors.

In the 2000s, the US Secretary of Commerce policy discussions focused on the leadership of universities. According to the National Advisory Council on Innovation and Entrepreneurship (NACIE, 2011), the areas of discussion were promoting student innovation and entrepreneurship, encouraging faculty innovation and entrepreneurship, actively supporting university technology transfer, facilitating university–industry collaboration, and engaging in regional and local economic development efforts. In 2018, the United States Agency for International Development (USAID) published the public policy framework for higher education, which considers higher education a central actor in driving sustainable local

development (USAID, 2021). Concretely, this higher education program framework includes educational reforms, organizational transformations, and individual abilities oriented to three core university functions (USAID, 2021, p. 2): advance knowledge and research, provide quality and relevant education for workforce, and engage and strengthen networks and communities.

Adopting the USAID principles (equity-inclusion, data transparency, local ownership, and sustainability), this program looks for outcomes, such as capacity development and reinforced partnerships in sustaining a continued performance across university functions, and is the central actor in developing/managing solutions to local problems (USAID, 2021). Consequently, university managers/leaders have responded to public policy pressures by developing innovations and technological advances that have been transferred and commercialized without ignoring sustainable and digital views (Guerrero & Urbano, 2021a). Figure 1.1 shows how this framework has reinforced the pre-existing university capabilities (entrepreneurial and innovative) as well as the emergence of new ones (sustainable).

After the COVID-19 pandemic, according to the American Association of State Colleges and Universities (AASCU, 2022), effective public policy is vital to sustaining a high-quality, affordable, and accessible American public higher education system. In this regard, the 2022 Public Policy Agenda (PPA) focused on two main purposes: (a) outline the most beneficial policies to students more affected due to the pandemic and (b) provide a guide to react to unanticipated policy and political developments (AASCU, 2022, p. 3). Concretely, this PPA concentrated on pressing issues confronting universities:

- Affordability looks for financial vitality by removing barriers for students.
- A campus climate that guarantees to fulfill university missions, including teaching and social engagement (minorities, first generations, undocumented individuals, and others).

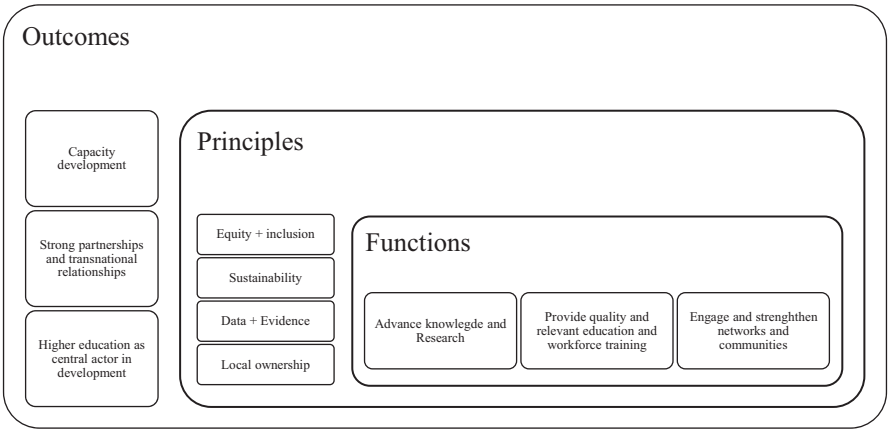

Fig. 1.1 US higher education program framework. (Source: Authors, based on USAID, 2021, p. 1)

- High-quality educational experience and cost-efficient accountability articulate a sustainable quality assurance system and regional economic competitiveness.

These public policy issues demand university managers' entrepreneurial abilities to identify alternatives that incentivize public–private investments in higher education to help low-income families (university entrepreneurial and sustainability capabilities). Likewise, we observe that the link between the higher education PPA and the university missions promotes the university managers' abilities to allocate resources to foster entrepreneurial, innovative, and sustainable capabilities (Teece, 2018; Heaton et al., 2022). It has reinforced the pre-existing university capabilities (entrepreneurial, innovative, and sustainable) as well as the emergence of new ones (digital). Indeed, at the public policy and management collective, according to the Public Policy Division of the (NASPA, 2021), the United States higher education PPA from 2021 to 2024 should have direct focus on the following critical themes:

- Advancing students learning and success by reinforcing postsecondary education, providing them assistance (educational, wellness) and skills development.
- Opening pathways for equity, inclusion, and social justice.
- Reinforcing research, analysis, and scholarships for public policy development.
- Reinforcing professional development and engagement for future public policy issues.

In sum, the United States higher education public policy has provoked the updating/re-building of university capabilities (entrepreneurial, innovative, sustainable, and digital), as well as has highlighted the need for entrepreneurial and innovative abilities for public university managers. Therefore, new organizational justice and responsibility models should be considered in managing science, technology and innovation (Aguilera et al., 2022; Siegel 2022; Waldman et al., 2022). Consequently, universities will contribute to the develop, commercialize, and generate spillovers due to innovations and technologies.

1.2.2 The United Kingdom

In the United Kingdom, higher education public policy-related innovation and technology have been mostly oriented toward reinforcing performance-based research university funding systems (Sivertsen, 2017). In the 1980s, the Thatcher government implemented the Research Assessment Exercise (RAE), based on a peer-review system, to assess research quality and funding allocation. For over 20 years, the higher education public policy based the funding bodies in England, Scotland, Wales, and Northern Ireland to distribute funds of about £2 billion per year, selectively based on the assessed research quality and university efficiency (Sivertsen, 2017). Consequently, university leaders reconducted strategic decisions to react to emerging stakeholders' priorities/needs. During this time, these public policies

reinforced teaching and research missions that demanded university innovation capabilities (Audretsch et al., 2022a, b; Audretsch et al., 2023).

In 2014, the RAE was replaced by the UK Research Excellence Framework (REF), which combined performance-based institutional funding and research evaluation. It evidences the need for new university managers' entrepreneurial and innovative abilities to efficiently allocate resources that generate university outcomes that significantly contribute to economic prosperity, national well-being, and the dissemination of knowledge (REF, 2014). In particular, the REF 2014 supported equality and diversity by applying a code of practice on the transparent equality impact assessment (REF, 2015). While the outputs included the originality, significance, and rigor of academic publications, the impact considered the reach and significance of change or benefit to the economy, society, culture, public policy or services, health, the environment, or quality of life beyond academia (see Fig. 1.2). As a result, new university capabilities were needed for ensuring research scholarly impacts related to entrepreneurship, innovation, and sustainability.

Most recently, the higher education policy has also been influenced by the exit of the United Kingdom from the European Union (Conlon et al., 2021) and due to the COVID-19 disruptions. In this regard, the Higher Education Policy Institute (HEPI) started an interesting conversation about the projection of higher education in England to 2035 (Hewitt, 2021). According to this report, one of the main relevant challenges generated by the recession caused from the pandemic was increasing the disadvantage gap of certain collectives to enter higher education. Due to the radical impact of the COVID-19 pandemic in higher education (UUK, 2022), the current UK higher education public policy should focus on shaping development by

- Ensuring sustainable university funding.
- Protecting students via legislation.

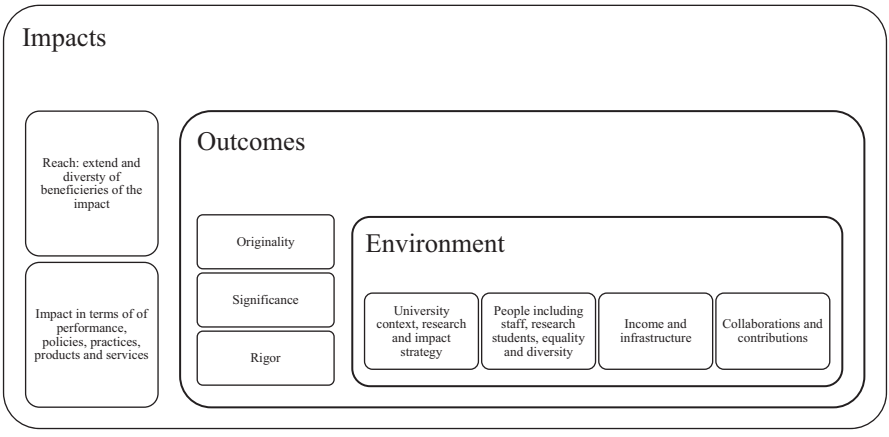

Fig. 1.2 UK research excellence framework. (Source: Authors, based on REF, 2014, 2015)

- Providing high workforce skills, enhancing the value and progress on tackling inflation, and ensuring research, innovation, and business.

In sum, the UK higher education public policy has promoted the quality of education, the effectiveness in resource allocation, and scholarly impacts in the society (Audretsch et al., 2022b). These elements have been strongly needed to update/re-build university capabilities (entrepreneurial, innovative, sustainable, and digital). As a result, the UK policy trend has highlighted the need for reinforcing entrepreneurial and innovative capabilities for university managers to lead the development, commercialization, and spillover effects of university innovations and technologies.

1.2.3 The European Union

After the Second World War, knowledge, technologies, and globalization played a critical role in the education approach. In the European Union (EU) context, the goal was to maintaining collaboration and integration among the members of the union within the framework of common cultural values.

In the 1980s, higher education policy focuses on increasing the quality and efficiency of education and learning at all stages of life of the EU member states (Cankaya et al., 2015). In the 1990s, several higher education reforms were introduced (Sorbonne Declaration, Lisbon Declaration, and Bologna Declaration), looking to establish a competitive European Higher Education Area (EHEA) and a social model focused on cooperation and harmonization that reinforced freedom, equality, and skills (Cankaya et al., 2015; Moser et al., 2022). In the 2000s, higher education experimented with a consolidation period focused on five areas: quality, access, contents, openness, and efficiency (Cankaya et al., 2015). These agreements were configured through different declarations hosted in Prague, Berlin, Bergen, London, and Leuven.

Over the last three decades, the EU authorities from member states implemented the EHEA based on higher education public policy initiative oriented to improving high-quality education by continuing homologation/joint educational programs (Bologna, European Joint Degrees), increasing student mobility (Erasmus), employability, study structures, and attractiveness. In parallel, higher education reforms are pursuing the vision of a unified European Research Area (ERA), open to the whole world and allowing the free transfer of researchers, scientific knowledge, and technologies (Moser et al., 2022). For instance, the European Political Strategy Centre recognized several higher education trends to be considered by the member states' higher education systems (European Commission, 2019, pp. 4–9):

- Investing in early childhood education skills due to the highest rate of social and economic return in higher education.
- Demands for competencies keep evolving and investing in lifelong learning. Therefore, graduation is not the end of learning.

- Digital skills are becoming a core literacy and young people are at an advance and outperform older ones on digital problem-solving. Therefore, reduce the gap in digital literacy among generational cohorts.
- Humans are just some of the ones learning where digital technologies and machines are novel higher educational insights.
- From standardization to customization, by personalizing classroom learning based on job learning requests.
- Growing global competition for universities represents a time to reinvent them.

Directly or indirectly, university managers experimented with the internal transformation toward becoming more innovative and entrepreneurial organizations. Due to these transformation challenges, Fig. 1.3 shows the European Commission initiatives to facilitate organizational change and enhance universities' innovative, entrepreneurial, and digital capabilities (Volungeviciene et al., 2021).

After external shakeouts (2008 financial crises and the COVID-19 pandemic), the EU cooperates with higher education systems and the EU member states to take advantage of smart specializations (European University Association, 2018; Ibáñez et al., 2022) and enable the higher education sector to adapt to changing conditions, to thieve, and to contribute to Europe's resilience and recovery (European Union, 2021). Due to the external shakeouts (climate crisis, democratic-political pressures, social disparities, pandemics), according to the European University Association (2021), the future European universities should be more transformative, sustainable,

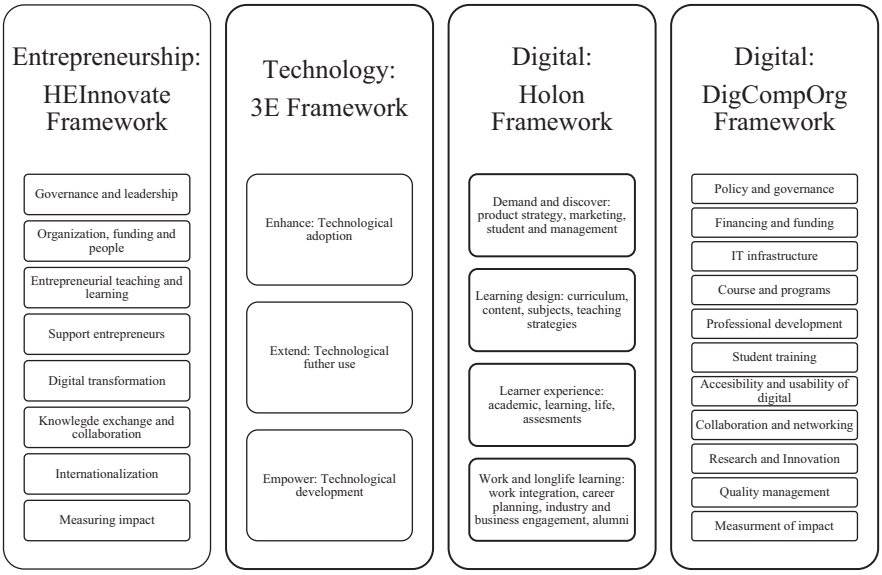

Fig. 1.3 European higher education frameworks. (Source: Authors, based on Volungeviciene et al., 2021)

diverse, and engaged across teaching-learning, research, innovation, and social engagement.

In this way, the EU is looking to recognize the innovative and entrepreneurial capacity building done by the universities across the state members in the last decades and to shape new ones to overcome societal needs, such as sustainability and digital. In sum, the EU higher education public policy has enriched values and capabilities across universities' managers allocated in all state members, becoming more entrepreneurial, innovative, digital, and sustainable.

1.3 Higher Education Public Policy and University Capabilities

1.3.1 Re-building University Capabilities Due to Public Policy Agendas

Table 1.1 shows the interplay between the higher education public policy agenda and the universities' capabilities to achieve the teaching, research, and social engagement missions across the higher education systems in the United States, the United Kingdom, the European Union countries, and the OECD countries. Concretely, higher education public policy has evolved universities' capabilities from innovative to entrepreneurial and sustainable. Indeed, due to the COVID-19 pandemic, we are observing some insights about enhancing the university's digitalization transformation.

The result has been evident in multiple inventions, discoveries, and socioeconomic returns to society (Magda & Buban, 2018). Even the similar/different transformational patterns across higher education systems, there is evident the need for understanding the role of university managers in the effective allocation of resources for achieving the university missions, as well as the university capabilities acquired/developed along transformational processes (Audretsch et al., 2022a; Heaton et al., 2022).

For instance, with some exceptions (the UK system), it is clear that the most common criteria to measure universities' contributions to public policy agendas are still the number/impact of research publications and patents (Audretsch et al., 2022b; Audretsch et al., 2023). A big pending issue is reducing a strong disconnection among university public policy, university funding, university outcomes, university promotion criteria, higher education evaluation protocols, and associations of programs' accreditation (Siegel & Guerrero, 2021).

Table 1.1 Higher education public policy and demand of university capabilities

Associations	Public policy agenda	Demand for new capabilities	Missions	Country
AASCU (2022)	Access, affordability, and value Learning environment Quality, accountability and outcomes	Innovative Entrepreneurial Sustainable	Teaching Research Social engagement	United States
NASPA (2021)	Advocacy for students success Equity, inclusion and social justice Research and scholarship Professional development and engagement	Innovative Sustainable	Teaching Research Social engagement	United States
USAID (2021)	Advance knowledge and research Provide quality and relevant education for workforce Engage and strengthen networks and communities	Innovative Sustainable	Teaching Research Social engagement	United States
REF (2014)	High-quality research Scholarly impacts in multiple areas	Entrepreneurial Innovative Sustainable	Research Social engagement	United Kingdom
UUK (2022)	High-skilled workforce Reduce inequality Sustainable funding Enhancing value for students Tacking grade inflation and big societal challenges Ensuring research and innovation Securing an effective regulatory environment Social recovery post pandemic	Entrepreneurial Innovative Sustainable	Teaching Research Social engagement	United Kingdom
European Union (2021)	Smart specialization Micro-credentials Mobility Resilience, recovery Digitalization and AI Sustainable	Entrepreneurial Innovative Sustainable	Teaching Research Social engagement	European Union

Source: Authors

1.3.2 *University Capabilities Metrics Due to Public Policy Demands*

Public policy's influence on universities has demanded establishing metrics that primarily evidence the university's outcomes derived from the stakeholders' pressures for updating university missions and capabilities. A good example of it

Table 1.2 Demand of university capabilities and university ranking proxies

University ranking	Criteria	Demand for new capabilities	Missions	Sources of information
Innovative University by Reuters (2019)	Patent volume, success Global patents Patent citations Industry article citations % industry collaborative articles Total web of science core papers	Innovative Entrepreneurial	Research Technology Transfer and commercialization	InCites, WOS, Derwent Innovation Index, Derwent Patent Index, Patent Citation Index
Shanghai Ranking by ARWU (2022)	Quality of education Quality of faculty Research output Per capita performance	Innovative Entrepreneurial	Teaching Research	Nobel Prize, Field Medals, Highly Cited Researchers by Clarivate
Times Higher Education by THE (2022a, b)	Teaching Research Citations International outcome Industry income SDGs	Innovative Entrepreneurial Sustainable	Teaching Research Entrepreneurship Social engagement	Academic reputation survey, Elsevier's Scopus dataset
QS University Ranking by QS Quacquarelli Symonds (2022a, b)	Academic reputation Employer reputation Citations International Research Network Employment outcomes Environmental impact Social impact	Teaching Innovative Sustainable	Teaching Research Social engagement	Academic Surveys, Employers survey

Source: Author

evidences the methodologies implemented by the most used university rankings (U.S. News, 2022; QS Quacquarelli Symonds, 2022a, b; THE, 2022a, b; Reuters, 2019; ARWU, 2022) by public policy agents, university managers, and university stakeholders. Table 1.2 shows the adoption of proxies that capture how universities had impregnated an innovative, entrepreneurial, and sustainable orientation in their missions: teaching, research, and social engagement.

Directly or indirectly, university rankings are globally legitimizing the university's contribution to the public policy agenda objectives and building the university's reputation. Particularly, university rankings are capturing some proxies of innovation and technological contributions via patents (Reuters, 2019), research outputs (ARWU, 2022), industrial collaborations, and the income derived from these collaborations (THE, 2022a, b), as well as international networks (QS Quacquarelli Symonds, 2022a, b). It has been used by university managers as a benchmarking analysis for improving their strategic approaches and reinforcing the development of capabilities (Magda & Buban, 2018).

1.4 The Emergence of Higher Education Models

The analysis of the higher education sector also matters to understand the evolution of university models, the market trends, and the pending new scenarios (Alexander, 2020). Figure 1.4 shows the different university models that have emerged due to the influence of public policy frameworks.

Worldwide governmental agencies have recognized the "Innovative University" and the "Entrepreneurial University" models (NACIE, 2011; USAID, 2021; HEInnovate, 2022). Before the COVID-19 pandemic, the Deloitte Center for Higher

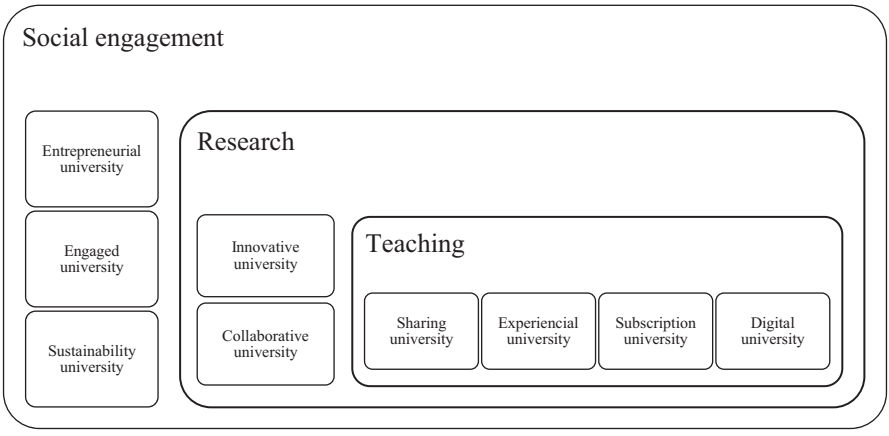

Fig. 1.4 University models derived from public policy. (Source: Authors)

Education Excellence, in conjunction with Georgia Tech's Center for twenty-first Century Universities, presented the higher education sector trends (Deloitte, 2018). According to this report, since the beginning of the 2008 Recession, the public higher education sector has faced an unprecedented set of external forces and pressures that have, in some extreme cases, threatened the very existence of certain types of universities (Deloitte, 2018, p. 3). For example,

- The "Sharing University" focuses on efficiently linking students and administrative services to scale/capitalize on organizations' expertise.
- The "Entrepreneurial University" focused on offerings educational investments based on student and state economic needs.
- The "Experiential University" focuses on integrating work experiences deeply into the curriculum, with students toggling between long stretches in the classroom and the work world related to their study area.
- The "Subscription University" focused on reimagining education as a platform for continual learning that provides students with multiple opportunities to develop both soft and critical technical skills.
- The "Partnership University" focused on making it easier for strategic investments and funding collaboration and consolidation, and also private fundraising.

After the COVID-19 pandemic, UNESCO, OECD, and Inter-American Development Bank elaborated on several diagnoses that evidenced embryonic transformations in higher education models. For example,

- The incipient worldwide digital transformation across higher education systems revealed that digital technologies capabilities are demanding the "Digital University" model (OECD, 2021).
- The evidence shows insufficient attention to reducing inequalities across human resources and disadvantaged students, the constant reduction in the allocation of public funds, and the lack of diversity in the university strategies (Inter-American Development Bank, 2021). It has increased the sustainability demand within universities and the emergence of the "Sustainability University" model (OECD, 2021; Golden et al., 2021).
- The public awareness and commitment to mitigate and rapid innovative responses to societal needs reinforce the idea of the "Engagement University" (OECD, 2021).

The emergence of "university models" was undoubtedly influenced by the transformation of higher education public policy agendas and market pressures in the last few years. In the North America context, the model of "new American University" (Crow & Dabars, 2015) has been incorporated for supporting "public interest technologies" related to the application of technology expertise that generates public benefits and promotes the public good.

1.5 Conclusions

Due to higher education public policy and stakeholders' pressures, universities and their governance structures should become entrepreneurial ambidextrous organizations (Guerrero, 2021; Heaton et al., 2022). It has also demanded new organizational justice and responsibility models for managing science, technology and innovation (Aguilera et al., 2022; Siegel 2022; Waldman et al., 2022). Looking to the future, the higher education public policy agendas are concentrated in the fourth gaps identified by industry, university stakeholders and non-profit organizations (see Ford Foundation, 2022; Bull, 2022; Bouchrika, 2022). First, *regarding sustainability trends*, universities are tasked with enhancing gender/racial diversity, reducing workforce-opportunity gaps, and paying attention to mental health awareness. Second, *regarding technological trends*, universities are demanded to be equipped with multiple skills, including artificial intelligence, hybrid learning environments, and technical skill gaps in the curriculum. Third, *regarding governance trends*, universities face a changing pathway for fundraising due to the heavy reliant on public funding, as well as the growing need for alternative funding options. Fourth, *regarding public interest technologies*, universities face a challenging pathways for applying technology expertise to generate public benefits. Consequently, multiple capabilities within the university governance, missions, and outcomes are needed to achieve current/future higher educational sectoral trends.

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Chapter 2
Managerial Implications to Innovation and Technology

Maribel Guerrero and Marina Dabić

2.1 Introduction

Over the last decades, higher education systems have been exposed to multiple organizational transformations derived from "public policy agendas and stakeholder pressures" (Audretsch et al., 2022a, b), such as new economic models (knowledge-based economy) (Audretsch, 2014; Crow et al., 2020), societal challenges related to high-quality education and affordable accountability (Pinheiro et al., 2017), sustainable development goals' (SDGs) contribution to the reduction of societal inequalities (Fini et al., 2018; Siegel, 2022; Guerrero & Lira, 2023), the budget restrictions due to economic crises, and societal engagement due to pandemics (Siegel & Guerrero, 2021; Guerrero & Pugh, 2022), and the crucial role of organizational justice and science responsibility in managing new technology and innovations (Aguilera et al., 2022; Waldman et al., 2022). As a result, the external pressures have reconducted the considered core functions of universities (teaching and research) toward the incorporation of other activities (technology transfer, social engagement, scholarly impacts) to configure the "third university mission." Most of the literature has focused on proving theoretical and empirical insights about what the "third university mission" means (Compagnucci & Spigarelli, 2020).

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Undoubtedly, each organizational transformation requires university managers/leaders with an entrepreneurial, innovative, technological, and sustainable orientation to allocate resources effectively to each university mission (Heaton et al., 2019, 2020, 2022). However, more is needed about the university managers' abilities that are needed behind each university's transformation step, as well as the potential trade-off effect in the effective allocation of resources to each mission. This chapter exposes how university managers/leaders have effectively addressed university transformations by acquiring/developing certain university capabilities (entrepreneurial, innovative, technological, and sustainable). This chapter discussed the higher education sector trends and which roles should be assumed by university managers to achieve them.

The remainder of this chapter is organized as follows. Section 2.2 clarifies the understanding of university capabilities as well as their connection with a public policy perspective. Section 2.3 introduces the higher education sector trends. Section 2.4 highlights the discussion. In the final section, we conclude by outlining policy implications.

2.2 University Capabilities

2.2.1 Capabilities

According to Teece (2023, p. 118), a capability is defined as

> a set of learned processes and activities that enable an organization to produce a particular outcome

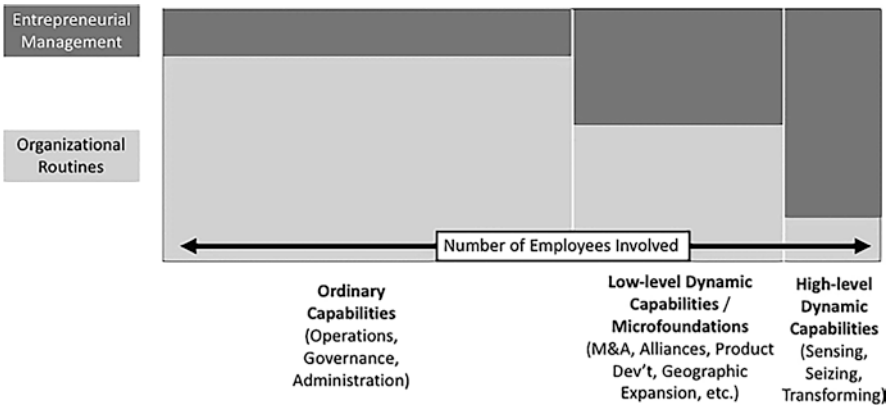

Fig. 2.1 Capabilities, routines, and managerial decisions. Note: Horizontal width reflects the quantity of organizational resources committed to each category of capabilities. (Source: Teece, 2023, p. 124)

Figure 2.1 shows how the capabilities are classified into ordinary and dynamic (Teece et al., 1997, 2016). While ordinary capabilities represent those needed for efficient operation (e.g., traditional labor, physical capital, operations, governance, and administration), dynamic capabilities are those management needed to be involved in developing and testing emerging technologies, redefining new business models, and orchestrating the necessary assets inside/outside the organization (Teece, 2023). Concretely, Teece et al. (1997, p. 516) defines dynamic capabilities as

> the organization's ability to integrate, build, and reconfigure internal/external competences to address rapidly changing environments. …. reflects the organization's ability to achieve new and innovative forms of competitive advantage …

An entrepreneurial behavioral approach is impregnated by organizational management to enhance dynamic capabilities (Teece, 2016). Thus, dynamic capabilities involve a combination of organizational routines (specific assets) and entrepreneurial management (Teece et al., 1997; Teece, 2023). In this view, the level of dynamic capabilities depends on the low or high evolutionary changing of organizational routines and culture. Teece (2007, p. 1342) defined three high-level categories of dynamic capabilities: sensing (analytical systems to sense, filter, shape, and calibrate), seizing (structures, procedures, and designs for seizing opportunities), and transforming (alignment and realignment of specific tangible and intangible assets). The dynamic capabilities literature has recognized them as key factors for the organization's adaptation to its changing environment. In this assumption, organizations are integrating new dynamic capabilities (sensing, seizing, transforming) considerations in their strategy due to environmental, social, technological, digital, innovative, and sustainable pressures (Castiaux, 2012).

2.2.2 University Capabilities

Universities face uncertainty on many fronts, such as rapid and unforeseen developments in higher education public policy agendas, funding, new teaching demands, and global talent competition (Audretsch et al., 2022a). As a result, universities compete vigorously with other universities for students, faculty, grants, donations, and government support (Heaton et al., 2019). Therefore, within the university context, the dynamic capability framework can be useful for understanding how university managers entrepreneurially achieve external stakeholders' needs and environmental challenges (Teece, 2018). It means the operational logits to achieving public value by transforming the bureaucratic reasoning toward an entrepreneurial decision-making reasoning (Crow et al., 2020).

Previous studies have shown that strong dynamic capabilities help organizations to be more innovative, entrepreneurial, and resilient in the presence of external turbulences (Teece & Leih, 2016) or new socioeconomic paradigms (Audretsch, 2014). This approach has been aligned with the evolution of university missions (Compagnucci & Spigarelli, 2020). The reason is that their nature must periodically

renew strong dynamic capabilities because routines gradually become less well-adapted as circumstances change (Heaton et al., 2020, 2022). Organizations, creating strong capabilities typically involves an entrepreneurial university culture (Teece, 2016) that should be propagated/shared across the university community (Guerrero et al., 2021). Table 2.1 shows a compilation of studies that have evidenced the antecedents (higher education public policy and stakeholder's demands) and the emergence of new university capabilities.

First, innovative universities' capabilities have emerged from the new advanced knowledge and inventions to create social value. University managers have developed abilities to effectively combine the pre-existing ordinary capabilities with sensing innovative opportunities that could be seized and transformed (Teece et al., 2016) into inventions, patents, licenses, and other technological products that could be transferred and commercialized and generate spillover effects (Audretsch et al., 2022a, b; Graf & Menter, 2022). For instance, unexpected external shakeouts (e.g., economic crises or the most recent pandemic) have forced university managers to make disruptive technological and innovative changes in response to university stakeholders' needs (Guerrero & Pugh, 2022). Interestingly, the achievement of these demands is covered among the teaching, research, and social engagement core functions of the university (Audretsch et al., 2022a), as well as in collaboration with multiple socioeconomic agents (Ibáñez et al., 2022).

Second, entrepreneurial universities' capabilities have emerged from the highest unemployment levels of university students after graduation, the need for professionals with an entrepreneurial vision for development, and engagement in societal and organizational problematics. University managers have improved skills to entrepreneurial and effectively combine routines with sensing business opportunities that could be seized and transformed (Heaton et al., 2019) into entrepreneurial students, academics, alums, and staff (Guerrero & Urbano, 2019; Heaton et al., 2020). Likewise, the achievement of entrepreneurial capabilities is covered among teaching, research, and social engagement core functions of the university (Audretsch et al., 2022a; Cunningham et al., 2022), as well as taking competitive advantage of the learning curve obtained from innovative capabilities.

Third, digital universities' capabilities have emerged from new digital and technological paradigms that need a high-skilled digital workforce, flexible micro-credentials for updating digital competencies, a competitive digital learning environment, and rapid technological transformation (Teece, 2018). Consequently, the university community has upgraded ICT skills by sensing digital opportunities that could be seized and transformed into digital teaching-learning environments and discovering digital and technological artifacts, devices, platforms, or AI solutions (Guerrero et al., 2021). Likewise, digital capabilities are transversal across university functions (teaching, research, and social engagement) and taking competitive advantage of innovative entrepreneurial universities' capabilities (Guerrero & Urbano, 2021).

Table 2.1 University capabilities

Antecedents: Public policy and stakeholders	University capability	Ordinary capability	Dynamic capability	Authors
Ensuring research and innovation Engage and strengthen networks and communities Advanced knowledge and technological inventions Smart specialization	Innovative	Funding infrastructure High-skilled researchers Industrial networking Innovative ecosystem Intellectual property rights	Sensing innovative opportunities Seizing resources for achieving them Transforming resources into inventions and innovative solutions	Teece et al. (2016), Audretsch et al. (2022a, b), Guerrero and Pugh (2022)
Professional development and engagement Tacking big societal challenges Young unemployment and labor market Enhancing value for students Resilience and social recovery	Entrepreneurial	Financial resources Entrepreneurial ecosystem Entrepreneurial culture Networking Leadership	Sensing business opportunities Seizing resources for achieving them Transforming resources into entrepreneurial business models or initiatives	Teece (2017), Fini et al. (2018), Heaton et al. (2019, 2022, 2022), Guerrero and Urbano (2019), Cunningham et al. (2022)
High-skilled workforce Digital learning environment Digitalization and AI trends Micro-credentials longline learning	Digital	Financial resources Digital infrastructure ICT Human capital Digital platforms	Sensing Seizing Transforming	Teece (2018), Guerrero et al. (2021), Guerrero and Urbano (2021)
Equity, inclusion, and social justice Sustainable funding Tacking big societal challenges Scholarly impacts in multiple areas Resilience and social recovery	Sustainable	Financial resources Infrastructure Human capital Networking Learning curve	Sensing alternatives to generate a sustainable impact Seizing resources to develop them Transforming resources into impactful and sustainable	Fini et al. (2018), Guerrero and Pugh (2022), Guerrero and Lira (2023), Ibáñez et al. (2022), Waldman et al. (2022)

Source: Authors

Fourth, sustainable universities' capabilities have emerged over the last decade from the urgent achievement of the big societal challenges (climate challenges) and the United Nations' Sustainable Development Goals focused on reducing societal gaps related to equality, inclusion, economy, collaboration, and among others (Fini et al., 2018; Guerrero & Lira, 2023). University managers and the community have focused on sensing sustainable opportunities that could be seized and transformed into internal and external impactful sustained initiatives across university functions (teaching, research, and social engagement). The most recent COVID-19 pandemic was a good experiment when the university helped provide a digital social entrepreneurial response to the global stakeholders' needs (Ibáñez et al., 2022).

2.2.3 University Capabilities Applied to Innovation and Technology

According to Heaton et al. (2020), many university managers/leaders have come to understand that the most contemporary university is no longer an organization that provides learning and research. Instead, universities are considered key ambidextrous actors involved within the innovation and entrepreneurial ecosystems in a determinate region/country (Guerrero, 2021). As a result, it is expected that universities will have a larger impact on the local economy via innovative and technological outcomes (Audretsch et al., 2022a, b). We discussed university leaders' and managers' new roles and reasonings (Crow & Dabars, 2015; Crow et al., 2020). As a result, we try to propose a visual explanation of how universities have created the expected public returns and societal value creation (innovative disruptions and technological solutions) due to the interplay among drivers (higher education public policy agendas, stakeholders' pressures) and organizational transformations (internal impregnation of new strategical orientations by sense, seize, and transformation the pre-existing capabilities). It is important to consider that these processes need to be contextualized per geographical space and time (see Fig. 2.2).

2.3 Conclusions

As geographical context and time are crucial factors, conducting an in-depth analysis of the re-building of university capabilities across higher education systems is important. It is necessary to review the accumulated theoretical and empirical contributions published in this research area and provide examples of re-building of university capabilities in different geographical contexts. Likewise, it is crucial to understand the competitive forces faced by university managers in allocating available resources to which specific or complementary university capability. The

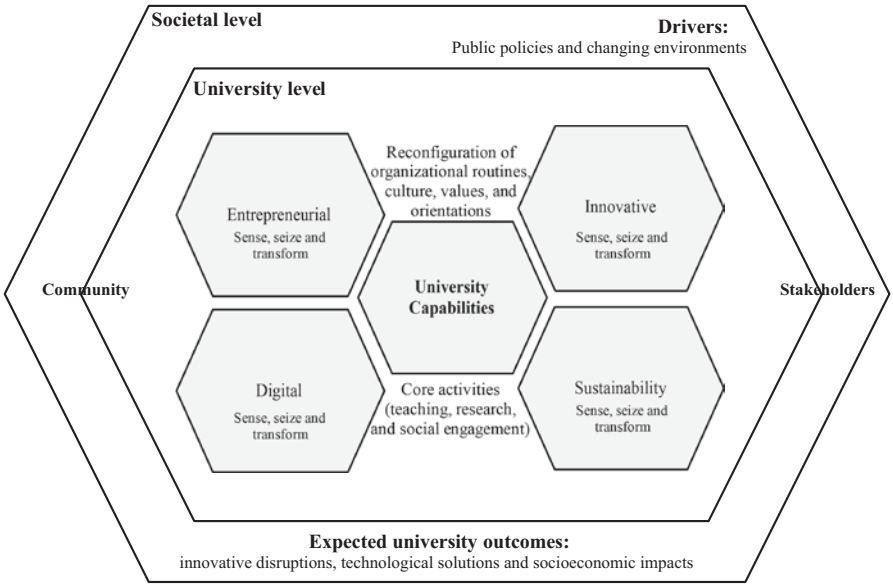

Fig. 2.2 University capabilities. (Source: Authors)

following sections of this book focused on the re-building of four university capabilities (entrepreneurial, innovation, digital, and sustainable) from both theoretical and empirical approaches.

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Part II
Re-building University Entrepreneurial Capabilities

Chapter 3
A Theoretical Approach

Jason J. Roncancio-Marin, Maribel Guerrero, and Marina Dabić

3.1 Introduction

The role of universities in developing regions has been widely studied by different strands of literature. This is due in part to the fact that these organizations educate large numbers of individuals, promote, and forge capacities for research for the generation of knowledge and offer alternative career options to students through the construction of competencies for entrepreneurship (Siegel et al., 2007; Siegel & Wright, 2015). Similarly, recent literature begins to see universities as agents of social change and more involved in addressing sustainability challenges. Consequently, universities are key players in national innovation systems and entrepreneurship ecosystems (Siegel & Wright, 2015).

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Although such organizations did not initially have the physical infrastructure and human talent to promote entrepreneurship, they have had to transform themselves over time to build useful entrepreneurship capabilities that would allow them to adapt to their changing contexts (Rasmussen & Borch, 2010; Rasmussen & Nielsen, 2004). Although universities have been studied extensively enough, the literature still does not clearly explain how universities adapted, created, or modified their capabilities for entrepreneurship. More specifically, little is known about how contextual factors have influenced the development of universities' entrepreneurial capabilities, what is the role of stakeholders in their environment, and how such elements affect entrepreneurial outcomes. Consequently, in this chapter, we address this knowledge gap through a systematic search and review of published articles about universities in general and about universities that are actively involved in entrepreneurship through the means offered by the mission of technology transfer and entrepreneurship.

The research question guiding the present literature review is: how the contextual factors (and stakeholders) have influenced universities' capabilities to generate and manage entrepreneurial initiatives? We consolidate the results of existing studies and extract results that are generally applicable. In a further step, we compare our findings with what is already known about entrepreneurial capabilities in other sectors and for other organizations. Such an analysis allows us to inquire to what extent universities are transformed driven by the same elements and variables as other organizations or whether this represents a conceptually different phenomenon that needs to be addressed independently by policy makers and authorities at universities (Peerally et al., 2022; Vu, 2020).

In this vein, this chapter contributes to the existing literature in four different ways. First, we provide the first systematic review that connects and explains the concept of entrepreneurial capabilities and their embeddedness in universities. Second, we draw a picture that explains how contextual factors and stakeholders influence entrepreneurial capabilities in universities. Third, we synthesize the empirical results of this review into a theoretical framework on university entrepreneurial capabilities, with which, therefore, we hope to facilitate the bridging between the streams of literature on universities and on entrepreneurial capabilities. Fourth, we present the conclusions of our study.

The remainder of this chapter is organized as follows. Section 3.2 exposes the theoretical foundations of university entrepreneurial capabilities. Section 3.3 describes the methodological design of this study. Section 3.4 reveals the evolutionary trends and evidence for our proposed framework to rebuild entrepreneurial capabilities within universities. Finally, Sect. 3.5 presents the main conclusions of this chapter.

3.2 Theoretical Foundations

3.2.1 Understanding the University Entrepreneurial Capabilities

Universities themselves continue to be of interest not only to their stakeholders but also to policymakers because of the promise they hold to bring knowledge throughout the economy and society (Guerrero et al., 2016). In developed contexts, universities have contributed to the economic growth of their regions due to their capacity to transfer knowledge in the form of IP or spin-off companies (Lockett & Wright, 2005; Wright, 2018). Such valorization of knowledge is a habitual activity of universities that have not only the physical but also the organizational infrastructure to stimulate entrepreneurship and innovation in the university community. Consequently, a dynamic is generated that allows the commercialization of research results to later reinvest the economic benefits resulting from such activity in R & D or for the profit of the parties involved (e.g., faculty, industry, inventor) (Audretsch & Caiazza, 2016; Schumpeter 1911; Audretsch et al., 2022a).

Similarly, universities have recently begun to address other sources of value generation, e.g., social value. The literature reports that, particularly in developing economies, such organizations have developed alternative mechanisms to transfer knowledge to society, interact with other actors in their regional ecosystems, and even collaborate with industry (Klofsten et al., 2019; Roncancio-Marin et al., 2022a, b). However, such activities are not based on the commercialization of IP or the creation of a technology-based spin-off. In such developing contexts, innovation and entrepreneurship activities coming from universities are often directed toward solving social problems. For instance, the industry collaborates with universities to sponsor an outreach activity where students apply their knowledge in situ to address a local problem (Roncancio-Marin et al., 2022a, b). In the case of entrepreneurship, it is common to find in those latitude social entrepreneurship initiatives with similar purposes and, in some cases, frugal innovation. The literature suggests that this is due to the low number of patents produced in emerging economies, while others suggest that political barriers are the main problem for the promotion of spin-off companies (Reichelt, 2007; Thorn & Soo, 2006). In any case, university entrepreneurship also flourishes even without intellectual property outcomes.

Despite the above, universities have not always had an entrepreneurial vocation legitimized in their strategic mission, and given that, in the beginning, they were mainly dedicated to two missionary activities, teaching and research (Grimaldi et al., 2011; Guerrero & Urbano, 2012). It was only in 1980 in the United States, with the passing of the Bayh–Dole Act (BDA), that universities were allowed to commercialize research results, and inventors were allowed to participate in the profits of such commercial activities (Popp Berman, 2008). In this way, the BDA served as a catalyst for creating technology-based spin-off companies and marketable IP assets in the university context (Kenney & Patton, 2009; Shane, 2004; Guerrero et al., 2015). Consequently, faced with the high number of companies

created and patents, universities had to adapt their mission structure to be able to adequately "digest" the processes of innovation and entrepreneurship, thus creating the third mission, also known as Technology Transfer and Entrepreneurship (Kitagawa et al., 2016; Laredo, 2007). Subsequently, other developing economies used the BDA as an inspiration to formulate similar policies to promote university entrepreneurship and innovation in their economic settings (Thorn & Soo, 2006).

On the other hand, universities became more involved with their ecosystem actors, as some of their stakeholders acted as funders of university research projects to exploit the subsequent results in the market. Similarly, other stakeholders played the role of potential customers (i.e., buying patents, licensing, or purchasing the spin-off companies' products), which accelerated the collaboration between the university, government, industry, and society (Audretsch et al., 2019; Link & Sarala, 2019; Scaringella & Radziwon, 2017). Consequently, faced with the complexity of this growing business and the need to respond to all stakeholders, universities have also adapted their internal ecosystem, creating technology transfer offices, entrepreneurship units, incubators, and established transversal entrepreneurship courses not only in business schools but in all university academic offerings (Audretsch et al., 2022b). Although not formally, next to the third mission, co-creation is known as the fourth mission, in which the university produces joint solutions with other actors in spaces that are not governed by complex intellectual property rules and generally seek to alleviate social problems through entrepreneurship and joint work (Berggren & Lindholm Dahlstrand, 2009; Kumari et al., 2019). As already demonstrated, universities have adapted and reinvented themselves to respond to environmental changes (e.g., market, political, social, and economic) (Fuster et al., 2019; Roundy, 2017). Similarly, they have evolved gradually from only organizations dedicated to teaching, where the research component was included years later due to the need for innovation in the environment and the university's strengths in human capital. With the research results growing and inspired this time not only by the environment's needs but also by market opportunities, universities are known as entrepreneurial universities that provide outlets for research products from the 1980s onward (Grimaldi et al., 2011; Guerrero et al., 2016; Klofsten et al., 2019; Kirby et al., 2011; Wright, 2018).

In line with the above, it is evident that universities have a dynamic profile that evolves to remain valuable and competitive in their environment (Wright, 2018). Today's entrepreneurial university has proven to identify opportunities and threats and transform itself to leverage them or address the threats of changing economic and social environments (Fischer et al., 2020; Pacheco et al., 2010; Portales, 2019). However, the relevant academic literature on entrepreneurship and innovation is still scarce when it comes to explaining in a granular way how universities have had to create, adopt, or modify their entrepreneurial capabilities. More specifically, it does not explain, at least to the best of our knowledge, how the context and the apparent pressure or presence of certain stakeholders contribute to universities generating and managing entrepreneurial initiatives and technological innovations.

3.2.2 *Re-building Entrepreneurial University Capabilities*

The accumulated academic literature on innovation and entrepreneurship universities shows a specialization in the emergence of subcategories such as entrepreneurial universities, entrepreneurial ecosystems, sustainable universities, innovation ecosystems, graduates entrepreneurship, and academic entrepreneurship that explain how the generation of value with university knowledge can contribute to the economic development of nations (Guerrero et al., 2016; Alzahrani et al., 2019; Klofsten et al., 2019; Wright, 2014; Dabić, 2021; Audretsch et al., 2022b; Dabić et al., 2022). Guerrero & Urbano (2012) recognized that the phenomenon of entrepreneurial universities could be considered as intrapreneurial dynamic process developed within universities. It is simulating the evidence of corporate entrepreneurship or corporate venturing literature (Guerrero et al., 2021). However, the accumulated literature has partially focused on studying entrepreneurial capabilities in the university context.

In the 2000s, Lockett and Wright (2005) found the existence of several capabilities that foster the creation of entrepreneurial initiatives in the university context. Concretely, these authors found that the ability to develop entrepreneurial innovation initiatives, with clear intellectual property processes and trained staff, are determinants of spin-out creation in universities in the United Kingdom (Lockett & Wright, 2005; Guerrero & Urbano, 2021). Entrepreneurial capabilities are distinguished such as dynamic capabilities by Arthurs & Busenitz (2006) and understood as abilities to identify a new opportunity and develop the necessary resources to pursue it (Arthurs & Busenitz, 2006; Guerrero et al., 2021). Although a few studies have been conducted in the university context, we found interesting qualitative insights. For example, Walter et al. (2006), using quantitative methods with a database of 149 spin-offs, investigated the impact of spin-offs' network capability and entrepreneurial orientation on their organizational performance. These authors found that networking capability moderates the relationship between entrepreneurial orientation and organizational performance, where network capability is the most important determinant of organizational performance (Walter et al., 2006), where network capability is the ability to initiate, maintain, and utilize relationships with various external stakeholders. Likewise, the entrepreneurial capabilities are strongly aligned to the dynamic (intra)entrepreneurial process (Amit & Schoemaker, 1993; Li & Calantone, 1998; Teece et al., 1997; Guerrero & Urbano, 2012). Based on these antecedents, previous students connected entrepreneurship and institutional theory to emerge a new research line: "institutional entrepreneurship". Through this lens, it was presumed to be easier to understand how institutional transformations and leverage resources to create new organizations, but mostly observed in private corporate contexts (Phillips & Tracey, 2007). Similarly, Kor et al. (2007) connected corporate entrepreneurship literature and the perception of economic opportunities. Thus, Karra et al. (2008) mentioned that entrepreneurs need—to develop international ventures—to develop international opportunity

recognition, organizational bridging, and a capacity and preference to collaborate cross-culturally.

In the 2010s, already the relevant academic literature began to study the development of entrepreneurial capabilities in universities whose main interest consisted in the acceleration of the processes of commercialization of research results (Siegel et al., 2007; Wright et al., 2007; Guerrero & Link, 2022). To this end, Rasmussen et al. (2011) conducted a longitudinal study with spin-off companies to determine what are those capabilities in universities that facilitate entrepreneurship. Among the findings of this study are that the opening of new paths of action (exploration), the balance between commercial and academic interests, and the integration of new resources are the capabilities that facilitate entrepreneurship in universities (Rasmussen & Borch, 2010). On the other hand, other studies focused more on the individual level, particularly inquiring about entrepreneurial capabilities in university students as Sindhu et al. (2011) for instance, studied the relationship between business education and entrepreneurial capabilities among 320 students in 4 different universities, for which they found that in their empirical context (i.e., Pakistan), such relationship turned out to be very weak. Likewise, Guerrero and Urbano (2014) explored the knowledge filters generated by universities on academics' entrepreneurial intentions. At students' level, Urbano et al. (2017) and Guerrero et al. (2018) focused on the context that affected graduate entrepreneurship.

Despite the above, the number of studies relating universities to entrepreneurial capabilities is few. This is partly because the literature has focused on proposing new theories and conceptual frameworks to delineate and understand the components of such capabilities in organizations. Nevertheless, the literature has continued to develop and often uses concepts from dynamic capabilities to extract knowledge useful for understanding the formation of entrepreneurial competencies in organizations (Faroque et al., 2020; Hayton et al., 2013). For example, Hayton et al. (2013) suggest that individuals are embedded in an organizational culture through collective knowledge processes that are a dynamic contribution to the development of entrepreneurial competencies. Other studies dare to merge the concept of entrepreneurial capabilities with other concepts that suggests the concept of "dynamic entrepreneurial capabilities" composed of entrepreneurial insight, heuristics, and flexibility needed in small firms (Lanza & Passarelli, 2014). Also, the study of Singhry (2015), suggests the term "technology entrepreneurial capabilities," implying that technological capabilities, relational, financial, and how knowledge flows influence the entrepreneurial intentions of university community (Guerrero & Urbano, 2014; Singhry, 2015; Guerrero & Marozau, 2023). Likewise, the entrepreneurial capabilities are impregned at managerial level (Leih & Teece, 2016; Guerrero et al., 2021; Audretsch et al., 2022c). In general, based on these antecedents, the accumulated literature in entrepreneurship and innovation science has failed to establish a clear boundary between dynamic capabilities and entrepreneurial capabilities (Dabić et al., 2016a, b). Consequently, it seems that entrepreneurial capabilities depend on identifying opportunities and how actors realize, understand, and process them in their specific contexts.

3.3 Methodological Design

3.3.1 Systematic Literature Review

We conducted a qualitative study based on a systematic literature review of the available evidence on university entrepreneurial capabilities (Tranfield et al., 2003). As mentioned in the previous sections, the literature on universities and how they develop entrepreneurial capabilities is rather scarce. It is based on the corporate entrepreneurship literature more at the firm level. Despite this novelty—regarding the development of entrepreneurial capabilities in universities—the literature is limited and fragmented as it concentrates on studying entrepreneurial universities. This represents a fertile and rich ground to condense micro-level, contextual, and stakeholder elements to explain such a phenomenon. Therefore, a systematic review of the literature provides valuable data necessary to achieve the objectives of this study. Our research methodology consisted of collecting, analyzing, and classifying data on the adoption of entrepreneurial capabilities in universities, how they emerge, and the influence of context and stakeholders on such capabilities. We use the insights we gained from this systematic review of the literature and available theory on entrepreneurship to advance this process, which we explain in the following subsection.

3.3.2 Data Collection

To achieve the objectives of this research, we applied the following procedure consisting of five steps (see Fig. 3.1).

First, we used the Web of Science (WOS) as a database due to the large number of journals it covers (Falagas et al., 2008; Mongeon & Paul-Hus, 2016). Then, we searched for the keywords "Universities," "Entrepreneurial Universities," "Entrepreneurship," and "Capabilities," obtaining 540 publications from the year 2000 to the year 2022. Second, to refine the search, we selected only academic articles published. Following Nabi et al. (2017), we selected only the WOS categories of management, business, and economics to include the most important publications, obtaining 255 papers. Third, in screening through abstract reading, we selected 152 qualitative, quantitative, and theoretical documents (i.e., literature reviews) to further explore the topic of university entrepreneurship, including only those papers published from the year 2000 to the year 2022. Fourth, we read, classify, and code the resulting 152 papers—in light of the objectives of this chapter—in Atlas ti 9.0 software to analyze their individual contribution. To do so, we compared in our analysis the results obtained in the review (i.e., the impact of context and stakeholders and the adoption of entrepreneurial capabilities in universities) with what we already know about entrepreneurial capabilities in general, so we added 25 more articles. Contrary to the literature on entrepreneurial universities, literature

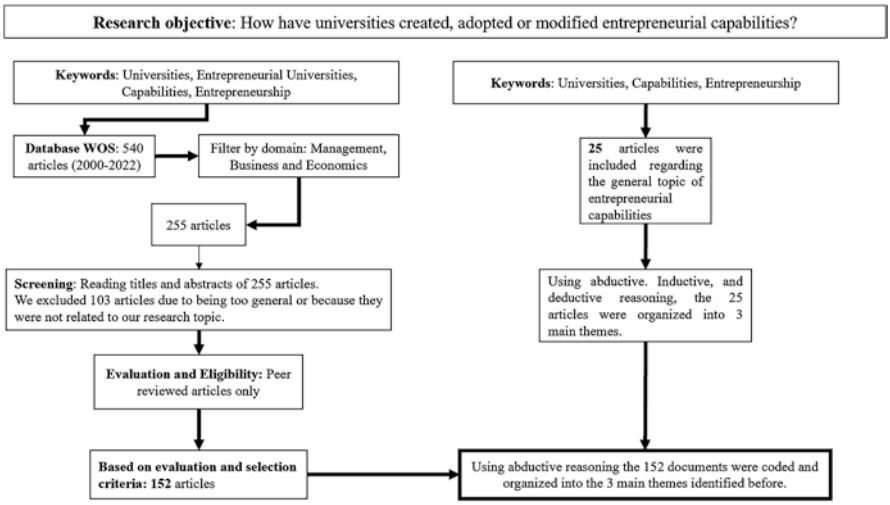

Fig. 3.1 Literature review process. (Source: Authors)

extensively documenting how universities develop entrepreneurial capabilities is still scarce, so in this chapter, we use some literature reviews and other publications on that topic as a point of comparison and discussion (Roy & Singh, 2017; Sjöö & Hellström, 2019). As a fifth and final step, we use abductive, inductive, and deductive reasoning to analyze and organize the 25 articles into three main themes (i.e., sensing and shaping, seizing, and transforming) that serve not only to classify the 152 articles but also to shed light on the understanding of university entrepreneurship as shown in the next subsection.

3.3.3 Data Analysis

Because our primary intent was to use existing knowledge and observations to propose new cases, we used inductive reasoning (Fischer, 2001; Hayes et al., 2010) and applied it to data on entrepreneurial capabilities in general from research that has studied that phenomenon of the organizational level (i.e., the 25 articles). We then analyzed the secondary data (i.e., 152 papers) from the literature review through deductive and abductive reasoning to propose cause-and-effect relationships (Lipscomb, 2012; Paul, 1993). We reviewed a total of 177 (i.e., 25 + 152) academic articles in detail using abductive reasoning to identify organizational activities, micro-level elements related to individuals, stakeholders, and macro-elements coming from the context, and resources that entrepreneurial competencies comprise. Abductive reasoning allowed us to capture not only studies that explicitly mention entrepreneurial competencies in universities but also those that only hinted at or implied them.

We did not focus on the frequency of the appearance of entrepreneurial competence in the documents but rather on grouping their diversity, even if they appeared only once, as has been done in other studies during coding (Peerally et al., 2022). Subsequently, using abductive reasoning, we constructed a list of different entrepreneurial competencies that we have grouped into three themes that are key in the adaptation and dynamics of organizations' capabilities: (1) sensing, (2) seizing, and (3) transforming. The nature of these themes gave us to understand during the analysis that these background documents base their different approaches on the premise that entrepreneurial competencies in organizations are mostly acquired over time and are a consequence of dynamic capabilities (Teece, 2010, 2014). The last step was to classify the information obtained from the remaining 152 documents into the three themes mentioned above to propose a theoretical model that achieves the research objectives of this chapter.

3.4 Findings

3.4.1 Evolutionary Trends

Figure 3.2 shows that, from 2000 to 2016, the literature has been rather timid when associating universities with issues of entrepreneurship and entrepreneurial skills. However, in 2017, we observed an increase in publications (in)directly related to entrepreneurial capabilities. It is expressed by the increment in the number of publications related to universities, entrepreneurship, and entrepreneurial capacities due to the emergence of multiple global trends such as digitalization, new technologies,

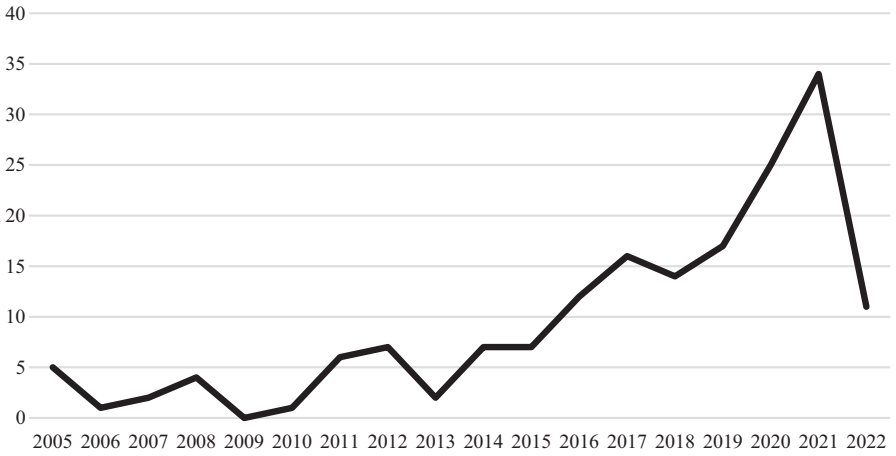

Fig. 3.2 Entrepreneurial university capabilities evolutionary trends. (Source: Authors)

the promotion of entrepreneurship and innovation, global crises (pandemics, war), or general changes in the national priorities of governments, which increasingly recognize and legitimize universities as key actors in the development of their regions (Alcántara-Rubio et al., 2022; Buera et al., 2020; Ibáñez et al., 2022).

Table 3.1 shows that the papers that addressed the topics under study in this chapter have been published mostly in some of the journals listed in the list of the 50 most important journals of the financial times and in level 4 of the Association of Business Schools (ABS). This is important because it represents not only a validation of the importance of the study of universities as agents of development but also the trend toward entrepreneurship research in the university context. It is important to mention that the scope of the journals that have more papers on the topic of our concern are not journals specialized in the topic of entrepreneurship since they focus on aspects that study the dynamics between the topics of innovation, entrepreneurship, economic development, technology transfer, and strategic management of development. Consequently, those journals that do specialize in publishing articles on entrepreneurship or on the topic of strategic capabilities of organizations to adapt to change have fewer publications. The most referenced journals are *Research Policy, Technovation, Technological Forecasting and Social Change, Strategic Management Journal, and Journal of Technology Transfer*, where also are published the top 10 most cited papers in the research theme. As mentioned above, it is not common to find specialized journals in such a list, given that the topic of universities' entrepreneurial capabilities is rather a combination of the domains of entrepreneurship and innovation with the organizational capacity to adapt to new conditions to be more competitive in the light of dynamic capabilities.

Table 3.1 Top 10 academic journals

Journal	Identified papers
Journal of Technology Transfer	15
Technological Forecasting and Social Change	12
Technovation	11
Research Policy	10
Entrepreneurship and Regional Development	4
International Entrepreneurship and Management Journal	4
International Small Business Journal-Researching Entrepreneurship	4
Journal of Management Development	4
Small Business Economics	4
European Journal of Innovation Management	3
Industry and Innovation	3
International Journal of Entrepreneurship and Innovation	3
Journal of Asian Finance Economics and Business	3
Journal of Business Research	3
Journal of Entrepreneurship in Emerging Economies	3

Source: Authors

Table 3.2 shows a few papers that explicitly addressed the issue of entrepreneurship capabilities possessed by universities. For example, Rasmussen et al. (2011) explicitly addressed the issue of entrepreneurial competencies. More specifically, Thomas et al. (2020) addressed the issue of entrepreneurial skills in the preformation stage of university spin-offs suggesting that entrepreneurial skills are the result of a process, which the authors propose as a theoretical model to extend the theory of dynamic capabilities (Thomas et al., 2020). Likewise, Rasmussen et al. (2011), from the perspective of capabilities, explored how context impacts the entrepreneurial process. These authors found that new paths for action, the balance between commercial and non-commercial interests, and the integration of new resources are the capabilities that facilitate the process of creating entrepreneurial university initiatives (Rasmussen & Borch, 2010). Most of the 152 articles analyzed

Table 3.2 Top 10 academic publications

Title	Authors	Journal	Year	Cites
Entrepreneurial orientation, technology transfer and spinoff performance of US universities	O'Shea et al.	Research Policy	2005	536
Entrepreneurial effectiveness of European universities: An empirical assessment of antecedents and trade-offs	Van Looy et al.	Research Policy	2011	185
The effectiveness of university knowledge spillovers: Performance differences between university spinoffs and corporate spinoffs	Wennberg et al.	Research Policy	2011	180
University capabilities in facilitating entrepreneurship: A longitudinal study of spin-off ventures at mid-range universities	Rasmussen & Borch	Research Policy	2010	159
The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures	Rasmussen et al.	Research Policy	2014	141
Government instruments to support the commercialization of university research: Lessons from Canada	Rasmussen	Technovation	2008	122
The entrepreneurial university as driver for economic growth and social change—Key strategic challenges	Klofsten et al.	Technological Forecasting and Social Change	2019	109
Determinants of invention commercialization: An empirical examination of academically sourced inventions	Nerkar & Shane	Strategic Management Journal	2007	100
Academic entrepreneurship, technology transfer, and society: where next?	Wright	Journal of Technology Transfer	2014	98
Pathways to impact and the strategic role of universities: new evidence on the breadth and depth of university knowledge exchange in the UK and the factors constraining its development	Hughes & Kitson	Cambridge Journal of Economics	2012	97

Source: Authors

in this part of the paper have focused on studying the precursors, accelerators, and promoters of university spin-off creation. They have also focused on studying the university as an entrepreneurial entity that, analogous to how entrepreneurs do at the individual level, exploits opportunities, recognizes them, and orchestrates resources for achieving its objectives (Guerrero et al., 2016; Klofsten et al., 2019; Wright, 2014; Guerrero & Link, 2022). Likewise, in the 152 papers, the influence of stakeholders and the context in university spin-offs are analyzed without considering the potential presence of the innate capabilities that universities have or have developed to facilitate the entrepreneurial process. Consequently, it is necessary to complement the systematic review of the 152 papers with the literature on dynamic capabilities in other contexts (e.g., organizational) to extract key elements to understand the emergence of capabilities for entrepreneurship in universities, as we do in the following sub-section.

3.4.2 Evidence of University Entrepreneurial Capabilities

To identify the university capabilities that have helped to achieve entrepreneurial missions, we analyzed the selected papers from a dynamic capability perspective (e.g., seizing, sensing, and transforming) adopted in previous studies (Teece, 2010; Rasmussen et al., 2011; Guerrero et al., 2021; Peerally et al., 2022; Audretsch et al., 2022c). Table 3.3 shows more than 45 actions coded in the second order and three subthemes in the first order related to the entrepreneurial process (e.g., opportunity recognition, championing, and resource orchestration).

Using abductive reasoning, the 45 actions related to dynamic capabilities were illustrated using the Shankey Diagram (Fig. 3.3) to show how universities have to build entrepreneurial capabilities by capturing information from the environment, adapting and integrating the environmental challenges within their mission, structures, and managerial procedures (Breznitz et al., 2008; Jones-Evans, 1998; Leih & Teece, 2016; Audretsch et al., 2022c). Prior literature has mostly studied the antecedents, drivers, barriers, and impacts, but there are several studies that have recognized the emergence and relevance of entrepreneurial capabilities in the last decades (Rasmussen & Borch, 2010; Rasmussen & Nielsen, 2004; Guerrero et al., 2021). Following Guerrero and Urbano (2012), we consider the university an entrepreneurial entity. Then, if it is an entrepreneurial entity, it possesses entrepreneurial competencies, where each of the internal and external actors contributes to the achievement of such objectives (Rasmussen & Wright, 2015). Then, according to what has been seen in the literature, such entrepreneurial competencies should be embedded in the innate dynamic capacities of universities, which in theory would allow them to evolve over time, to adapt, and therefore to change not only their mission strategy but also their infrastructure (Leih & Teece, 2016; Teece, 2014). Thus, universities are entities whose entrepreneurial trait is acquired—since they were not born or conceived for that purpose—such a trait varies according to the context (e.g., culture, social problems, and economic opportunities), is evolutionary, and modifiable,

Table 3.3 Coding structure per theme

Second-order code	First-order code	Theme
Access to business opportunities	Opportunity Recognition	Sensing
Access to financing opportunities		
Access to networking opportunities		
Identification of business opportunities		
International opportunity recognition		
Knowledge acquisition from inside/outside the organization		
Knowledge identification from inside/outside the organization		
Opportunity identification		
Perception of economic opportunities		
Exploitative learning		
Cross-cultural collaboration		
Exploitation of market opportunities		
Opening of new courses of action (Exploration)		
Technology transfer		
Entrepreneurial flexibility	Championing Entrepreneurship	Seizing
Entrepreneurial heuristic		
Entrepreneurial insight		
Access to entrepreneurial training		
Balance between commercial and academic interests		
Business education		
Entrepreneurial mindset		
Entrepreneurial motivation		
Negotiation skills	Resource Orchestration	Transforming
Network capabilities		
Business and management knowledge		
Personnel training		
Technical knowledge		
Access to equipped physical space		
Creation of new products and services		
Incremental refinement of existing knowledge		
Integration of new knowledge		
Integration of new resources and processes		
Investments in IP protection		
Knowledge recombination within the organization		

Source: Authors

and therefore should also be examined in the light of dynamic capacities (Teece, 2010; Teece et al., 1997; Guerrero et al., 2021; Audretsch et al., 2022c).

In other words, if universities are dynamic entities that can adapt to meet the needs of their context and their stakeholders, it means that they evolve over time and that they can recognize opportunities (Sułkowski & Patora-Wysocka, 2020; Wright, 2018). Then, such opportunities must be promoted within the organization, so it is necessary to have the organizational, intellectual, and infrastructural resources to

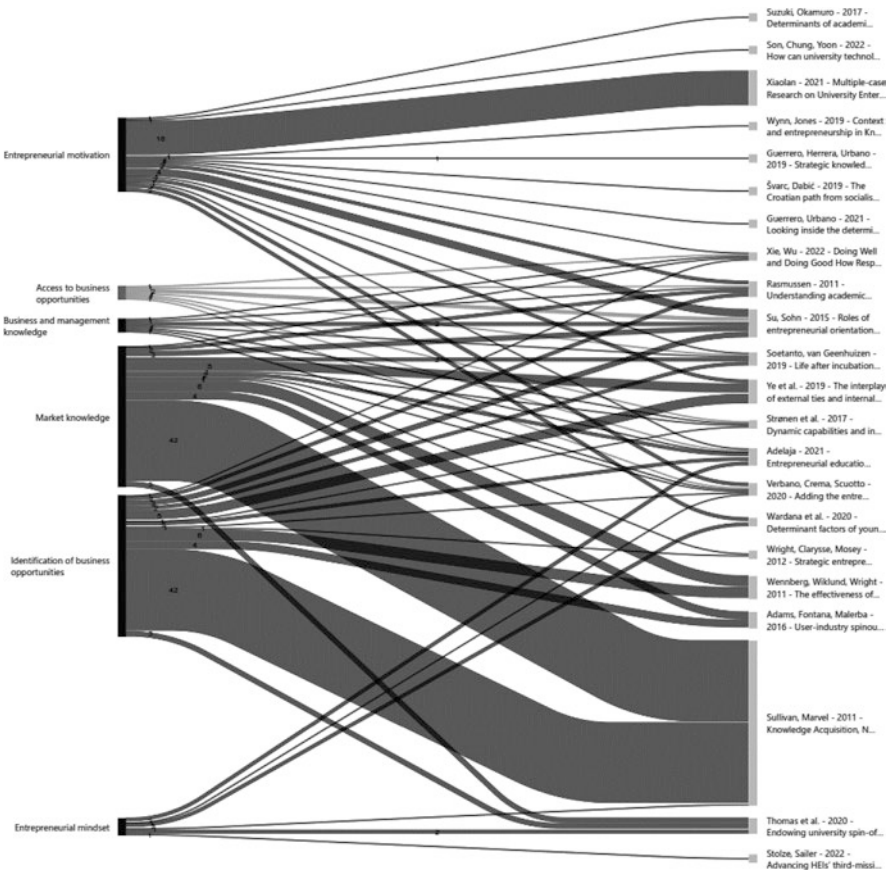

Fig. 3.3 Shankey diagram. (Source: Authors)

first champion entrepreneurship and then seize the opportunity (Aldawod, 2022). As a result, universities orchestrate the necessary resources to transform such opportunities into tangible elements that translate into entrepreneurial initiatives that actively possess a match in the marketplace (Ahn & York, 2010; Kor et al., 2007; Powers & McDougall, 2005). Every new entrepreneurial initiative is based on exploiting a business opportunity (Rasmussen et al., 2011). In the case of university spin-offs/start-ups conceived in the university context, such a business opportunity is based on the development of a product or service based on the knowledge that has the capacity to become a (non)profit venture depending on the information that the university has captured from its environment or its stakeholders (Fini et al., 2018; Siegel et al., 2007; Siegel & Wright, 2015; Guerrero & Urbano, 2014; Urbano et al., 2017). However, not all universities have appropriated capabilities for capturing information, processing and seizing opportunities, building a culture of

entrepreneurship, and transforming ideas into products or services. This is because they are not all in the same environment, have different stakeholders and resources, and obey different contextual elements that ultimately affect the outcomes of entrepreneurship, so it is common to see university spin-offs in developed countries, while the number of social enterprises and frugal innovations produced in universities located in developing countries continues to increase (Ambos et al., 2008; Lam, 2010; Spithoven et al., 2021).

3.4.3 University Entrepreneurial Capabilities Framework

From the theoretical point of view, it is necessary a conceptualization and integration related to university entrepreneurial capabilities to understand the composition and building (Audretsch et al., 2022c) by adopting the dynamic capability approach proposed by (Teece, 2010, 2014; Teece et al., 1997). Table 3.4 shows a framework for understanding universities' entrepreneurial capabilities through four steps: capturing, connecting, building, and integrating.

Capturing At the macro level, universities identify opportunities in the close environment, and the nature of these opportunities depends largely on the characteristics of the entrepreneurial ecosystem (Meoli et al., 2019). Universities have developed the entrepreneurial competence to recognize opportunities that may have commercial features if they are captured from market niches or social features if the information is captured from the problems available in the local environment where the university is located (Williams Middleton et al., 2020; Guerrero et al., 2018; Aldawod, 2022). In this sense, at the macro level, the information captured from the environment can be highly influenced by elements from the entrepreneurial and innovation ecosystems or new trends, such as the Sustainable Development Goals (SDGs)(Alcántara-Rubio et al., 2022). At the individual level, the context could act as driver or filter. It thus provides valuable information that can be captured by students, professors, researchers, and university staff (Meoli et al., 2019; Guerrero & Urbano, 2014). Normally, the direction of entrepreneurial initiatives is motivated by the researchers' desire to fill a need in the market, which mostly comprises inventions with commercial interests (Civera et al., 2020; Perkmann et al., 2021). However, the literature also reports that the orientation of such inventions also depends on the nature of the social problems of the context, giving space also to the emergence of entrepreneurial initiatives that seek to address such problems using research results. By capturing external information, universities can explore and exploit opportunities (Agafonow, 2014; Bingham et al., 2007). Furthermore, this capacity frames the marketing intelligence centers of universities that often also capture information from stakeholders through the available means of the third and fourth university missions (Payne et al., 2008; Trencher et al., 2014, 2017), by capturing valuable information from multiple stakeholders to shape opportunities (Leih & Teece, 2016; Teece, 2014; Wright, 2014; Guerrero et al., 2021).

Table 3.4 Proposed university entrepreneurial capabilities framework

	Theme 1: Sensing and shaping	Theme 2: Seizing	Theme 3: Transforming
	Subtheme A: Opportunity recognition	Subtheme B: Championing entrepreneurship	Subtheme C: Resource orchestration
Capturing capability	Universities sense opportunities (in the market or from social problems) available in their context. To shape the knowledge captured, universities adapt their organizational strategy (i.e., university mission) to impact the individual level	Universities promote entrepreneurship in the university community through the third mission (incentives) and formal and informal entrepreneurship courses	To seize the information captured, organizational direction, and trained personnel, universities count on special internal units (i.e., intermediaries) such as incubators or technology transfer offices
Connecting capability	Universities connect with many stakeholders in their external ecosystem, who also contribute to identifying opportunities or are often the ones who provide them On the other hand, universities identify social problems through the involvement of the university community in community services	Such collaborations with the government or industry promote the dynamics of technology transfer, entrepreneurship, and innovation in the university community and in the ecosystem in which the university is embedded	Universities are organized to establish, maintain, and enhance collaborations with other actors through university outreach and technology transfer offices. They also assimilate new resources and connect internal human capital
Re-building capability	Universities shape knowledge through teaching and create it through research. Often, the outcomes translate into intellectual property or services that are likely to be commercialized	Universities promote innovation and entrepreneurship in their internal ecosystem, allowing them to leverage intellectual property and business ideas	Universities make entrepreneurship courses, incubators, co-working spaces, business fairs, and the technology transfer office available to potential entrepreneurs, where they can access resources relevant to entrepreneurship
Integrating capability	Universities integrate internal and external knowledge, allowing them to identify opportunities to shape new knowledge or refine existing knowledge. This is also where the balance between commercial and academic interests is generated	Universities often promote scenarios where multiple actors converge that integrate their entrepreneurial experience into the entrepreneurial knowledge of the university community	Universities help entrepreneurs to achieve their goals since they integrate the human capital into available in entrepreneurship, with the social capital that universities have due to the three previous entrepreneurial capabilities (i.e., capturing, connecting, and building)

Source: Authors

Connecting This capability can have two distinct but equally complementary connotations. First, "connecting" refers to how universities are organizations that connect with their stakeholders to achieve entrepreneurial goals (Terjesen & Elam, 2009). Second, "connecting" refers to how universities actively combine internal resources to achieve the entrepreneurial goal (Nicholls-Nixon et al., 2020; Rubin et al., 2015; Sansone et al., 2020; Guerrero et al., 2021). In this way, universities connect with their stakeholders in different ways to achieve their entrepreneurial goals, which are available through their missions: teaching, research, technology transfer, and co-creation. Externally, universities connect with the government and industry to collaborate on multiple social and economic issues (Guerrero et al., 2016, 2021; Liñán et al., 2011; Dabic et al., 2015). Naturally, universities are connected to the student community through teaching activities. Students can connect with society through community service-learning activities or through internships in industry, which contributes to increasing their experiential learning (Guerrero et al., 2018; Roncancio-Marin et al., 2022a, b). Regarding research, universities connect with multiple research funding organizations, investors, or promoters of knowledge generation, technology transfer, and co-creation as mechanisms of entrepreneurial initiatives (Villani et al., 2017). Likewise, universities have created infrastructures (e.g., incubators, technology transfer offices, business creation offices, technology parks, and internationalization offices) to foster the identification and exploitation of entrepreneurial opportunities by the university community (Guerrero & Urbano, 2012; Perkmann et al., 2013; Villani et al., 2017). Also, through this capacity, universities increase the social capital not only as an organization but for individuals as they connect the university community with key external actors that facilitate entrepreneurship and innovation processes within it.

Re-building This capacity can be approached in two different ways. The first consists of how universities have "built" internal units to promote entrepreneurship and the second consists of the "building" of an entrepreneurial culture in the university community. Universities shape the knowledge captured in their external ecosystem and promote innovation and entrepreneurship in their internal ecosystem (Audretsch et al., 2019, 2022a). The capacity for "building" that universities have in their internal ecosystem has allowed them to create units that, in themselves, have as their ultimate goal the materialization of opportunities through entrepreneurship. Evidence of the above is the case of incubators, technology parks, innovation offices, and accelerators that, as internal units, are responsible for being key agents that serve as a bridge between the market and social problems and the generation of new knowledge (Villani et al., 2017). The construction of new entrepreneurship paradigms allows universities to bridge the gap between inventions and business ideas. This capacity is also dynamic and feeds on the two previous capacities. It also contributes to the understanding of the university logic that establishes entrepreneurship courses transversally in the programs that universities offer, not only in business schools but also in engineering and other domains. Likewise, universities, aware of the importance of entrepreneurship in the development of their regions, have built a culture of entrepreneurship in the university community (Guerrero &

Urbano, 2012; Audretsch et al., 2022b), for which they have carried out activities that promote entrepreneurial thinking, such as hackathons, networking events, startup weekends, entrepreneurship boot camps, entrepreneurship fairs, and consulting activities, among others. Consequently, entrepreneurial thinking has been normalized in the university context. It is also increasingly common to find principal investigators involved in entrepreneurial activities, even if they do not necessarily involve the commercialization of research results (Shepherd et al., 2010). Similarly, the entrepreneurial culture was already on its way to legitimization when academics began to be offered incentives for establishing ventures with research results. This capability is one of the most important as it maintains the entrepreneurial momentum that the university community needs to finally not only exploit opportunities but also transform them into tangible entrepreneurial initiatives.

Integrating Universities worldwide have been working on rebuilding capabilities to configure their own entrepreneurial and innovation ecosystem (i.e., incubators, accelerators, entrepreneurship courses, entrepreneurship professors, hackathons, industry contacts, intellectual property, and business development) within their facilities to transform ideas and opportunities into new ventures (Guerrero et al., 2018). To achieve this transformation, it is necessary to look holistically at the whole entrepreneurial process, from its ideation stage until the commercialization of a university's entrepreneurial outcomes (Ambos et al., 2008; Spithoven et al., 2021; Audretsch et al., 2022b). For instance, when it comes to establishing spin-offs/start-ups, patenting, licenses, and other entrepreneurial innovation initiatives. The sensing and shaping dynamic capabilities allow universities to bring such an opportunity as an idea into the entrepreneurial process. Subsequently, the parties involved champion their idea so that others join the team to seize the entrepreneurial opportunity (Leih & Teece, 2016; Teece, 2010; Guerrero et al., 2021), as well as the link between university missions' outcomes, market demand, and uncertain external conditions (Siegel & Guerrero, 2021; Guerrero & Pugh, 2022). If this match exists, the entire entrepreneurial innovation university ecosystem's actors are integrated to participate in this entire transformation process. We, therefore, consider integrating capability as key during the entrepreneurial process of universities.

3.5 Conclusions

The purpose of this chapter was to investigate the influence of stakeholders and context in building the capabilities of universities that allow them to create and manage entrepreneurial initiatives, while addressing other academic debates from on entrepreneurship and innovation (Audretsch et al., 2022c; Guerrero, 2021; Ozen et al., 2023; Meissner et al., 2022; Wang et al., 2022). To that end, we have found that there are four main entrepreneurial competencies in universities that are a consequence of such processes. Consequently, we can put forward the following two conclusions based on the results of our systematic literature review.

The first conclusion is related to the impact of context and stakeholders on the entrepreneurial capabilities of universities. Previous studies report that universities are entities that capture information from the context in which they are located. The orientation of their research interests is highly influenced by the needs and inputs of their internal and external stakeholders. The context has the capacity to shape the orientation of a knowledge-based venture, which in turn can address either a market opportunity or a social issue. On the other hand, stakeholders contribute to capitalizing on the opportunities identified in the contexts. That is because they are facilitators of financial resources, provide experience, and share their connections with industry or government that enable universities to seize and subsequently transform the opportunities and information of the context into new ventures.

The second conclusion relates to the entrepreneurial capabilities of universities. As a result of our systematic literature review, this chapter brings to the fore four entrepreneurial competencies namely capturing, connecting, building, and integrating, which enable universities to generate and manage entrepreneurial initiatives. These competencies are useful to understand that universities were not conceived as entrepreneurship factories but that their entrepreneurial trait is acquired, evolving, and modifiable since it adapts to the needs and opportunities of the context and its stakeholders. Therefore, we believe that the study of universities in light of the four proposed capabilities could shed light on how universities capitalize on knowledge in the form of ventures that can contribute to the economic or social development of their regions.

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Chapter 4
An Empirical Approach

Jason J. Roncancio-Marin, Maribel Guerrero, and Marina Dabić

4.1 Introduction

Universities are key players in entrepreneurial innovation ecosystems due to their contribution to socio-economic development (Audretsch et al., 2022a, c; Guerrero et al., 2015; Wright, 2014, 2018). Entrepreneurship literature has evidenced the university teaching and research capabilities (Fischer et al., 2020; Lockett & Wright, 2005; Wright, 2018) as well as entrepreneurial capabilities (Civera et al., 2020; Perkmann et al., 2021) via students (Meoli et al., 2020), academics (Guerrero & Urbano, 2014), and links with regional ecosystems (Audretsch et al., 2022c). However, previous studies have also recognized the difficulty of measuring

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entrepreneurial capabilities (see Rasmussen et al., 2010, p. 610). This chapter explores the mechanisms that contribute to the development of university entrepreneurial capabilities, as well as the influence of stakeholders in this process. Using 80 semi-structured interviews, our results reveal the development of entrepreneurial capabilities in some universities located in Belgium, Colombia, Ecuador, and Uganda.

The remainder of this chapter is outlined as follows. In Sect. 4.2, the theoretical foundations are described. In Sect. 4.3, the methodological design is presented. In Sect. 4.4, the main findings are shown and discussed. The chapter ends in Sect. 4.5 with the conclusions and a suggested roadmap for future research.

4.2 Theoretical Framework[1]

Based on the literature review developed in the previous chapter, we found that universities are organizations with resources and capacities that allow them to develop their activities (Guerrero & Urbano, 2012; Lanza & Passarelli, 2014). Most have been dedicated to teaching activities until research was impregnated as a legitimized mission (Borah et al., 2021; Fernández et al., 2019; Wright, 2014). Then, due to market demands, universities increased their investments in research development and commercialization via courses and new infrastructures (Lockett & Wright, 2005; Carayannis & Grigoroudis, 2016; Grimaldi et al., 2011; Wright, 2018; Siegel & Wright, 2007; Siegel et al., 2007; Wright et al., 2012a, b). As a result, universities generated new innovative outcomes like patents, licenses, inventions, and others with multiple stakeholders (Audretsch et al., 2022c; Guerrero & Urbano, 2019). From an economic perspective, as an analogy with production factors, these entrepreneurial innovation outcomes were considered a new production function element understood as entrepreneurship capital (Guerrero et al., 2015, 2016). From an organizational perspective, as an analogy of resources and capabilities, it represented an evolution into dynamic entrepreneurial capabilities (Audretsch et al., 2022c; Guerrero et al., 2021; Teece, 2014) to foster entrepreneurial initiatives in the university community (Guerrero & Urbano, 2014; Rasmussen et al., 2014). In this view, entrepreneurial capabilities encapsulate bottom-up and top-down strategies and processes (Guerrero et al., 2019, 2021; Sullivan & Marvel, 2011). Universities possess dynamic capabilities that allow them to promote entrepreneurship. Therefore, theorizing these entrepreneurial capabilities should improve and manage them.

[1] An in-depth theoretical review is presented in Chap. 3. To avoid theoretical duplicities, please consult it for further details.

4.3 Methodology

4.3.1 Research Setting

Our study was developed in universities allocated in four research settings: Belgium, Colombia, Ecuador, and Uganda. As a developed economy, Belgium has a considerable orientation toward implementing policy frameworks supporting entrepreneurship and innovation. Belgium universities have configured an entrepreneurial ecosystem characterized by technology transfer offices, entrepreneurship centers, incubators, and accelerators that facilitate and promote the entrepreneurship culture throughout the university community (Jones-Evans, 1998; Kalar & Antoncic, 2015) as a mechanism for creating value for regional development (Guerrero et al., 2016; Jones-Evans, 1998; Kalar & Antoncic, 2015). As emergent economies, Colombia, Ecuador, and Uganda have been characterized by the highest levels of entrepreneurship due to the labor market conditions. Likewise, these economies have implemented several policy frameworks to reinforce entrepreneurial initiatives developed by university academics (see Montoya, 2009). However, the entrepreneurial innovation outcomes across the research settings have different patterns and impacts influenced by their specific organizational particularities (Gaiger et al., 2019; Sutz, 2000; Calderón-Hernández et al., 2020; World Bank, 2022). It provides the evolutionary entrepreneurial capabilities' patterns, as well as the influence of stakeholders (Roncancio-Marin et al., 2022a, b).

4.3.2 Case Selection and Data Collection

By adopting a multiple-case approach (Courgeau & Baccaini, 1998; Snijders & Bosker, 2012; Yin, 2018), we selected universities allocated to the described research settings. To reduce selection bias, the selection criteria identified participants with similar profiles (Eisenhardt, 1989) involved in the creation/development process of entrepreneurial capabilities in universities (Rasmussen & Borch, 2010). Concretely, the participants represent at least two individuals per research setting, with the following profiles: comprised university presidents, technology transfer officers, entrepreneurs, social entrepreneurs, professors, business incubator staff, faculty members, researchers, undergraduate students, graduate students, funding organizations, policymakers, and financial organizations (see Table 4.1). It represents a holistic approach that contributes to shedding light on the required evolution in entrepreneurial capabilities in each of the empirical contexts to achieve conditions of university entrepreneurship, such as those already existing in developed contexts (Belgium). This qualitative design among universities and contexts provides insights into the stakeholders´ influences. It is important to identify the evolution patterns across countries (e.g., developed and developing) and entrepreneurial activities due to the national/regional stakeholders (Amos et al., 2015).

Table 4.1 Participants

Colombia			**Belgium**		
Data collection	**Domain**	**Participants**	**Data collection**	**Domain**	**Participants**
Interviews (20)	**University**	Coordination of university incubator (P1)Director Entrepreneurship Center (P2)Director of Social Engagement (P3) International Projects Coordinator (P4) International Students Coordinator (P5) Internationalization advisor (P6)Senior Professor (Architecture) (P7)Senior Professor (Architecture) (P8)Students Entrepreneur (P9)Coordinator of mentorship program (P10)	**Interviews (24)**	**University**	PhD Researcher (P1)Director Entrepreneurship Center (P2)PhD researcher (P3)Professor (P4)Researcher (P5)PhD Researcher (P6)PhD researcher (P7)Senior Professor (P8)Students Entrepreneur (P9)PhD Researcher (P10) TTO (P11) TTO (P12) TTO (P13) Principal investigator (P14)
	Social Enterprise	Director (P11)Director (P12)		**Spin-off**	Entrepreneur (P15) Entrepreneur (P16)
	Non-Profit Organizations	Coordinator of community projects (P13)Manager (P14)		**Social Entrepreneurship**	Entrepreneur (P17) Entrepreneur (P18) Entrepreneur (P19) Entrepreneur (P20) Entrepreneur (P21) Entrepreneur (P22)
	Government (Major Office)	Coordinator of Entrepreneurship (P15)		**Impact Investment Org. and incubator**	Director (P23) Trainer (P24)
	Chamber of Commerce	Director of innovation (P16)			
Ecuador			**Uganda**		
Data collection	**Domain**	**Participants**	**Data collection**	**Domain**	**Participants**

Interviews (20)	**University**	Junior Professor (Management) (P1) Junior Professor (Management) (P2) Junior Professor (Management) (P3) Senior Professor (Business School) (P4)	**Interviews (20)**	**University**	Coordination of university incubator (P1) Director Entrepreneurship Center (P2) Director of Social Engagement (P3) International Projects (P4)
	Technical	Academic Director (P5) Academic Director (P6)Vocational Trainer (P7)			
	Enterprises	Entrepreneur (P8)Entrepreneur (P9) Entrepreneur (P10)Entrepreneur (P11) Entrepreneur (P12) Entrepreneur (P13)Entrepreneur (P14) Entrepreneur (P15) Entrepreneur (P16)		**Social Enterprise**	Entrepreneur (P5)Entrepreneur (P6) Entrepreneur (P7)Entrepreneur (P8) Entrepreneur (P9) Entrepreneur (P10)Entrepreneur (P11) Entrepreneur (P12)Entrepreneur (P13) Entrepreneur (P14) Entrepreneur (P15)Entrepreneur (P16)
	Non-Profit Organizations	Director (P17)		**Non-Profit Organizations**	Coordinator of community projects (P17) Manager (P18)
	Incubator	Director (P18)Director (P19)		**Government (Major Office)**	Coordinator of Entrepreneurship (P19)
	Bank	Director (P20)		**Chamber of Commerce**	Director of innovation (P20)

Source: Authors

Then to facilitate the exploration of unresearched phenomena about our knowledge gap and our research question, we used semi-structured interviews as a qualitative research technique (Alvesson & Karreman, 2011). The data collection process was based on 80 semi-structured interviews in Belgium, Colombia, Ecuador, and Uganda, during non-consecutive times between December 2017 and December 2021. The interviews generally focused on inquiring about the different ways, precursors, political, institutional, and individual level elements that contribute to creating and managing entrepreneurship in the university context. We ensured anonymity for the participants, who had the right to ask questions during the interview (Brink, 1993). The interviews were recorded, with an average length of 45 min and were subsequently transcribed to ensure the reliability of this research. The interview protocol followed was subjected to evaluation, discussed, and validation by nine experts on the topic of entrepreneurship and innovation to ensure the validity of this study (Yin, 2018).

4.3.3 Data Analysis

The analysis of the data obtained was qualitative, following Corbin and Strauss (1998) and other studies that have also addressed similar themes and methodologies in the domain of university entrepreneurship and in different empirical contexts (O'Shea et al., 2008). To classify the interviews inductively, we used open, axial, and selective coding using the qualitative analysis software Atlas TI 9.0. as a tool (Corbin & Strauss, 1998; Creswell & Creswell, 2018). We proceeded to perform open coding, searching for those codes that represented the first ideas to classify the data obtained in situ. Then we looked for the interconnectedness of the codes through the second order of coding to then, group the latter into clustered or more global dimensions that would allow us to propose a theoretical model or framework (Creswell & Creswell, 2018; Golfashani, 2003; Lipscomb, 2012). Finally, when different codes could no longer be assigned to the data, and instead, we began to see codes appearing repeatedly, we assumed saturation as has been done in other studies (Brink, 1993; Golfashani, 2003). Table 4.2 shows the main themes, emergent constructs, and aggregated themes that allowed us to finally propose a theoretical model or framework (Corbin & Strauss, 1998).

4.4 Results

4.4.1 University Entrepreneurship Capabilities

The context can be considered as the set of external elements to the university where the economic and political conditions of a country converge (Edsand, 2017). These are related to the constructs that make it a factor, efficiency, or innovation-driven

Table 4.2 Coding structure

Theme	Second-order	First-order
Influence of context	National policies	P1, Belgium: "In this university, everything we do research on, obeys the national innovation priorities, also, the main researcher tells us that the projects we are funded also obey the priorities of the European Union, so the outcomes in terms of spin-offs are also aligned to those priorities."
	Regional policies, social awareness	P1, Colombia: "Governments always have priorities in their agendas, and based on this they give guidelines to universities, particularly public universities, so that our goals in terms of entrepreneurship and innovation and their typologies are aligned with the needs of the region."
Influence of stakeholders	Neighboring industries	P4, Colombia: "We have entrepreneurship programs that have been motivated by the country's national innovation and entrepreneurship policies. Likewise, these have been fed by international knowledge transfer programs with universities such as MIT, where they have shared with us their logic for creating spin-off companies and the way in which they collaborate with industry."
	Collaboration with government agencies	P10, Belgium: "We do market research and are constantly on the lookout for opportunities in our ecosystem. For this we connect with industry, and we are also attentive to what from an entrepreneurship point of view could contribute to the creation of value with research results. The European Union, located 20 minutes away from the university, offers us directions that could guarantee funding for future projects."
Entrepreneurial capital	Need for incubators	P1, Uganda: "In our university we have very bright and creative students who want to do something for their community through entrepreneurship. It is very difficult; it is very difficult because we still don't know how to support them to turn their ideas into businesses. Most of them rely on NGOs to help them."
	Equipment for entrepreneurship	P13, Belgium: "Our organizational infrastructure allows us not only to promote the culture of entrepreneurship, but we can manage a spin-off company up to its scaling or eventual sale. However, we are not equipped to manage social enterprises, we do not yet understand them very well."

Source: Authors

economy (Levie & Autio, 2008), the regulations of the innovation and entrepreneurship ecosystems (Leal Filho et al., 2020; Salvia et al., 2019). Next, two participants mention that national government guidelines shape the innovative and entrepreneurial interests of universities, as seen below:

> P1, Belgium: "In this university, everything we do research on obeys the national innovation priorities. Also, the main researcher tells us that the projects we are funded for also obey the priorities of the European Union, so the outcomes in terms of spin-offs are also aligned with those priorities."

> P1, Colombia: "Governments always have priorities in their agendas, and based on this, they give guidelines to universities, particularly public universities, so that our goals in terms of entrepreneurship and innovation and their typologies are aligned with the needs of the region."

It seems that all this external environment forges certain capacities in the universities that allow them to subsequently create and manage enterprises, whose orientation (i.e., social or traditional enterprises) also seems to depend on the priorities of the context (Newth & Woods, 2014), as expressed by the following participants:

> P3, Belgium: "The ecosystem is surrounded by high-growth potential and technology-based companies. We often collaborate with companies from the pharmaceutical sector, mainly because {company name} is right in front of the campus."

> P4, Ecuador: "The university is aware of the needs of its environment, particularly the social problems that are also very close to the university. We often connect with vulnerable groups to find solutions together. It's difficult to generalize technology when you have social problems around the corner."

This is clear evidence that, in our empirical contexts, the priorities of universities are different. Consequently, it is possible to assume that knowledge-based social entrepreneurship is also a consequence of the context (Roncancio-Marin et al., 2022a, b). For example, one participant mentioned that they would do more research addressing social issues. Therefore, it would be easier for them to establish other types of spin-offs if only the priorities of the university and the context were different:

> P2, Belgium: "We are not socially oriented. In our lab, we only focus on exploiting opportunities that we know will take us further in funding and publications. The university's priority is not to solve the problems of the environment."

Organizations are dynamic and possess capabilities that allow them to adapt to abrupt environmental changes (Teece, 2014; Yuan et al., 2018). In the case of universities and entrepreneurship capabilities, it seems that universities count with capabilities that allow them to capture information from the context in which they are embedded to transform themselves, a posteriori, as demanded by such a context in terms of national needs for entrepreneurship and innovation:

> P4, Colombia: "We have entrepreneurship programs motivated by the country's national innovation and entrepreneurship policies. Likewise, these have been fed by international knowledge transfer programs with universities such as MIT, where they have shared their logic for creating spin-off companies and how they collaborate with industry."

As established by the academic literature in business and management, when it comes to context, dynamic capabilities play a fundamental role in adapting organizations to changing environments (Leih & Teece, 2016; Zahra et al., 2006). Consequently, the ability of an organization to sense the opportunities in such an environment is determinant in the adaptation of universities to contextual needs in terms of entrepreneurship (Heaton et al., 2020). Based on our data collection and analysis, it appears that from a multilevel perspective (Courgeau & Baccaini, 1998),

universities since the opportunities available in the context according to external enablers that can not only create but influence the orientation of new spin-offs:

> P14, Belgium: "In Belgium, we have the decree of 1991 that supports us in the commercialization of research results through patents or the creation of spin-off companies. Since that moment, everything has changed in our university for technology-based entrepreneurship."

> P1, Uganda: "At the university, we see the Sustainable Development Goals as an opportunity to promote initiatives that catalyze social entrepreneurship. I believe that if the university succeeds in addressing these goals, we will contribute to the well-being of our region and the world."

However, the ability to sense and consequently shape the opportunities that can be translated into university spin-offs seems to depend on the ability of the individuals who are part of the university community (e.g., professors, officers, staff, students, researchers) to shape the information captured in their contexts as informed by other literature (Schmutzler et al., 2018). Our analysis of the data obtained for this research shows that in developed economies, individuals shape entrepreneurial opportunities in their contexts through market matching:

> P10, Belgium: "We do market research and constantly look for opportunities in our ecosystem. For this, we connect with industry, and we are also attentive to what, from an entrepreneurship point of view, could contribute to the creation of value with research results. The European Union, located 20 min away from the university, offers us directions that could guarantee to fund for future projects."

On the other hand, in the case of the developing economies studied for this chapter, we find that individuals identify social issues and market failures that they then address through the means of entrepreneurship, where the community is also part of the stakeholders and influences the direction of new entrepreneurial initiatives (Roncancio-Marin et al., 2022a, b), as can be seen in the statements of the following participants:

> P12, Colombia: "Through Community Service-Learning activities, students connect with populations in vulnerable conditions … some of them also actively participate in the activities promoted by the business incubator to create social enterprises."

> P18, Ecuador: "For us at [name of university], we see social problems as opportunities to take advantage of our students' creativity...."

> P3, Uganda: "We at [name of university] feel the need to contribute to the development of our region through knowledge. We connect with other actors to complement our capacities and increase our impact."

In general, and from our analysis, universities develop capabilities useful for entrepreneurship as they sense and shape the information captured in their specific contexts. Also, due to their interaction with stakeholders, universities identify and shape opportunities that can be seized through social or commercial entrepreneurship. Accordingly, we make the following theoretical proposition:

> Proposition 1: The entrepreneurial capacities of universities are highly influenced by the context and their stakeholders.

4.4.2 Evolution of Entrepreneurial Capabilities

The entrepreneurial capabilities of universities have been evolving over time, and as demonstrated in the previous subsection, they can be influenced by context and stakeholders. The academic literature suggests that organizations translate information from their environment and stakeholders through dynamic capabilities (i.e., sensing, shaping, seizing, and transforming) (Teece, 2014) to adapt to the conditions of their environment or to become more competitive (Guerrero et al., 2016). As the literature has shown, for almost three decades, universities in developed countries have embraced entrepreneurship as a source of competitive advantage (Perkmann et al., 2021; Sá & Pinho, 2019). Therefore, the outcomes of university activities that contribute to entrepreneurship can be measured by the ability of a university not only to create social or commercial ventures but also to manage them (Benneworth & Cunha, 2015; Nurmukhanova et al., 2021). The following participant suggests that the university was transformed due to the inclusion of a policy, which consequently promoted change within the university to create and manage entrepreneurial initiatives:

> P2, Belgium: "The university has not always been the same. Only after 1993 the valorization office was established, the government enabled us to be able to promote the commercialization of research results and entrepreneurship. Since then, we have been very active in creating spin-offs and offering entrepreneurship courses for researchers."

This has serious implications for the understanding of university entrepreneurship as it seems that dynamic capabilities contribute to the building of entrepreneurial capital (i.e., technology transfer offices, intellectual property protection, outreach activities, University-Industry Collaboration, entrepreneurship courses, incubators, accelerators, hackathons) within universities. Evidence of the above can be seen in the following sentences coming from the participants:

> P3, Colombia: "We are surrounded by social issues, which is why the government is now talking about the social appropriation of knowledge. We identified that there could be funding there, so we formally created the university extension office."

> P11, Ecuador: "We think that the best way to address social problems is through knowledge. For that reason, we teach Arduino to children in vulnerable conditions, and we plan to create a social spin-off company that not only addresses social problems, but also contributes to the economic development of the region. The research results office has helped us a lot in this process."

> P2, Uganda: "We don't have technology transfer offices at the university yet, but the business incubator is relatively new. Through it, we promote entrepreneurial culture throughout the university community, where we try to respond to opportunities we identify in the market or apply research to address regional issues."

Consequently, and in line with other studies, it seems that universities and their capacity to create and manage ventures depend largely on the entrepreneurial capital they have. That is, if universities have the organizational and physical infrastructure- that is useful for promoting the culture of entrepreneurship, they will have a

better *capacity* to create and manage university entrepreneurial initiatives. In contrast, a university without entrepreneurial capital will hardly be able to turn an idea into a venture, as mentioned by the following participant:

> P1, Uganda: "In our university, we have very bright and creative students who want to do something for their community through entrepreneurship. It is very difficult; it is very difficult because we still don't know how to support them to turn their ideas into businesses. Most of them rely on NGOs to help them."

From an evolutionary perspective, according to the data collected in the empirical contexts under study, the availability of such entrepreneurial capital in universities determines the entrepreneurial capacity of universities. This can be seen when looking at the situation of the universities in Uganda, where these are mostly focused on teaching and are hardly making any progress in research (Sserwanga et al., 2014); in other words, this means that they are not organizationally prepared to manage ventures.

> P9, Uganda: "I have had a dream of setting up my social enterprise, where I plan to develop prostheses for people born with disabilities. Unfortunately, the university has not given me much help in terms of how I can write my business plan. Things are changing and, in the future, they will be able to help me more."

If we consider the case of universities in Colombia and Ecuador, they have been teaching for a considerable time and are carrying out applied research processes, which, as a result, increases the amount of intellectual property produced that is susceptible to being transformed into a company (Calderón-Hernández et al., 2020), however, the entrepreneurial capital of universities in such contexts is just being established, but its fruits can already be seen, as the following participant mentions:

> P2, Colombia: "Since the approval of the spin-off law in 2017, we have adapted our internal infrastructure to create the office for the transfer of research results and spin-offs. However, the number of patents we produce is still low, but step by step, we will manage to improve our processes."

On the other hand, when looking at universities whose entrepreneurial capital is well established in our sample, as in the case of those in Belgium, it stands out that they are most likely not equipped for the management of social enterprises, which in turn means that the emergence of such enterprises in those universities should be lower or non-existent:

> P13, Belgium: "Our organizational infrastructure allows us not only to promote the culture of entrepreneurship but we can manage a spin-off company up to its scaling or eventual sale. However, we are not equipped to manage social enterprises. We do not yet understand them very well."

In synthesis, and in line with everything mentioned above in the last two subsections, the consequences of a university with dynamic capacities are reflected in the construction of entrepreneurial capital. This, consequently, means that the availability of such entrepreneurial capital in universities determines their entrepreneurial capability. That is the capability of universities to create and manage social and commercial ventures. Therefore, we make the following theoretical proposition:

Proposition 2: The entrepreneurial capabilities of universities evolve depending on the available entrepreneurial capital.

4.5 Conclusions

The purpose of this exploratory research was to shed light on the knowledge gap regarding the need to understand how entrepreneurial capabilities are impregnated within universities by following the dynamic capability approach (Teece, 2010, 2014). We have used a multilevel approach (Courgeau & Baccaini, 1998; Rasmussen et al., 2014), to study how entrepreneurial capabilities are created and evolve and whether context and stakeholders play a fundamental role in the evolution of these ambidextrous organizations (Guerrero, 2021). Therefore, we can draw two conclusions based on our data analysis in Belgium, Colombia, Ecuador, and Uganda.

Our first conclusion is related to our finding that context and stakeholders influence the entrepreneurial capabilities of universities. Previous studies report that the socio-economic and cultural context impacts the entrepreneurial attitude of individuals and organizations with entrepreneurial behavior (Riviezzo et al., 2019; Schmutzler et al., 2018). Consequently, universities use their dynamic capabilities to capture and process contextual information, which translates into opportunities that are then exploited through entrepreneurship (i.e., entrepreneurial capital) available within the university (Leih & Teece, 2016; O'Reilly et al., 2019). Our findings are aligned with the literature and add that there are organizational-level elements that allow understanding of national and regional policies as opportunities that can be exploited through commercial entrepreneurship means (i.e., as in the case of the Bayh–dole Act and similar policies) or through social entrepreneurship means (i.e., as in the case of the Sustainable Development Goals). Our study also shows that such policies and context affect entrepreneurship orientation at the individual level, whereby individuals sense commercial opportunities through match-making that they exploit through commercial entrepreneurship pathways (Patzelt & Shepherd, 2009). Similarly, in the case of social ventures produced in the university context, their orientation is partly due to the influence of the social issues of the context, as has also been shown in other studies (Castaño et al., 2015). On the stakeholder side, the literature mentions that university collaborations with industry are mostly based on selling intellectual property or that universities carry out their social goals through joint ventures with industry (Perkmann et al., 2021). However, our results yield results that extend the literature on university–industry collaboration and the quadruple helix of innovation (university, industry, government, and society) (Carayannis & Grigoroudis, 2016), as we found that the mere interaction between universities and their stakeholders provides them with information that universities then capitalize on—at the organizational and individual level—in the form of commercial or social ventures.

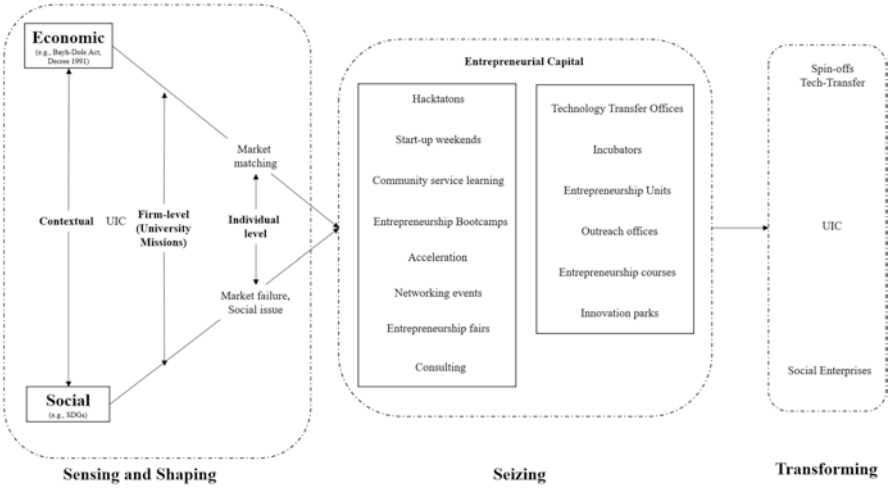

Fig. 4.1 Re-building entrepreneurial university capabilities. (Source: Authors)

Figure 4.1 shows how universities sense and shape contextual opportunities and those provided by stakeholders at different levels and have different implications that mostly impact how universities interpret external information (Amos et al., 2015; Teece, 2010; Ye et al., 2019; Siegel & Guerrero, 2021). Nevertheless, our results report, in line with other studies, that leveraging opportunities depend largely on the entrepreneurial capital available in universities, for which we elaborate in the following conclusion.

Our second conclusion is related to the evolution of universities' entrepreneurial capabilities. Based on our results, the consequences of dynamic capabilities are often reflected in the construction of entrepreneurial capital. Consequently, our findings also show that the availability of such entrepreneurial capital determines the entrepreneurial capabilities of universities. The results obtained in this chapter are in line with the academic literature on entrepreneurship and innovation, which indicates that organizations that possess dynamic capabilities are more competitive since they adapt better to be more competitive (Leih & Teece, 2016; Nurmukhanova et al., 2021; Zhang et al., 2016). For the particular case of universities, we also add to such literature, as we found that the dynamic capabilities of sensing and shaping particularly push universities to evolve in terms of organizational strategy (e.g., including the third mission of technology transfer and entrepreneurship), as seen in the different evolutionary degree of university missions among the empirical contexts explored in this study. Regarding entrepreneurial capabilities, the literature has focused on arguing that the ability to differentiate between commercial and academic interests and intellectual protection are two of the main entrepreneurial capabilities of universities (Rasmussen & Borch, 2010). We obtained opposite results, based on which we argue that such capabilities are part of university entrepreneurial capital. We also add to the academic literature, as our results also report that once

universities have already transformed their strategy, they evolve toward the creation of entrepreneurial capital (see Fig. 4.1, Seizing section), which gives them the ability to transform opportunities into social enterprises, commercial enterprises, or elements transferable to industry or society. In general, the entrepreneurial capabilities of universities seem to depend on the intimate interplay between dynamic capabilities and available entrepreneurial capital, so the possible moderating effect of entrepreneurial capital and a university's ability to create and manage ventures should be the subject of future studies, perhaps from a quantitative perspective.

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Part III
Re-building University Innovation Capabilities

Chapter 5
A Theoretical Approach

Claudia Yáñez-Valdés, Maribel Guerrero, and Marina Dabić

5.1 Introduction

Universities are widely regarded not only as teaching centers but also as organizations that foster research, the creation of new bodies of knowledge, and innovation (Numprasertchai et al., 2009: Grimaldi et al., 2011; Perkmann et al., 2013, 2021). The drastic changes resulting from the industrial revolution 4.0 become a new challenge for education and require skilled, agile, adaptable human resources with the ability to cope with rapid change (Avila et al., 2014; Guerrero et al., 2021). Therefore, universities are becoming more flexible in adapting to changing situations and contexts. In this sense, the synergy between professors and the work environment is necessary for universities to continuously improve innovation and performance (Purwanto, 2020; Guerrero et al., 2018). The development of innovation capabilities is a task that requires technical, monetary, and human resources, in addition to a multidisciplinary knowledge capital (Chen & Huang, 2009; Guerrero & Link, 2022). However, the accumulated literature has paid no much attention to

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the antecedents of university innovation capabilities. The research focuses on reviewing the existing literature on university innovation capabilities through content analysis of the literature over the last 12 years. The findings relate to the need for university and public management matching capabilities to reinforce knowledge-innovation generation and transfer. Hence, the importance of a university entrepreneurial orientation. Likewise, it is important to highlight the importance of students and faculty members as key actors in this process who transform the strategy into action.

The remainder of this chapter is organized as follows. Section 5.2 includes the theoretical bases to understand the link between universities, capabilities, and innovation. Section 5.3 introduces the methodological literature review design. In Sect. 5.4, we present the content analysis and discusses the proposed theoretical framework. Finally, Sect. 5.5 concludes by outlining the main conclusions and implications.

5.2 Theoretical Framework

5.2.1 Innovation-Based University Management

Universities have played an important role in national innovation and technological development. As creators of knowledge and trainers, they develop world-class research and invention capabilities. The university environment is a privileged place to transform ideas into innovative and/or technological solutions that respond to the needs of today's society (Arocena et al., 2015). University innovation responds both to the need for strategic differentiation and to a social mission. The innovation process requires intention, planning, and effort, but results may not be achieved. For this reason, university-based research and development are particularly important and relevant, as it creates viable resources and reduces uncertainty (Arvanitis et al., 2008).

Innovation in education means the deliberate process of introducing changes to improve education. Innovations in student learning procedures can be independent of teaching styles in the traditional sense. In addition, university students are exposed to various innovative ideas and concepts. The university environment is, therefore, the ideal place to develop ideas and concepts into practical techniques, thus developing creative skills (Binali et al., 2021). Most university professors are inventors and researchers of great innovations. It is, therefore, difficult to list all the innovative possibilities of the university. This includes creating artistic, commercial, and social projects, as well as university courses (Dentoni et al., 2016; Numprasertchai et al., 2009).

Universities present great challenges in the field of knowledge development. Connect with the environment with learning productivity, patents, and technology transfer, among other tools (Arvanitis et al., 2008; Bellini et al., 2019; Ar et al.,

2021). One of the main tasks that universities must undertake is related to the creation of new knowledge, which must contribute to the society to which they belong. Because it is these organizations that must assume responsibility for the creation and dissemination of knowledge. The capacity to generate innovation is closely related to the ability to work in an interdisciplinary manner since innovation occurs in border regions, which implies a combination of resources and competitive factors. The academy must be open to collaboration and the development of public–private alliances that consider researchers, professors, students, and other actors and influence the construction of innovation capacity at the organizational level (Azagra-Caro, 2014; Rialti et al., 2017).

University has a great responsibility to society as it is responsible for training the professionals of tomorrow. Developing capabilities and soft skills for teamwork depends on university education and the challenges that must be overcome during this formative stage (Bergdahl et al., 2020; Biletska et al., 2021). Universities are major centers of research and innovation. For this reason, it is important to have the economic resources allocated to education to promote the development of academic research and a complete and quality educational experience available to all. Investing in these two aspects of education can be the most powerful and effective pillars of a country's social and economic development, especially with the aim of reducing inequality gaps and improving access to education (Bormann et al., 2021).

5.2.2 Innovation-Based Higher Education

Technology itself has been seen as an element of innovation. But real change will be reflected as technology becomes central to the development of our digital society. Increasing the use of the Internet does not necessarily mean changing practices or adopting new aspects of learning to acquire skills (Binali et al., 2021). Most training models are based on traditional teaching models where information transfer is key. Students access the teacher's content through the network, with no need for intermediaries or added value to the learning process. This is exactly one of the reasons why many online training initiatives have failed. The presence of the teacher on the network and the social interactions created among students are important elements of the learning (Biletska et al., 2021).

It is important to propose and systematize innovations to improve educational models that support learning. In addition, technology-assisted learning is evolving rapidly in the higher education sector, so the integration of innovation is more than an indicator of quality. It is a necessity (Caena & Redecker, 2019). A culture of knowledge and collaboration must support the various actions and changes occurring in the system to facilitate and support continuous development to ensure the quality and competitiveness of the work. So far, we have a lot of experience with online training activities, but we need to improve our knowledge transfer and management system (Numprasertchai et al., 2009).

Action should be aimed at creating systems that encourage innovation as a necessary practice in educational and administrative work. It is imperative that the innovations developed be evaluated in the process of evaluation and certification of supervisors and teachers (Gupta & Bhaskar, 2020). In this sense, innovation must be achieved through teamwork, and we attach great importance to creating interdisciplinary teams that involve people with different functions and positions within the company. This type of innovation can facilitate the development of quality projects that enhance organizational and educational models toward those of entrepreneurial universities (Guerrero et al., 2021).

Strategic innovation processes, on the other hand, respond to environmental stimuli, such as government grants and policies to promote the development of innovation skills. This innovation process gives rise to science labs, prototyping labs, and business incubators. From these applications, their transition and generalization both within the university itself and in other contexts will be evaluated (Azagra-Caro, 2014; Bellini et al., 2019). These initiatives may also lead to the joint preparation of applications for formal funding of research and/or development activities, both nationally and internationally.

5.2.3 Innovation-Based University Engagement

The university has been articulated with the environment. This articulation has depended to a great extent on the development of social formation and on the understanding of the social commitment of the university community. As societies have become more complex, their demands on universities have become more diverse, facilitating the transition to an entrepreneurial university (Guerrero et al., 2020). An innovative university refers to an organization that promotes knowledge transfer, teaching for entrepreneurship, research and innovation, the relationship with companies, involvement in the region in which the university is located and society in general, internationalization, autonomy, the culture of entrepreneurship or the financing system and, in short, the integration of the entrepreneurial culture in the university's strategy (Lin & Yang, 2020).

Currently, society demands greater involvement from universities in the process of economic and social development of the territory. This has given rise to a new consideration of the organization, one that combines and integrates traditional activities with the contribution to economic and social development (Arocena et al., 2015). This new consideration of its functions as an entrepreneur requires a redesign of its strategy to face the challenges imposed by its new role in society. The promotion and dissemination of the entrepreneurial culture within itself and at all levels (teaching, research, and extension) is a key process to promoting economic and social contribution in a truly effective way. In its dual social and economic role, education and training have a fundamental role to play in ensuring that everyone acquires the necessary skills to adapt flexibly to these changes (Bormann et al., 2021; Bozkurt et al., 2020).

Knowledge transfer in a university context refers to a wide range of activities ranging from less formal joint projects between universities and industry, such as joint publications, student projects, and executive education, to more formal collaborative research, consulting, and start-up activities. Thus, also the development of collaborations with industry has enabled benefits for both parties, and its process is composed of bidirectional flows of knowledge, skills, capabilities, and expertise between collaborating partners (Guerrero et al., 2021). The approach between universities and business has been gradually strengthened and encouraged, and, in this sense, government promotion programs that have served to link research with development and innovation, bringing both worlds closer together, are relevant (Numprasertchai et al., 2009; Son et al., 2019). In this way, the university provides knowledge that can become a product to be patented and incorporated into the market. From the industry perspective, knowledge transfer with universities can provide new knowledge, skills, and equipment that can contribute to innovation and economic development.

Cooperation with universities is crucial for firms not only to exploit valuable external resources, such as scientists and research infrastructure, but also to assimilate knowledge, especially in science-based industries characterized by high uncertainty (Hewitt-Dundas, 2013). As a learning organization, the company needs to develop critical competencies over time. Developing collaborative knowledge relies on the experience accumulated through previous cooperative work. This experience is not only of direct collaboration, as any kind of contact with a university can contribute to closing the gaps between these two types of organizations, and thus to a better mutual understanding (Fischer et al., 2018; Tseng et al., 2020).

5.3 Methodology

We conducted a thematic content analysis to identify the main themes associated with digital capabilities at the university. Content analysis is a research method for making replicable and valid inferences from data in context. The purpose is to provide new knowledge, a representation of facts, and a practical guide for action, as well as to achieve a condensed and complete description of the phenomenon (Krippendorff, 1980). The result of the analysis is concepts or categories that will allow us to categorize the elements of the innovation system (Lindgren et al., 2020).

First, the analysis implies first setting out the focus of our research on the role of innovation capabilities formed in the university context. The research will be based on the coding of the selected articles.

Second, we made the selection of the content of the communication and of the sample. To investigate innovation capabilities, we conducted a search in Web of Sciences (WOS) and Scopus for articles under the following criteria: “Innovation Capabilities” and “University” or “Higher Education” from 2010 to 2022. From the initial search in both databases, we obtained 326 results. By removing duplicates and leaving only journal articles, we reduced the number of articles to 143. To

adjust the results to the specific research topic, we reviewed the abstracts and keywords, and we selected articles directly related to digital capabilities in universities. From this last review, 67 articles are selected.

Third, we established the content categories based on inductive coding in the first instance: The coding schemes were created from previous studies on the topic of innovation capabilities. As we read the content of the articles, we labeled key phrases and text segments.

Finally, to validate the coding, the authors of this chapter reviewed the coding separately. In this way, the abstraction process allows us to arrive at the categories of information (Lindgren et al., 2020).

5.4 Findings

5.4.1 Understanding University Innovation Capacity

University innovation capacity is influenced by external and internal factors that are mainly from the innovation processes of organizations and/or the outcome of innovation processes (Dost et al., 2020). Innovation is a process of co-creation and knowledge transfer that generates social, economic, and environmental benefits through new ideas, approaches, technologies, or forms of organization (Chin et al., 2019). In the particular case of the university, the change and dynamism of the environment urge it to constantly improve its resources and capabilities to be compatible with the changing environment (Bocken & Geradts, 2020; Audretsch et al., 2022a; Guerrero & Pugh, 2022). External organizations are the main demanders of human capital from universities seeking recent graduates considering they are competent professionals in the digital issues (Cahen & Borini, 2020; Fischer et al., 2020, 2022).

The success of recent graduates depends exclusively on their ability to understand the changes in the business environment and the opportunities and threats arising from them (Malik, 2018; Guerrero et al., 2018; Audretsch et al., 2022b). This capacity can be created by students during their classes by creating a good curriculum based on the latest concepts that are emerging in the business world, specifically with the knowledge associated with the use of digital technologies (Afonasova, 2018; Guerrero et al., 2021; Guerrero & Marozau, 2022). In this regard, universities foster innovation capacity in three ways. First, through the basic and applied research in universities involving the university community (Guerrero & Urbano, 2012, 2014). Second, the faculty working in the R & D unit are qualified and trained in research-oriented universities (Perkmann et al., 2013, 2021). Third, universities also produce innovative graduates for the future industry, so innovation in the teaching curriculum is the basis (Owusu-Agyeman, 2021; Guerrero et al., 2021). The interrelationship between university, student, and faculty members translates into measurable and quantifiable innovation capabilities outcomes.

5.4.2 *Re-building Innovation Capabilities via University–Industry Collaboration*

The accumulated literature reveals multiple knowledge actors (i.e., research institutes, universities, and industry) that demand and offer innovation capabilities to capture/create innovation value (see Table 5.1). Producers of innovation are commonly influenced by the (in)effectiveness of governments (i.e., the central or regional) policy instruments and public funding mechanisms (Grimaldi et al., 2011; Perkmann et al., 2013; Guerrero & Urbano, 2021; Yáñez-Valdés & Guerrero, 2021, 2022; Lopez-Rubio et al., 2022). Therefore, it is generally accepted that university–industry collaboration represents significant contributors of new knowledge and technologies overcoming the market failure conditions produced by government inefficiencies (Chung, 2002; Leydesdorff & Meyer, 2006; Santangelo et al., 2016; Guerrero & Urbano, 2021).

Universities and industry collaborations are (in)directly stimulators of innovation capabilities (Schaeffer et al., 2021). First, the university shares new skills, knowledge, techniques, and tools that enable new technological discoveries (Perez & Sánchez, 2003). Second, the industrial partner exploits the most updated knowledge, technologies, and human capital, but also shares risks and public–private (funding) sources (Grimaldi & Von Tunzelmann, 2002; Grimaldi et al., 2011; Guerrero & Link, 2022). Third, the success of the collaboration will depend on the

Table 5.1 University–industry collaboration as antecedent of university innovation capabilities

First order	Theme
The analysis shows that the research quality of universities has an impact higher than geographic distance on the capability for collaborating with industry.	Innovation collaboration partnerships
Companies often prefer to conduct R & D independently without outsourcing tasks to universities.	
Cooperation between universities and business is manifest in a wide range of activities related to the three missions of the entrepreneurial university: education, research and entrepreneurship.	
University–industry collaboration produces networks that may be capable of innovations, such as novel products and services. The collaboration projects also need to benefit student learning, yet teachers have little clarity with regard to innovation competence development. Conceptualizing higher education's developmental role, through its stress on the importance of education, skills, work, innovation, and production for economic development.	Innovation capacities
Universities is usually seen as serving the public good, especially when funded directly by the state, and because of potential social effects such as a reduction in inequality and an increase in social mobility. Public support for higher education is conditional; however, on its capacity, capability, and willingness to educate citizens, and to create and disseminate knowledge.	Higher education entrepreneurial innovation ecosystems

Source: Authors

outcomes' competitive advantages and its dynamic innovation capabilities (Rajalo & Vadi, 2017; Dabić et al., 2022). As a result, when this collaboration becomes progressively more active among industries, universities, and research institutes, several externalities would be produced in terms of building regional innovation capabilities (Hewitt-Dundas, 2013; Jiao et al., 2016) and reinforcing innovation ecosystems (Audretsch et al., 2022a; Fischer et al., 2020, 2022). Therefore, university innovation capabilities are re-generated through R & D collaborations.

5.4.3 Re-building Innovation Capabilities via Entrepreneurial Orientation

An entrepreneurial university is characterized by adaptable organizational structures to impregnate an entrepreneurial orientation into teaching, research, and managerial functions (Kirby et al., 2011; Guerrero & Urbano, 2012; Beliaeva et al., 2019). Table 5.2 shows the important role of entrepreneurial universities as a generator of human capital, research, and inventions that produce economic growth, job

Table 5.2 Entrepreneurial orientation as antecedent of university innovation capabilities

First-order coder	Theme
The world was changed in 2020 by the COVID-19 pandemic, which reorganized society in the way of thinking, acting, producing, consuming, and creating new innovative businesses.	Respond to external shakeouts and changes
Organizations that are prepared to new innovation and technological challenges	
Innovation capabilities entail a rigorous assessment of the region's knowledge base, experimentation, and the institutionalization of new collaborative work forms that mobilize industry–university interaction aimed at identifying and facilitating the emergence and growth of new domains.	Innovation and entrepreneurial processes
Identifying the unmet needs in the ecosystem, knowing the platforms' strengths and required capabilities, and matching with partners that have complementary resources are found to be effective strategies of the platforms.	Ecosystem
Three roles that entrepreneurial universities play in regional economic development as growth supporter, steerer, and driver.	Strategic orientation, culture, and learning process
Organizational culture, ensure how organizations are developing and managing knowledge	
Students enrolled in entrepreneurship education reported higher entrepreneurial and innovation intentions.	Education programs
Organizational agility is a necessary innovation capability for universities in times of turbulence.	Organizational agility
Emphasizing relationship and co-production as crucial values for digital design and enrich innovation capabilities.	Co-production

Source: Authors

creation, and competitiveness to respond to entrepreneurial and knowledge-based societies' stakeholders (Guerrero et al., 2015, 2016; Klofsten et al., 2019; Pugh et al., 2022; Audretsch et al., 2022b).

The most recent literature has also recognized the adaptation and contribution of entrepreneurial universities to respond to external shakeouts (e.g., economic crises, pandemics, natural disasters) (Siegel & Guerrero, 2021; Audretsch et al., 2022c). For instance, during the COVID-19 pandemic, entrepreneurial universities were active protagonists in developing proactive new (social) entrepreneurial innovation initiatives (Bozkurt et al., 2020; Capano et al., 2020; Siegel & Guerrero, 2021; Ibáñez et al., 2022). The universities' entrepreneurial orientation is proactively impregnated in new teaching-learning tools/contents to enrich the interaction between student and teacher, as well as achieving the labor market needs by a close connection with external stakeholders (Guerrero & Pugh, 2022). Entrepreneurship education has been an important mechanism to reinforce entrepreneurial intentions in the entire university community (Guerrero et al., 2020). A university entrepreneurial orientation plays an essential role in building an entrepreneurial culture, promoting entrepreneurship as a desirable and feasible career, and enhancing entrepreneurial capabilities within university community (Vivar-Simon et al., 2022).

Moreover, entrepreneurial universities establish virtuous circles linking knowledge production (research activities), knowledge dissemination (teaching/learning activities), and stakeholders needs (Klofsten et al., 2019; Bakry et al., 2022; Ozen et al., 2023). Entrepreneurial universities roles vary depending on regional characteristics, the university's motivation and ability to engage in third-mission activities, and the constellation of active agents working for regional development (Wakkee et al., 2019; Audretsch et al., 2022b). In this perspective, university entrepreneurial capabilities are rebuilding based on agile responses to external changes, strategic mobilization of resources among external agents, and strategic orientation impregnated in the missions (Fischer et al., 2018, 2020, 2022). Therefore, university innovation capabilities are re-generated through its entrepreneurial orientation.

5.4.4 Re-building Innovation Capabilities via Teaching-Learning

Table 5.3 shows how the education system requires multiple perspectives to understand its contexts, dynamics, and actors' interactions, especially with regard to the development of technological/innovation capabilities (Castro, 2019; Guerrero et al., 2021). New paradigms (e.g., globalization, digitalization, open innovation, sustainability) have demanded the design and the implementation of adaptable competency-based educational approach to the labor market and external changes demands (de Boer Garbin et al., 2021). Educational technologies have expanded the possibilities for educators to productively reinforce students' innovation competencies through novel pedagogical methods (Bag et al., 2020; Guerrero et al., 2021). In fact, the

Table 5.3 Teaching-learning as antecedent of university innovation capabilities

First-order code	Theme
Teaching innovation capabilities in science, technology, engineering, and math education in isolation in specific disciplines, programs, or departments.	Active learning methodologies
Impact of AI that highlights educators need to understand how embrace the use and development of innovative/technology skills and capabilities	Adoption of AI and learning solutions
Education is a complex system that requires multiple perspectives and levels of analysis to understand its contexts, dynamics, and actors' interactions, particularly concerning technological innovations.	Complex competence-based learning approaches
A current university education curriculum has shifted from a training and professional development model to an innovation capability development model, from work-oriented to a life orientation, from a teaching paradigm to a learning paradigm.	Teaching-learning environment
Training teachers as learning designers helps promote technology-enhanced educational innovations capabilities.	Teachers-students as learning designers
The imagination capability in technology commercialization is the key success factor for innovation. However, higher education in general and engineering-related curricula has offered limited courses incorporating imagination.	
An increased number of initial teacher education using/designing pedagogical content knowledge for improving capabilities.	Pedagogical content for developing innovation capabilities
The eLearning adoption has increased the motivation and technological/innovation capability of faculty	Role that e-competence of faculty members

Source: Authors

most updated university curriculum reconsider students' involvement in new social and economic paradigms that demand entrepreneurial and innovation competencies (Castro, 2019; Martzoukou et al., 2020), as well as other competencies such as sustainably and resilience (Brewer et al., 2022; Younis et al., 2020).

This new educational trends is commonly observed in science, technology, engineering, and mathematics (STEM) education, transversal educational programs, or industrial PhD programs (Guerrero et al., 2018, 2020; Liu et al., 2020; Bormann et al., 2021). Another cutting-edge technology that has enhanced innovation capabilities through the educational process is Artificial Intelligence (AI) which can play a pivotal role in reshaping higher education innovation capabilities (Lee et al., 2019; Zhang & Wei, 2017) and generate ambidextrous entrepreneurial and innovative students (McNeil et al., 2012; Van den Berg, 2018; Guerrero, 2021). AI has transformed conventional teaching methods into much more dynamic and personalized methods to reduce learning barriers and embrace university innovation capabilities (Gupta & Bhaskar, 2020). Although are still needed higher educational reforms, university innovation capabilities are re-generated through teaching-learning environments.

5.4.5 *Re-building Innovation Capabilities via Sustainability Trends*

Inclusivity and sustainability in higher education have introduced multiple changes to reduce gender/racial gaps (Horta & Shen, 2020). In this view, university innovation capabilities are directly related to preventing/reducing disadvantages among young/elder university community (Salmi & D'Addio, 2021). Indeed, there is a reverse causality because university community inclusivity and diversity are also fundamental to generating innovative capacities due to flexibility, adaptation, and multiple points of views (Dwyer & Gigliotti, 2017). From this perspective, empirical evidence suggests that universities contributing to innovative patterns have been collated in sustainable-oriented regions, for example, multicampus universities have transformed cities into innovative spaces where habitats are capable of the development of innovative social technologies as well as implementing sustainable pilot experiments (Guerrero et al., 2018, 2020). By following a sustainable innovation approach, universities can expand activities, innovation outcomes, and innovation ecosystem regional capabilities (Avila et al., 2014; Audretsch et al., 2022a) (Table 5.4).

5.4.6 *Proposed University Innovative Capabilities Framework*

Adopting the dynamic capability approach (Teece, 2010, 2023; Teece et al., 2016, 1997; Teece & Leih, 2016), the re-building of university innovation capabilities represents an interplay between external and internal components that influenced the sensing, seizing, and transformation processes.

External drivers behind re-building innovation capabilities: the sensing, seizing, and transformation processes derived from external pressures, such as technological trends (Balocco et al., 2019), changes in paradigms (Audretsch et al., 2022c), external shakeouts (Bozkurt et al., 2020), or intersections with other crucial societal themes (inclusion and sustainability, as suggested by Teece, 2023). Due to these

Table 5.4 Sustainability as antecedent of university innovation capabilities

First-order code	Theme
Education and the RDI nexus may affect HEI's capability to handle SD-related wicked problems and enhance their societal impact.	Sustainability
Action and reflection develop the conditions of awareness, agency, and association required to develop the circular economy.	
Efficacy of action learning to achieve measurable progress toward sustainability goals.	
Impact of two particularly important cognitive capabilities, task reflexivity and intercultural sensitivity, on academic performance	Inclusion

Source: Authors

external drivers, university managers focus on generating disruptive innovations and technologies that achieve the expected university outcomes from external actors (Guerrero & Pugh, 2022). Consequently, externally, university managers have the information needed to sense innovative opportunities, potential seize of resources, and the needed transformation processes.

Internal promoters for re-building innovation capabilities: The first promotors of re-buidling innovative capabilities are university leaders who should take advantage of the pre-existing resources and university capabilities (Teece et al., 2016) to allocate them to those aligned with the higher education public demands of technological and innovative outcomes (Lee et al., 2019). It represents the main opportunities to generate the demanded social returns and impacts, including the redefinition of university strategies and business models (Teece & Leih, 2016). Likewise, researchers and faculty can contribute to this step in the process based on their previous/current experiences (Guerrero & Pugh, 2022). In seizing, university managers should take advantage of the pre-existing capabilities (e.g., infrastructures, experiences, and networks with other actors involved in the innovation ecosystem, as suggested by Fischer et al., 2020, 2022). For instance, strategic research partnerships between researchers and companies, government agencies, or civil society groups can help to access resources needed to develop new innovations and technological advances (Perkmann et al., 2013, 2021). It is important to recognize that the transformation process includes all the university functions and actors: teaching, research, and social engagement (Audretsch et al., 2022c) (Table 5.5).

5.5 Conclusions

University innovation capabilities are vital to respond to emergent paradigms and to achieve the demands of multiple stakeholders in terms of skilled professionals who can meet the challenges of a changing world, new technological inventions, and reinforced national innovation agendas. The main conclusion is that universities with an entrepreneurial orientation are more likely to transform into regional capacity innovation builders as well as create bridges among organizations to ensure equality, inclusivity, and sustainability. Intuitively, a complementary or substitution effect could be experimented with by universities managers who are looking to allocate resources to the priorities and taking advantage of pre-existing university capabilities in the sensing, seizing, and transforming of new innovative and technological opportunities that achieve public policy agendas and to generate public value and socio-economic returns. The main limitations of this study are associated with the number of articles analyzed and the need to establish cases that make it possible to demonstrate with examples how national innovation systems operate in the current context and how they are projected in the future. Future research lines should provide empirical evidence about the definition, configuration, measurements, and outcomes of university innovation capabilities among disciplines, contexts, and approaches.

Table 5.5 Proposed university innovation capabilities framework

	Theme 1: Sensing	Theme 2: Seizing	Theme 3: Transforming
Re-building capability: External drivers and expected outcomes	Due to higher education public policy agendas and stakeholders' pressures, universities are immersed in multiple demands for public returns in the form of technological advances and innovative disruptions. These are the main sources for identifying "opportunities."	Typically, the priorities related to public policy agendas are linked to specific incentive programs where university managers can access public funds in collaboration with other agents involved in the innovation ecosystem. Therefore, it could be a good alternative to identify the external financial funds that may be useful in the re-building of innovative capabilities within universities.	Based on the expected public policy agenda outcomes, university managers could allocate internal and external resources to achieve them in the form of innovations, technologies, and other outcomes that could be transferred to public returns and value creation in society.
Re-building capability: Internal promoters	University managers should take advantage of the pre-existing resources and university capabilities to allocate them to those aligned with the higher education public demands of technological and innovative outcomes. It represents the main source of opportunities to generate the demanded social returns and impacts. Likewise, researchers and faculty can contribute to this process based on their previous/current experiences.	University managers should take advantage of the pre-existing capabilities (e.g., infrastructures, experiences, and networks with other actors involved in the innovation ecosystem. Particularly, strategic research partnerships between researchers and companies, government agencies, or civil society groups can help to access resources needed to develop new innovations and technological advances.	The transformation process includes all the university functions and actors: teaching, research, and social engagement.

Source: Authors

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Chapter 6
An Empirical Approach

Claudia Yáñez-Valdés, Maribel Guerrero, and Marina Dabić

6.1 Introduction

The social, economic, and technological paradigms have transformed universities' missions, activities, capabilities, and interactions with multiple stakeholders (Chin et al., 2019; Guerrero et al., 2019; Guerrero & Pugh, 2022). Universities have enhanced and legitimized their contribution to the entrepreneurial innovation ecosystems where they share resources/capabilities and transfer/commercialize knowledge among multiple actors (Audretsch et al., 2022c; De Wit-de Vries et al., 2019). In the past few decades, due to the restrictions of public education budgets, higher education evaluation systems and policymakers have promoted "measuring" and "evaluating" socioeconomic benefits generated by the universities' entrepreneurial innovation initiatives (Audretsch et al., 2022; Bellini et al., 2019). Likewise, open innovation principles and practices have accelerated the debate on the "democratization model" of research and inventions generated by university research teams (Vicente-Saez et al., 2020), as well as new teaching-learning environments more

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adequate to the grand societal challenges (Bauer, 2018). Consequently, funding mechanisms have been oriented to reinforce individual, organizational, and regional innovation capabilities (Castro, 2019; Audtretsch et al., 2022a) by prioritizing themes and collaboration in the public agendas (Perkmann et al., 2013). Even though most European countries have positive innovation outcomes, members are facing multiple challenges regarding research impact, stakeholder integration, inclusiveness, and sustainability (Ávila et al., 2017; Dwyer & Gigliotti, 2017; European University Association, 2022a).

This study explores the European Union case which, through initiatives, organizations, and public agendas, aims to foster university innovation ecosystem. These objectives are not exempt from difficulties and challenges; in this chapter, we analyze the European Union case as a territory that has implemented collaborative innovation capacity-building programs among countries, universities, and public–private organizations. By using data from the European University Association, the European Commission, and Eurostat, we provide insights about the university innovation capabilities panorama. Results show funding is one of the main filters/barriers for materializing innovative capabilities, solutions, and research. In addition, results reveal inclusivity and sustainability challenges regarding university innovation capabilities. Interestingly, the chapter provides interesting insights regarding the public policy and management approach adopted by the European Union governments to facilitate university sustainable innovation capabilities. Finally, the main chapter contributes to the interplay of the pressures from public policy agendas, the pre-existence of university capabilities, and the advantage of regional competencies in re-building innovative European university capabilities.

The remainder of this chapter is organized as follows. Section 6.2 introduces the theoretical bases. In Sect. 6.3, we describe the methodological design and contextualize the case. Then, Sect. 6.4 describes the insights of university innovation capabilities in Europe, as well as their challenges. Finally, Sect. 6.5 concludes by outlining the main conclusions and implications.

6.2 Theoretical Foundations[1]

The understanding and reconceptualization of the universities' innovation capabilities respond to the emergence of new social and economic paradigms (Morrar et al., 2017). Based on the literature review presented in the previous chapter, Fig. 6.1 shows the proposed framework to understand how university innovation capabilities are materialized or re-building through the intersection of several components.

The re-building of university innovation capabilities includes:

[1] An in-depth theoretical review is presented in Chap. 5. To avoid theoretical duplicities, please consult it for further details.

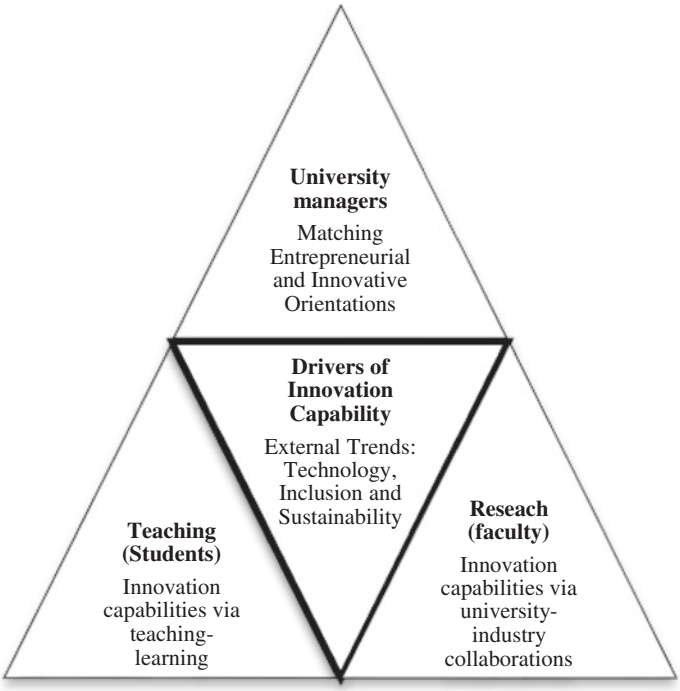

Fig. 6.1 University innovation capability framework. (Source: Authors)

(a) *Drivers*. Innovation capabilities are influenced by technological trends, changes, or intersections with other crucial societal themes (inclusion and sustainability). Indeed, university innovation capabilities represent the rapid adaptation and demand from the university community and multiple stakeholders (Balocco et al., 2019; Bozkurt et al., 2020; Guerrero & Pugh, 2022).

(b) *University managers*. The re-building of university capabilities demands entrepreneurial, innovative, and managerial leadership to transform routines into new ways to achieve stakeholders' needs (Lee et al., 2019). In this regard, several university managers have invested resources into specialized infrastructures (e.g., business creation centers, clusters, and science parks) to foster a strategic orientation toward innovation that has also been impregnated by an entrepreneurial orientation (Fischer et al., 2020, 2022). Thus, the implementation of strategic and clear property rights university norms (e.g., technology transfer offices) (Rådberg & Löfsten, 2023).

(c) *Research activities*. The link between faculty members (researchers) and strategic partnerships (e.g., companies, government agencies, or civil society groups) have reinforced the re-building of innovation university capabilities (Perkmann et al., 2013, 2021; Bellini et al., 2019). In other words, researchers have sensed

innovative opportunities as well as seized and transformed them into inventions and technologies that have created social value and public returns.

(d) *Teaching activities*. The continuity in the re-building process of innovative university capabilities have demanded the redesign of entrepreneurial innovation curricula with the most updated technical/specialized skills and content (e.g., industrial doctorates, Massive Open Online Courses, or MOOCs) (Kirby et al., 2011; Guerrero et al., 2021). Likewise, the fostering of entrepreneurial innovation mindsets/identities among students, teachers, and alumni (e.g., flexible learning pathways, project-based learning, and international classrooms) (Guerrero & Urbano, 2014; Hayter et al., 2022).

In the re-building process of university innovation capability, certain elements may act as complements but others as substitutions among the core university activities (teaching, research, social engagement) and university community (students, faculty, and university managers). Indeed, the externalities of innovation capabilities have been (in)direct translated into a more inclusive, sustained, and innovative university ecosystem (Chung, 2002; Guerrero et al., 2016; Dwyer & Gigliotti, 2017; Klofsten et al., 2019; Wakkee et al., 2019; Salmi & D'Addio, 2021).

6.3 Methodology

6.3.1 Contextualization

The European Union (EU) represents a unique economic, political, and geographical association of country members that share policy frameworks (European University Association, 2022a). Regarding innovation, the EU implemented the Horizon[2] 2020 program with a budget of €80 billion to enhance innovation capabilities among universities, research centers, and ventures (European University Association, 2022b). Concretely, this policy framework considered multiple initiatives to reinforce/develop innovation capacity-building among members.

At the higher education level, innovation and technology transfer become priorities in universities' research strategies (Beliaeva et al., 2019; European University Association, 2022a). It explains why European universities impregnated an innovative culture among activities, functions, and roles with internal/external stakeholders (Aguiar & Gagnepain, 2017; Huybrechts & Haugh, 2018; Van den Berg, 2018). According to Chin et al. (2019), European higher education strategy has been based on reinforcing innovation capabilities in three ways: (a) via qualified staff to fulfill all university missions and incentives to increase staff motivation to engage in innovation; (b) via investments to support both innovation directly and long-term

[2] For further information, visit: https://european-union.europa.eu/priorities-and-actions/actions-topic/research-and-innovation_es

oriented research, including curiosity-driven research as one of the fundamental drivers of innovation; and (c) via spaces where researchers and students from different disciplines and other actors in the innovation ecosystem can engage in a process of co-creation. Consequently, European universities have developed innovation and entrepreneurship capabilities that have contributed in new generation of inventors, reinforced regional smart specialization capabilities, reinforced regional innovation ecosystems, and produced innovative entrepreneurial solutions that satisfy societal needs (Audretsch et al., 2022a, b, c).

Nowadays, the democratization of research via open innovation policies and practices has also been an interesting debate among the country members (Younis et al., 2020). Likewise, the orientation toward sustainable initiatives to return to society via digitalization (Ávila et al., 2017; George et al., 2020). A good example was the accelerated response from many universities and actors collaborate together via innovative initiatives to support the European community during the COVID-19 pandemic (Barnes, 2020; Bozkurt et al., 2020; Guerrero & Pugh, 2022).

6.3.2 Methodological Design

To analyze university innovation capabilities, we focused on the European Union case using data from the European University Association (EUA) Survey and the European Commission Statistic (Eurostat). The EUA survey captures the different levels of innovation capabilities of universities, as well as how these levels contribute to a wide range of societal impacts and outcomes.

The EUA survey collects information from 166 organizations in 28 European countries. In this regard, we focused on the open responses provided by the survey participants, as well as additional statistical analysis obtained from the dataset. This unique body of evidence has enabled the association to develop recommendations for universities, policymakers, and funding agencies on how to further improve the contribution of universities to the innovation ecosystems (European University Association, 2022a; Kozirog et al., 2022).

In addition, the European Commission presents an annual report called the Education and Training Monitor, which presents an annual assessment of the education and training system across the EU. The report brings together the latest data, technical reports, technical reports, and studies, as well as examples of policy measures from different EU countries. The main theme of this year's Education and Training Monitor is education and well-being. The Monitor 2021 also analyzes the EU-level objectives adopted by the Council Resolution on a strategic framework for European cooperation in education and training toward the European Education Area and beyond (2021–2030) (European Commission, 2018).

Table 6.1 University innovation capabilities in Europe

University profile	University orientation	Perception about university innovation capacity	Evaluation of university innovation capacity	Conditions enhancing innovation capacity	Regional innovation capacity assessment system
Comprehensive: awards degrees in all three cycles and is multidisciplinary (i.e., offers programs in more than two subject areas/fields of science)	Research-intensive (4%)	P97: "Since the inception of the university Technology and Knowledge Transfer Office, the attention to research and innovation has grown exponentially"	Very high	(a) Cooperation (b) Connections (c) Funding	Yes
	Teaching-led (8%)	P140: "Given the definition you give of 'innovation', in all the main areas of activity (research, teaching, public outreach) university is pursuing innovation, mostly 'incremental' rather than 'radical'"	Neither high nor low	(a) Qualified staff (b) Funding (c) Autonomy (d) Governance	No
	Both (54%)	P21: "The university promotes innovative research in many areas, from technology to life sciences, from ethics and humanities to medical sciences and in the fields of Education, Social Sciences and International Studies. This strategy is accomplished through support to the participation to competitive research calls, to technological transfer (such as the creation of spin-off companies and the activation of collaborations, joint labs, and contracts with companies), to technological districts at a regional level. The university also allocates funds for PhD programs, support of applied and base research, and for new research infrastructures (such as competitive calls to acquire new equipment)"	High	(a) Qualified staff (b) Cooperation (c) Funding (d) IPR	No
		P137: "Innovation is core to the DNA of the university and this is reflected in our strategy. The vision of the strategy is for university to be recognized as an organization with a reputation for equity and innovation in education that empowers students and communities to transform their lives and society through teaching, learning, research and enterprise. The strategy is underpinned by four core themes – Education & Student Experience; Research & Impact; Global university; and Enterprise & Innovation"			

Specialized: awards degrees in all three cycles and specializes in a particular subject area/field of science, e.g., medical science, business, music or arts school)	Research-intensive (1,5%)	P143: "Creation of an incubator several years ago. The spirit of innovation and the sense of entrepreneurship are instilled in university – our students throughout their studies, especially through learning formats that focus on the project mode. In addition, the school encourages students to join associations and participate in humanitarian and societal projects in order to develop a taste for entrepreneurship."	High	(a) Qualified staff (b) Governance structures (c) Cooperation (d) Connections	Yes
	Teaching-led (1,5%)	P155: "Our university aims to become one of the main creative innovations hubs (focusing on Design innovation) in the region in the next 5 years. The university has created dedicated infrastructure and organizational units for innovation, with dedicated staff (researchers, innovation management, administration)"	High		
	Both (4%)	P111: "Research and development is one of the main values of university. However, university focuses on education of its student and their future worth on the labor market. The university has created Centre for Innovation and Technology Transfer in order to create a bridge between science and research and business, as well as to focus on innovation in medicine field".	Neither high nor low		
Applied Sciences: offers more career-orientated studies, usually in the first and second degree cycles	Both (11%)	P11: "In its mission statement, organization is committed to shaping social innovation. This strategically addresses all areas of the university. We are committed to fundamental knowledge-generating research and solution-oriented applications of science, as well as to critical reflection on the effects of application-related innovations. We promote inter- and transdisciplinary cooperation in research in order to address current challenges and urgent questions for the future by combining academic and practical expertise. We want to shape the social innovation processes induced by this in a partnership-based and interdisciplinary manner and reflect on their conditions, constructs and effects."	High	(a) Qualified staff (b) Cooperation (c) Funding	No

(continued)

Table 6.1 (continued)

University profile	University orientation	Perception about university innovation capacity	Evaluation of university innovation capacity	Conditions enhancing innovation capacity	Regional innovation capacity assessment system
Technological: awards degrees in all three cycles, and specializes in technology, and engineering	Both (13%)	P35: "Innovation is one of the main topics of Strategic Plan of the university. The university aims to play a driving role in research and innovation, combining cutting-edge technological contents with social issues. A flexible and interdisciplinary research that counts on structures of excellence and on the development of human capital, while successfully obtaining financing from European programs. Among the main objectives: a consolidated relationship with enterprises, also by supporting start-ups and enterprise development."	High	(a) Qualified staff (b) Cooperation (c) Funding	No

Source: Authors based on the European University Association survey (Kozirog et al., 2022)

6.4 Findings

6.4.1 University Innovation Capabilities in Europe

Table 6.1 shows evidence from the EUA survey on re-building innovative university capabilities in Europe. Concretely, our analysis reveals three important dimensions related to European university innovation capabilities re-building: (a) the *first dimension* is related to the innovative capabilities introduced/developed inside universities to achieve teaching activities; (b) the *second dimension* is related to innovative capabilities impregnated in the university community to obtain innovative outcomes; and (c) the *third dimension* is related to innovative capabilities impregnated in the regional ecosystems and often part of general university performance frameworks.

The *first dimension* is related to the innovative capabilities introduced/developed inside universities to achieve teaching activities (Vincent-Lancrin et al., 2017). In this regard, innovative university capabilities could be distinguished by pedagogical innovation capabilities (teaching pedagogies/techniques), work innovative capabilities (managerial procedures), and innovative external capabilities (engagement with parents and external actors). The most common practice is in the classroom, where universities have implemented innovative innovation pedagogies/techniques that introduce content/simulations in the curricula for students' innovative skills and digital practices. According to the European University Association (2022a) survey,[3] the university innovation capacity is understood as the organization's ability to transform knowledge and ideas into new products, processes, and systems with beneficial outcomes (Lawson & Samson, 2001). Most of the respondents agree that their universities have an innovative orientation orchestrated toward an innovative strategic plan where innovation capabilities are supported by policies, incentives, and abilities. Concretely, the respondents explained:

> P28 [Applied Science, Research-Teaching Intensive]: "The university has always paid particular attention to innovation. In particular, through participation in research and development projects funded by the European Commission, the establishment of an ad hoc office that deals with innovation, technology transfer and relations with local companies and manages joint laboratories where innovative research projects are carried out with companies and tailor-made research services are offered based on the requests received. Furthermore, relations between research groups and companies are encouraged for the carrying out of common R & D projects"

[3] Methodological note: The survey was divided into five sections comprising 32 open-ended, ranking, multiple and single-choice questions covering a wide variety of topics related to innovation at universities. The survey was open from 4 May to 28 June 2021. It was preceded by a pilot phase involving six organizations of different sizes, profiles and geographical locations. This study obtained 166 valid responses from organizations in 28 European countries. Concretely, of the total 166 responses, 134 are from EUA members, and 32 from non-member organizations. For further details, review European University Association (2022a, p. 12) and (Kozirog et al., 2022).

P48 [Comprehensive, Research Intensive]: "University aims a sustainable knowledge economy in the region to include (i) material and biomedical technologies, (ii) green and digital technologies and (iii) quantum technologies. Closely related to this main goal is the contribution to the development of social areas, including the care of an aging population (the so-called Silver Economy) and a healthy lifestyle for the working-age population"

P109 [Comprehensive, Research-Teaching Intensive]: "We promote innovation by favoring the transfer of research results onto the market through patents, spin-offs and start-Ups in various fields. We have established a joint initiative with other universities to foster technology transfer by building a bridge between research laboratories and the industry and by attracting international investors. We also pursue this aim through collaboration with firms and industrial clusters, problem-oriented training activities focusing on entrepreneurship, and various dissemination and public engagement initiatives such contribution to the European researcher's night, an innovation pub, an annual crowdfunding contest collaboration with a leading reward/donation platform, and organization of business plan contests"

P111 [Comprehensive, Research-Teaching Intensive]: "The university represents the main attraction for students of the region. Characterized by the multidisciplinary of the training offer and the scientific areas of research, responds to the task of generating in the young people who attend it that 'critical thinking' which, together with research and innovation, is the engine of the development of an inclusive society and capable of responding to the increasingly complex challenges of today's globalization. The university's strategic planning enhances the identity and the territory and gives a strong boost to the cultural, social and economic development of the Region. Pursue this through the quality of the training offer, thanks to a highly qualified and highly qualified teaching characterized by research, innovation and dissemination of knowledge and a support structure effective and efficient. It is an ambitious project which, in enhancing the importance of mutual contamination between the university and the territory, underlines the role and social responsibility of our organization."

P156 [Comprehensive, Teaching Intensive]: "Till now, low attention has been paid to innovation actions and a clear strategy to increase innovation capacities does not exist. It is now under development. The collaboration university/companies are not much developed, due to the lack of policies to boost innovation capacities, but also due to the economy profile of our region, which is majorly devoted to tourism."

The *second dimension* is related to innovative capabilities impregnated in the university community to obtain innovative outcomes. According to the European University Association (2022a, p. 19), most respondents perceived those three key organizational characteristics that enhanced their university innovation capacity were: the qualified staff, sustainable funding, and cooperation among the innovation ecosystem actors. Likewise, other relevant conditions that have reinforced innovation capabilities are related to governance structures, autonomy, and IP regulations (Kozirog et al., 2022). Most of these elements have been recognized by empirical studies (see Audretsch et al., 2022a, b, c; Guerrero & Urbano, 2012). Indeed, these mechanisms are responsible for the main university innovative outcomes. However, the recognition of multiple innovation staff activities is not considered common practice in career evaluation, particularly when innovation is considered in a broader sense beyond intellectual property, beyond the commercialization of intellectual property, and the creation of innovative ventures. Particularly, these elements were

reinforced by the respondents who evaluated very-high their university innovation capability as follows:

P11 [Very-high innovation capacity]: "Uni's capacity for innovation is very high, as we develop innovative approaches to a wide range of topics with a broad range of study programs in faculties. In addition, the Uni and its location are integrated into a highly innovative infrastructure of projects, companies, alliances, and other universities."

P26 [Very-high innovation capacity]: "The innovative capacity of our university lies in the number of quality professors and researchers, in the number of high-level students it has, in the administration and services staff and in the infrastructures of its campuses, all in a medium-sized university that promotes quality teaching, research excellence and the transfer of results to society and companies."

P28 [Very-high innovation capacity]: "The University considers innovation a conscious and proactive practice. This means that it can and must, be measured on an ongoing basis. We adopted Key Performance Indicators (KPIs) as performance metrics that measure how effectively the University is performing its innovation capacity. For instance, we consider as KPI: the participation in European projects, Future and Emerging Technologies actions, Marie Sklodowska-Curie actions, the number of relations between research groups and companies, and the number of framework agreements signed between research groups and companies."

P62 [Very-high innovation capacity]: "The innovation capacity at Uni is a high potential, in chemical sciences. This potential is measured by one of the highest scores in the number of patent applications among Polish technology universities. However, the researchers are still offered too little organizational support to apply in practice outcomes of their basic research. Uni creates and strongly supports academic entrepreneurship, e.g., by becoming actively engaged in the creation and development of new innovative companies based on the intellectual property of the University, as well as through the dissemination of knowledge regarding the commercialization of innovative technologies and cooperation between the academic community and the economic environment. Activities undertaken by Uni staff resulted in establishing spin-off companies and signing licensing agreements with industrial partners for technologies developed with the support from the 'Innovation Incubator'."

P101: "University has well-established processes with supporting services for innovation propositions, invention disclosures, innovation proposals, trademarks, patenting, IPR (Intellectual Property Right), commercialization, and technology transfer. Uni has an online electronic tool to manage, assess, evaluate and maintain all IP-related documents and decisions for the entire lifespan of research projects, from research ideas and invention disclosures to patenting to commercialization of the research results. Uni TTO (Technology Transfer Offices) also uses other public and commercial IP tools in evaluation and assessments. Uni TTO has published its own guide for Uni researchers, personnel, and students to help and advice with matters related to IP, inventions, and commercialization, as well as knowledge transfer and technology transfer. Uni also has a Legal Services unit that supports the functions of the Uni TTO unit. Business Development Manager leads the unit, and the Innovation Managers are responsible for IP Management and TTO functions of the university. The innovation activity and IP portfolio at the Uni are annually followed using the indicators shown in the below table. Furthermore, the IP portfolio consisting of over 50 patent families and more than 100 trademarks are extensively analyzed and evaluated quarterly, reflecting both the stage of patent prosecution and the technology transfer agreements

made. The patent portfolio is constantly moving: while patent families are commercialized from the other end, new priority applications are made in nearly double-digit numbers yearly. Uni TTO also coordinates new trademark applications and registrations and manages the whole trademark portfolio of university."

The *third dimension* is related to innovative capabilities impregnated in the regional ecosystems and often part of general university performance frameworks (Audretsch et al., 2022). Several cases are captured by university impacts measured by universities' knowledge transfer and commercialization activities, patenting activity, preparation of the ground for business start-ups, and academic entrepreneurship. In the European context, universities have contributed to the smart specialization through collaborations with multiple partners enrolled in the innovation ecosystem (Bukhari et al., 2021). The EUA survey shows that for universities to remain drivers of innovation in these ecosystems, it is necessary to close the gap between their strategic commitment to innovation and their innovation capacity (Kozirog et al., 2022). It usually happens if policymakers support universities to attract and develop human talent, ensure sustainable investments in research and innovation, and build spaces where universities can co-create with all actors in innovation ecosystems. Particularly, these elements were also reinforced by the respondents who explained how their university innovation capability is fostered across the European Union states' members, as follows:

P6: "In Switzerland, innovation parks; innosuisse, and different initiatives to promote innovation in collaboration between universities and SMEs."

P13: "In England, the newly introduced 'Knowledge Exchange Framework' covers a good fraction of the intent behind the question, and seems to be a useful mechanism for assessing innovation and knowledge exchange effectiveness across the sector."

P25: "In Spain, the National Agency for HE evaluation has a pilot program evaluating innovative capabilities. Moreover, indicators of innovation are included in a six-year program sent by each HE to the Ministry for HE and Research. Concretely, this pilot project assesses the individual capacity of each researcher, considering six-year periods, in knowledge transfer activities (the so-called 'sexenio de transferencia')."

P27: "In Italy, the Ministry of University and Research established the Agency for the Evaluation of the University and Research System (ANVUR) oversee the national public quality assessment system of universities and research bodies. It assesses the effectiveness and efficiency of public funding and incentive programs for research and innovation activities. It evaluates technology transfer activities and, in particular, academic research on an annual basis."

P64: "In Hungry, fundamentally, the Ministry for Innovation and Technology as well as the National Research, Development and Innovation Office deliver such activities to assess regularly universities' innovation capacity."

P76: "In Ireland, Knowledge Transfer is charged by the Government to undertake an Annual Knowledge Transfer Survey and a report of performance of all Irish universities is published annually. Its remit is specific to commercialization and doesn't incorporate innovation capacity in the broader sense."

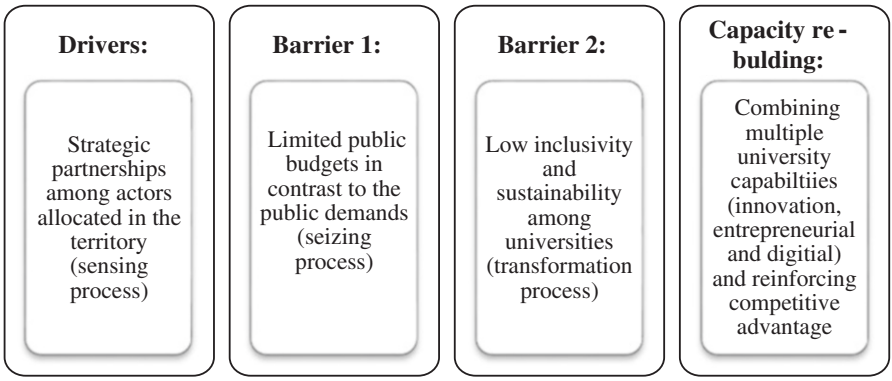

Fig. 6.2 Re-building innovation capability by European universities. (Source: Authors)

6.4.2 University Innovation Capabilities Challenges in Europe

According to the European University Association (2022a, pp. 48–50), the main challenges related to university innovation capabilities in Europe is the limited staff resources and the limited incentives to increase staff innovation motivation. The lack of sufficient funding, especially for long-term oriented strategies, defines the effectiveness of innovation outcomes (Tseng et al., 2020). Among EU members, the public investment in innovation varies from 3.1% GDP (e.g., Ireland) to 6.0% GDP (e.g., Belgium, Denmark, and Sweden). Likewise, another innovation capacity challenge is related to governance structures and autonomy among European higher education systems. Prior studies have evidenced that economic crises and natural disasters have stimulated innovative behaviors among individuals, organizations, governments, and universities (Hayat et al., 2018; Ibáñez et al., 2022).

With the COVID-19 pandemic, universities abruptly moved all activities toward the online scenario (Bormann et al., 2021; Brammer & Clark, 2020; Guerrero & Pugh, 2022) and reinforced innovative capabilities via developing new (open social innovation) solutions (Chesbrough, 2020; Dienel & Fava, 2021). As a result, the European Commission incorporated sustainable capacity innovation building into the policy framework agendas, such as the Innovation Union Flagship Initiative and the Recovery and the Resilience Mechanism (RRM). The RRM includes several reforms in six pillars: Green Transition; Digital Transformation; Social and Territorial Cohesion; Economic, Social and Institutional Health and Resilience; and Policies for the Next Generation, Children, and Youth. In addition, EU members have also mobilized funds to support digital innovation skills under the COVID-19 response investment initiative (e.g., Digital Education Action Plan 2021–2027). Another challenge is the role of the university in the maximization of the effectiveness of Strategies for Smart Specialization (RIS3) in developing regional innovation ecosystems. It is important to fully capitalize on tangible and intangible assets that universities offer to benefit the culture, society, and economy of their regions

(Bukhari et al., 2021; Temel et al., 2021). Likewise, it considers inclusiveness and equality across the university community (students, staff, researchers) and stakeholders (Guerrero & Pugh, 2022). Therefore, we hope this chapter provides some insights into the gaps that could be useful in future research for extending the understanding and empirical evidence about university innovation capabilities in different contexts.

6.5 Conclusions

Universities play a critical role in innovation (Castro, 2019), especially via developing innovation capabilities among research actors. Therefore, universities are enrolled in a privileged sector to improve skills through teaching and research programs (Mascarenhas et al., 2018; Vivar-Simon et al., 2022). It explains why universities are recognized for enhancing innovation skills via lifelong learning (Beliaeva et al., 2019; European University Association, 2022a, b).

Figure 6.2 shows the main conclusion of this chapter is that the European universities' innovative re-building of capabilities responds to the strategic partnerships among different actors allocated in their territory (Dienel & Fava, 2021). Likewise, by combining digital and innovative capabilities, university managers have responded to the most recently experienced COVID-19 crisis (Siegel & Guerrero, 2021). It is a very interesting interconnection between new challenges and previous experiences in sensing, seizing, and transforming (Teece et al., 1997) by reconfiguring business models (Teece, 2010; Teece & Leih, 2016) and ambidextrous tensions (Guerrero, 2021).

We identified two university challenges in the process of re-building of innovative capabilities. First, most universities are characterized by limited public budgets for innovation capabilities (Aguiar & Gagnepain, 2017) and transformative innovation policy (Švarc & Dabić, 2021). Therefore, taking advantage of regional innovation capabilities has been an alternative to compensate for this limitation among different innovation ecosystem actors (Fischer et al., 2018; Perkmann et al., 2013; Rippa & Secundo, 2019). For this reason, special attention should be paid to universities with lower innovation capacity to promote capacity building, networking opportunities, funding, incentives, and advice among those more experience in re-building innovative capabilities. Second, we identified a challenge associated with the low levels of inclusivity and sustainability among university innovation capabilities (Klofsten et al., 2019; Pugh et al., 2022). For example, universities should consider the high rates of migrant populations in European countries and the potential contribution to innovation processes (Dwyer & Gigliotti, 2017; Salmi & D'Addio, 2021). With scarce resources and uncertain socioeconomic environments, universities should adopt sustainable orientation in all strategies, particularly in developing innovative and technological solutions that benefit society and the environment (Dienel & Fava, 2021; Fischer et al., 2020, 2022; George et al., 2020; Schaeffer et al., 2021). It demands close collaboration between universities, civil

society organizations, and local public sector organizations (Klofsten et al., 2019; Teece et al., 2016).

Finally, regarding the university's role as a leader of the innovative system, efficient governance structures should be supported, and university autonomy should be promoted as a fundamental value (Peng et al., 2019; Dabić et al., 2022a, b). This will increase the universities' commitment to society by developing independent, high-quality, innovative solutions to current and future challenges. It explains the relevance of policy frameworks that promote open technology, open innovation practices, sustainability, and equality will create favorable conditions for frugal social innovations (Dabić et al., 2022a; Yáñez-Valdés & Guerrero, 2021, 2022). These are relevant pathways that universities should impregnate in their missions and activities. Likewise, future research should continue extending the academic conversation about re-building university innovation capabilities (Teece, 2023).

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Part IV
Re-building University Digital Capabilities

Chapter 7
A Theoretical Approach

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7.1 Introduction

An increasing amount of research has emerged in recent years emphasizing the need to develop digitally competent, literate, and skilled individuals (Fulton & McGuinness, 2016). This trend has become noticeably more pronounced following the COVID-19 pandemic, where the need to keep educational systems functional amidst confinement and mobility restrictions increased (Martzoukou et al., 2020; Guerrero & Pugh, 2022; Ibáñez et al., 2022). University managers have tested the mobilization of technological, physical, and human resources to respond to changes in a context of uncertainty (Guerrero & Urbano, 2021). Thus, faced with the need for integrated educational systems, universities have been forced to change teaching strategies toward more flexible and student-oriented approaches (Tang et al., 2021; Guerrero et al., 2021b).

Nowadays, universities have a huge challenge to train competent professionals both within their area of specialization, as well as to transfer knowledge that will

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enable them to insert themselves in a digital society (Audretsch et al., 2022; Ribeiro, 2020). The term capabilities are used especially in general discussions about what skills and knowledge people should have in a knowledge society (Ilomäki et al., 2016). In contrast, digital refers to having the necessary skills and abilities to operate technological applications as with the use of technology to meet personal and collective needs (Erstad, 2010).

According to the European Commission (2018), "digital competence implies the safe and critical use of Information Society Technology for work, leisure, and communication. It is based on basic technological skills: using computers to retrieve, evaluate, store, store, produce, present and exchange information, and communicate and participate in collaborative networks via the Internet." The importance of researching this topic lies in the fact that education is a complex system that requires multiple perspectives and levels of analysis to understand contexts, dynamics, and interactions of the actors, especially as related to technological innovations (Castro, 2019; Guerrero et al., 2021b).

The digital transformation of education offers a wealth of opportunities and challenges, mainly in higher education (Gómez et al., 2021). Efforts have focused on addressing the capabilities required by students to thrive as effective and responsible participants in a digital society (McGuinness & Fulton, 2019), as well as another disadvantaged group (Guerrero & Mickiewicz, 2022). This chapter conducted an evolutionary review of the literature to investigate the rebuilding of digital capabilities within universities. Concretely, we focused on how universities have had to create, adopt, or modify digital capabilities over time. Our results show that digital competence is an evolving concept related to the development of digital technology and the political goals and expectations of citizenship in a knowledge society (Ilomäki et al., 2016; Guerrero et al., 2021b). We pose the results based on three dimensions: university, teachers, and students.

Following this introduction, the chapter is structured as follows. In Sect. 7.2, we include the theoretical foundations. Section 7.3 explains the methodology of the study. The findings of the study are presented in Sect. 7.4. Finally, Sect. 7.5 provides conclusions and suggests some limitations and future research lines.

7.2 Theoretical Framework

7.2.1 Digital Capabilities

The development of digital competencies has become one of the areas of greatest interest in educational policies worldwide. There is no doubt that today's digital technologies are constantly present in all areas of our daily lives, thanks to the rapid digitization of services and communications (Bormann et al., 2021). Their widespread use of digital technologies has changed how people interact with each other and the world and can separate those born and raised in the digital environment

from those who have had to adapt to the change (Bag et al., 2020). Therefore, people need to develop digital skills to actively participate in education and the labor market concerning the information society. The development of digital skills is multifactorial, and there is a wide debate about the literacy configurations required for full participation in the digital age (Bergdahl et al., 2020).

Some theoretical foundations need to be considered to understand what digital capabilities mean. "Digital literacy" is related to the ability to understand and use information in multiple formats from various sources when presented through computers (Gilster, 1997). Martin (2006, p. 20) extends this definition by including the awareness, attitude, and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, integrate, evaluate, analyze and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, to enable constructive social action; and to reflect on this process (Cortesi et al., 2020). A few years later, the understanding of digital literacy emerged as the ability to read and interpret media (text, sound, images), reproduce data and images through digital manipulation, and apply new knowledge acquired in digital environments (Jones-Kavalier & Flannigan, 2008). Today, the use of digital tools in education gives way to a broader perspective, and one of the necessary changes is digital visualization skills. In this sense, digital competencies related to university courses include new ways of learning and teaching, as well as new ways of designing learning processes, greatly facilitated by the technological tools provided by the Internet (Bergdahl et al., 2020).

With the evolution of the digital technologies (Baird & Henninger, 2011) and policy frameworks (Yáñez-Valdés & Guerrero, 2021, 2022), focusing on the learning process, digital competencies are represented by the ability to use digital technologies as part of the teaching-learning environment (Krumsvik, 2011: pp. 44–45). Therefore, digital competence represents "values, beliefs, knowledge, skills, and attitudes to adequately use technology, both computer technology, and the different programs and the Internet, which allow the possibility of research, access, organization, and use of information to produce knowledge" (Porlán, 2014, p. 201). This approach positions digital competence at the level of those trained in universities and who generate knowledge. More recently, the definition of digital literacy became a multimodal perspective when new devices, and applications, including social networks, began to massify (Tan, 2013). In this respect, Stordy (2015, p. 472) argues that the skills that a person or a social group draws on when interacting with digital technologies derive or produce meaning and the social, learning, and work practices to which these skills are applied. Likewise, digital competencies are used to explore new technological situations, exploit technological potentialities to solve problems, and build collaborative knowledge, fostering awareness of one's own responsibilities and respect for reciprocal rights/obligations (Scuotto & Morellato, 2013). Digital competencies are not isolated skills to be developed but include skills, competencies, and attitudes toward different fields and dimensions of knowledge (Hämäläinen et al., 2019).

To standardize digital competencies, the European Commission proposed a conceptual framework for digital capabilities integrated with four dimensions (Vuorikari et al., 2016): first, *information and data literacy* to articulate information needs and to locate/retrieve data in the digital content; second, *communication and collaboration* to interact, communicate, and collaborate through digital technologies being aware of cultural and generational diversity; third, *digital content creation* to create and edit digital content to enhance and integrate information and content into an existing body of knowledge while understanding how copyright and licensing apply; and four, *security* to protect devices, content, personal data, and privacy in digital environments.

7.2.2 University Digital Capabilities

At the university level, there needs to be more evidence about the evolution of digital technologies on university campuses. Previous literature link university digital capabilities and students' competencies. Concretely, how students are using technologies as a teaching-learning environment where students and professors could interact effectively in the development of specific assignments (Biletska et al., 2021) that directly or indirectly help students to develop digital interpersonal skills (Gui & Argentin, 2011). For instance, technology has provided new ways to enhance new learning opportunities (Gupta & Bhaskar, 2020) by improving student language proficiency, shifting paradigms from teacher-centered to student-centered learning environments, preparing students to enter the digital world, and providing equal opportunities for all students (Hämäläinen et al., 2019).

Digital competencies are continuously changing, so the constant evolution of technologies must be considered, which forces us to maintain a constant process of revision and updating (Purwanto, 2020). Most schools have courses dedicated to students' digital skills or incorporating them into the traditional curriculum. This is necessary because not all young people have experience in using computers or the Internet since, in some regions of the world, there is no access to network connectivity (Dwyer & Gigliotti, 2017). This way, they can become comfortable with new technologies and applications and avoid displacing the most disadvantaged groups. It explains why many universities have transformed their teaching model over the last decades by offering online courses, where students can take classes from anywhere in the world without ever setting foot on campus (Broos & Roe, 2006; Martzoukou et al., 2020).

It has impacted educational outcomes (Caena & Redecker, 2019) where universities have the commitment to "Think Differently" about how digital technologies can best be implemented in the education process and managerial processes (Falloon, 2020; Farani et al., 2017; Caena & Redecker, 2019). Researchers often define student engagement as a concept that includes three dimensions: behavioral engagement, cognitive engagement, and emotional engagement (Bergdahl et al., 2020; Chen, 2018). However, in the context of e-learning, the main characteristic of

e-learning is active collaboration, socialization, learner–student interaction, or learner–teacher interaction, especially through online discussion forum (Dabbagh & Kitsantas, 2012). However, little is known about how universities have rebuilt traditional into digital capabilities (Baran & Correia, 2014; Binali et al., 2021).

7.3 Methodology

To investigate digital competencies in universities, we conducted a thematic review of the literature. To review the articles selected for this study, we used content analysis based on the methodology proposed by Mayring (2019). Content analysis is performed in four steps:

In step one, we focused on the collection of material. The objective of this step is to identify all potentially relevant studies published in academic journals of the Web of Science (WOS) and Scopus. We focused from 2010 to the present to collect information from the last 12 years. Only published articles were selected, where the search criteria were the following keywords: "Capacity," "Digital," and "University."

In step two, we focused on the category of selection. We extracted information from each database to enter them into spreadsheets and thus sorted and analyzed the content. The total number of articles was 282 WOS and 335 Scopus. After eliminating duplicates, we were left with 418 articles that were reviewed and filtered to ensure that the content was oriented to higher education. We also eliminated those articles that did not focus on digital capability. After this review, we retained 109 articles, 52 Scopus, and 57 WOS. It is not surprisingly the pandemic effect in this research line, most of the research has been concentrated in the last 3 years (63%) and mainly published in journals with a higher education orientation (62%), as well as journals with a technological or innovation orientation (48%). It denotes the relevance of digital capabilities for university managers during this decade.

In step three, we focused on the literature evaluation. The selected articles will be read and coded considering three criteria: first, the year of publication, and since one of the objectives is to evaluate the evolution of digital capabilities, it is relevant to divide the articles; second, the focus of each study will be identified, which can be the technology used, the skills developed, the teaching role in the process, barriers, facilitators, among others; and finally, they will be grouped using an evolutionary approach that evidences the changes over time.

In step four, we focused on the descriptive analysis: The content of the analysis will be deployed in a thematic timeline to identify trends and patterns in the evolution of digital capabilities at the university. We base our results on three main dimensions: university, students, and faculty.

7.4 Results

7.4.1 Research Evolution of University Digital Capabilities

Before 2010, research on digital capabilities was based on developing the competencies of students and teachers in a learning dynamic where facilitating elements of education were incorporated. Distance education became a topic for debate due to the scope and limitations associated with the different actors. At the beginning of the decade, there was already a greater consistency and volume of research oriented to integrating competencies, new technologies, and innovation in education. After the 2010, we observe an increase in the number of publications that paid attention on digital capabilities of universities, teachers, and students. Most of these studies have been published in journals related to higher education, teaching-learning environment, and a few on management (Guerrero et al., 2021b).

Table 7.1 summarizes the key research trends related to university digital capabilities. In the following sections, we describe these evolutionary trends per period of analysis (from 2010 to 2015, from 2016 to 2020, and after 2020) as well as per level of analysis (universities, teachers, and students).

Table 7.1 Evolution of university digital capabilities

Level of analysis	2010–2015	2016–2020	After 2020
Universities	Incorporation of online repositories as part of the education system	Increased use of devices and platforms for education Use of digital repositories Digital laboratories	Global closures. 100% online education Classes by zoom or Google meets. Adaptation of educational processes and digital capabilities of the entire community
Teachers	Learning new methodologies Depending on their teaching area, digital skills were more or less necessary	Process of adoption of educational technologies Resistance to change of the more traditional Dealing with students' knowledge to practice as a model.	Digital transformation of teaching practices Learning resources for e-learning Changes in evaluative and relational systems
Students	Limited educational artifacts and platforms The use of technologies is incorporated as an innovation Dependence on teachers	"Digital natives" know a lot about social networks and online communication, but lack defined skills to fit into a digital society	Self-efficacy in learning Autonomy for educational processes Self-regulation of online learning Well-defined digital competencies

Source: Authors

7.4.2 *From 2010 to 2015: A Multidisciplinary View of University Digital Capabilities*

From 2010 to 2015, the university's digital capabilities research focused on two trends. The first trend was adopting a multidisciplinary approach by combining the sociology of education and the technology (Nordahl & Kofoed, 2012). The second trend was focused on understanding digital self-efficacy or confidence in using technologies (Gui & Argentin, 2011; Van Acker et al., 2013). In this regard, research extends by distinguishing digital operational capabilities (skills related to the use of hardware and software), digital information capabilities (skills related to searching, selecting, and processing information on computers and network sources), and digital strategic capabilities (skills related to using computers and network sources to reach particular goals in society)(Van Dijk, 2006). Both research trends, self-efficacy and digital capabilities were fundamental in explaining the scopes and levels of capabilities. This distinction is important because they are related to the potential benefits derived from individuals' engagement with ICT use (Helsper & Eynon, 2013).

At the university level, studies regarding digital capabilities in higher education combine how when with what for? One of the priority issues according to the purposes of digital capabilities is sustainability since this objective will enable future professionals to become agents of change and key leaders (Blewitt, 2010; Guerrero et al., 2021a). For this, it will be important that generic skills and knowledge are coupled with the ability to lead beyond one's own disciplinary or professional authority. Thus, the university must manage students' performance at both a behavioral and interpersonal level. Assessing the capabilities of the education system for the successful introduction and implementation of digital learning programs is of paramount importance if the goals of higher education are to be achieved (Darab & Montazer, 2011). Information technologies have enabled knowledge accumulation and interaction to be increasingly reconfigured, with significant ramifications affecting the processes of knowledge acquisition, communication, and dissemination (Song & Song, 2010). One of the challenges facing universities is the lack of (quality) access to ICT. However, researchers and policymakers shifted their focus to the lack of digital competencies as a major barrier to gaining the benefits associated with ICT use (Van Deursen & Van Dijk, 2016). In addition, the economic potential of distance education and academic globalization increased competition among higher education providers, many of whom operate for profit. The result is an increase in choice for students, leading to increased pressure on universities to control costs and rising tuition. Despite the quality, online programs that cannot successfully adapt to this competitive environment risk failure (Rovai & Downey, 2010). Therefore, the challenges associated with the digitization of universities can be summarized as the reconfiguration of space, time, and responsibility; the individualization of education; the study of educational inequalities; and the educational contexts where technology is used (Selwyn & Facer, 2014).

At the teacher level, in the literature of this period, the concern for training teachers who educate their students about the use of current and emerging digital resources in their own professional practice, but also about how to make their students "able to use technology productively" (Lund et al., 2014, p. 286). Teachers represent role models for their students' use of ICT. "Teaching as preached" will be an important guideline for forming digitized learning environments for pupils and students and assumes that there will be a digitally confident teacher. Likewise, teachers must continuously make pedagogical-didactical judgments based on how ICT can expand the learning possibilities for pupils/students in particular subjects (Krumsvik, 2011). The integration of digital tools into existing pedagogical practice includes the use of blogs, podcasting, or other communication tools in teaching and learning activities teaching and learning activities or the development and use of assessments (Kabakci Yurdakul & Coklar, 2014).

At the student level, there are several competing terms intended to identify a generation of young students now entering universities around the world. Three of the most common terms to refer to them are Net generation, Digital Natives, and Millenials (Gui & Argentin, 2011; Guerrero et al., 2021a). Despite associating young people with digital natives, there are low levels of use and degrees of familiarity with some more advanced technologies and services (Margaryan & Littlejohn, 2008; Guerrero & Urbano, 2021). Students use a limited range of established technologies for learning and another limited range for recreational and social use, so students' attitudes toward learning conform to traditional, teacher-dependent pedagogies (Guerrero et al., 2021b). Regarding specific skills, research has linked self-efficacy to an increased propensity to take risks online and offline, try things out, and learn through trial and error (Shank & Cotten, 2014). On the other hand, higher skill levels are related to greater achievement of positive outcomes and avoidance of negative outcomes from Internet use. What is interesting is that when high self-efficacy is coupled with low skill levels, this could actually hinder people's improvement in skill levels, as it prevents them from understanding what they are doing wrong and causes them to attribute failures to factors beyond their control (Broos & Roe, 2006). In addition, Bayne and Ross (2007) have argued that the persistence of this image of the Net generation or digital native learner has a strong relationship with the logic of the market and corporate culture. It is evident in advertising that these ideas are reinforced by marketing aimed at the education sector (Bayne & Ross, 2007).

7.4.3 From 2016 to 2020: University Digital Capabilities in the Digital Society

From 2016 to 2020, the university's digital capabilities research focused on two trends. The first trend was focused on the definition of digital skills has broadened to include not only the practical and functional skills common in political and IT

discourse but also the critical and evaluative skills more commonly referred to in the pedagogical and media literacy literature (Ilomäki et al., 2016; Guerrero & Urbano, 2021). The second trend was focused on the functional and critical components of digital skills that are essential when incorporating digital skills into the broader study of well-being in increasingly digital societies (Cortesi et al., 2020; Guerrero et al., 2021b). Although these two aspects of skills are often difficult to separate in practice, they should be separated in conceptualizations. This is because having only functional skills (understanding ICT functionalities and being able to use them) is associated with more passive and consumerist participation in digital societies. In contrast, critical skills (understanding how and why technologies are designed and certain content is produced in particular ways) are essential for more active and constructive participation in society (Darvin, 2019).

At the university level, digital capabilities were associated with spreading entrepreneurial culture and behaviors of their students, researchers, and staffs (Wakkee et al., 2019). Moreover, universities introduced digital technologies to establish virtuous circles linking knowledge production through research activities and knowledge dissemination via teaching/learning activities (Klofsten et al., 2019; Guerrero & Urbano, 2021). In this regard, universities incorporated the development of digital capabilities, including technical and operational skills (Helsper & Eynon, 2013; Van Deursen et al., 2016). Likewise, Van Deursen & Van Dijk (2016) distinguished four dimensions of digital competencies: (a) technical and operational, (b) navigation and information processing, (c) communication and interaction, and (d) content creation and production. As a result, the university educational programs reinforce technological teaching-learning environments to enhance digital self-efficacy and confidence unequally distributed according to those in more dominant societal positions, even when this is not reflected in a difference in skill levels (Helsper et al., 2020; Guerrero & Urbano, 2021). While digital self-efficacy was most related to digital learning/engagement, digital capabilities became more important in terms of positive participation and well-being in society (Bergdahl et al., 2020; Guerrero & Pugh, 2022).

At the teacher level, research has shown that students generally require help from teachers to develop the ability to evaluate digital information (Falloon, 2020). Critical evaluation of the information is a skill that needs to be developed, and students need training and instructional criteria to perform evaluations (Harmandaoğlu Baz et al., 2018). Teachers have played an important role in enhancing students' digital capabilities that allow them to evaluate the quality of information; however, there are variations among teachers concerning their technological literality in the teaching (Hatlevik & Hatlevik, 2018). Concerning teachers' digital capabilities, there is a critical notion that teaching professionals face greater challenges than adults working in other sectors (Hämäläinen et al., 2019; Guerrero & Urbano, 2021). The roles of teachers in an online environment differ significantly from their traditional roles in the classroom. Most teachers and professors today do not possess sufficient digital literacy (Wineburg & McGrew, 2016). Equipping teachers with the right tools to efficiently and effectively use the wide range of capabilities enabled by new technologies requires a conceptual redefinition of teacher roles, well-designed

training, and continuous support systems in the learning/teaching process (Guri-Rosenblit, 2019). Little attention is paid to the crucial role of faculty in online environments results in restricted and moderate adaptation of technologies in the higher education (Rosenblit, 2018). New educational trends have emerged to update digital capabilities via long-life learning, such as MOOCs (Guerrero et al., 2021b).

At the student level, the widespread adoption of digital technologies has changed how individuals interact, and differences that distinguish digital natives from their older counterparts are increasingly noticeable (Chen, 2018). University students already possess some digital skills by the time they enter university (Guerrero et al., 2021a). Yet, despite being considered digital natives, many of them are not accustomed to using online learning platforms to study (Bag et al., 2020). The use of these platforms is closely related to technical skills and motivation, which are key factors for student retention and engagement (Feng & Feng, 2021). The problem behind the motivation to learn with technology tools is that there appears to be a disconnect between how students experience and interact with technology in their personal and social lives and how they use technology in their role as learners (Sleeman et al., 2020; Wineburg & McGrew, 2016). Many young students use new technologies for various purposes, such as downloading music files, chatting with friends, playing complex video games, and even preparing PowerPoint presentations. Still, most do not know or are unwilling to study through electronic media (Wineburg & McGrew, 2016). In this regard, it is not enough for university students to simply know how to use the range of mobile devices, software, and media creation tools that exist at any given time throughout their studies at an organization of higher education. They must also be able to acclimate to new digital and develop habits that cultivate the continued mastery of new digital skills, given the rapid pace of technological development (Kirschner & De Bruyckere, 2017).

7.4.4 After 2020: University Digital Capabilities and the COVID-19 Pandemic

After 2020, the research related to university digital capabilities focused on the impacts and challenges derived from the COVID-19 pandemic. In particular, the COVID-19 pandemic forced the faster digitalization of higher education systems worldwide (Guerrero & Pugh, 2022). Despite technological advances (artificial intelligence) and the massification of smart devices, there are several challenges in the digital capabilities development (Makruf et al., 2022; Swartz et al., 2022).

At the university level, several drawbacks and difficulties arose in maintaining hybrid teaching-learning environments due to the students' accessibility, affordability, flexibility, learning pedagogy, lifelong learning, and educational policy (Murgatroyd, 2020). Hybrid learning has been challenging in emerging economies for applicable courses/programs due to the societal restriction (Nortvig et al., 2018; Guerrero & Pugh, 2022) as well as limited access to the most updated technological tools for those students allocated in remote or rural areas limitation the access to

education (Kebritchi et al., 2017). Many emerging economies face substantial online learning problems (Pokhrel & Chhetri, 2021). In this regard, universities adopted/implemented various learning modes using open-access digital platforms to ensure that students can continue to access the education (Muktiarni et al., 2021). In this sense, digital technologies acted as mediators and enablers of higher education learning, as well as evidenced the relevance of digital competencies, skills, or achievements (Hartnett, 2021). As a result of the pandemic, the higher education system has digitalized/updated teaching-learning environments and pedagogies based on the student's needs (Tang et al., 2021). Successful implementation of these methods still relies heavily on students attending face-to-face classes. Successful implementation of learning pedagogies depends on whether students are motivated to use such online learning (Kundu & Bej, 2021).

At the teacher level, research has evidenced the transformation of educational pedagogies and questioned the productivity of the digital teaching-learning environment (Guerrero & Pugh, 2022). Several authors have recognized that digital capabilities have been a bridge that must ensure the university teachers' productivity and technological competency-based students' educational process (Biletska et al., 2021). As a result, the emergence of multiple digital/technological professional competencies (e.g., digital awareness, digital self-criticism, digital objectivity, digital responsibility) demands a continued updating/adapting of curricula, pedagogies, teaching tools, and updated teachers' digital literacy (Vishnevsky et al., 2021; Guerrero et al., 2021b). In many cases, it has represented a disadvantage to the elder teachers' generation with respect to the young teachers' generation (Winter et al., 2021). Many teachers in higher education whose fields rely heavily on processes that use technology may be overwhelmed by the pace of advances and, in turn, have difficulty identifying the digital capabilities needed for their students to master (Huber et al., 2020).

At the student level, research has focused on student engagement, which is considered a prerequisite for online learning and a central component of instruction because of its strength in predicting student retention, achievement test scores, learning, and graduation (Binali et al., 2021; Martin & Borup, 2022). Previous studies have noted that students are likely to engage in online learning when they have a positive perception of active learning when their contributions to learning activities are valued, when they are confident that they can manage their self-regulation and achieve academic success, or when they recognize that their instructors can provide supportive feedback, useful course resources, and opportunities to interact with their peers (Salta et al., 2022). In this vein, researchers have often identified student engagement as a construct composed of three aspects: behavioral engagement, cognitive engagement, and emotional engagement (Salta et al., 2022). However, in the context of online learning, an additional dimension, social engagement, must be incorporated into the construct of student engagement, as a key feature is to foster active collaboration, socialization, as well as student–student or student–teacher interactions (Binali et al., 2021). Likewise, student engagement is hindered by technological barriers relayed to difficult access to own devices, Internet connectivity, technological costs, and lack of technological capabilities (Rahiem, 2021; Guerrero et al., 2021b). Students had problems with incompatible devices,

sharing devices with other family members, unstable Internet connection, restricted or unavailable Internet access, data costs, purchasing new devices, new software or applications, inexperience with digital technologies, and inadequate digital learning platforms (Saha et al., 2021; Yan et al., 2021; Guerrero & Pugh, 2022). Uncertainty, insecurity, volatility, reduced autonomy, and self-direction are typical feelings experienced by learners during the pandemic crisis (Khudaykulov et al., 2022).

7.4.5 Proposed Digital University Capabilities Framework

The research evolution of university digital capabilities has resulted from incorporating new digital technologies as the universities' transformation (Afonasova, 2018) and adaptation to the new socioeconomic paradigms (Guerrero & Pugh, 2022). It is a relevant research line considering the universities' commitment to human capital generation with the professional capabilities required by the labor market. In this process, during the last two decades, it is clear that revised literature reveals that digital capabilities have been impregnated in university activities and main actors (teachers and students). However, Ribeiro (2020) rightly pointed out that this digital transformation demanded several logistical challenges and attitudinal modifications. It has been demonstrated during the COVID-19 pandemic (Bozkurt et al., 2020).

Table 7.2 shows the re-building of digital capabilities by adopting the dynamic capability approach: sensing, seizing, and transforming (Teece et al., 1997; Teece, 2023). The digitalization of universities started with administrative tasks to facilitate interaction with their students (Guerrero et al., 2021b). Even though the evidence of emergent digital capabilities within universities were the MOOCs (Teece, 2018), the most recent external determinant of digital disruption within universities was the COVID-19 pandemic. Therefore, due to the COVID-19 pandemic, universities experimented with a faster and more immediate need for re-building digital capabilities. It represented multiple "opportunities" across university functions (Guerrero & Pugh, 2022). In this context, university managers re-administered the lack of public recourses by collaborating with multiple actors (Ibáñez et al., 2022). Internally, university managers have taken advantage of the pre-existing digital routines and university capabilities (entrepreneurial and innovative) to identify the stakeholders' needs (opportunities) and redefine priorities across university functions, for example, prior experiences in the use of digital technologies in teaching, research, and engagement activities (Guerrero & Urbano, 2021). Consequently, the redefinition of priorities and university strategy provoked the reallocation of available university resources to the specific expected outcomes during this period. The transformation process includes the digital transformation of university functions: teaching, research, and social engagement—likewise, the organizational culture and attitudes across all university communities.

Based on our analysis, we have observed at least four future research lines: First, the use of digital devices in the teaching of digital skills, staying ahead of the curve

Table 7.2 Proposed university digital capabilities framework

	Theme 1: Sensing	Theme 2: Seizing	Theme 3: Transforming
Re-building capability: COVID-19 pandemic	Due to the COVID-19 pandemic, universities experimented a faster and rapid need for re-building digital capabilities. It represented multiple "opportunities" across university functions.	Due to the limited public resources allocated to COVID-19 priorities, university managers re-administered the lack of public recourses via collaborating with multiple actors.	Based on the COVID-19 needs, university managers re-allocate internal and external resources to prioritize the value creation in society.
Re-building capability: Disruptive	University managers have taken advantage of the pre-existing digital routines and university capabilities (entrepreneurial and innovative) to identify the stakeholders' needs (opportunities) and re-define priorities across university functions.	Due to the redefinition of priorities and university strategy, the available resources were re-allocated to the specific expected outcomes during this period.	The transformation process includes the digital transformation of university functions: Teaching, research, and social engagement—Likewise, the organizational culture and attitudes across all university communities.

Source: Authors

is no easy matter (Selwyn & Facer, 2014). Technological devices have increased digital capabilities but also have restricted students' efficiency (Tadesse & Muluye, 2020; Yilmaz Ince et al., 2020). Therefore, future research must be oriented to evaluate the positive/negative impact of digital/technological devices in the learning education process. Likewise, exploring how universities have contributed to the imminently digital capabilities professionalization of current/future generations of university graduates.

Second, the universities' digital capabilities have produced teachers'/students' generations of winners/losers (Guerrero & Pugh, 2022). After the COVID-19 pandemic, we need more evidence about these trends (Younis et al., 2020; Crawford et al., 2020), as well as the talent university management (Martin et al., 2022). Concretely, future research must be focused on how do online or hybrid educational systems produce advantages or disadvantages among university minorities (rural/urban students, elder/young teachers, and poor/rich students).

Third, external stakeholders are a critical influence on university strategies and transformations (Guerrero & Urbano, 2021). During the COVID-19 pandemic, the government's decisions changed the university's strategy and priorities (Winter et al., 2021; Guerrero & Pugh, 2022; Yáñez-Valdés et al., 2023). Likewise, multiple societal actors demanded university support to respond to the health crises. However, little is documented about the multiple collaborations and the role of universities' digital capabilities in these stakeholder collaborations (Siegel & Guerrero, 2021). Future research should consider the influence of universities in developing regional digital capabilities thanks to their collaborations with multiple stakeholders and actors enrolled in the digital ecosystem.

Finally, digital platforms have been unrepresented topic in the evolution of digital technologies in higher education (Guerrero et al., 2021b). Nowadays, there is an emergent research line related digital entrepreneurship platform with multiple opportunities for understanding this phenomenon (Fernandes et al., 2022). In this regard, future research should pay more attention on the providers of university digital platforms and their contribution to rebuilding university digital capabilities.

7.5 Conclusions

Digital technologies are transforming all facets of society, not only in work environments but also in an educational-learning context. In this process, the university has been the protagonist as a trainer of digital skills that will enable individuals to cope with a digital society. The main conclusion of this chapter is that digital capabilities have been impregnated across universities' activities through technological inventions, teaching tools, digital platforms, and devices. It has evidenced several challenges related to digital sustainability, digital inclusivity, and digital self-management that need to be understood by universities, higher education systems, and higher education accreditation organizations. Likewise, the evolution of digital platforms that reinforce university entrepreneurial ecosystems has accelerated the rebuilding of university digital capabilities (Sussan & Acs, 2017; Guerrero et al., 2021b), particularly during the COVID-19 pandemic (Guerrero & Pugh, 2022). Similarly, policymakers should take special interest in promoting digital collaboration with universities to reap the benefits and mitigate the risks of facing a new global crisis without the necessary human capital. Therefore, the re-building of digital skills is the result of an evolution of higher educational systems, as well as the influence of the environment and society for a digital future. It should motivate future research to continue documenting and providing more theoretical/empirical contributions related to how universities are rebuilding digital capabilities.

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Chapter 8
An Empirical Approach

Claudia Yáñez-Valdés, Maribel Guerrero, and Marina Dabić

8.1 Introduction

New digital society paradigms have accelerated the use of digital technologies to respond to societal challenges (Akram et al., 2018; Castro, 2019; Sunkel et al., 2013; Yáñez-Valdés, 2022; Yáñez-Valdés et al., 2023; Ibáñez et al., 2022). However, the adaptation of policy frameworks has shown considerable delay concerning reforms that legitimize their use in multiple socio-economic activities (Yáñez-Valdés & Guerrero, 2021, 2022). During the last decades, the evolution of digital technologies has also transformed multiple higher education administrative functions (e.g., registration process, digitalization of students' profiles), as well as core teaching activities related to new learning opportunities for lifelong learning (e.g., online courses, MOOCs, educational tools) (Navarro, 2020; Guerrero & Urbano, 2021; Guerrero et al., 2021b). Adopting digital technologies, universities have also satisfied the demand for new digital/technological professional competencies (Urbancikova et al., 2017; Afonasova, 2018). However, it is also recognized that

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multiple inequalities have limited the integration of digital competencies into higher education across the globe (Okoye et al., 2022; Sunkel et al., 2013), such as financial constraints, the lack of policies that support open innovation educational resources (Golden et al., 2021). Interestingly, the COVID-19 pandemic intensified the integration of digital technologies into higher education (OECD, 2021).

Inspired by these gaps/inequalities, this chapter explores the university's digital capabilities and how individuals acquire them in Latin America and the Caribbean (LAC) region. In addition, we do a benchmarking analysis between LAC economies' digital capabilities and European economies. Using data from different higher education sources, the findings show that the development of digital capabilities in LAC is linked to increased spending on education due to gaps and inequalities between spending and investment in the higher education (Inter-American Development Bank, 2021; Okoye et al., 2022; European University Association, 2022). Indeed, except for some countries (e.g., Brazil, Colombia, and Mexico), the empirical evidence shows the slow incorporation of digital technologies in higher education systems. Likewise, we provide evidence about the perception of different university managers about the university digital capabilities in the European context.

The following setup is used in the chapter. In Sect. 8.2, we first include the theoretical foundations related to university digital capabilities. In Sect. 8.3, we describe our methods of analysis. Section 8.4 describes the results related to the LAC case and some benchmarking analysis with European universities. Section 8.5 discusses implications for various stakeholders and concludes.

8.2 Theoretical Framework[1]

Based on the literature review presented in the previous chapter, we found that modern higher education systems have been focused on providing updated skills demanded by the labor markets, including digital literacy, creativity, citizenship, self-education, lifelong learning, and absolution (Okoye et al., 2022; Urbancikova et al., 2017; Guerrero & Urbano, 2021). There is a lack of consensus about what digital capabilities mean. A few studies have understood the skills as individual or social group uses when interacting with digital technologies to derive or produce meaning and the social, learning, and work practices to which these skills are applied (Stordy, 2015). Although the emergence of research about university digital capabilities, previous studies have recognized three drivers of the integration of digital capabilities into higher education:

(a) The first driver has been the new generational cohorts of students: the digital natives (Guerrero et al., 2021a). All digital natives have demanded a new

[1] An in-depth theoretical review is presented in Chap. 7. To avoid theoretical duplicities, please consult it for further details.

teaching-learning environment that integrates enhancing learning via digital tools, devices, and skills, given their expectations/experiences (Bag et al., 2020).

(b) The second driver has been the global demands/trends in the technological and digital sector during the last two decades (Guerrero & Urbano, 2021). Employers demand higher education professionals with digital competencies (Paredes-Chacín et al., 2020).

(c) The third driver has been the digital trends in the higher education sector by the emergence of online educational platforms (Guerrero et al., 2021b), as well as external shakeouts such as economic crises and pandemics (Guerrero & Pugh, 2022).

Previous studies have recognized the retard in integrating digital transformation into universities across countries (Golden et al., 2021). Anecdotal findings have revealed discrepancies between those who have and do not have access to new information and communication technologies (Hawash & Lang, 2020; Van Dijk, 2006). This digital gap has been evident among minority social groups, generational cohorts, and diverse economies (Van Dijk, 2017; Guerrero et al., 2019). The main digital challenges in these groups are related to improving multicultural integration, reducing dropout rates, facilitating smooth transitions from educational programs to first jobs, and implementing flexible and relevant lifelong learning processes (Bozkurt et al., 2020; Williamson et al., 2020). Consequently, it is necessary to know more about how universities have impregnated digitalization as part of all their core activities, the use of particular types of digital tools or infrastructures across these activities, as well as the potential outcomes captured from the university's digital capabilities.

8.3 Methodology

8.3.1 Contextualization

Latin America and the Caribbean (LAC) comprise four regions with a predominant Spanish language: South America, Central America, the Caribbean, and Mexico. As with any emerging economy, the LAC region faces multiple socioeconomic challenges in poverty, undernourishment, unemployment, lack of investment in education and health, and social inequalities (Justino et al., 2003; Molyneux, 2002). In terms of education, access to higher education continues to be a focus in the region due to its significant progress in participation with gross rates more than doubling since the mid-1990s (Inter-American Development Bank, 2021). Consequently, we have observed an increment in the number of universities, and higher education programs demanded clear public policy reforms, students loans, and scholarships. One of the critical problems faced by the LAC universities in the region is that a high percentage of students enter the educational system, but they do not finalize their studies. Concretely, failure to graduate from higher education programs

restring the opportunities of the young population for better economic and labor conditions, social mobility, and well-being (UNESCO, 2020). It also explains the lower levels of high-skilled human capital (Huđek et al., 2019).

Despite these challenges, the LAC region has a high life expectancy at birth and good literacy rates, especially in comparison with Africa and Asia (Bilal et al., 2021; Paprotny, 2021). Post the COVID-19 pandemic, the LAC's GDP was expected to grow by 2.3% in 2022 and 2.2% in 2023, with most countries reversing GDP losses from the pandemic crisis. However, these modest projections place regional performance among the lowest in the world (World Bank, 2022). Likewise, during the pandemic, social protection measures prevented a further increase in poverty and extreme poverty. For instance, the participation of disadvantaged groups (young, women, ethnic, and migrants) in the formal labor market considerably decreased in the last 3 years (World Bank, 2022; Guerrero & Mickiewicz, 2022). Given the social distance restrictions, digital connectivity was vital to maintaining daily activities in the LAC region. However, the most updated empirical evidence shows deepened structural digital inequalities that affect access to social protection, health, and education (CEPAL, 2021a, b). Given these unique particularities, it is important to analyze the case of university digital capabilities in the LAC region, as well as to benchmark with the most digital advanced regions like Europe.

8.3.2 Methodological Design

To analyze university digital capabilities, given the limited available information, we consult public reports/data developed by well-recognized organizations. In the LAC context, we revised the most updated statistics about digital capabilities published by the World Bank, and the OECD, as well as the most recent reports focused on higher education digitalization sponsored by the Inter-American Development Bank (2021)[2] and UNESCO.

Regarding benchmarking with the European university digital capabilities, we use data from the European University Association (2022) survey.[3] The European

[2] Methodological note: The survey was developed by HolonIQ's Impact Intelligence Platform and consisted in a stakeholders survey plus in-depth interviews higher education leaders in the LAC region. Three organizations from 14 countries in LAC were represented in the survey. Over half (53%) were from Brazil, followed by Colombia (14%), Mexico (8%), and a broad spread of organizations from Argentina, Chile, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Perú, and Uruguay. However, we did not have access to the full dataset. Based on the available information in the report, we discussed some relevant findings. For further details, review Inter-American Development Bank (2021, p. 5).

[3] Methodological note: The survey was divided into five sections comprising 32 open-ended, ranking, multiple and single-choice questions covering a wide variety of topics related to digital capabilities at universities. The survey was open from May 4 to June 28 2021. It was preceded by a pilot phase involving six organizations of different sizes, profiles and geographical locations. This study obtained 166 valid responses from organizations in 28 European countries. Concretely, of the total

University Association (EUA) survey captures relevant components involved in the rebuilding of university digital capabilities (e.g., digital transition areas, support/challenges in the digital transition, success measures, and others). We have access to the open responses provided by the survey participants, as well as additional statistical analysis obtained from the dataset (Kozirog et al., 2022). Likewise, we revised other reports about the digitalization of teaching and learning in European higher education (Gaebel et al., 2021).

8.4 Results

8.4.1 University Digital Capabilities in the LAC Region

According to the OECD (2016), the LAC region is ranked significantly lower (18.63) than the average of the digital industries development index of OECD countries (33.54), North America (43.21), and Western Europe (35.75). Regarding Internet penetration, the LAC region is ranked in the top four of the world's highest users. However, there are still significant differences among countries in the LAC region (e.g., Mexico reaches a similar rank to the United Kingdom and Korea), with more than 300 million LAC people still needing access to the Internet (OECD, 2016). Consequently, the LAC region generally has lower digital technology adoption rates due to the high price, which is among the world's highest, so organizations are restricted from requiring or incorporating digital delivery in the teaching and learning process (CEPAL, 2021a, b).

In the LAC region, the demand for the higher education system has grown exponentially over the past two decades. For instance, Brazil, Chile, Colombia, and Venezuela have led the increase in the university enrollment rate with a growth of more than 30 percentage points in the last 15 years. In this regard, the UNESCO director in the LAC region states:

> LAC [UNESCO Director]: "We still have a long road to travel before having universal access to higher education in Latin America and the Caribbean. This is despite the fact that access has more than doubled in two decades". (Inter-American Development Bank, 2021, p. 10)

According to the study developed by the Inter-American Development Bank (2021), it is possible to access the opinion of LAC university managers, leaders, and stakeholders regarding digitalization. Most interviewees recognized the temporality of the higher education hybrid system because face-to-face ensures higher education quality. Concretely, their opinions are the following:

166 responses, 134 are from EUA members, and 32 from non-member organizations. For further details, review European University Association (2022, p. 12).

> Brazil [CFO]: "Face-to-face is important in the student's education process, but we will format different products to suit this new reality, like the hybrid model, there will be no going back for students." (Inter-American Development Bank, 2021, p. 7)
>
> Brazil [Dean]: "The most impactful trend is a high-quality distance education model, with great interaction, with a more personalized learning experience, the usual degree combined with micro degrees." (Inter-American Development Bank, 2021, p. 13)
>
> Colombia [Dean]: "We are lacking a pedagogical structure that aligns to a new reality post-pandemic, where the student is not quite close to universities as they used to be." (Inter-American Development Bank, 2021, p. 15)

Undoubtedly, the digital ecosystem conditions in LAC have influenced the higher education digital/technological transition (Castañeda-Trujillo & Jaime-Osorio, 2021; Manturuk & Reavis, 2022). It explains why, with a few exceptions (Brazil, Colombia, and Mexico), the limited digital/technologies capabilities in the LAC higher education systems, gaps in the STEM careers (CEPAL, 2021a, b), and limited resources/infrastructures. According to the interviews developed by the Inter-American Development Bank (2021), LAC universities should re-think their integration and collaboration within the global/regional/local ecosystem actors for improving higher education public policies, the interconnectivity, support the learning-process, and explore market segments that have been ignored (e.g., life-long programs):

> Colombia [Vice Chancellor]: "We should leverage what the pandemic brought. It brought a socially complex topic, questioning the role of universities in the change and support of learning and re-thinking the ecosystem at regional and global level." (Inter-American Development Bank, 2021, p. 6)
>
> Colombia [Vice Chancellor]: "Before the pandemic we were strengthening tech infrastructure and multi- modality. We worked with the Ministry of Education to register online programs. These initiatives supported the implementation of remote learning." (Inter-American Development Bank, 2021, p. 22)
>
> Colombia [CEO]: "The educational organizations that have not managed to update themselves will unfortunately disappear. As many sectors will continue to evolve, I think that the biggest change will be lifelong learning." (Inter-American Development Bank, 2021, p. 12)
>
> Mexico [IT Director]: "Beyond being a traditional organization, we are becoming a platform where we connect our students, alumni, we want to integrate this network of collaborators and become a hub for interconnectivity." (Inter-American Development Bank, 2021, p. 8)

Independently, the university struggles to update programs to ensure relevance to the evolving workforce and student needs (Cueva Gaibor, 2020). However, given the COVID-19 pandemic, the LAC higher education system evidenced digital equality and quality challenges provoking the highest university students' dropout rates over the last decade (CEPAL, 2021a, b). The abrupt university campus closure forced the prioritization of a gradual digitalization transition in university operations and core activities (Guerrero & Pugh, 2022). In this regard, the interviews developed by the Inter-American Development Bank (2021) reveal the problems faced by students in disadvantaged connectivity conditions:

> Brazil [Dean]: "It is always possible to do better, to reach a new phase of what we call data-driven. It is necessary to have patience and persistence, collecting data and improving the student's journey is essential." (Inter-American Development Bank, 2021, p. 16)

> Brazil [CFO]: "Due to COVID, there were drastic changes in the process of enrolment, retention, and student learning processes. Everything must be 100% online and integrated with technologies that we weren't prepared for. We want to help our students with a quality remote experience." (Inter-American Development Bank, 2021, p. 23)

> Mexico [Senior Executive]: "Many students have unstable connections or devices that can't support some technology or platform. We have to make it accessible." (Inter-American Development Bank, 2021, p. 11)

At the organizational level, although the forced transition learning experiences online ensured the continuity of educational processes (Bormann et al., 2021; Biletska et al., 2021; Darling-Hammond et al., 2021), the situation evidenced the lack of basic digital capabilities in many LAC universities' communities (staff, teachers, and researchers), the lack of satisfaction of stakeholders' digital skills needs (students, business, governments, society), and the lack of digital pedagogical teaching-learning experience/environments (Baran & Correia, 2014; Caena & Redecker, 2019; Hodges et al., 2020; Hodges & Fowler, 2020). In this regard, several stakeholders involved in the LAC higher education organizations mentioned the importance of re-building university digital capabilities by focusing on the culture and the mentality of change among the university community. Concretely,

> Brazil [CFO]: "I see discussions of digital transformation where the focus is on technology rather than culture, which is not the case. To implement real Digital Transformation, it must be built from the inside out." (Inter-American Development Bank, 2021, p. 21)

> Colombia [Dean]: "It' s not about having the latest technology or buying devices - digital transformation starts with mentality and it should be to transform the educational organization." (Inter-American Development Bank, 2021, p. 18)
> Ecuador [Director]: "To be able to serve in the digital revolution 4.0, we need 5.0 universities, faculty and staff." (Inter-American Development Bank, 2021, p. 28)

> Argentina [Vice Chancellor]: "We need to learn about global trends and understand what are other organizations are doing. We need to generate networks with professors that are evolving, support them and provide reassurance that this is scalable." (Inter-American Development Bank, 2021, p. 29)

The digital transformation of university capabilities in the LAC region also depends on policymakers' hand-design public frameworks. Although most governments have promoted incentives for fostering university–industry digital and innovation competences (Guerrero et al., 2019), the higher education authorities are still facing highest levels of failure and problems related to the retention of students. It implies the implementation of appropriate support for reducing educational gaps, such as grants and mentoring. Indeed, it is crucial to connect the higher education system and changing world of work. Similarly, 14 LAC countries have offered massive training programs to strengthen the digital competencies of university teachers, promote the effective use of IT tools during the design of virtual courses, mitigate the negative impact on the quality standards of higher education, and improve the quality standards of higher education (UNESCO, 2020). However, there is a global competition with better value-added and reduced costs (Inter-American Development

Bank, 2021). Therefore, it demands a collaboration strategy with the main platforms, universities, governments, and employers. Finally, the new socio-economic paradigms have increased the demand for occupations related to the digital economy. It also has demanded structural changes in the job market and new credentials updating higher education competencies (Dahlman et al., 2016; Navarro, 2020; Orishev & Burkhonov, 2021; Okoye et al., 2022). Therefore, a strategic shift in the LAC region could be the development of new credentials when the "learners" have access to short, flexible, and specialized content. In this regard, universities need closer alignment with the workforce in the LAC region (Inter-American Development Bank, 2021). It demands the recognition of these new higher education credentials by both higher education systems and employers.

8.4.2 University Digital Capabilities in the European Region

According to the European University Association (2022, p. 39), due to the prioritized digital policy agenda in the European Union (e.g., artificial intelligence, cybersecurity technologies, big data, and digital infrastructures), most European university managers optimistically consider that innovation capabilities have allowed them to achieve a leadership position in the digital transition characterized by interdisciplinarity strategy covering teaching-learning, research, governance, and incentives for staffs. Relevant outcomes derived from the European university's digital capabilities strategy have been captured by the increment of digital innovation solutions promoted with partnerships, addressing new curriculums, and digital transformation of local industries and public services (see Kozirog et al., 2022). It is important to mention that these outcomes have been possible to multiple enablers (e.g., qualified staff, sufficient funding, interdisciplinarity, and infrastructure) that have allowed universities to overcome digital challenges (e.g., technological upgrades, hired digitally skilled staff, and cybersecurity). Nevertheless, regional heterogeneity also matters in this analysis. The data also reveals the non-optimistic perception of university digital capabilities among some participants due to rigid structures, global competitiveness, ethics, and dependency on the United States and China that reduce the opportunity in Europe to be technological leaders instead of followers. Particularly, the respondents explained:

> P12: "Only some EU countries (e.g., Finland, Sweden, Denmark, the Netherlands) have the potential for global competitiveness in digital innovation, while the USA, China (Hong Kong) are much further ahead in the field of digitalization (USA in the IoT). That is, the EU has the potential to be one of the leaders, not a world leader in this area."

> P32: "Although the efforts in the European system of higher education, there some countries' political structures are rigid and do not promote digitalization within universities."

> P133: "The current focus on data and the ethics of data in Europe is certainly a good step in the direction of university digital leadership, but the other regional powers (the USA and China, particularly) are not idle and even have the leadership today. One of the main challenges, in my opinion, is the difficulty of educating and then hiring highly skilled people in

> the digital domain. The other one is a dependency on Asia for manufacturing of the hardware. Europe has today a good position in the embedded systems domain. It should also try to reinforce and build upon this leadership position. Europe should (and does) focus on decentralized solutions to break free of the mostly American digital platforms and foster a diverse higher education ecosystem. Education of the EU citizens about digital and data skills are a major challenge and lever to gaining a digital leadership position."
>
> P139: "Greater emphasis on the adaptability and flexibility of knowledge transfer intra-institutionally, inter-institutionally, and with startups and enterprises. Emphasis on the human dimensions within the digital transition."
>
> P148: "Europe is a follower, not a leader, in this field, and GDP will cause additional problems to AI innovation and attraction of big companies."
>
> P152: "Data protection (as important as it is in the first place) prevents many possible and fast transitions, this may put Europe at a disadvantage in digital leadership. Bureaucracy and slow administrative processes block innovative ideas."

According to Gaebel et al. (2021, pp. 9–10),[4] most interviewed European universities institutionalized a digitalization learning and education strategy led between central university units and faculty-based digital units. Although the COVID-19 pandemic accelerated digitalization in 2020, most universities started the digital transition in 2014 by implementing new communication/collaboration tools, ways of teaching, an online library, and managerial processes. Likewise, directly or indirectly, the regional digitalization policies have fostered digital governance and budgets to support university digital capabilities focusing on data protection, prevention of plagiarism, cyber security, ethics, and intellectual property. Today, the managerial rebuilding process of university digital capabilities faced three main barriers: lack of staff, lack of external funding opportunities, and difficulty devising a concerted approach in the entire university as an organization. Similarly, the strategic teaching-learning priorities focus on new learning-teaching methods, international collaboration with other universities, and outreach provision of international students.

8.4.3 University Digital Capabilities Framework

University digital capabilities are a relevant socio-economic development driver in the LAC region. Although the limited available data at the university level, considerable efforts have been done by multiple higher education associations (UNESCO, European University Associations) and well-recognized sources of public statistics

[4] This report maps the situation regarding digitally enhanced learning and teaching at European higher education universities over the past 7 years and is mainly based on data from a survey conducted between April and June 2020 via an online questionnaire to organizational leadership. Concretely, the response rate was 368 higher education organizations' leaders with a significant and a representative number of European countries. Although we did not have access to the dataset of this study, we have interpreted the trends included in the report. For further information, revise Gaebel et al. (2021).

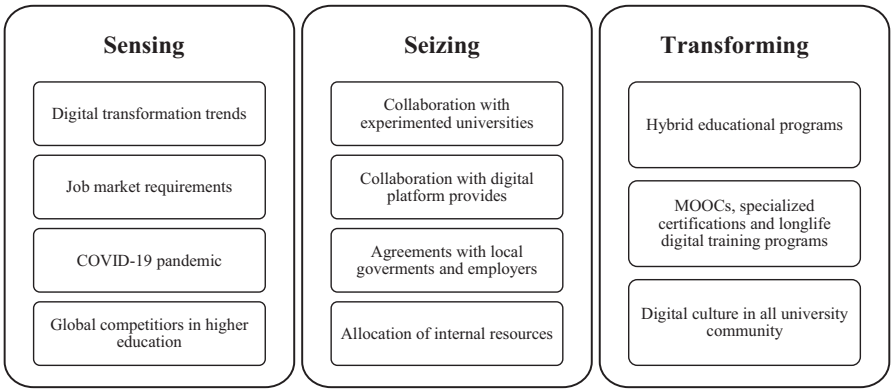

Fig. 8.1 Re-building digital universities' capabilities. (Source: Authors)

(World Bank, the Inter-American Development Bank) to provide some insights about this relevant theme for policymakers, university managers, and academics. Thanks to their datasets and publications, this chapter has analyzed how LAC universities have tried to define a pathway to rebuild digital capabilities.

Given the available information, it took a lot of work to identify the re-building process of university digital capabilities. Figure 8.1 shows the components related to each dynamic capability (Teece, 2018, 2023; Teece et al., 1997). The sensing of teaching digital opportunities was due to external conditions (technological trends, high-skilled job market needs, the COVID-19 pandemic, and global competitors). Given the necessity of a rapid response, seizing was mostly focused on accessing resources via collaborations and internal sources to transform the teaching model into a hybrid, certifications, and cultural change.

We also identified several challenges that have affected the re-building process and that need to be considered to enable university digital capabilities. It represents gaps that need to be considered for further research. For example:

(a) *Equal digital teaching-learning access*: The highest prices and poor technological/digital infrastructures in LAC economies have significantly increased the educational gaps for disadvantaged students during the pandemic. Affordability is one of the obstacles to expanding digital services in the LAC region. Higher education systems and policymakers in the LAC region should address this barrier through public policy frameworks and investing (Inter-American Development Bank, 2021). A good practice observed in the European region has been aligning the digital agenda, universities initiatives, and societal priorities by generational cohorts (Guerrero & Martínez-Chávez, 2020; Guerrero et al., 2021a; European University Association, 2022). For university managers, covering this challenge is crucial across the sensing, seizing, and transforming processes of this university's digital capability, as well as other as sustainability (Teece, 2018, 2023; Teece et al., 1997).

(b) *Digital capacity-building across universities*: There are several universities in the LAC region with strong experience and outstanding outcomes associated with digital capabilities (Inter-American Development Bank, 2021). Given the limited resources in most universities, an interesting practice for enhancing digital capabilities is exchanging digital experiences via university digital collaboration projects (Bukhari et al., 2021), as well as open digital resources for students (Castro, 2019; Paredes-Chacín et al., 2020; Orishev & Burkhonov, 2021). For university managers, covering this challenge is crucial across the seizing processes of this university's digital capability, as well as innovation and entrepreneurship (Teece, 2007, 2018, 2023; Teece et al., 1997, 2016).

(c) *Leveraging digital partnerships and ecosystems*: The university stakeholders demand a reconceptualization of the digital university model by providing innovative digital solutions, supporting SMEs' digital transformation process, and implementing flexible educational offers according to the digital workforce needs (Inter-American Development Bank, 2021; World Bank, 2022). It implies leveraging digital partnerships/communities with domestic/foreign agents involved in the digital innovation ecosystem (Guerrero & Pugh, 2022), including higher educational digital platforms (Guerrero et al., 2021b). This development is essential for operating in the digital economy (Urbancikova et al., 2017). For university managers, covering this challenge is crucial across the sensing, seizing, and transforming processes of this university's digital capability, as well as sustainability, innovation, and entrepreneurship (Teece, 2007, 2018, 2023; Teece et al., 1997, 2016).

(d) *Digital openness and inclusive societies*: The accelerated and disrupted digitalization due to the pandemic has produced winners/losers among different sectors (Bozkurt et al., 2020; Siegel & Guerrero, 2021). Still, these positive/negative effects have radically changed due to the most recent socio-economic conditions that need to be addressed to progress in the fight against poverty and social tensions (World Bank, 2022). The aftermath of the COVID-19 crisis will take years to fade if the LAC region does not take immediate action to kick-start a slow recovery process, with poverty at its highest level in decades. Long-standing challenges in infrastructure, education, innovation, and spending efficiency must be met with policy reforms that also address the effects of climate change and take advantage of the enormous opportunities for growth on the path to more sustainable economies (Darling-Hammond et al., 2021; Hodges & Fowler, 2020). For university managers, covering this challenge is crucial across the sensing, seizing, and transforming processes of this university's digital capability, as well as sustainability (Teece, 2007, 2018, 2023; Teece et al., 1997, 2016).

Behind each university's digital challenges is an interdisciplinary research opportunity to extend the theoretical/empirical understanding of the digital transformation pathways of the university capabilities, especially documenting pre/post-effects of the COVID-19 pandemic. In this regard, the universities have a tremendous opportunity for restructuring the socio-economic conditions in the LAC region.

8.5 Conclusions

The progress of digital technology has been accompanied by socially positive and negative results, such as excluding a significant part of the world's population from the benefits of digitization. This occurs primarily because their incomes do not allow them to have quality access to devices, fixed connection at home, and the capacity for daily use. This unresolved balance between the benefits and costs of digitization is occurring in an adverse global context due to the COVID-19 pandemic, which presents several challenges and opportunities (Audretsch et al., 2022).

This chapter provides a few insights into the rebuilding of university digital capabilities. The LAC region is seeking a balance that will allow them to take advantage of the benefits of digital technologies and a digital society (CEPAL, 2020). Indeed, several European universities are also faced with similar challenges (OECD, 2021). Therefore, the digital capabilities of professionals trained in universities must be addressed from a multidisciplinary perspective with a special focus on multiple public–private collaborations (Ibáñez et al., 2022).

To move forward on university digital capabilities, it is imperative to implement clear strategies in the digital, social, and economic spheres to develop cross-cutting tools to overcome barriers and gaps. Addressing the challenge of digital inclusion means not only considering physical accessibility but also ensuring the right to develop skills and promote digital citizenship while leaving no one behind. In addition to taking digital technologies into account in social policies, overarching goals need to be integrated into digital policies and investments in new technologies. We hope this chapter inspired more researchers to extend the research on this topic.

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Part V
Re-building University Sustainability Capabilities

Chapter 9
A Theoretical Approach

Matías Lira, Maribel Guerrero, and Marina Dabić

9.1 Introduction

Over the last two decades, we have observed multiple policymakers and academics debate the societal challenges and the contribution of different socioeconomic agents to achieve them. One of these agents has been the universities due to their strong territorial presence and outstanding socio-economic contributions (Guerrero et al., 2015, 2018, 2020). Particularly, the relevance of a sustainable orientation within the university strategy takes a strong interest after the proclamation of the United Nation's Sustainable Development Goals (SDGs) (Fini et al., 2018; Guerrero & Lira, 2023) and COVID-19 pandemic (Siegel & Guerrero, 2021; Guerrero & Pugh, 2022).

As quality assurance is mandatory in the higher education system, therefore, education for sustainable development was integrated within as part of the strategy, curriculum and provide indicators that allow its measurement and implementation

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(Von Der Heidt & Lamberton, 2011). Integration of sustainable capability within the university was elusive for the entire university community (staff, students, academics, researchers) and offers opportunities to impregnate a sustainability orientation across university values, traditions, and disciplines (Sammalisto et al., 2015). As a result, many sustainable initiatives developed by university partnerships emerged for including solutions; integrating sustainability into the curriculum; integrating sustainability in all operational, strategic, and outreaching sustainable principles (Barber et al., 2014). Consequently, these sustainable initiatives have shown the importance of cultural change in sustainability integration, as well as the role of university capabilities in this process (Adams et al., 2018).

This chapter revises the existing literature from 2010 to 2022 to understand the research evolution of sustainable capabilities within universities. Our findings reveal the active university transformation from "the unsustainable model" to "the sustainable model." Particularly, our content analysis of the literature review shows patterns related to the influence of university stakeholders on the configuration of sustainable capabilities within universities through curricula and partnerships. Several implications associated with university contribution to sustainable public policy frameworks are also highlighted in this chapter. After this introduction, the remainder of this chapter is structured as follows. Section 9.2 includes the foundations of university sustainable capabilities. Section 9.3 details methodological content analysis and literature review. Section 9.4 explains the research evolution about university sustainable capabilities. Section 9.5 presents the conclusions and future research lines.

9.2 Theoretical Foundations

9.2.1 University Sustainability Capabilities

University sustainability capabilities have been understood in the context of university curricula. For instance, de Lange (2013) argues that academic literature has focused on defining sustainability approaches/paradigms by configuring a university curriculum; consequently, the need to develop multiple sustainability capabilities within universities. In this view, according to Thomas and Day (2014), university sustainability capabilities are mainly associated with the discussion of abilities, attributes, competencies, and skills that are the learning outcomes. Therefore, several academic approaches have identified several capabilities related to sustainability, such as awareness of sustainable development, including the knowledge/skills/values toward social justice, equity, and diversity (Thomas & Day, 2014, p. 221).

Another group of academic scholars has understood university sustainability capabilities as the result of working with the university community (alumni, faculty, staff, and students), as well as their wider stakeholder community (government, employers, civic organizations, enterprises, non-profit organizations) toward the achievement of the SDGs such as reducing poverty, protect the planet, and others (Purcell et al., 2019). In this context, universities are considered change agents that

should rebuild their ordinary capabilities into sustainable capabilities. It demands multiple resources, strategies, partnerships, and actors involved in this organizational transition. However, to the date, it is not clear how university sustainability capabilities are defined, configured, and developed.

9.3 Methodology

To investigate how universities have rebuilt their sustainable capabilities, we conducted a thematic review of the literature based on a content analysis adopting the four steps proposed by Mayring (2019) as follows:

In step one, we focused on collecting relevant studies published in academic journals of the Web of Science (WOS) and Scopus from 2010 to 2022.[1] The section criteria were keywords: "Capacity," "Sustainable," and "University."

In step two, we created a spreadsheet with the outcome of the initial search: 350 WOS and 521 Scopus publications. After eliminating duplicates and unrelated sustainable capability publications, our final sample includes 193 publications to be revised in-depth.

In step three, we focused on reviewing and coding the publications to identify the research evolution of university sustainable capabilities. An initial insight is the concentration of the publications 2015 (70%), denoting the influence of the SDGs on the university's sustainable capabilities.

In step four, we focused on content analysis by identifying the thematic trends and patterns in the evolution of sustainable capabilities at the university.

9.4 Results

9.4.1 Research Evolution of University Sustainability Capabilities

Table 9.1 shows the distribution of the research on sustainable university capabilities.

Regarding the area of knowledge, the concentration of publication has been specialized journals in the intersection between education and sustainability (e.g., *International Journal of Sustainability in Higher Education, Environmental Education Research, and Journal of Environmental Education*), as well as in sustainability (e.g., *Journal of Cleaner Production, Journal of Environmental Studies*

[1] This analysis period is important considering 5 years before and after the Sustainable Development Goals were set up in 2015 by the United Nations General Assembly with the intention to be achieved by 2030.

Table 9.1 University sustainability capabilities research trends 2010–2022

Area	Journal	Times	Year	Publications
Business & Economics	*Business and Society Review*	1	2010	1
	Contemporary Economic Policy	1	2011	9
	Ecological Economics	1	2012	5
	Journal of Business Ethics	1	2013	16
	Transformations In Business & Economics	1	2014	8
Education	*Education and Training*	2	2015	19
	Education Sciences	2	2016	9
	Higher Education	2	2017	16
	Studies in Higher Education	2	2018	27
	International Journal of Management Education	1	2019	33
	Higher Education Policy	2	2020	32
	Journal of International Education in Business	1	2021	10
	Journal of Applied Research in Higher Education	1	2022	8
Education + Sustainability	*International Journal of Sustainability in Higher Education*	49	Total	193
	Environmental Education Research	1		
	Journal of Environmental Education	1		
Management	*Journal of Management & Organization*	2		
	Journal of Organizational Change Management	2		
	R & D Management	2		
Public Management	*Australian Journal of Public Administration*	1		
	Science and Public Policy	2		
	Journal of Public Budgeting Accounting & Financial Management	2		
Sustainability	*Journal of Cleaner Production*	41		
	Journal of Environmental Studies and Sciences	4		
	European Journal of Sustainable Development	4		
	International Journal of Ecosystems and Ecology Science	4		
	Sustainability	51		
	Environment Development and Sustainability	5		
Technology & Innovation	*Technological Forecasting and Social Change*	1		
	International Journal of Innovation and Sustainable Development	2		
	International Journal of Innovation	1		

Source: Authors

and Sciences, European Journal of Sustainable Development, Sustainability and Environment Development and Sustainability).

Regarding the year of publication, the trend reveals that more than 70% of the publication is concentrated after the 2015 United Nations General Assembly, where the Sustainable Development Goals were published.

Table 9.2 University sustainability capabilities top 12 publications 2010–2022

N	Authors	Title	Journal	Year	Cites
1	Lozano et al.	Declarations for sustainability in higher education: becoming better leaders, through addressing the university system	*Journal of Cleaner Production*	2013	501
2	Trencher et al.	Beyond the third mission: Exploring the emerging university function of co-creation for sustainability	*Science and Public Policy*	2014b	223
3	Lozano	The state of sustainability reporting in universities	*International Journal of Sustainability in Higher Education*	2011	210
4	Leal et al.	Sustainable Development Goals and sustainability teaching at universities: Falling behind or getting ahead of the pack?	*Journal of Cleaner Production*	2019	150
5	del Mar Alonso-Almeida et al.	Diffusion of sustainability reporting in universities: current situation and future perspectives	*Journal of Cleaner Production*	2015	144
6	Wiek et al.	Integrating problem- and project-based learning into sustainability programs. A case study on the School of Sustainability at Arizona State University	*International Journal of Sustainability in Higher Education*	2014	131
7	Fonseca et al.	The state of sustainability reporting at Canadian universities	*International Journal of Sustainability in Higher Education*	2011	128
8	Wright	University presidents' conceptualizations of sustainability in higher education	*International Journal of Sustainability in Higher Education*	2010	121
9	Trencher et al.	University partnerships for co-designing and co-producing urban sustainability	*Global Environmental Change-Human and Policy Dimensions*	2014a	120
10	Ralph & Stubbs	Integrating environmental sustainability into universities	*Higher Education*	2014	116
11	Trencher et al.	Co-creating sustainability: cross-sector university collaborations for driving sustainable urban transformations	*Journal of Cleaner Production*	2013	102
12	Beynaghi et al.	Future sustainability scenarios for universities: moving beyond the United Nations Decade of Education for Sustainable Development	*Journal of Cleaner Production*	2016	102

Source: Authors

Table 9.2 shows the top 15 cited publications in the analyzed period. The most referenced authors are Lozano et al. (2013), Trencher et al. (2014a, b), Lozano (2011), Leal et al. (2019), and del Mar Alonso-Almeida et al. (2015). These authors have delighted the foundations about the sustainable declaration of university managers, the link between the third mission and sustainability, and the sustainable-teaching orientation. Importantly, these top 12 publications have mainly concentrated in the *Journal of Cleaner Production* and the *International Journal of Sustainability in Higher Education*.

9.4.2 *University Orientation and Sustainability Capabilities*

The content analysis revealed the link between university governance and sustainability (see Table 9.3). As an organization, universities have a significant socially sustainable commitment as change agents in their communities (Lozano et al., 2013). This literature review shows that, before the public announcement of the Sustainable Development Goals (SDGs), many worldwide higher education systems had recognized the imperative urgency to integrate a sustainable agenda into universities' strategy (Lozano & Young, 2013).

Table 9.3 University orientation and sustainability capabilities

First-order code	Second-order code
Universities act as sustainable change agents in their local and regional communities	Sustainable change agents
Higher education systems are increasingly recognizing the critical role in integrating social sustainability commitments in their strategies	
Many universities are aware of their impact on the environment	Sustainable awareness
In some countries it is imperative that universities measure and report on their campus greening efforts	
University sustainable awareness for publicizing efforts and outcomes	
Many universities publicly endorsed sustainability-related goals and values	
Universities are oriented to become more green, more friendly to environment, and sustainable campuses	
Sustainability performance is introduced in the education, research, operations, governance, and community engagement indicators	Sustainability orientation
Sustainability should be implicitly considered as normative standards within universities	
The most barriers of adopting a sustainable orientation within universities are financial problems, lack of understanding and awareness of sustainability issues among staff, students, and researchers	
Quality assurance is mandatory for adopting a sustainability orientation	
Many sustainable-oriented universities have taken on the role of disseminating knowledge, values, attitudes, and behaviors conducive to sustainability	

Source: Authors

The universities' sustainable awareness was focused on endorsing sustainable-related goals, values, and green campuses efforts (Soini et al., 2018). However, after September 2015, many universities were imperatively oriented toward contributing to the three dimensions of sustainable development: economic, social, and environmental (Leal et al., 2019). By introducing the SDGs, a new successful sustainable development strategy should be impregnated in universities' missions, strategies, and engagement with the community (Peer & Stoeglehner, 2013). Concretely, university managers designed strategies by core activities:

(a) *At the university governance*, the impregnation of sustainable values has been addressed via university capabilities and translated into shared visions, objectives, competencies, and actions (Peer & Stoeglehner, 2013).
(b) *At the teaching level*, training university professors to apply sustainability criteria in their respective disciplines was essential to catalyze students' sustainability engagement (Zamora-Polo & Sánchez-Martín, 2019).
(c) *At the research level*, universities have disseminated/transferred knowledge, values, attitudes, and behaviors conducive toward sustainability research projects (del Mar Alonso-Almeida et al., 2015).
(d) *At the community engagement level*, universities collaborate with government, industry, and civil society to advance the sustainable transformation of a specific geographic area or social subsystem (Trencher et al., 2014a, b). This translates into an effort to reach across campus boundaries to create partnerships to drive an urban sustainability transformation by co-creating sustainable initiatives (Lozano, 2011).

University governance can do more to meet the Sustainable Development Goals (SDGs) when strategically working with the university community (faculty, staff, students, alumni, researchers), stakeholders, and society (Beynaghi et al., 2016). Thus, sustainable-oriented universities can help accelerate the achievement of the SDGs, enabling other actors to contribute more fully to sustaining the economic, environmental, cultural, and intellectual well-being of our global communities (Leal et al., 2019; Zamora-Polo & Sánchez-Martín, 2019). Advancing sustainability through social collaboration and various functions such as education, research, and outreach will increasingly become a core mission for universities (Brusca et al., 2018).

The most significant obstacles to building sustainability capabilities are financial problems, lack of understanding and awareness of sustainability issues among the university population, and resistance to change (Jorge et al., 2015). The problem is often the lack of willingness of leadership, policymakers, and decision-makers to envision a sustainable future within the universities (Holmberg et al., 2012). Without the support of a university's top management, bottom-up sustainable initiatives seem destined to fail in the long run for lack of investment and administrative support (Ávila et al., 2017). Even if higher education organizations declare themselves sustainable and publicly uphold the related goals and values, the commitment needs to be reflected in the vision, mission, and graduate attributes of the business faculties/schools of the same organizations, training professionals with sustainable capabilities (Lee et al., 2013).

9.4.3 University Stakeholders and Sustainability Capabilities

The growing concern about excessive resource consumption, environmental degradation, and social inequality has led to calls for a transition to a more sustainable economy and society (Shi & Lai, 2013). It accelerated multiple debates on organizations' disclosure of social and environmental indicators (Ralph & Stubbs, 2014). Given the social mission and engagement, public/societal agents expect universities to meet the needs of their multiple stakeholders (Yáñez-Valdés et al., 2023; Holm et al., 2015; Wright, 2010). In this way, universities have been involved in fostering sustainability influenced by their stakeholders' needs and debates. In this way, the university strategy contributed to achieving societal challenges (Purcell et al., 2019). Universities must synergistically integrate multiple stakeholders' opinions to address the "learning holistically for sustainability" approach (Ralph & Stubbs, 2014).

By considering the factors that influence individuals' pro-sustainable behaviors (e.g., procedures of knowledge, social incentives, economic incentives, warnings/reminders), the new sustainable/green university model focused on helping students, alumni, and companies to become more sustainable (Levy & Marans, 2012; Trencher et al., 2014a, b). Students at so-called "green universities" are more committed to their university if it is presented as environmentally friendly than non-green universities (Dagiliūtė et al., 2018). Consequently, to infer the current level of environmental performance and translate targets into societal progress, higher education systems started to measure/report greening efforts to the community in universities have embedded (Townsend & Barrett, 2015) (Table 9.4).

Critical factors that enable universities to undertake the transformational changes necessary to integrate environmental sustainability into all universities' localities include a strong policy environment, resourcing strategies, and encouragement of environmental sustainability of local leaders and advocates (Ralph & Stubbs, 2014; Trencher et al., 2014b). In this way, universities address global environmental challenges, as their education, research, and community engagement can produce lasting environmental impacts and social change (Fischer et al., 2015). Thus, universities are increasingly advancing sustainability at local, regional, and national scales through cross-sector collaborations (Trencher et al., 2014a). This "co-creation for sustainability" function could be interpreted as the germ of an emerging new mission for the university (Trencher et al., 2014b). Some outcomes of university sustainability initiatives have been the co-design and co-produce sustainable urban areas, as well as public policy interventions (Jones & de Zubielqui, 2017). Universities also have encompassed the co-creation of new sustainable technological prototypes in collaboration with local enterprises to transformation more sustainable natural environments (Orecchini et al., 2012; Purcell et al., 2019).

Table 9.4 University stakeholders and sustainability capabilities

First-order code	Second-order code
The social and public on climate debate pushed universities to sustainability and reporting that they are contributing to the needs of a range of stakeholders	Social/public stakeholders debate on climate challenges
Ecology, environmental awareness, but also from politics, ethics, and even spiritual approaches claimed the university's participation in the construction of this concept of the subject	
Universities refocused their strategies due to the SDGs by working with faculty, staff, and students, as well as their broader community of stakeholders and the alumni body	United Nation SDGs
Each university was positioning sustainability as an intentional and aspirational strategy, with sustainable development and the SDG framework being a means to achieve it. University leadership was the key to success in acting with a shared purpose	
Growing concerns about excessive social inequality	Stakeholders debate about societal challenges
Democratization of knowledge and innovation to society	
Helping to create new ways of life by educating the world's citizens	
Critical role in addressing societal challenge through education, research, and community involvement	
Partnerships within and with universities can help accelerate the achievement of the SDGs, enabling higher education to contribute more fully to sustaining the economic, environmental, cultural, and intellectual well-being of our global communities	Co-creation sustainable partnerships
The potential outcomes of university initiatives to co-design and co-produce urban sustainability are not limited to knowledge and policy. Universities also encompass the creation of new technological prototypes, enterprises, and new socio-technical systems, as well as transformations of the built and natural environment	
Universities move beyond campus boundaries to form partnerships with government, industry, and civic organizations to drive urban sustainability transformation. We refer to this emerging and possibly new academic role as "co-creation for sustainability"	
Universities collaborate with government, industry, and civil society to advance the sustainable transformation of a specific geographic area or social subsystem by "co-creation of sustainability initiatives"	

Source: Authors

9.4.4 University Curricula and Sustainability Capabilities

Education for sustainable development poses new challenges for universities. Faculty and staff are expected to prepare students to deal with society's complexities and take responsibility for sustainability, which scientists urgently call for today (Adams et al., 2018). Thus, the role of individual change agents and the human dimension, in general, are increasingly recognized as critical elements in the integration of sustainability in higher education organizations (Aznar et al., 2011). Several universities around the world have created new courses and degrees or

modified existing ones in response to the growing interest of companies in recruiting sustainability graduates (Alghamdi et al., 2017). Education for sustainable development specifically involves course design and delivery, using theories of teaching and learning and linking course objectives, delivery, and assessment (Lozano et al., 2015).

Integrating sustainability into the formal curriculum has been the greatest challenge for all universities knowledge areas (Aznar et al., 2011). For example, business schools have been perceived as key socializing agencies for the intelligence of advanced capitalist societies. At the same time, sustainability students must be helped to critique the dominant capitalist paradigm and consider its alternatives (Von Der Heidt & Lamberton, 2011). University sustainability improves education, research, operations, governance, and community engagement (Shi & Lai, 2013; Sayed & Asmuss, 2013). In this way, universities generate sustainability leaders and drivers of change that must effectively ensure that the needs achievement of present and future generations (Alghamdi et al., 2017). Consequently, by educating students of "all ages," universities contribute to the transition from "traditional models" to "sustainable societal models" (Gamage & Sciulli, 2017; Lozano et al., 2013) (Table 9.5).

9.4.5 University Sustainability Capabilities Framework

This chapter reveals academic insights into how universities are helping to shape new ways to understand and contribute to a sustainable world by tracking the grand societal challenges via teaching, research, and stakeholder engagement. Based on these insights, Table 9.6 shows the proposed model to understand the re-building process (sensing, seizing, and transforming) of sustainable university capabilities (Teece et al., 1997, 2016; Teece, 2023). This model covers two different periods, which could also vary by geography and time.

Before the publication of the United Nation's SDGs, the big societal challenges represented the main source of sensing opportunities. In this vein, universities experimented with multiple pressures or demands for contributing to these issues. Therefore, the sensing process of looking for opportunities was specifically oriented to climate challenges. As a result, university managers started to impregnate all university functions, as well as develop several collaborations with societal actors and governmental agencies, allowing access to external resources. In addition, university managers allocated an internal percentage of the university budget to research, infrastructure, and teaching competencies. Preliminary insights about the transformation process revealed several research outcomes as well as certain innovations for reducing the impacts on preserving sustainability. Indirectly, the intention was also included in fostering sustainable values across the university. After the publication of the United Nations' SDGs, universities have experimented with multiple pressures or demands for contributing to these issues. The sensing process of looking for opportunities was specifically oriented to advance in those related to

Table 9.5 University curricula and sustainability capabilities

First order-code	Second order-code
To address sustainability goals, the "learning for sustainability" approach was integrated into all aspects of university operations synergistically	Sustainable capabilities
Education for sustainable development poses new challenges for universities, where faculty and staff are expected to prepare students to deal with the complexities of society and take responsibility for sustainability, which scientists are urgently calling for today	
The integration of sustainable development as a core competence of the university is elusive for the entire university. Interpretive flexibility offers opportunities to discuss the concept of sustainability in diverse academic traditions in different disciplines	
A sustainability educational approach consists of courses designed using theories, methodologies, and learning environments oriented to understanding the importance of sustainability and how to contribute to meeting societal goals	
An emergent need to evaluate how university curricula address sustainable development has increased over the last decade	Sustainability curricula
The challenge of integrating sustainability into the formal curriculum has been greatest across knowledge areas' curricula. For example, business schools have been perceived as key socializing agencies for the intelligentsia of advanced capitalist societies. At the same time, sustainability students must be helped to critique the dominant capitalist paradigm and consider its alternatives	
Several universities around the world have created new courses and degrees, or modified existing ones, in response to growing corporate interest in hiring sustainability graduates	
University sustainability assessment frameworks are gaining popularity as more and more universities demonstrate leadership in combating climate change and pursuing sustainability	

Source: Authors

Table 9.6 Proposed university sustainability capabilities framework

	Theme 1: Sensing	Theme 2: Seizing	Theme 3: Transforming
Re-building capability: big societal challenges	Due to the big societal challenges, universities have experimented with multiple pressures or demands for contributing to these issues. The sensing process of looking for opportunities was specifically oriented to climate challenges. In this regard, university managers started to impregnate all university functions	Several collaborations with societal actors and governmental agencies allowed access to external resources. In addition, university managers allocated an internal percentage of the university budget to research, infrastructure, and teaching competencies	The transformation process generated several research outcomes as well as certain innovations for reducing the impacts on preserving sustainability. Indirectly, the intention was also included in fostering sustainable values across the university
Re-building Capability: the United Nation's SDGs	Due to the United Nations' SDGs, universities have experimented with multiple pressures or demands for contributing to these issues. The sensing process of looking for opportunities was specifically oriented to advance in those related to higher education (reducing education gaps, gender gaps, and socioeconomic development). In this regard, university managers started to impregnate all university functions	Several collaborations with societal actors and governmental agencies allowed access to external resources. In addition, university managers allocated an internal percentage of the university budget to inclusion and equality. At the same time, university managers have been compromised to provide transparency, accountability, and sustainable management of resources	Due to the lack of information, the transformation process evidences preliminary outcomes in innovations for reducing gender gaps and contributing to socioeconomic development. Indirectly, the intention was also included in fostering sustainable values across the university

Source: Authors

higher education (reducing education gaps, gender gaps, and socioeconomic development). In this regard, university managers started to impregnate all university functions. As a result, collaborations with socio-economic actors allowed access to external capabilities and resources needed in the seizing process. At the same time, university managers have been compromised to provide transparency, accountability, and sustainable management of resources. Due to the lack of information, the transformation process evidences preliminary outcomes in innovations for reducing gender gaps and contributing to socio-economic development. Indirectly, the intention was also included in fostering sustainable values across the university.

The SDGs' goals have influenced universities' strategies in pursuit of sustainability. Although there are recognized significant capabilities development efforts via education, several gaps among university dimensions are also evident. For example,

(a) First gap in the literature is related to university governance and sustainability orientation approach. Intuitively, previous research has recognized several outcomes that require a sustainability orientation within university governance. However, little is known about the pathways adopted by university managers/leaders to introduce a sustainability orientation, to measure benefits/conflicts of incorporating this sustainability orientation, as well as to identify successful/failed strategic distribution of resources/capabilities for achieving the sustainability orientation goals.
(b) Second gap in the literature is related to the impregnation of the sustainability orientation approach within higher education evaluation systems. Intuitively, we have observed several rankings that have included metrics to evaluate the university resources and outcomes for achieving the sustainability orientation goals. It implies the interplay between university efforts and its contexts. Not all universities are homogenous because they are allocated in contexts with different sustainability needs, as well as they have other availability of resources and interaction with local/country stakeholders.
(c) Third gap in the literature is related to the lack of theoretical/empirical studies that help to understand the university sustainability contribution per each core activity: teaching, research, and social engagement. Future research should focus on proposing theoretical frameworks with operational metrics to understand the inputs, outputs, and outcomes per university core activity.
(d) Fourth gap in the literature is related to an inverse relationship between university sustainability capabilities and public policy frameworks. It implies a clear understanding of the sustainability ecosystem and the positive/negative/inverse relationships among the actors who promote sustainability in the city/region/country.

We hope these identified gaps inspire future research to extend the current knowledge about university sustainability capabilities.

9.5 Conclusion

A sustainability approach has transformed how organizations and policymakers define their strategies and actions. Given societal engagement, universities have adopted their facets, strategies, and activities toward a sustainability orientation. It has repressed an interesting pathway in achieving big societal challenges (Audretsch et al., 2023; Guerrero & Lira, 2023) such as ambidextrous organizations (Guerrero, 2021). The accumulated research has considerably increased after the publication of the sustainable development goals. However, it is still known about the real returns of the university in sustainability measures. Likewise, the need for understanding the strategic and managerial process to impregnate a sustainability orientation among all university dimensions demands more theoretical and empirical studies. Therefore, we hope this chapter motivates future research to extending theoretical/empirical contributions related to how universities are rebuilding sustainability capabilities.

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Chapter 10
An Empirical Approach

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10.1 Introduction

The sustainable orientation within the university strategy takes a strong interest due to the big societal challenges and the proclamation of the United Nation's SDGs (Guerrero & Lira, 2023). The accumulated literature has evidenced significant advances in the participation of universities in developing sustainable capabilities (Von Der Heidt & Lamberton, 2011). Before the publication of the SDGs, the theoretical and empirical studies evidenced the university's contribution toward sustainability via sustainable solutions, technological advances to reduce the climate effects, and curricula. After the publication of the SDGs, the research patterns revealed the sustainability relevance in governance, strategic planning, and university functions (Barber et al., 2014; Adams et al., 2018; Sammalisto et al., 2015). However, the lack of information about each indicator has represented an effort of multiple organizations to collect data. Due to the availability of information, this study explores the sustainable transition in European universities and North

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American universities. This chapter shows insights into the university's sustainable transformation patterns and metrics using data from the European University Association (EUA, 2022) and the Sustainable Campus Index (AASHE, 2021). Preliminary insights reveal how university managers have impregnated a sustainable approach to developing new university capabilities (Teece & Leih, 2016; Teece, 2023).

The chapter is structured as follows. In Sect. 10.2, the theoretical framework is described. In Sect. 10.3, the methodological design is described. In Sect. 10.4, the findings are analyzed and discussed. In Sect. 10.5, the concluding remarks and implications are described.

10.2 Theoretical Framework[1]

Based on the literature review analyzed in the previous chapter, universities have a significant socially sustainable commitment as change agents in their communities (Lozano et al., 2013; Lozano & Young, 2013) through sustainable awareness focused on endorsing sustainable goals, values, and green campus efforts (Soini et al., 2018). University managers should develop abilities to achieve sustainable development at the economic, social, and environmental levels (Leal et al., 2019). Prior studies (Peer & Stoeglehner, 2013; Guerrero & Lira, 2023) have evidenced that successful sustainable strategy should be impregnated in universities' missions, strategies, and engagement with the community. Considering it is difficult, university managers should adopt an entrepreneurial and innovative view (Teece et al., 2016; Teece, 2023) by introducing sustainability actions into university daily activities, such as the reduction of negative climate effects (Peer & Stoeglehner, 2013), the improvement of students' understanding via curriculum (Zamora-Polo & Sánchez-Martín, 2019), the generation of innovative solutions to community problems (del Mar Alonso-Almeida et al., 2015), and the community engagement with government, industry, and civil society (Trencher et al. 2014a, b).

10.3 Methodology

We adopted the qualitative approach for exploring the transition toward sustainable capabilities within the European and North American universities. Regarding the European context, the data came from the European University Association (EUA) Survey[2] that survey captures the different patterns adopted in the transition toward

[1] An in-depth theoretical review is presented in Chap. 9. To avoid theoretical duplicities, plese consult it for further details.

[2] Methodological note: The survey was divided into five sections comprising 32 open-ended, ranking, multiple and single-choice questions covering a wide variety of topics related to innovation at

sustainable capabilities, as well as preliminary metrics. The EUA survey collects information from 166 organizations in 28 European countries. We focused on the open responses provided by the survey participants, as well as additional statistical analysis obtained from the dataset (European University Association, 2022; Kozirog et al., 2022). Regarding the North American context, the data came from the Sustainable Campus Index[3] developed by the Association for the Advancement of Sustainability in Higher Education (AASHE). We focused on the performed scores by impact area, as well as additional organizational highlights (AASHE, 2021). Based on these sources of information, we defined the components related to the re-building of sustainability university capabilities.

10.4 Results

10.4.1 Re-building of European Universities Sustainability Capabilities

Based on the analysis of the qualitative data provided by the European University Association (2022), except for 10% of the participant universities that do not recognize any sustainable transition, we identified three patterns adopted by 90% of the participant universities in transition toward the development of sustainability capabilities.

The first pattern, *the link between research functions and sustainable capabilities,* was adopted by 17% of the participant universities. Internally, the top three elements that contributed to the sustainability transition were (a) developing new technologies through university research activity (89%), (b) improving student and staff understanding of sustainability (82%) and (c) improving student and staff competence to innovate (64%). Externally, the top three elements that contributed to the sustainability transition were (a) improving social acceptance of new technologies (71%), (b) changing production processes in various industries (68%), and (c) contributing to nature conservation (54%). Consequently, based on the perception of the participants, the best-ranked performance metrics were the number of granted

universities. The survey was open from 4 May to 28 June 2021. It was preceded by a pilot phase involving six organizations of different sizes, profiles and geographical locations. This study obtained 166 valid responses from organizations in 28 European countries. Concretely, of the total 166 responses, 134 are from EUA members, and 32 from non-member organizations. For further details, review European University Association (2022, p. 12) and (Kozirog et al., 2022).

[3] Methodological note: Top Performer scores are based on performance at the time of the Sustainability Tracking, Assessment and Rating system report submission. Top performers in each impact are were determined based on the percentage of applicable points earned within the relevant category: air & climate, building, campus engagement, coordination and planning, curriculum, diversity and affordability, energy, food and dining, grounds, investment and finance, public engagement, pursing, research, transportation, waste, water and well-being. For further details, review AASHE (2021, p. 66).

patents, the number of sustainability spin-offs, the development of solutions and sustainability partnerships. According to the open questions, the participants explained the university departments involved in this transition, the challenging experiences in the transition, as well as the link with European environmental initiatives as follows:

P89: "The main promoters of the transition are: Vice rectorate in innovation, Vice rectorate in sustainability, Institute of environmental science and technology, Centre of research in agricultural, Centre for ecological research and forestall applications, Research groups in several faculties (e.g., Geography, chemistry, sociology, etc...)."

P102: "It is not easy to identify specific solutions developed (other than patents in some areas). Some examples are: Improved designs and efficiencies for wind and wave energy devices; Improved management of national and regional water resources; Authorship contributions to reports of UN Intergovernmental Panel on Climate Change, projections, mitigations; and Towards reduction of Greenhouse gas emissions resulting from agriculture and land use. Work towards solutions is possible only because of deep disciplinary expertise that is fostered by basic research."

P140: "At the European level, we are running a Proof of Concept program, the evaluation and implementation phases of which already include an overview on societal and environmental impact. In our view, environmental issues are of key importance, yet the depth of analysis is not fulfilling that of impact studies."

The second pattern, *the link between teaching functions and sustainable capabilities,* was adopted by 19% of the participant universities. Internally, the top three elements that contributed to the sustainability transition were (a) improving student and staff understanding of sustainability (91%), (b) developing new technologies through university research activity (81%), and (c) reducing the environmental impact of existing university infrastructure (69%). Externally, the top three elements that contributed to the sustainability transition were (a) improving social acceptance of new technologies (59%), (b) changing consumer behaviors in society (50%), and (c) contributing to nature conservation (50%). Consequently, based on the perception of the participants, the best-ranked performance metrics were the number of students/graduates of sustainability educational programs, the development of community solutions, and sustainability partnerships. According to the open questions, the participants explained the university departments involved in this transition, the challenging experiences in the transition, as well as the link with European environmental initiatives as follows:

P29: "The focal point for the implementation of university strategy of innovation for a sustainable transition is the inter-disciplinary center. At the departmental level, the most relevant experiences are: the Department of Environment, earth and physical sciences coordinates the transversal subject in sustainability and hosts the Bachelor in Natural and Environmental Sciences and the Master in Ecotoxicology and Environmental Sustainability. The Department of Economics and Statistics hosts the master in Economics for the Environment and Sustainability. The Department of Biotechnology, chemistry and pharmaceutical sciences hosts the Master in Sustainable Industrial Pharmaceutical Biotechnology."

P52: "The main effort of university is that of prioritizing basic skills for ALL OUR STUDENTS. In fact, a transversal subject offered to all our students covers sustainable development goals and practices. Every single department develops its own additional priorities. The most relevant ones are in the following fields: environmental protection,

equality, gender balance, tolerance, no-hate, professional ethics and sustainable development, sustainability and management, better organizations at the local, national and supranational levels."

P90: "At the European level, several research staff, especially from the Faculty of Education, where the departments are focused on natural sciences (geography, biology, ecology, chemistry) participate in various assessments that deal with environmental impact studies. Conferences and workshops on these topics are also organized at the university, and final theses on these topics, including those on climate change, are also commissioned."

The third pattern, *the link among teaching, research, and sustainable capabilities,* was adopted by 54% of the participant universities. Internally, the top three elements that contributed to the sustainability transition were (a) developing new technologies through university research activity (94%), (b) improving student and staff sustainability competencies (92%), and (c) improving student and staff understanding of sustainability (91%). Externally, the top three elements that contributed to the sustainability transition were (a) improving social acceptance of new technologies (72%), (b) improving citizen/stakeholder involvement in innovation activities (68%), and (c) changing production processes in various industries (67%). Consequently, based on the perception of the participants, the best-ranked performance metrics were the number of granted patents, the number of sustainability spin-offs, the development of solutions, the number of students/graduates of sustainability educational programs, and sustainability partnerships. According to the open questions, the participants explained the university departments involved in this transition, the challenging experiences in the transition, as well as the link with European environmental initiatives as follows:

P67: "The promoters are Vice Rectorate for Communication and Culture, Vice Rectorate for Strategy and Digital Education, Vice Rectorate for Students and Equality, Vice Rectorate for Studies, Vice Rectorate for Scientific Policy, Vice Rectorate for Teaching Staff, and Vice Rectorate for Institutional Relations and Sustainable Development."

P131: "They are strongly linked, In many different ways. All students undertake research projects as part of their degrees, many have an innovation or applied research component. In-curricular education will often draw on case studies from innovation activities. Students engage with internship opportunities in research labs or with partners. Our most successful innovations are based on very strong fundamental research foundations. Many of the staff teaching our students are involved in innovation activities and connect them to the taught curriculum. Many of our graduates from undergraduate programs go on to masters or doctoral work that connects to innovation."

P159: "The University adapts scientific and technological developments and results that help to use physical resources in an efficient and sustainable way. Through education, research and innovation activities, the University contributes to new results, and works to increase the commitment of future generations. Uni delivers also various research and innovation activities and participation in cooperation related to sustainability and environmental protection (international project for the easier handling of nuclear waste, project for the development of an energy-efficient electrolysis process using water and carbon dioxide and offering a solution for storing electricity in the form of gas, Sustainable Green Chemistry and Mobility Competence Center, etc.)."

10.4.2 Re-building of North American Universities Sustainability Capabilities

In the North American context, the Association for the Advancement of Sustainability in Higher Education (AASHE, 2021) has implemented the Sustainable Campus Index to recognize top-performing colleges and universities overall and in 17 sustainability impact areas: air & climate, building, campus engagement, coordination and planning, curriculum, diversity and affordability, energy, food and dining, grounds, investment and finance, public engagement, pursing, research, transportation, waste, water, and well-being. In addition, this index includes innovative and high-impact organizational highlights and recognizes organizations with exceptional report accuracy and quality. Our analysis focused on similar areas identified in the EUA survey.

First, the university's climate sustainability impact (air, climate, energy, transportation, and waste) this indicator is measured by the university's impact on the reduction of greenhouse gas emissions assessment (AASHE, 2021, pp. 5, 17, 32, 34). It reveals how university managers have implemented several actions to measure the university's impact. The top universities listed in this area have considerably reduced their annual emissions (approx. 112,000 metric tons of CO_2 equivalent) via business travel, purchasing of goods, fuel, and energy, promoting sustainable transportation, and waste respect to all listed universities.

Second, the university infrastructures sustainability impacts (buildings, grounds, water). This indicator is measured by the university's impact on the reduction of potable water, maintenance, and operations (AASHE, 2021, pp. 7, 21, 36). The top universities listed in this indicator have sustainably renewed green buildings, certified constructions, and implemented a green cleaning policy based on multi-attribute rainwater management and green cleaning systems.

Third, the university governance sustainability impacts (coordination and planning, diversity and affordability, investment and finance, well-being), this indicator is measured by the university's impact on implementing sustainable governance, sustainable finances, enhancing diversity, and affordability (AASHE, 2021, pp. 11, 15, 23, 39). The top universities listed in this indicator have sustainably contributed to impregnating sustainable planning and sustainable use of resources, as well as impacting organizational diversity and well-being.

10.5 Conclusions

This chapter provided insights into the university's sustainable transformation patterns and metrics using data from the European University Association (EUA, 2022) and the Sustainable Campus Index (AASHE, 2021). Preliminary insights revealed how university managers had impregnated a sustainable approach to sensing, seizing, and transforming capabilities via teaching, research, and social engagement

(Teece et al., 1997; Teece & Leih, 2016; Teece, 2023). The main conclusion of this chapter is showing the complementary contribution of entrepreneurial, innovative, and digital capabilities during the university managers' transition to sustainability capabilities. The main limitation of this study is the need for developing surveys that help us capture the transition process in geographical space and time. Longitudinal analysis is required to understand internal organizational transformations and the university managers' decision-making process behind each sustainable strategy and metric. Future research needs to extend the rigor of data collection and the contribution of the emergence of university capabilities.

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Part VI
Concluding Remarks

Chapter 11
Concluding Remarks

Maribel Guerrero and Marina Dabić

11.1 Conclusions

The book entitled *Re-building University Capabilities: A Public Policy and Managerial view Applied to Innovation and Technology* aims to, in five parts and 10 chapters debate, comprehend, and exchange views on how policies and practice frameworks related to science, innovation, and technology have influenced and rebuilt numerous universities' capabilities. This book sheds light on this topic by highlighting the challenges faced by universities seeking to become more entrepreneurial and the moves made by policymakers striving to cultivate environments in which entrepreneurial attitudes and behaviors are competently designed, developed, and supported.

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11.1.1 Public Policy and Managerial View

Many public policy reforms have occurred in the higher education sector over the last few decades due to reduced resources, stakeholder pressure, educational trends, and socio-economical changes.

Chapter 1 of the book explores how public policies have radically altered the ways in which universities are organized and modified from the inside. Universities and their governance structures should strive to transform into entrepreneurial ambidextrous organizations in response to pressure from stakeholders and higher education public policies. Looking ahead, the three gaps that business and university stakeholders identify pertain to issues related to higher education public policy objectives. Universities must work to improve gender and ethnic diversity, close gaps in employment opportunities, and focus on mental health awareness. Colleges should be equipped with a variety of technical abilities, including those related to artificial intelligence, hybrid learning environments, and other technical capabilities that fill gaps in the curriculum. With governance trends in mind, universities should adapt their fundraising strategies in light of their significant reliance on public money and the rising demand for alternative funding sources. Consequently, the governance, missions, and outcomes of the organization should encompass a variety of competencies.

A thorough analysis of the ways in which university capabilities are rebuilt across higher education systems should be performed, as geographic contexts and time are both critical elements. Chapter 2 identifies the reasons why the theoretical and empirical work published in this field of study requires further research. It also provides examples of the ways in which university capacities in various geographic locations have been rebuilt. It is also important that we understand the competitive pressures that university administrators must contend with when deciding which specific or supplementary university capabilities they should fund. The remainder of the book discusses how to rebuild the four university capabilities (entrepreneurial, innovative, digital, and sustainable capabilities) using both theoretical and empirical methods. University managers require specific capabilities to support each stage of a university's transformation. These capabilities require further examination. This book outlines how university managers and leaders have developed specific capabilities to successfully address university transitions (entrepreneurial, innovative, technological, and sustainable). Trends evident in the higher education industry are also discussed, along with the roles that university administrators need to play to realize them.

11.1.2 University Entrepreneurial Capabilities

Due to their significant contribution to regional economic growth, universities have received sufficient attention in academic literature on entrepreneurship. This is because of their organizational qualities, which enable them to be both producers of ideas and promoters of the kind of entrepreneurial thinking that makes it possible to start new businesses. Scholarly literature, however, still needs to be more thorough when outlining how contextual factors and stakeholders influence university capabilities, allowing them to generate and manage entrepreneurial initiatives, despite the abundance of studies that address the relationship between universities and entrepreneurship. Because of this, this book posits that entrepreneurial qualities, such as constructing, capturing, linking, and integrating, are all affected by the university's stakeholders and its context. These conclusions are drawn from a comprehensive evaluation of 152 publications published between 2000 and 2022. We demonstrate cause-and-effect links between works of literature on entrepreneurship, universities, and entrepreneurial capacities, supporting our claim using logical, inductive, and abductive reasoning.

This book seeks to assess how stakeholders and contexts affect a university's ability to develop and manage entrepreneurial ventures, while simultaneously addressing other academic discussions on entrepreneurship and innovation. To do this, we have identified four key entrepreneurial competencies that universities incorporate into such processes. Consequently, based on the findings of our systematic literature analysis, we can make the following two conclusions. The first conclusion relates to how contexts and stakeholders affect a university's entrepreneurial capacity. Chapter 3's findings established what universities should do to take advantage of their entrepreneurial capacity. The chapter identifies four entrepreneurial competencies—capturing, connecting, building, and integrating—that enable universities to create and oversee entrepreneurial activities, based on our thorough literature study. Understanding these competencies is vital, as they reveal how entrepreneurial traits can be acquired, changed, and adapted to respond to the demands and opportunities of contexts and stakeholders. However, it is worth noting that universities were not designed to be factories for entrepreneurship. Therefore, examining universities in light of the four suggested capabilities could provide insights into how they use knowledge to launch businesses that aid social and economic advancement.

Using the dynamic capabilities approach, the exploratory research in Chap. 4 sought to fill in the knowledge gap with regard to our understanding of how entrepreneurial talents are imbued within organizations. We have studied how these entrepreneurial qualities are formed and how they evolve, as well as whether contexts and stakeholders significantly impact upon this evolution. Two conclusions can be drawn based on the data analyzed for Belgium, Colombia, Ecuador, and Uganda. We initially conclude that stakeholders and contexts impact upon universities' entrepreneurial potential. According to prior research in this area, socioeconomic and cultural backgrounds affect how individuals and organizations who

exhibit entrepreneurial behavior feel about themselves. Universities use their dynamic capabilities to gather and analyze contextual data, resulting in opportunities that are then taken advantage of using entrepreneurial capital (which is available within the organization). Our findings are consistent with existing scholarly literature. We enhance that organizational-level factors facilitate a better understanding of national and regional policies. These policies can be viewed as opportunities to take advantage of commercial entrepreneurship (such as the Bayh–Dole Act and similar policies) and social entrepreneurship (such as the Sustainable Development Goals). Our research demonstrates how contexts and policies impact entrepreneurial orientation on a personal level, whereby people identify business possibilities through matchmaking and pursue these goals through commercial entrepreneurship pathways—just as social ventures formed in university settings are partially influenced by the social challenges of the setting, which has also been demonstrated in previous studies. The second result discussed in Chap. 4 relates to advancing entrepreneurship capabilities in higher education. According to our findings, entrepreneurial capital development often reflects the effects of dynamic capacities. As a result, our findings also demonstrate that the availability of such entrepreneurial capital determines a university's capacity for entrepreneurship. The results of this chapter are consistent with prior academic research on entrepreneurship and innovation, which shows that dynamically capable firms are more competitive because they are better able to adjust to develop their competitive nature.

11.1.3 University Innovation Capabilities

Chapter 5 stressed the importance of university innovation capabilities in meeting the expectations of various stakeholders, especially for trained workers who are able to handle the difficulties of a changing world, new technological advancements, and strengthened national innovation agendas. The chapter's key finding is that organizations with an entrepreneurial focus are more likely to develop into regional innovation builders that can construct bridges between organizations to ensure equity, inclusivity, and sustainability. Taking advantage of existing university capabilities when sensing, seizing, and transforming new innovative and technological opportunities that achieve public policy agendas could theoretically allow researchers to experiment with a complementary or substitution effect.

Chapter 6 examines the European Union. The European Union seeks to support the university innovation ecosystem through many projects, organizations, and public agendas. However, these goals are not free from obstacles and problems. In this chapter, we examine the European Union as a region that has created programs to allow cooperating countries, universities, and public–private organizations to build their innovation capabilities. We offer information on the landscape of university innovation capabilities using data from the European University Association, the European Commission, and Eurostat. The findings indicate that finance is one of the major filters or barriers preventing new capabilities, solutions, and research. These

results also point to issues with inclusivity and sustainability concerning universities' capacity for innovation. The chapter also offers fascinating insights into the public policy and management strategies used by governments within the European Union to support universities' sustainable innovation capabilities.

11.1.4 University Digital Capabilities

Chapter 7 discusses how digital technologies are changing every aspect of society, including work environments and the contexts of education and learning. The university has taken the lead in this process, enabling people to function in a digital society by providing digital capabilities training. Digital innovation management has become a topic of particular interest for companies, along with the rise of the digital entrepreneurial ecosystem, which is rooted in the concepts of the entrepreneurial economy, national entrepreneurship systems, and entrepreneurial ecosystems connected with universities. The fundamental finding of this chapter is that technical advancements, instructional tools, digital platforms, and devices have all contributed to digital capabilities through university operations. The chapter identifies several issues with digital sustainability, inclusivity, and self-management that universities, higher education systems, and organizations that certify higher education must seek to better comprehend. The development of universities' digital capabilities has also been expedited by the evolution of digital platforms that have supported universities' entrepreneurial ecosystems, particularly during the COVID-19 pandemic.

Chapter 8 offers insights into how universities can help professionals to develop their digital capabilities by creating policy frameworks to improve digital capabilities through higher education. The advancement of business and society is fundamentally dependent on digital capabilities. At the moment, the job market needs people with digital capabilities. Because of this, it is vital that we fully understand how people develop digital capabilities in response to higher pay and employment opportunities. This chapter examines the digital capabilities of the university, establishing how people in Latin America and the Caribbean (LAC) acquire them. We compare the digital capacities of LAC economies to those of European economies, and our investigation demonstrates the environmental factors in these economies that support digital capabilities (e.g., broadband subscriptions, internet access, and socioeconomic conditions).

11.1.5 University Sustainability Capabilities

Over the past 10 years, university stakeholders have become increasingly interested in sustainability capabilities, and universities have made significant efforts to integrate a sustainability perspective into all aspects of their operations. Scholarly

literature published between 2010 and 2022 is examined in Chap. 9 to better outline the development of research on sustainable capabilities inside organizations. Our findings show that universities are actively moving away from "the unsustainable model" and toward "the sustainable model." Our analysis of the literature's content reveals trends connected to the influence of university stakeholders on the development of sustainable capacities within universities through partnerships and the curriculum. Chapter 9 also highlights a number of consequences related to universities' contributions to frameworks for sustainable public policies.

External demands relating to major societal concerns and the United Nations Sustainable Development Goals have impacted upon the development of universities' sustainability capacities. This study examines the sustainable transition in North American and European universities, because information on these universities is readily available. Our analysis provides insights into universities' sustainable transformation trends and key performance indicators, using data from the European University Association and the Sustainable Campus Index. The initial findings presented in Chap. 10 reveal how university administrators have encouraged a sustainable strategy by creating new university capabilities.

11.2 Final Remarks

This book seeks to provide new insights into established frameworks, tracing how joint research between universities, firms, and public policy instruments can have both direct and indirect effects on the involved firms' innovativeness. This conceptualization is determined by commercialization, results arising from the direct innovative effects of university collaboration and university/academic engagement (through technology transfer, social engagement, scholarly impacts), constituting the "third university mission" (Dábic et al., 2022). Consequently, it amplifies firms' inner abilities, thereby indirectly increasing innovativeness. Although most firms consider research and development (R&D) investment to be closely connected with existing products and services, for scientific policies, the state finances are fundamental as long-term research, which applies to many diverse actors, and thus has a considerable impact on the economy (Audretsch et al., 2022). In contrast, innovation policies are often defined quite broadly, for example, as the integral of all state initiatives regarding science, education, research, technology policy and industrial modernization, overlapping also with industrial, environmental, labor, and social policies (Kuhlmann, 2001, p. 954). As a result, cooperative research has shown that innovation capabilities increase in line with network expansion.

All theories stress the significance of entrepreneurial opportunity discoveries and the pursuit of business innovation when it comes to competitiveness and economic growth. This new paradigm of entrepreneurship-based digital innovation complements and replaces the "technology-push" type of innovation, translating scientific knowledge and research advances into commercial applications. However, how entrepreneurs develop, transfer, adopt, use, evolve, change, or create new digital

technologies within networks and cooperate with universities (supported through European Commission financed projects and different science policies), has been under-investigated. A limitation of the entrepreneurial ecosystem framework, as emphasized by Song (2019, p. 571), is that until recently, there has been little discussion of technological advancements in general and digitization in particular. The question we sought to address in this book concerned the role of universities in rebuilding digital technologies for entrepreneurship, benchmarking the digital capabilities of LAC and European economies to support entrepreneurs to foster digital innovation.

The book sets out how university cooperation and science, innovation, and technology policies have all evolved as a result of the rapidly changing environment for R&D influenced by the rise of the digital economy, Industry 4.0 (Dabić et al., 2016), and external disruptions such as the COVID-19 pandemic (Guerrero & Pugh, 2022). It is important that we thoroughly analyze the rebuilding of university capabilities across higher education systems, as geographic contexts and time are both critical elements (see Crow & Dabars, 2015; Teece, 2023). Reviewing the body of theoretical and empirical work published in this field of study is crucial, as it provides examples of how universities have rebuilt their capacities in various geographic situations. Analysis of this work is also instrumental in comprehending the competitive pressures that university administrators must contend with when deciding which specific or additional university capabilities to fund. A key message that this book strives to communicate is that the main outcome of innovation policies ought to be to emphasize and highlight the challenges fronted by universities in becoming more entrepreneurial, innovative, digital, and sustainable. Policymakers should work to create sustainable environments in which entrepreneurial attitudes and behaviors can be competently designed, developed, and supported.

We must admit that we are fully aware of our limitations and the possible future topics requiring further analysis in this area. We therefore sincerely welcome all readers and all those currently working in this field to share their thoughts and comments. We would like to thank all those involved—either directly or indirectly—in the publication of this book. It is only by introducing best policies, sharing examples that support universities' future development, and taking on joint work to prepare business owners, managers, and students for the realities they will face that we can strengthen the university's university mission.

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