





Guide on educational needs in Europe and state of the art on the use of Systems Thinking in digital transformation and sustainable development

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Structure of the Document

The purpose of the current report is to investigate the issues of Digital Transformation and Sustainable Development. In particular, a literature review was performed to analyse how Systems Thinking and System Dynamics dealt with the two issues.

Furthermore, a questionnaire was designed and developed with the purpose of gaining insights on people's opinion of Digital Transformation and Sustainable Development and more importantly what are the barriers and missing skills that could accelerate the two processes. Analysis of the results and the lessons that have been learned are discussed in detail.

Task TITLE OUTPUT In the document Pages 25-Survey 36 Identification of Needed skills and competencies map Pages 6-9 Current and Future Educational T1 Needs for Sustainable Development and Digital Transformation Scenario Analysis Pages 27-29, 45-46 T2 Identification of Pages 48-Target groups matrix target groups 50

The current document will answer the following questions/tasks as they are described in the project description:

T3	Assessment of	Organizations skill shortage report	Pages 73-
	current skill gaps	Learners skill gap map	76, 84-87
T4	Analysis of existing Case Studies and Educational Programs	Map of available applications of ST in educational experiences on SD and DT	Pages 13- 27, 33-43

INTRODUCTION

The characteristic of the modern world is that it has entered a digital era, identified by accelerating technological innovations, shifts in the way people socialize, live and socialise. This Fourth Industrial Revolution has been achieved by advances in Big Data and Artificial Intelligence (Hoe, 2019) and has had significant consequences in industries, societies and governments (Bienhaus & Haddud, 2018); (Omar, 2019); (Schwab, 2017).

Small and Medium Enterprises (SMEs) have not been immune to these changes, since they form the 95% of global enterprises and provide 60-70% employment to the world population (Viswanathan & Telukdarie, 2021). The factors that have shifted the culture of SMEs in the last few years and could possibly drive their future development are:

- An increasing trend to operate online
- Use of Artificial Intelligence for tasks (such as chatbots)
- Increased use of social media and related technologies
- Reliance on cloud technology (Viswanathan & Telukdarie, 2021)

A report by the World Economic Forum (2018) has indicated that these factors not only drive the modus operandi of SMEs, but SMEs need to embrace *Digital Transformation* in order to become sustainable. This implies that SMEs need to:

1) Fundamentally change their business models

2) Digitise their operating models

3) Attract and retain people with the necessary skills to succeed in the Fourth Industrial Revolution

4) Develop new digital metrics of success

Hence, not only digitisation but Digital Transformation (DT) should be the goal of SMEs and organisations in general in order to succeed in the new world that is emerging. Digital transformation can be defined as:

"Increasing application of digitization on the structure or characteristics of individual work, internal processes, communication, infrastructure, business ecosystems and

products/services for internal and/or external customers. The core of Digital Transformation is the overall digitization and cross-linking of the value creation process".

As a result, digital transformation means adopting a broader mindset that encompasses Big Data, cutting-edge technology and human-centered design which has the potential to transform traditional business models (Ghobakhloo, 2018); (Lin, et al., 2018). Adopting digital transformation does not solely mean to use digital means but it requires the synergy of multiple stakeholders to innovate and create value across the ecosystem (Dellermann, et al., 2017); (Vogelsang, et al., 2019) find a new way of combining products and services,(Kagermann, et al., 2013),(Schwab, 2017), offer competitive advantages to businesses and optimize their processes (O'Leary, 2013) and change the meaning of productivity, thus creating the opportunities for wide range impact across all economic sectors and the society (Lichtenthaler, 2018); (Matzner, et al., 2018);(OECD, 2018).

It is clear that Digital Transformation offers tremendous opportunities for success (von Kutzschenbach & Brønn, 2017), however SMEs and other organisations are facing great challenges that hinder their digital transition (Prasanna, et al., 2019).

Surveying the literature and reports on the issue of Digital Transformation one can find numerous barriers that are faced by managers and enterprises. Those include:

- 1) Lack of innovation
- 2) Lack of technical expertise
- 3) Difficulties in implementing new technologies
- 4) Underestimation of the effort to push innovation
- 5) Technical barriers (dependency on other technologies)
- 6) Individual barriers (loss of data, fear of transparency and fear of job loss)
- 7) Organisational and cultural barriers (keeping traditional roles....)
- 8) Environmental laws (lack of standards, lack of laws)

However, one of the most important barriers that is constantly brought up is the lack of necessary skills (Hess, et al., 2016); (Smit, 2018);(Vogelsang, et al., 2019) that could assist an organisation to transform digitally, be it digital and technical skills or soft skills that enhance the ability to be aware of social consequences in any digitisation process (Korableva, 2020).

Moreover, Digital Transformation is also being seen usually as a move accompanied by great risk by enterprises (Hoe, 2019). According to the World Economic Forum (2018) technological risks such as cyber-attacks and data fraud rank among the top global risks besides environmental risks, which could result in financial losses and severe damage to reputation.

Hence, it is imperative to increase the literacy of employees and managers with regards to digital and Information and Communication Technologies (ICT) in general.

It is not enough to have the digital/computer infrastructure that would assist the business to achieve digital transformation, but such an effort should be accompanied by an ability to manage, integrate and create information (ICT Literacy Panel, Digital transformation: A framework for ICT literacy, 2002), consequently increasing ICT literacy.

ICT literacy is using digital technology, communication tools and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society (ICT Literacy Panel, 2002, p. 2).

In conclusion, Digital Transformation can be a source of success and sustainability, but for it to be successful, an organisation needs to become a learning organisation (Senge, 1990) which can be the only type of organisation that thrives during the digital transformation.

Another term that has dominated the discussion and research efforts across many disciplines is the one of Sustainable Development (SusDev). The term made its appearance in the 1980s with the Brudtland report and is defined as "the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, et al., 1987). The report was an effort to identify how human activities had damaged natural integrity and what types of ecological imbalances could threaten the security of societies (Rezaee, Izadbakhsh, & Yousefi, 2016).

Furthermore, this effort identified that in order to achieve a state of sustainable development, not only economic development should be achieved without a detriment to the environment, but societal values needed to be included in any policy (Tsaples & Papathanasiou, 2021). Thus, Sustainable Development was conceived as a multi-dimensional issue and policies at any level should reflect that complexity.

Despite the importance of Sustainable Development and the recognition that is multidimensional in nature, no two definitions of it coincide. There are those that focus on the typical 3-dimensional structure (economic, environmental, societal) (Robinson, 2004) and there are those that highlight the importance of technological innovation as the path to be travelled (Drucker, 2014).

Nonetheless, international organisations and governments recognized the importance of Sustainable Development and a series of international treaties cemented the term as a goal of governmental policies. This has been expressed with the 2030 Agenda for Sustainable Development on which 17 Sustainable Development Goals¹ (SDGs) have been outlined ranging from reducing CO₂ emissions to eradicating poverty (Zhang, Prouty, Zimmerman, & Mihelcic, 2016).

As a result, both Digital Transformation and Sustainable Development are complex processes which involve multiple stakeholders across industries and disciplines that are hard to define, but essential to achieve. To assist policy makers reach better decisions and deal more effectively with the complexities involved in both DT and

¹ <u>https://sdgs.un.org/goals</u>

SusDev, policy modelling could be used; research – either quantitative or qualitative – which uses techniques to evaluate the causes and effects of policies (Estrada, 2011).

However, the nature of Digital Transformation and Sustainable Development means that traditional models which rely on linearities and equilibria might not be suitable (Forrester, 2003). Furthermore, the prominent role of people's behaviour (either through skills in Digital Transformation or societal values in Sustainable Development) have to be included. Finally, both DT and SusDev could have long-term consequences, meaning that delays should be introduced between when a potential policy is applied and when its consequences could appear (Tsaples & Armenia, 2016).

Hence, Systems Thinking and System Dynamics (SD) are great candidates to assist policy makers to successfully achieve both states. They are based on a computer-based modeling methodology that facilitates the understanding of complex systems over time (Sterman J., 2000) and in particular how a system's structure could affect its future behavior (Santos, Belton, & Howick, 2002).

Their main elements are stocks, flows, feedback loops and time delays, which are inherent in complex socio-economic systems (Sterman J., 1989). Furthermore, SD relies on non-linearities, systemic structures and internally generated dynamics rather than the effect of externalities (Meadows D., 1980).

SD uses a top-down approach to represent the system under study and can be both quantitative and qualitative (Systems Thinking), meaning that the boundaries of the system could be expanded to include notions that are not easily quantifiable, such as aspects of human behaviour (Tsaples & Armenia, 2016). Finally, the methodology is easy to communicate and can easily be used for experimentation by non-experts.

Systems Thinking and System Dynamics employ another, qualitative tool to reveal insights about the systems under study and that is the Causal Loop Diagram (CLD). A CLD is a combination of causal links between systemic elements or variables; it is a mapping diagram that visualises how the elements of a system interact with each other. A CLD is a graph consisting of nodes (systemic elements) and edges (causal relations) that connect the various nodes.

This link represents a causal relationship between two variables, one being the cause (start of the edge) while the other the effect (end of the edge) and can be graphically represented as an arrow (Figure 1).



Figure 1 Causal link between two variables

A causal link can be of two types:

- Positive. It is marked as + and it means that the two variables change in the same direction. For example, if variable A increases then variable B also increases. Or if variable A decreases then variable B also decreases.
- Negative. It is marked as and it means that the two variables change in opposite directions. For example, if variable A increases then variable B decreases. Or if variable A decreases then variable B increases.

In a CLD, closed cycles are usually formed which are called feedback loops and are one of the essential aspects of Systems Thinking. Similar to causal links there can be two types of feedback loops:

Positive feedback loop (Figure 2). In such a case all variables change in the same direction.



Figure 2 Example of positive feedback loop

In a positive feedback loop, assume that variable A increases. This increase is followed by an increase in variable B, which increases variable C and in turn further increases variable A.

A positive feedback loop can be also formed with negative direct links as in Figure 3.



Figure 3 Positive feedback loop with negative links

Assume an initial increase in variable A. Consequently, variable B will decrease which will cause an increase in variable C. The increase in variable C will cause a further increase in variable A. A rule of thumb of how to recognise a positive feedback loop in the presence of negative links is to count those negative links: if their number is even then the loop is positive.

A negative feedback loop is formed when all links are negative (or when their number is odd). For example, in figure 4 on the left, an increase in variable A will cause a decrease in variable B, which will increase variable C that will cause a decrease in variable A. This final decrease of variable A might cancel the initial increase of the variable and for that reason negative feedback loops are also called balancing loops.



Figure 4 Examples of negative feedback loops

Finally, another mark in feedback loops is that of a delay illustrated as a double line on a link. For example in Figure 5, an increase in variable A will cause an instantaneous increase in variable B. The increase of variable B will cause after a delay an increase in variable C which will cause a decrease in variable A.



Figure 5 Negative feedback loop with a delay

Feedback loops in an CLD are not isolated; they can be connected forming modular structures which are called Systemic Archetypes. These archetypes give rise to a particular behavioural pattern. Finding such patterns inside a system can provide deeper insights about the dynamics and behaviour of the system under study. Detailed information about system archetypes can be found in the work of Senge (Senge, 1997)

In conclusion, Systems Thinking and Systems Dynamics are suitable frameworks to use to understand and explore both Digital Transformation and Sustainable Development at any level (Qudrat-Ullah, 2008) and the next sections will focus on how they have been used in those aspects.

SYSTEM DYNAMICS AND DIGITAL TRANSFORMATION

Scientific Literature Review

A search was performed on the scientific databases of Scopus and Google Scholar with the keywords "Digital Transformation", "System Dynamics" and "Systems Thinking". The number of returns was extremely high and for that reason a further refinement was performed by reading the title, keywords and abstract of the proposed papers to account only for those that specifically deal with the use of System Dynamics in Digital Transformation. The final list includes 13 papers (although no claim is made that this is a comprehensive list).

Sánchez (2017) used the methodology to explain the management choices that are necessary to achieve digital transformation, while von Kutzeschenback et al. (2018) developed a System Dynamics model to understand what consequences can be generated with a shift in digital strategy.

Apart from general models of digital transformation, several works are focused on specific industries. For example, von Kutzeschenback and Brønn (2017), developed a System Dynamics framework to explain the drivers and constraints of digital transformation for Uber. Jungthawan et al. (2019) used systems thinking as a framework to explain digital supply chain transformation, while Moellers et al. (2019) investigated five cases within the BMW industry. Finally, Ghadge et al. (2020) analysed the impact of Digital Transformation in the supply chain.

Moreover, attempts are made in the literature to investigate Digital Transformation from a regional perspective. Casalino et al. (2010) developed a System Dynamics model to identify the benefits from the digitisation of the Italian Public Administration. Special attention was given to the interaction between citizens and administrators and the model was applied for 8101 Italian municipalities. Vogelsang et al. (2019) employed a System Dynamics model to understand the causal relationships among enablers and barriers of Digital Transformation of SMEs in South Africa, while Lu et al. (2020) developed a Systems Thinking framework to investigate the integration and exploration of China's scientific and technological resources in order to achieve Digital Transformation.

Finally, the highly instructional value of Systems Thinking and System Dynamics has also been recognised in the literature and authors have developed models and frameworks purely as educational/instructional tools. Belolipetskaya et al. (2020) attempted to study the skills that are necessary in the context of DT to teach (HR) managers that seek talent and Monat et al. (2020) used Systems Thinking as a hands-on educational tool for managers that wish to embark on a process of Digital Transformation. A review of several case studies of Digital Transformation across all industries has been performed in the work of Kutnjak et al. (2019).

Systems Thinking and Digital Transformation in Projects

Systems Thinking and System Dynamics have been used in projects that address Digital Transformation; To check for such projects, the SYSTEMA partners were asked to investigate whether any existed in their own countries, while additional searches were made in the EU project platform, LinkedIn etc. Similar to the literature review, not many projects have been conducted that combine Systems Thinking and Digital Transformation.

For example, Robu and Lazar (2020) present an example in practice led by knowledge management within Alberta Health Services, while the Systema Research Center constructed and used in a pilot a digital marketing itinerary for the secondary school curricula through practice on a System Dynamics model².

In conclusion, not many papers or projects have been developed that focus on Digital Transformation under a Systems Thinking lens and that can be considered a gap in the literature. However, useful conclusions can be drawn also from this short list. First, System Dynamics can be used either for case studies (industrial or regional) or as a theoretical tool that could assist in the operationalisation of Digital Transformation. Second, especially during the last years, Systems Thinking has been recognised as a valuable educational tool that could help managers and students alike to better understand what can accelerate and what can hinder Digital Transformation, what its potential impacts (positive or negative) could be and experiment with potential policies in a consequence-free environment, but more case studies and practical applications (either in tertiary education or in vocational training or adult education) are necessary. The SYSTEMA project will address all these needs.

Furthermore, Digital Transformation has been an important element of programs and projects across the world. For example, to illustrate its commitment to bridge the gap towards Digital Transformation, the European Union renewed and expanded its policy initiative to support the sustainable and effective adaptation of the education and training systems of Member States to the digital age. The so call Digital Education Action Plan:

- Offers a long-term strategic vision for digital education that is inclusive, accessible and of the highest quality
- Attempts to foster cooperation on digital education at the EU level
- Supports the digitalization of teaching methods
- Provides the necessary infrastructure for a successful digital transformation³

Furthermore, a new EU funding program was established called Digital Europe Programme (DIGITAL) lasting from 2021-2027. The Digital Europe Programme will provide strategic funding to answer challenges related to Digital Transformation, supporting projects in five key capacity areas: in supercomputing, artificial intelligence, cybersecurity, advanced digital skills, and ensuring a wide use of digital technologies across the economy and society, including through Digital Innovation Hubs.

Finally, E+ has always been a place for teaching and fostering all the necessary skills for Digital Transformation across all industries and organization. The table below summarizes some of the projects that have been funded by E+ over the years.

² <u>https://systema.euc.ac.cy/project/digital-marketing-at-secondary-schools-dimas/</u>

³ <u>https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en</u>

Project Name	Project Reference	Details
Digital Transformation of European Micro enterprises	2016-1-UK01-KA202- 024362	The objective of the project is to develop an e-learning platform in order to transfer knowledge and understanding of digital solutions to the MEs in a user-friendly and easily accessible manner. The platform provides an introduction to digital technologies. As a consortia we agreed that due to the nature and pace of technology development, the platform should be an explanatory rather that instructional platform.
Empowering Digital Literacy in a Transforming World	2018-1-DE02-KA204- 005179	The project resulted in a wiki on the described three dimensions of digitalisation, see <u>http://digiwiki.weltgewandt-</u> <u>ev.de/</u> . It contains both information on various issues related to digitalisation and teaching inspirations for trainers to arrange a common "analog" learning on these topics.
Digital Literacy for NGOs (DLNGO 2.0)	2020-1-FR01-KA204- 079868	The Digital Literacy for NGO 2.0 (DLNGO 2.0) project aims to improve the digital literacy skills of the social sector (or third sector) staff and volunteers, as well as the marginalised communities they serve, at a European wide level through the exchange of best practices between 11 leading social sector capacity building

Table 1 E+	projects focus	ed on Digital	Transformation
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		organizations.
Industry 4.0 in Healthcare	2020-1-PL01-KA202- 081397	Provide essential insights on the current status of IND4.0 application in the healthcare sector as well as relevant VET guidelines and create appropriate curricula
Digi-Sporting. A new step towards digital transformation through sports science	2019-1-ES01-KA203- 065505	The project is aimed to create, develop and transfer the professional profile of technologist-analyst (postgraduate training - higher degree) in the field of sports sciences with the aim that sport academies and clubs can fully explore the opportunities offered by digital transformation.
Digital Transformation	2020-2-EL02-KA105- 006076	The DIGI-TRA project aims to acquire new skills for young people. The project will help improve the collaboration of young people who have fewer opportunities through the use of high quality digital tools and methods. Aiming to upgrade society and the economy for young people with fewer opportunities and to recognize the importance of non-formal learning to the general public.
Digital VET Readiness	2020-1-NO01-KA226- VET-094087	The project aims to: 1. Identify criteria's for VET institutions digital educational readiness and create guidelines and checklist to implement digital pedagogical readiness competences among educators and

Creative digital	2020-1-DE02-KA227-	 schools as an organization. 2. Create mapping tool supporting the developed criteria's to score the Digital pedagogical preparedness. 3. Create E-Activities within digital pedagogical practical knowledge and digital pedagogical guidelines with visual supportive steps for practical creation of learning modules giving students holistic learning experience. 4. Create easy to use, low and secure E-VISIT learning tool for improved digital collaboration between school, students and companies.
transformation: Adapting local cultural, touristic and educational activities to a new virtual paradigma by creatively digitalising community offers	ADU-008153	Transformation project will accelerate digital transformation of entities, SMEs and organisations in the target sectors (creative industries, culture and tourism, and education) via creative and innovative solutions, by strengthening their workers' competences, and by reinforcing the cooperation and networking within them.
Digital Training Toolbox to FosteR EU'S IndusTry 4.0 RevoluTion	2017-1-ES01-KA202- 038446	Involve the industrial sector in the transformation of VET systems, in order to meet the need of digital skills consistent with the technological developments in industries
Digi4SME - Digital Competences of VET	2020-1-IT01-KA226-	The aim of the DIGI4SME project if extending digital

Trainers for SME	VET-009004	competences of VET trainers providing training to SMEs
Digital Entrepreneurship for Employability Paths	2019-1-PL01-KA202- 065880	The DEEP project focus is also set on entrepreneurship as a key skill in VET as more entrepreneurs are needed in order to bring Europe back to growth and create new jobs - The Entrepreneurship 2020 Action Plan shows. Entrepreneurship education is perceived as highly important and, along with entrepreneurial teacher training, addressed by a large number of European strategic documents, including ET 2020.
Digital Transformation and Employability: acquiring transversal competences in curricular education	2019-1-IT02-KA203- 062324	The DiTEMP project therefore proposes an action aimed at embedding Digital Transformation elements, with reference to its impact on field-specific labour markets, in curricular education
Digital skills and tools for Young Female Entrepreneurs	2014-1-EL01-KA202- 001397	The PROJECT contributes to the efforts for reduction of youth unemployment specially among women and for recognition and certification of skills developed in environments of non-formal and informal training/education that can be adapted to different work needs and environments.
Boosting digital skills and competences for librarians in Europe	612411-ЕРР-1-2019-1- IT-ЕРРКА2-SSA	The project BIBLIO addresses the skills gap in the library sector due to the digital transformation that is changing the role of

		libraries and library professionals. The project will facilitate the acquisition of digital and transversal skills for library professionals, in order to respond to the digital transformation by setting up a system for skill assessment, learning offer and validation and recognition.
DataSkills4SMEs	612873-EPP-1-2019-1- BE-EPPKA3-PI- FORWARD	The project's aim is to guide SMEs towards the implementation of innovative learning methods for their employees, in order to deal properly with advanced data management, like e.g. cybersecurity, data protection, cloud computing, internal and external data flows, as well as CRM tools and data management for marketing purposes, all issues linked to digital transformation and the related need to continuously upskill and reskill workers, empowering them to be ready for the future and resilient in the present
Training Blueprint for the Digital Transformation of Health and Care	2018-1-IT01-KA202- 006735	The project aims at increasing health professionals digital & soft skills in order to reduce the current existing gap between digital technology trends and their effective use in the health sector.
The "Digital Industry Training Atlas": Connecting European Training Opportunities for	2019-1-IT01-KA202- 007457	The DITA project wants to strengthen transnational cooperation among synergic training organizations and

a stronger Digital Single		increase the mobility
Market		opportunities of trainees in
		the European digital
		industry scene by a)
		providing a transparent and
		useful overview of available
		training opportunities in the
		field of Digital
		Transformation, b)
		supporting trainees in
		identifying which available
		training opportunities may
		best fit to their needs and
		expectations, c) establishing
		permanent cooperation
		schemes among the
		identified training,
		programs and facilities, d)
		delivering and permanently
		maintaining an open but
		supervised tool (The Digital
		Industry Training Atlas)
		that will collect, connect
		and display synergic
		available training
		opportunities in Europe on
		digital transformation.
Business Transformation	2016-1-DE02-KA202-	BITTMAS solution
towards Digitalization and	003437	supports training and self-
Smart Systems		driven processes for the
5		required business
		transformation through
		employees and managers of
		SME
Open Source Applications	2016-1-ES01-KA203-	Development of innovative
for Industrial Automation	024921	high technical level training
	021921	materials for higher VET
		HE institutions and
		enterprises
	2010 1 0502 2 4 101	
Digital transformation at	2018-1-DE03-KA101-	Improvement of the
schools: success in living	046605	intercultural competences
and learning with digital		and the teaching and
media.		school's quality

Education 4.0: Digital	2019-1-DE02-KA104-	develop an overview over
tools in educational work	005336	existing digital tools in
		educational work and
		ensuing possibilities
		through teaching or training
		assignments, structured
		courses or job shadowing,
		as well as to give them an
		opportunity to develop their
		own ideas to fruitfully
		engage with digital tools in
		their own work
EUROPEAN DIGITAL	2019-1-ES01-KA102-	To continue fostering the
TRANSFORMATION	062569	economic, social and
		cultural development of the
		province of Valencia, in this
		case promoting the
		professional mobility of its
		young people at European
		level in order to increase
		their employability levels,
		in particular those that are
		trained in VE1 specialities
		Telated to IC 18.
Key competences for an	2019-1-FR01-KA202-	qualifying new
European model of	062965	professionals able to
Industry 4.0		support the digital
		transformation of the
		European companies in the
		industrial sector, according
		to the Industry 4.0
		paradigm.
Shaping Digital	2020-1-DE02-KA102-	The aim is to make the
Transformation in	007086	overall social trend of
Vocational Education		digitisation and its
		consequences tangible
Digital transformation of	620089-EPP-1-2020-1-	The module is dedicated to
European governance,	RU-EPPJMO-MODULE	the study of successful
politics and public		European experience of
communications		digitalization of political
		and public-management
		spheres
Digital Transformation in	621496-EPP-1-2020-1-	The project aims to create

Advanced Manufacturing	ES-EPPKA2-SSA	and provide innovative curricular training (reskilling and upskilling opportunities) in digital transformation competence for the advanced manufacturing sector (AM), for mid-high level IT and OT technicians at EQF Levels 4-5 +
Introducing digitalisation for boosting SMEs in Tourism and Hospitality	2020-1-EL01-KA202- 079096	The project is seeking to train and certify agents that will promote digitalisation to boost SMEs, in Tourism and Hospitality, performance, namely dTour agents.
Digital Transformation in Humanities	2019-1-EE01-KA203- 051622	The project aims to develop a set of tools and guidelines addressed to higher education educators/professors in the field of humanities (literature, history, geography, philosophy etc.) with the goal to improve their ICT skills, teaching performance and consequently the attainment of their students and motivation.
Digital Transformation for VET	2020-1-UK01-KA226- VET-094509	Assessment of level of digital transformation of a representative set of VET schools in partner countries
Digital transformation manager: leading companies in Furniture value chain to implement their digital transformation strategy	601011-EPP-1-2018-1- ES-EPPKA2-SSA	DITRAMA project aims to provide an innovative MOOC training managers to lead Furniture companies implementing it along their whole value chain.
Digital transformation of	2020-1-FR01-KA226-	DigiFoodEdu aims to foster

project-based learning guidance in agri-food Higher Education Institutions	HE-095523	the development of digital skills and exchange of good pedagogical practices in the digital era directed at the guidance of project-based learning approaches
Managing Digital Transformation	2020-1-NL01-KA203- 064643	This project will address the shortage of 'digital leaders' by developing a 30 ECTS program (EQF 5-7) called 'Managing Digital Transformation' (MDT). The program will be designed for students AND professionals with a high interest in entrepreneurship and management, who possess a Bachelor's degree in a study as Economics, Communication, Business Administration, Education, Public Management, or a Bachelor's degree of a technical study. The program consists of six specializations of each 5 ECTS. These specializations will address the three core elements of the 'leadership skills triangle': technology, business/commerce and leadership. The multidisciplinary program will deliver digital leaders who can enable successful digital transformations, thereby contributing to the competitiveness of Europe and of individual organizations.
Digital Transformation of Global Entrepreneurial Mindsets	2019-1-PL01-KA203- 065472	To transform mindsets of entrepreneurs to perform as global innovators and entrepreneurial leaders in

		the era of digital transformation
Changing SME business by industry 4.0	2018-1-PT01-KA203- 047330	Chain project aimed to provide a basis for the creation of new competencies for HE students and SMEs (managers and owners) to deal with the change brought by the digital "revolution".

Even this subset of E+ projects illustrates that Europe has an extensive array of training and educational programs covering all ages, roles and sectors. Moreover, the focus of these programs is not only on the Digital part of the transformation (meaning the development of digital skills) but covers all dimension of Digital Transformation as illustrated by the definitions provided in the Introduction.

Apart from projects, funding mechanisms and policies, several institutions public and private offer programs specifically designed for people in businesses. The table below provides a summary of the well known ones across the world.

Institution	Details	Target group	Duration and fees
UC Berkeley	Aims to help	mid- to senior-	Fees are applied
Executive	business leaders	level managers	and the program
Education Digital	identify	looking to create a	runs for 2 months
Transformation	problematic areas	strategy and action	
program	in their	plan as they <u>lead</u>	
	organization where	their organization	
	technology can	through digital	
	make a difference,	transformation	
	manage the people		
	and processes		
	required to enable		
	digital efforts, and		
	navigate the murky		
	legal and ethical		
	waters of digital		
	business.		
Stanford Digital	Offers an	business leaders	Fees are applied.
Transformation	extensive	and employees	Eight courses are
Certificate	framework for	looking to create	offered that take 5-
	implementing	and sustain a	8 hours to

Table 2 Example of training/educational programs focused on Digital Transformation

	digital	digital culture	complete at the
	transformation. It	throughout their	learner's pace
	covers the tools	organization	
	and techniques		
	needed to		
	effectively lead in		
	times of change		
	and build a		
	sustainable digital		
	culture and		
	integrate		
	technology and		
	processes to		
	further enhance		
	customer and		
	employee		
	experience.		
Coursora Digital	It concentrates on	Individuals	Foos are applied
Transformation	two specific areas	starting a new	Fees are applied.
course	of digital	career in an	learner's pace
course	transformation: the	industry where	learner s pace
	urgency it creates	technology is	
	for businesses and	prevalent and who	
	what needs to be	want to learn about	
	done to win in the	the economics.	
	digital age	innovation. market	
	8	disruptions,	
		challenges and	
		business benefits	
		of the technologies	
		driving digital	
		transformation	
Disidal	It fo avono on	Entropy and another	Ease are applied
Digital	digital innovation	business and IT	Fees are applied.
Cornell Cartificate	and	loadore who wont	Four monuis
Drogram	concepts and	to expand on their	
Flogram	idention process to	discuptiva husinasa	
	help discover and	ideas through	
	neip uiscover and	digital auditing	
	disruptivo husinoss	and a ranid	
	ideas	ideation process	
	10000	Incation process	
Digital	Part of an edX	Business leaders in	Fees are applied.
Transformation in	MicroMasters	industries across	Seven weeks
Business from edX	Program in MBA	the enterprise who	
	Core Curriculum	want to gain a	

	geared toward the emerging technologies and <u>trends driving</u> <u>digital</u> <u>transformation</u>	better understanding of current digital technologies to determine which are the most beneficial to their organization	
LinkedIn Learning Digital Transformation	Considered one of the more popular courses on digital transformation on LinkedIn Learning with over 100,000 learners, Digital Transformation to help business leaders better understand what exactly digital transformation is and why it can beneficial for an organization	Informative online course intended for business leaders active on LinkedIn who are interested in learning more about digital transformation trends and their implications for companies.	For subscribers to the platform. 45 minutes
Leading Digital Business Transformations	IMD Center for Digital Business Transformation – CISCO. The program helps to assess how an organization can extract the best value from its digital transformation	Business leaders in industries across the enterprise who want to gain a better understanding of current digital technologies to determine which are the most beneficial to their organization	Fees are applied. 5 days. Offered in Lausanne and on of the few programs offered in Asia
Exploiting Disruption in a Digital World	London Business School. Focused on the changes and trends that drive global businesses	For senior executives with at least 10 years of senior leadership experience, who are responsible for the strategic direction of their organization,	Fees are applied. 5.5 days

leading its digits transformation	ital , or
preparing it for future	r the

Generalized CLD on Digital Transformation

From the papers, programs and projects that were researched, a general Causal Loop Diagram (CLD) can be derived on how the process of Digital Transformation has been addressed in System Dynamics. Figure 6 below illustrates the aforementioned CLD.



Figure 6 CLD on Digital Transformation

As it can be observed from the CLD, Digital Transformation is a series of positive feedback loops, which can illustrate how different future scenarios can evolve:

The more successful the Digital Transformation is, the higher the quality of the products or services offered will be.. In turn, high quality will attract more clients (in the broadest of terms) which can increase the sustainability of the organisation. Increased sustainability means that managers will be more willing to proceed with DT, which can then increase the DT of the organisation (Figure 7, loop in red).



Figure 7 First positive feedback loop

The majority of these variables also participate in another positive feedback loop which instead of the willingness to proceed with DT, the variable "necessary infrastructure participates": an increase in Digital Transformation increases the quality of the service/product, which increases the attractiveness to clients that in turn acts positively in the economic sustainability of the organisation. This sustainability can result in improvement of the necessary infrastructure which further increase the Digital Transformation of the organisation (Figure 8, feedback loop in green).



Figure 8 Second Positive feedback loop

Finally, economic sustainability and general success can increase (after a delay) the number of education opportunities that would increase the skills of personnel which can result in increased Digital Transformation (Figure 9, feedback loop in black).



Figure 9 Third positive feedback loop

Hence, all these loops would further improve the Digital Transformation of the organisation, exponentially improving the results. However, a positive feedback loop means that if the opposite occurs (low levels of DT, low quality of products etc.) then this would result in the cost of actually initiating DT to be considerably higher. In conclusion, the synergy between Systems Thinking and Digital Transformation has not been fully realized yet, despite the obvious benefits that it can offer to organisations. Finally, one gap that has been identified is that education that combines Systems Thinking and Digital Transformation is an area that has not been exploited yet and the SYSTEMA project will address the specific gap.

SYSTEM DYNAMICS AND SUSTAINABLE DEVELOPMENT

Scientific Literature Review

A search was performed on the scientific databases of Scopus and Google Scholar with the keywords "Sustainable Development", "System Dynamics" and "Systems Thinking". The number of returns was extremely high (over 10000 returns) and for that reason it was decided that focus would be on applications of SD in sustainable development in regions (countries, cities etc.) or general models that are used for exploration and/or teaching purposes⁴. The application of SD in SusDev in individual sectors of the economy or industries (like in logistics (Dong, Xu, Hwang, Ren, & Chen, 2019)) merits an investigation of their own.

The seminal work on System Dynamics and Sustainable Development is the Limits to Growth (Meadows, Meadows, Randers, & Behrens III, 1972) by the Club of Rome, where simulation was used to study and illustrate how the exponential and population growth collides with the finite supply of resources. Randers, one of the members of the Club, followed that research in 2000 (Randers, 2000) indicating that the tendencies that were identified in the Limits to Growth still persist although time cannot yet confirm the "overshoot and collapse" mode of behaviour of the original model. Randers also identifies several key points that could be used as policy leverages and these are: education, eco-efficiency and resource management.

The methodological advantages of System Dynamics and Systems Thinking allowed researchers to offer insights even in the definition of SusDev. For example, Bagheri and Hjorth (2005); (2006) used feedback loops as mean to illustrate that Sustainable Development is a never-ending process rather than a state and an adaptive approach should be employed by all, where policy makers go through a learning process and modify their decision processes according to real-world feedback. Angulo et al. (2015) used a simple System Dynamics model to showcase the relationship of Sustainable Development's three dimensions with demography dynamics. Li et al. (2016) enrich the original definition and propose the Sustainable Development of Green Space (SDGS) as the coordinated development of urban systems, social economy and the environment, while Zhang et al. (2016) use the Systems Thinking framework to understand the fundamental dynamics between the SDGs. Michnowski (2008) uses systems thinking to analyze world sustainable development and especially how information plays an important role in the creation of appropriate conditions. Nabavi et al. (2017) researchers the role of the modelers in the application of System Dynamics in Sustainable Development.

Sustainable development in cities has been gaining a lot of attention in SD studies. For example, Yao and Lu (2008) used the coal city of Jixi as their case study and identified leverage points in the parameters of "investment ratio of industry", "resource recycling" etc. Dacko (2010) found inspiration from the predator-prey dynamics to explain the relationship between economic growth and environmental resources. The author concluded that a thorough change in the management paradigm

⁴ For a comprehensive review on applications of SD on urban sustainable development, the reader is referred to (Pejic Bach, Tustanovski, Ip, Yung, & Roblek, 2019).

is imperative for sustainable development. Stave (2010) used Systems Thinking to initiate a participatory process on the issue of Sustainable Development.

Chun-fa et al. (2011) simulated the flows of material, energy and information in an eco-city, while Wing and Mingchao (2011) simulated the city of Jiangxi and identified technology as a mean to realize sustainable development. Similarly, Xu and Dai (2012) by simulating the heritage village of Xidi noted that careful planning and addressing the needs of the community in combination with conservation result in increased chances of sustainability. Finally, Ke et al. (2013) used the city of Ordos as their case study and pointed to efficiency as an important parameter.

Macrommati et al. (2013) investigated sustainability in urban coastal systems, while Navarra and Bianchi (2013) highlighted the importance of aligning the goals of different stakeholder groups. Kuai et al. (2014) quantitively represented the inherent conflict between environmental restraints and economic growth, while Li et al. (2014) concluded that greater stakeholder involvement is essential in any plan on sustainable development. Liao et al. (2014), Shih and Tseng (2014), Su (2014), Yang and Shi (2014), Tsolakis and Anthopoulos (2015), Tan et al. (2018), Fang et al. (2019) and Feng and Cao (2021) use cities/urban environments either simulated or real case studies as their modeling canvas to show that coordination, management and efficient planning can achieve great strides towards Sustainable Development. Among others, the above authors agree that political coordination, addressing local needs and values, and technical support can lead to Sustainable Development. The last point is also made by Ougolnitsky et al. (2018) who assert that successful regional sustainable development depends on efficient tools and information technology.

Xu et al. (2014) propose a model of developing countries that attempts to balance environmental protection and economic development. Guang et al. (2016) focus on China and propose that societal development is the next step towards sustainable development for the country. Taylor (2016) utilizes the model of the Limits to Growth to reflect a Canadian First Nation's view of Sustainable Development; Zuo et al. (2017) use System Dynamics to establish models of economic-energy-environment (3E) systems, while Cheng et al. (2018) explore interactive mechanisms of ecoenvironment, geo-disasters, poverty etc. as means for the Sustainable Development of China's poverty-stricken Reservoir Regions. Laspidou et al. (2020) focus on Greenhouse Gas Emissions (GHG) in Greece, while Xue et al. (2020) highlight that national Sustainable Development depends on sustainable mobility and public transport investments. Finally, Wu et al. (2021) support that the conflict between environmental protection and economic development is becoming more severe in developing countries and the authors believe that coordination and management can alleviate the mitigate the consequences of the conflict.

Another interesting stream that is observed in the literature is the combination of System Dynamics with different methodologies to increase the value of model. Guan et al. (2011) add Geographic Information System (GIS) in the model to evaluate the development of the Chongqing city in China with regards to environmental degradation. Similarly, Xu and Coors (2011) propose that the integration of SD with GIS can better explain the interactions of the various dimensions. Finally, Wu and Ning (2018) use System Dynamics with GIS to better analyse the 3E system in both temporal and spatial terms. Apart from GIS, several authors combine System Dynamics with other methodologies to explore different facets of the SusDev problem: Shang and Su (2012) combine SD with the Analytic Hierarchical Process (AHP), Yang et al. (2017) use the Prisoner's Dilemma to investigate the impact of technology proliferation, while Elliot et al. (2018) integrates Life Cycle Assessment and De Oliveira Musse et al. (2018) combined SD with the method of backcasting to support complex decision-making that involved multiple stakeholders in a planning problem in Brazil. Liu et al. (2019) combined SD with Data Envelopment Analysis (DEA). The model first uses SD to simulate a green town and DEA as an evaluation method for the different plans. Other different methods that are used with System Dynamics are fuzzy cognitive mapping (Assunção, et al., 2020), Material Flow Analysis (MFA) (Gao, Gao, Song, & Fang, 2020) etc.

Williams et al. (2017) performed a literature review from 1990 until 2015 and their findings show that for sustainable development among the most important aspects are: behavioural change, leadership innovation, paradigm shifts and sustainability education.

Especially the last aspect has been recognised extensively in the literature, where Systems Thinking is seen as a valuable tool to educate and train people (Kunsch, Theys, & Brans, 2007); (Schuler, Fanta, Rosenkraenzer, & Riess, 2018). For example Faham et al. (2017) developed a model to increase the sustainability competencies of students in higher education, while Schuler et al. (Schuler, Fanta, Rosenkraenzer, & Riess, 2018) focused on students of tertiary education. Finally, Perissi (2021) developed a set of simple SD models to teach to non-specialists the dynamics of sustainability.

Systems Thinking and Sustainable Development in projects

A series of projects has used System Dynamics in the context of Sustainable Development (Moquay, 2008). The European Commission sponsored the project SUCCESS in which researchers used SD to model Chinese villages and find those sources that cause un-sustainability and educated people on how to eliminate them from their practices (Levine, Hughes, Mather, & Yanarella, 2008). The University of Southern California in collaboration with local businesses promoted collaborative learning on sustainable practices (Madachy, et al., 2008), while the region of Valsequillo Lake in Puebla, Mexico was used as a testbed to explore the interactions among the different dimensions of Sustainable Development (Duran-Encalada & Paucar-Caceres, 2009) as illustrated in the figure below.



Figure 10 The four dimensions of Sustainable Development according to (Deakin, et al., 2002)

The ISLANDS project is implemented by the Indian Ocean Commission using the European Development Fund of the European Union to support the implementation of system dynamics modeling in five countries in the Eastern and Southern African and Indian Ocean Region for Sustainable Development (Deenapanray & Bassi, 2014).

Other initiatives also the include the Young Innovators programme of EIT Climate-KIC that aims to foster a systemic view on current climate challenges and empower young people to develop innovative solutions through Problem-based Learning experiences⁵, while the research center SYSTEMA is working with SMEs in Cyprus to build the necessary knowledge through Systems Thinking⁶.

Another European project was also focused on teaching on urban sustainability through game-based learning and System Dynamics. The project was called SUSTAIN⁷ and was focused on providing the necessary skills to students of universities to better prepare them to tackle the complex problem of Sustainable Development (Papathanasiou, et al., 2019). Finally, one of the most important projects on System Dynamics and Sustainable Development was the C-ROADS project⁸. Researchers from across the globe came together to address the issues of SusDev and build a shared understanding of the climate dynamics in a way that is grounded in scientific knowledge and at the same time avoids taking any sides (Sterman, et al., 2012).

Apart from the projects, there are numerous of educational programs (of all levels) that focus on Sustainable Development. The table below summarizes a set of them.

⁵ <u>https://yicy2020.cyprusinteractionlab.com/</u>

⁶ <u>https://systema.euc.ac.cy/project/project-1/</u>

⁷ <u>http://sustainerasmus.eu/wp/</u>

⁸ <u>https://systemdynamics.org/c-roads/</u>

Table 3 Educationa	l Programs	on Sustainable	Development
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Institution	Details	Target group	Duration and fees
Athens University of Economics and Business & United Nations Sustainable Development Solutions Network Global	The seminar is based on the six transformations to achieve the SDGs and support the implementation of the European Green Deal. The seminar is targeted for sustainability executives and practitioners with Prof. Phoebe Koundouri leading the course and 16 top national experts from different sectors: energy, maritime, circular economy, transport, innovation and start-ups, finance, law and CSR contributing with individual lectures. This is the only professional program in Greece accredited not only by a top national University, but also by UN SDSN Global!	Professionals	Fees are applied. 51 hours in 17 weeks
The Division for Sustainable Development Goals, at the United Nations Department of Economic and Social Affairs (UN DESA/DSDG) and the United Nations Institute for Training and Research (UNITAR)	SDGs Learning, Training & Practice – a series of capacity building and knowledge workshops held at the HLPF, featuring speakers and experts from academia and other sectors on crucial topics related to the implementation of the SDGs under review	-	5 days
<i>UNITAR</i> and the Division for	STRENGTHENING STAKEHOLDER	Governmenta 1 officers	Open

Sustainable Development Goals (DSDG) of the UN Department for Economic and Social Affairs (UN - DESA)	ENGAGEMENT FOR THE IMPLEMENTATION AND REVIEW OF THE 2030 AGENDA: The main objective of this e- learning course is to enhance the knowledge and skills of government officers to put in place institutional arrangements, systems and processes to ensure the participation of key stakeholders in national SDG reviews.		
<i>UNITAR</i> and the Division for Sustainable Development Goals (DSDG) of the UN Department for Economic and Social Affairs (UN - DESA)	UNDERSTANDING DATA AND STATISTICS BETTER – FOR MORE EFFECTIVE SDG DECISION MAKING: This e-course aims to offer a double opportunity: i) to help improve the understanding of how better data can help design more effective public policies and ii) to brush up on your core data skills. The course covers aspects related to the interpretation, analysis, and presentation of data of direct relevance to the SDGs and more broadly national and sectoral policies aimed at ensuring sustainable and inclusive development.	Public officials in charge of SDG policies, as well as data producers and anyone interested to learn more about the role of data in public policy design	
<i>UNITAR</i> and the Division for Sustainable Development Goals (DSDG) of the UN Department for Economic and Social Affairs (UN - DESA)	INTRODUCTION TO THE 2030 AGENDA: A NEW AGENDA FOR A SUSTAINABLE WORLD: This e-course on "Introduction to the 2030 Agenda: A New Agenda for a Sustainable World" is designed to improve general awareness about the 2030 Agenda and Sustainable Development	Policy makers, youth, public	Open

	Goals for policy-makers and the general public, especially youth. Participants can follow the course at their own pace, and can earn a certificate provided if they have met the certification requirements.		
University System of Maryland	Professional Certificate in Environmental Management for Sustainability: advising policy-makers, business leaders, and other environmental stakeholders on issues related to environmental management and sustainability.	All	Fees are applied. 4 courses in 5 months
<u>SDGAcademyX</u>	Cities and the Challenge of Sustainable Development: The basics of sustainability The Sustainable Development Goals and how they apply to cities What constitutes a sustainable city	All	Free and option for certificate with fees
<u>SDGAcademyX</u>	Age of Sustainable Development: The basics of the Sustainable Development Goals The role of people: from inequality, to poverty, to health and human rights The role of the planet: planetary boundaries, the value of renewable energy, and sustainable consumption of our natural resources	All	Free and option for certificate with fees

<u>UC3Mx</u>	SDG: Moving Towards Sustainable Work: Concepts and initiatives behind the UN's SDG (Sustainable Development Goals) How to build decent and sustainable work	All	Free and option for certificate with fees
<u>ImperialBusiness</u> <u>X</u>	Introduction to Corporate Sustainability, Social Innovation and Ethics: Develop an understanding of the strategic challenges faced by modern organisations in today's global business environment Develop a basic understanding of sustainability thinking and triple-bottom-line approaches	All	Free and option for certificate with fees
TUDelft, Wagenigen	Sustainable Urban Development: The most relevant challenges that metropolitan regions are facing How you can respond to these challenges Examples of sustainable, metropolitan interventions and solutions How to critically reflect on and engage in the sustainable cities debate	All	Free and option for certificate with fees
KU Leuven	The UN Sustainable Development Goals: an	All	Free and option for certificate
	Interdisciplinary Academic Introduction: Understand the emergence and development of the SDGs Understand how the different SDGs are interrelated Understand the structure of the SDGs in the United Nations context		with fees
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University of Copenhagen	The Sustainable Development Goals – A global, transdisciplinary vision for the future: The course will examine how various societal actors are responding to and implementing the SDGs.	All	Free. 10 hours to complete
Erasmus University Rotterdam	Driving business towards the Sustainable Development Goals: This course has been developed by Rotterdam School of Management at Erasmus University (RSM). It focuses on the role of businesses in achieving the SDGs. You will gain insights from leaders of international companies and academics in business and management who will guide you through the issue of how businesses can contribute to the SDGs. The course received a 'MOOC Award of Excellence' by the Sustainable Development Solutions Network and the SDG Academy in September 2019	All	Free and option for certificate with fees. 15 hours to complete

	(https://www.unsdsn.org/2019 -sdsn-awards-of-excellence- winners-announced)		
CEI International Affairs Escuela Diplomática de Barcelona	winners-announced) Master in Sustainable Development: This master's degree aims to raise awareness of the 2030 Agenda and, above all, to help the different stakeholders concerned to put it into practice. For this, the master has an interdisciplinary approach that aims to contribute to integrating and weighing the economic, social and environmental dimensions of sustainable development.	The master's main recipients are three groups of people: Postgraduate students who want to deepen and specialize in the field of sustainable development; People who work in the private sector and have professional reasons to go deeper into this area; People who carry out their	Tuition fees. 1- 2 years
		professional activities in the public sector and who have direct	
		responsibility for some of the aspects of the 2030 Agenda and the SDGs.	
New College of the Humanities	MSc Digital Politics & Sustainable Development:	Graduates, Professionals	GBD 10000/year. 1-2

	MSc Digital Politics & Sustainable Development aims to:		years
	to train in political science and international relations, including how to find sources, analyse and critique evidence, and evaluate the value of different sources		
	to develop an awareness and understanding of the different approaches to, and theories of sustainability and development, security, digital transition, and global citizenship in contemporary global politics		
	to give a thorough grounding in the discipline and practice of International Relations and to encourage critical evaluation of how the past is represented, constructed, debated, and contested in relation to the present and the future, in different settings, and at different unit levels of analysis		
	to give students an appreciation of the complexity of research within Political Science and International Relations		
Mälardalen University	Master in Environmental Engineering for Sustainable Development:	Graduate students	SEK 27000/year. 2 years

Örebro University	Master's Programme in Public Planning for Sustainable Development:	Graduate students	SEK 67000/year. 1 year
University of Sussex Business School	MSc Sustainable Development: This interdisciplinary course focuses on the policies and politics of transformations to sustainability.	Graduate students	GBD 12450/year. 1-2 years
Queen's University Belfast	MSc Leadership for Sustainable Development: This innovative conversion Masters programme is open to applicants from all disciplinary backgrounds and promotes leadership and embraces action-based, experiential learning, facilitated through a series of lectures, work placements and group projects.	Graduate students	GBD 17000/year. 1 year
Leuphana University Luneburg	Master of Science in Sustainability Science	Graduate students	Fees. 4 semesters
Utrecht University	Master in Sustainable Development: This two-year Master's programme is aimed at students who want to contribute to the design of the solutions needed to achieve an environmentally and socially accountable society.	Graduate students	EUR 2168/year. 2 years
TU-Campus EUREF	Building Sustainability (MBA)	Graduate students	EUR 5000/semester. 3 semesters
ESI Business	Master's degree in Sustainable	Graduate	EUR 7690year.

School	Development and Environment	students	2 years
University of Bologna	Master in Resource Economics and Sustainable Development:	Graduate students	Tuition fees. 2 years
	The Master's degree in Resource Economics and Sustainable Development offers a solid preparation in environmental economics, a critical understanding of the economics of sustainable development, and of the complex interactions between economic decisions, market forces, governmental policies, and the environment.		
Stockholm University	Master in Social-Ecological Resilience for Sustainable Development: resilience thinking as an approach to managing socio-ecological systems and to help you solve real-world problems.	Graduate students	SEK 70000/semester . 4 semesters
Aucal Business School	Master's Degree in Sustainable Development Goals: a training with a degree from the Pegaso University of Italy, and a certificate from CIFAL Miami (from the United Nations) directed by Smartly, Social Entrepreneurship in ODS in alliance with Aucal Business School that comes to deliver a real contribution to the global- local community contributing to the transformation process of the world affected by all current events and promoting greater inclusion of the human being with preservation of the	Graduate students	Tuition fees. 1 year

	planet.		
Linköping University	MSc in Science for Sustainable Development: The courses cover a broad range of topics – from climate change and biodiversity loss to feminism and colonization	Graduate students	SEK 220000/year/ 4 semesters
Queen's University of Belfast – Medical Faculty	MSc in Leadership for Sustainable Development: This innovative conversion Masters programme is open to applicants from all disciplinary backgrounds and promotes leadership and embraces action-based, experiential learning, facilitated through a series of lectures, work placements and group projects.	Graduate students	Tuition fees. 1 year
IBS International Business School Ljubljana	MA in International Business and Sustainable Development: MA programme International Business and Sustainable Development were created for BA graduates of different programmes who face sustainable development problems as an element of decision-making in the business world.	Graduate students	-
Grozny State Oil Technical University	Environmental Monitoring for Sustainable Development, Ecology and nature management, Master's Degree	-	-

It can be observed even from this set, that Sustainable Development is more integrated in educational programs than Digital Transformation. There are professional seminars, courses, master's programs etc. covering all dimensions of Sustainability from science to law. Thus, despite its abstract nature and complexity, people seem to be interested to learn on and about Sustainable Development. The differences compared to programs on Digital Transformation can be attributed partially to the maturity of the subject matter: Sustainable Development and Sustainability are older areas of research and application. On the other hand, Digital Transformation has entered the public debate in the last few years with the advancement of digital technologies and the internet. As a result, the SYSTEMA project aims at addressing also this gap.

In conclusion, the studying of the literature and the research projects revealed several insights regarding Sustainable Development and Systems Thinking/System Dynamics:

(1) The methodology appears to be suitable for policy modelling in the context of SusDev because it can represent many details that may not be easily quantified and are usually missing from purely econometric models. The inclusion of such parameters/variables illustrated that management is important if an organisation (or a country or the world) wishes to achieve Sustainable Development. Thus, similar to Digital Transformation, organisations (public and private) need to become "learning organisations".

(2) Systems Thinking is proven to be an ideal solution to bring together different stakeholders and incorporate different views/perceptions in the modeling process. Thus, the models become common for all and any policy that may result from them has the potential to be adopted as it might not feel imposed, but rather explored and agreed upon.

(3) Finally, Systems Thinking can be an ideal educational methodology since it allows any learner to test the theory in practice, observe any system holistically and design different policies in a consequence-free environment, but similar to Digital Transformation, more case studies and learning modules are necessary.

Regarding the lessons from the literature, it appears that the social dimension is not as extensively explored as the environmental and economic one; demographics might be integral to the majority of the models, but societal and individual values are not as often utilized, which can be considered a research gap. Furthermore, System Dynamics models might be criticized on the validity of their results (Qudrat-Ullah, 2008), however a participatory model building along with the integration of System Dynamics with other methodologies are efforts to increase the robustness of the SD models and their results.

Generalized Causal Loop Diagram (CLD)on Sustainable Development A CLD has been developed by the insights revealed in the literature and it is displayed in the figure below.



Figure 11 CLD of Sustainable Development dimensions

As it can be observed, the simple CLD contains a series of balancing loops between the economy, the population and the environment. These loops can offer several insights regarding how future behavior/scenarios could evolve: For example, an increased population in general means growth for the economy, which further increases the population. However, the increased population comes in detriment of the environmental resources, which in turn reduce the population. Thus, Sustainable Development contrary to Digital Transformation is a more abstract and encompassing notion that is more difficult to quantify and predict how it could evolve. Nonetheless, the insights that are offered by CLDs and Systems Thinking in general could guide potential policies to avoid bottlenecks and adverse consequences.

Moreover, Technology and Innovation have been included in models in the literature, but their relation to the environmental resources is not yet clear. However, what is mostly missing from SD models is a purely social dimension and how it can interact with the economy, the environment and technology. Such an inclusion might be vague (in terms of data) and uncertain but could reveal important leverage points for successful policies.

In conclusion, the synergy between Systems Thinking and Sustainable Development has been explored to a greater extent compared to Digital Transformation. However, Sustainable Development could mean different things to different stakeholders, using different temporal and spatial dimensions. For that reason, the generalized CLD is vaguer and more abstract than the one developed in Digital Transformation. At the same time this is not unexpected since sustainable development is a broad term that encompasses many dimensions that cannot be easily measured and/or quantified. Nonetheless, even the vague CLD could offer great insights to policy makers.

Contrary to the case of Digital Transformation, Systems Thinking has been used in education in parallel to Sustainable Development. The value of the discipline has been recognised and its use as a valuable educational tool has been gaining traction. The SYSTEMA project will expand on this trend.

One last point of discussion is the term of technology itself; if the term can be seen as the overarching concept of Digital Transformation that was discussed in previous sections, then the two CLD models can be connected, thus revealing that Digital Transformation can affect Sustainable Development (and possibly vice versa. Figure below).



Figure 12 Connected CLDs of Digital Transformation and Sustainable Development

Such a connection between the two terms offers new research avenues and potential leverage points for successful policies. At the same time, connecting the two systems increases their complexity which can prove daunting for non-experts, thus cancelling any value. However, we are of the belief that proper training in Systems Thinking can greatly assist in reducing the conceptual complexity of the interconnected systems, and SYSTEMA will work towards that goal.

IDENTIFICATION OF CURRENT AND FUTURE EDUCATIONAL NEEDS FOR SUSTAINABLE DEVELOPMENT AND DIGITAL TRANSFORMATION

To identify the current and future educational needs for sustainable development and digital transformation, the SYSTEMA partnership executed two tasks:

(1) Identified the target groups to which the project will be addressed

(2) Developed a survey with the purpose of identifying what these target groups are in need in terms of digital transformation and sustainable development.

Target Groups

For the identification of target groups, the partnership identified 4 types of organisations and stakeholders:

- 1. Managers and Leaders in Private Organisations (CEOs, HR Managers, CTOs etc.)
- 2. Educators on Digital Transformation and/or Sustainable Development
- 3. Students at First Degree or Masters level
- 4. Policy Makers

Each partner reached into their respective networks and identified stakeholders who fall in one or more of the above categories. The list includes stakeholders that are regional, national and transnational, from SMEs to large public organisations. The table below summarises the identified actors of the SYSTEMA project.

Table 4 List of groups that could participate in the SYSTEMA project

1-Organisations' Managers/ Leaders - CEO, HR Manager/ CTOs/ SD Managers	2-DT/SD Education/ Training multipliers - DT/ DS teachers, experts researchers and consultants
SNA - Scuola Nazionale delle Amministrazioni Pubbliche	Provincial Environmental Protection Agency (APPA) - Office for environmental education
Comune di Roma - Dip. Formazione Dipendenti	Tree Srl (Opinno Group)
Engineering Ingegneria Informatica	Istituto Tecnico Superiore Servizi alle Imprese
Cassa Depositi e Prestiti	Noema HR
United Nations - FAO	Formez PA
United Nations - DEPARTMENT OF	Federazione Italiana Aziende Sanitarie e Ospedaliere

ECONOMIC AND SOCIAL AFFAIRS	
United Nations - World Food Program	Digital Education Lab
World Bank (Andrea Coppola)	Nitage
Microsoft (Mattia De Rosa)	Forum PA
Accenture	RUS - Rete delle Università Italiane per lo Sviluppo Sostenibile
Asso Compliance	Politecnico di Torino
PWC	Università di Torino
Deloitte	Università degli Studi Gastronomici di Pollenzo
RAI Radio Televisione Italiana (various journalists)	Link Campus University
Infocredit Professional Education	IUL - Univ. Telematica degli Studi
Conicon training and management consulting	Univ. di Foggia
OXYGONO	Univ. degli Studi di Roma "Sapienza"
Zenox Public Affairs	System Dynamics Society
Mediterranean Institute of Management	SUPAGRO
Logicom Solutions	LUISS Business School
Cyprus Productivity Centre	Pontificia Università Gregoriana
Clinic Agia Foteini -Kalogeropoulos	Cyprus Institute of Professional Education
Bank of Thessaly	General Secondary Education Office
Sigma Economotexniki	Department of Higher Education
Mikel Coffee Company	UCLAN Cyprus
House Fitness Studio	Frederick University
	Cyprus Research Centre
3-Students - Bachelor or Master students of BA and STEM	The Cyprus Institute
SNA - Scuola Nazionale delle Amministrazioni Pubbliche	CIIM
Comune di Roma - Dip. Formazione Dipendenti	CIMA
Zenox Public Affairs	Cyprus College
Mediterranean Institute of Management	Neapolis University Paphos
SUPAGRO	European University Cyprus
LUISS Business School	Research support service, UCY
General Secondary Education Office	UNDP Cyprus

Department of Higher Education	AKTI
UCLAN Cyprus	Civic Engineering-Aristotle University of Thessaloniki
Frederick University	4-Policy makers
The Cyprus Institute	Agenzia per l'Italia Digitale (AgID)
CIIM	Dip. Funzione Pubblica
CIMA	Ministero delle Politiche Agricole e Forestali
Cyprus College	INDIRE
Neapolis University Paphos	Deputy Ministry of Research, Innovation and Digital Policy, Cyprus
European University Cyprus	United Nations - FAO
Research support service, UCY	United Nations - DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS
Civic Engineering-Aristotle University of Thessaloniki	United Nations - World Food Program
	World Bank (Andrea Coppola)
	Formez PA
	Federazione Italiana Aziende Sanitarie e Ospedaliere
	General Secondary Education Office
	Department of Higher Education

Questionnaire

The partnership developed a questionnaire which was disseminated to the list of organisations above (among others). The questionnaire is displayed below.

A. The SYSTEMA Project

The SYSTEMA project (**2020-1-IT02-KA204-080082**) was conceived to address the incentive of the European Commission that is focused on Sustainable Development and Digital Transformation. The SYSTEMA project therefore aims to address the priority of adult education "Extending and Developing the competences of educators and other personnel who support adult education" and other horizontal priorities like "Supporting individuals in acquiring and developing basic skills and key competences" and "Environmental and climate goals" by:

1. developing key competencies focusing on (a) systems thinking skills to improve information-processing, self-direction, problem-solving and communication (b) computational and mathematical skills to translate systems thinking skills into actionable models in the fields of sustainable development and digital transformation

- 2. leveraging the latest Information and Communication Technologies to improve the quality of training
- 3. developing a comprehensive training approach that will support educational organisations to identify the strengths and weaknesses of their skills development systems.

Hence, at its core, the SYSTEMA project is focused on providing advanced training that will include:

- the ability to know how to observe and grasp the "circular" nature of the world we live in
- develop a higher awareness of the role of the "Systems" structure in determining their behaviour
- improve the understanding of the role and impact on the behaviour of a system due to its feedback loops
- an enhanced understanding of the presence of systemic delays between actions and impact
- a deeper understanding that there are potentially unexpected consequences for actions

SYSTEMA

Official Website: <u>http://www.systemaerasmus.eu/wp/</u>

The Consortium

- System Dynamics Italian Chapter (Italy)
- Intellegere (Italy)
- University of Macedonia (Greece)
- The Academy of Code (Ireland)
- CSICY (Cyprus)
- Kompass (Germany)
- ASVIS (Italy)

B. Definitions

<u>Digital Transformation (DT):</u> Increasing application of digitisation and/or automation that has important impact on structure or characteristics of individual work, internal processes, communication, infrastructure, business ecosystems and products/services for internal and/or external customers. The core of Digital Transformation is the overall digitisation and cross-linking of the value creation process.

<u>Sustainable Development:</u> "The ability to meet the needs of the present without compromising the ability of future generations to meet their own needs". In a sense, Sustainable Development focuses on how social organisations and technology affect natural resources and the ability of the biosphere to absorb those effects. Ultimately, sustainable development implies a fair distribution of limited resources.

C. Survey sent to target groups

This study will collect data from people of all ages. Your participation involves filling out this questionnaire that examines issues of Digital Transformation and Sustainable Development in organisations. It will take you approximately 5-7 minutes to complete the survey. Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. The answers that you give will remain confidential and you will not be individually identified in any analysis of the results of this questionnaire. All information you provide will be anonymous and will be used for the specific purposes only in accordance with the GDPR regulations of the European Union.

Despite the fact that there may be no direct benefit to you, your participation in this survey will expand our knowledge and understanding of the current situation of Digital Transformation and Sustainable Development in Europe.

If you have any questions concerning the purposes of this research study or any other questions about the subject's validity and ethical issues you can communicate with the SYSTEMA partner of your country.

With kind regards,

The SYSTEMA project team

Part One: Demographics

Instructions: Please read each question carefully and tick the box that is true for you

1. What is your age group? (You can tick <u>only one</u> answer)	
a. 18-24 years old	
b. 25-34 years old	
c. 35-44 years old	
d. 45-54 years old	
e. 55-64 years old	
f. 65-74 years old	
g. 75 years or older	
h. I prefer not to answer	

2. What is your gender? (You can tick <u>only one</u> answer)	
a. Male	
b. Female	
c. Other	
d. I prefer not to answer	

3. What is the highest degree or level of school you have completed? If currently enrolled, highest degree received so far. (You can tick <u>only one</u> answer)

- a. Primary school
- b. Secondary school
- c. High school
- d. Professional degree
- e. Bachelor's degree
- f. Master's degree
- g. Doctorate degree
- h. I prefer not to answer

4. Please state (write down) the country that you are currently working in.

5 . Please indicate the sector that you are currently operating in. (You can tick	
<u>only one</u> answer)	
a. Information and Communication	
b. Manufacturing	
c. Wholesale and Retail Trade	
d. Education	
e. Health sector and Social services	
f. Energy	
g. Agriculture	
h. Tourism	
i. General Services	
j. Construction	
k. Public Sector	
1. Other	

6. What is your current role in your workplace (You can tick <u>only one</u> answer)

a. Employee without managerial responsibilities (private or public organisation)

b. Employee with managerial responsibilities (private or public organisation)

c. Director/CEO/ C-Level executive etc. (senior management – private or public organisation)

d. Founder and owner of Business

e. Consultant

f. Trainer, teacher etc.

g. Student in Tertiary education

h. Other

Part Two: Digital Transformation

Instructions: Please read each question carefully and tick the box that is true for you

7. What do you believe that Digital Transformation means for your business/organisation (You can tick <u>only one</u> answer)

a. Using Information Technologies as instrument to automate single activities

b. Implementing and replacing chains of process and employing Information and Communication Technologies (ICT) to coordinate activities and increase cooperation

c. The digitization of the product and/or service

d. All of the above

e. None of the above

Please answer the follo	owing questions:			
8. Do you feel that Di competitive advantag	gital Transform ge? (You can tick	nation will off c <u>only one</u> answ	er your orga : ver)	nisation a
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
9. Do you feel that Di competitive advantag	gital Transform ge? (You can tick	nation of your c <u>only one</u> answ	organisation	n will offer YOU a
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
10. Has your organisa	ation experience	ed difficulty in	n finding qua	lified applicants
for its Digital Transfe	ormation? (You	can tick <u>only c</u>	o <u>ne</u> answer)	
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
11. Do you believe the	at YOU are suit	ably prepared	d for the Dig	ital
Transformation of yo	our organisation	n (You can tick	<u>only one</u> ans	wer)
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
12. Has your organisa	ation commence	ed the process	of Digital T	ransformation
(You can tick <u>only one</u>	answer)			
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

13. Please indicate which of the following barriers you believe are those that obstruct the successful Digital Transformation of your organisation (You can tick <u>more than one</u> answers)

- a. Underestimation of the effort to push innovation
- b. Missing skills by employees
- c. Missing skills by employers/managers etc.
- d. Technical/Technological barriers
- e. Security issues
- f. Individual employee barriers (fear of job loss, fear of demotion etc.)
- g. Individual manager barriers (fear of losing traditional roles, no clear vision etc.)
- h. Tax rates and tax administration of the country
- i. Political instability of the country
- j. Access to finance
- k. Labor regulations
- 1. Corruption
- m. None of the above

14. Please indicate which of the following competencies are currently missing infrom your organisation that prevent a successful Digital Transformation

a. Literacy Competence (The ability to identify, express, understand, create and interpret concepts, facts and opinions. It implies the ability to communicate and connect effectively with others.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
b. Multilingual Comp effectively.)	etence (The abili	ty to use different	ent languages	appropriately and
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
c. Critical Thinking a apply critical thinking situations.)	nd Problem Solv g and insight in o	ing competence order to solve a	es (The ability range of prol	v to develop and blems in everyday
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
d. Competence in scie to the ability and will and engineering are a and needs.)	ence, technology ingness to explai application of kno	and engineerin n the natural w owledge of scie	ng (Competenc vorld. Compet vorce in respon	ce in science refers ence in technology se to human wants
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
e. Digital Competenc	e (It involves the	confident, criti	ical and respo	nsible use of, and

engagement with digital technologies for learning at work and participation in society.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
f. Personal, social and oneself, effectively ma way, remain resilient	d learning to lean anage time and in and manage one	rn competences formation, wo 's own learning	t (The ability t rk with others g and career.)	to reflect upon in a constructive
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
g. Citizenship Compe participate in civic an and political concepts	tence (The ability ad social life base s and structures.)	v to act as resp ed on understar	onsible citizen uding of socia	and to fully l, economic, legal
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
h. Entrepreneurship (and transform them in	Competence (The nto value.)	capacity to act	t upon opporti	unities and ideas
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
i. Cultural awareness respect how ideas and different cultures.)	and expression (d meaning are cr	Competence (T eatively expres	he ability to u sed and comm	nderstand and uunicated in
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
j. Business Managem projects.)	ent Competence (The ability to 1	nanage succe	ssful people and
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Part Three: Sustainable Development

15. What do you believe that Sustainable Development means for your business/organisation (You can tick <u>only one</u> answer)

a. Continuous economic growth

b. Economic growth while promoting "green solutions"

c. Economic growth and social developments while respecting environmental boundaries

d. All of the above

e. None of the above

Please answer the follo	owing questions:			
16. Do you feel that S competitive advantag	Sustainable Dev ge? (You can tick	elopment will x <u>only one</u> answ	offer your o ver)	ganisation a
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
17. Do you feel that S	Sustainable Dev	elopment of y	our organisa	tion will offer
YOU a competitive a	dvantage? (You	can tick <u>only o</u>	o <u>ne</u> answer)	
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
18. Has your organis	ation experienc	ed difficulty in	n finding qua	lified applicants
in order to achieve S	ustainable Deve	lopment? (You	u can tick <u>onl</u>	<u>y one</u> answer)
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
19. Do you believe th	at YOU are suit	tably prepared	l to help you	r organisation
achieve Sustainable l	Development? (You can tick <u>or</u>	<u>ıly one</u> answe	<i>r</i>)
Strongly disagree	Disagree	Neutral	Agree	Strongly agree
20. Has your organis	ation commence	ed the process	to achieve S	ustainable
Development? (You c	an tick <u>only one</u>	answer)		
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

21. Please indicate which of the following barriers you believe are those that obstruct the successful Sustainable Development of your organisation (You can tick <u>more than one</u> answers)

a. Underestimation of the effort to push innovation

b. Missing skills by employees

c. Missing skills by employers/managers etc.

d. Technical/Technological barriers

e. Security issues

f. Individual employee barriers (fear of job loss, fear of demotion etc.)

g. Individual manager barriers (fear of losing traditional roles, no clear vision etc.)

h. Tax rates and tax administration of the country

i. Political instability of the country

j. Access to finance

k. Labor regulations

l. Corruption

22. Please indicate which of the following competences are currently missing infrom your organisation that prevent a successful Sustainable Development

a. Literacy Competence (The ability to identify, express, understand, create and interpret concepts, facts and opinions. It implies the ability to communicate and connect effectively with others.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
h Multilingual Comm	store as (The shili	to to use different		annuan wigt also and

b. Multilingual Competence (The ability to use different languages appropriately and effectively.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

c. Critical Thinking and Problem Solving competencies (The ability to develop and apply critical thinking and insight in order to solve a range of problems in everyday situations.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

d. Competence in science, technology and engineering (Competence in science refers to the ability and willingness to explain the natural world. Competence in technology and engineering are application of knowledge of science in response to human wants and needs.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
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e. Digital Competence (It involves the confident, critical and responsible use of, and engagement with digital technologies for learning at work and participation in society.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree

f. Personal, social and learning to learn competencies (The ability to reflect upon oneself, effectively manage time and information, work with others in a constructive way, remain resilient and manage one's own learning and career.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
g. Citizenship Compe participate in civic ar and political concepts	tence (The ability nd social life base s and structures.)	v to act as respo ed on understar	onsible citizen Iding of socia	and to fully l, economic, legal

Strongly disagree	Disagree	Neutral	Agree	Strongly agree
h. Entrepreneurship (and transform them in	Competence (The nto value.)	capacity to act	t upon opporti	unities and ideas

Subligity disagree Disagree Redutar Refee Subligity agree

i. Cultural awareness and expression Competence (The ability to understand and respect how ideas and meaning are creatively expressed and communicated in different cultures.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
<i>j. Business Management Competence (The ability to manage successful people and projects.)</i>					
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	

Would you like to stay informed about the SYSTEMA project?	
a. No, I do not wish to stay informed	
b. Yes, I would like to receive promotional material and newsletters about the project	
If you wish to stay informed on the project please provide us with your email address (GDPR protections apply. Your email address is for receiving the project's promotional material and newsletters only. We will keep the email address only for the duration of the project. Should you wish at any point to sto receiving promotional material, please contact the project's Coordinator Stefar)p 10

Armenia at s.armenia@iuline.it)

Thank you for taking the time to complete this Questionnaire!

The analysis of the results is presented in the next section of the deliverable

ASSESSMENT OF CURRENT SKILL GAPS

The survey was disseminated by the SYSTEMA partners to their respective networks. 285 responses were collected.

The first step of the process was to cleanse the data. Entries that were left blank were replaced with the notation N/A. Data entries with more than half of the questions unanswered were deleted from the dataset. The final set did not differ significantly from the original.

Demographics and Descriptive Statistics

The 285 responses originate from 16 countries, while the countries with the highest return of answers were from Italy (90 responses), Greece (87 responses) and Cyprus (40 responses). The distribution of the answers per country can be observed in Figure 13 below.



Figure 13 Distribution of responses per country

In addition, the respondents were from all age groups (Figure 14 on the left), with the majority being in the 25-34 cohort, while the majority were male (56.14%)(Figure 14 on the right).



Figure 14 Age cohorts (left) and gender (right)

Furthermore, the majority of the respondents had a first degree or higher, and 113 out of 285 had a Masters degree (Figure 15).



Figure 15 Educational level of survey participants



Figure 16 Employment sector of the respondents

Moreover, the respondents worked across a variety of sectors, with education being the most common one, followed by Information and Communication Technology and Research and Consulting (Figure 16). Finally, 25.26% of the respondents self-identified employees with managerial responsibilities either in a public or private organisation, while 22.46% identified as employees without managerial responsibilities. Finally, 14.04% of the respondents were teachers, trainers etc. (Figure 17).



Figure 17 Role at the workplace of survey participants

Answers regarding Digital Transformation

Q7: What do you believe that Digital Transformation means for your business/organisation (*You can tick <u>only one</u> answer*)?

The first part of the questionnaire focused on the issue of Digital Transformation. In the question: "What does Digital Transformation mean for your business or organisation", the respondents answered:

- 18.9% Employing Information and Communication Technologies (ICT) to coordinate activities and increase cooperation
- 7% Using Information Technologies as instrument to automate single activities
- 5.95% The digitisation of the product and/or service
- 64.56% All of the above
- 1.4% None of the above (Figure 18)



Figure 18 What does DT mean for the organisation

Consequently, the majority of the respondents comprehend the full scope of what Digital Transformation is and do not consider that it merely means digitisation of products and/or services.

Q8: Do you feel that Digital Transformation will offer your organisation a competitive advantage? (*You can tick <u>only one</u> answer*)

Furthermore, in the question of whether Digital Transformation could offer a competitive advantage to the organisation, the majority of the answers either agree or strongly agree with the statement (Figure 19).



Figure 19 DT as a competitive advantage for the organisation

In addition, it was investigated whether there is a relation between the sector or role that a respondent has in the organisation and whether Digital Transformation is seen as a competitive advantage. For that reason two chi-squared tests (Pearson, 1900) were performed. The null hypotheses are stated as follows:

H0_1: A respondent's answer on the question whether DT can offer a competitive advantage to their organisation is independent of their sector

H0_2: A respondent's answer on the question whether DT can offer a competitive advantage to their organisation is independent of their role in the same organisation.

The results of the tests are summarized on table 5 and show that both null hypotheses cannot be rejected. As a result, all types of employees, employers, teachers etc. in all sectors recognize that Digital Transformation could be beneficial for their organisation.

Table 5 Results of the Chi-squared tests: $H0_1$: A respondent's answer on the question whether DT can offer a competitive advantage to their organisation is independent of their sector/ $H0_2$: A respondent's answer on the question whether DT can offer a competitive advantage to their organisation is independent of their role in the same organisation.

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_1	193.22	198	231.8	0.58
H0_2	45.88	35	49.802	0.1

Q9: Do you feel that Digital Transformation of your organisation will offer YOU a competitive advantage? (*You can tick <u>only one</u> answer*)

Similarly, the majority of the respondents believed that Digital Transformation would not only be beneficial for the organisation but also for themselves (Figure 20). However, compared to the previous question, the percentage of Strongly Agree option is lower and the Neutral option percentage is higher. Consequently, it could be argued that while DT is seen as a clear advantage for an organisation, the same clarity does not apply when it comes to the individual.



Figure 20 DT as a competitive advantage for the respondents themselves

Further, two chi-squared tests were performed to investigate whether the sector or the role of the respondent influenced the answer to the question whether DT is an advantage for the individual. The null hypotheses are formed as follows:

H0_3: A respondent's answer on the question whether DT can offer a competitive advantage to themselves is independent of their sector

H0_4: A respondent's answer on the question whether DT can offer a competitive advantage to themselves is independent of their role in the same organisation.

The results are summarised on Table 6 below.

Table 6 Results of the chi-squared tests: $H0_3$: A respondent's answer on the question whether DT can offer a competitive advantage to themselves is independent of their sector/ $H0_4$: A respondent's answer on the question whether DT can offer a competitive advantage to themselves is independent of their role in the same organisation.

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_3	148.04	198	231.82	0.99
H0_4	38.52	35	45.88	0.31

Similar to the previous results, the null hypotheses could not be rejected which means that neither the sector nor the position have a dependency with the answer to whether DT offers a competitive advantage to the respondents themselves.

Moreover, the next three questions focused on the process of DT itself and are:

- Whether the respondents believe that their organisation has experienced difficulties in finding people with the appropriate skills for DT (Q10)
- Whether the respondents themselves believe that they are suitably prepared (Q11)
- Whether their organisation has commenced the process of DT (Q12)

Figure 21 below summarises the results.



Figure 21 Answers on the process of DT

Interestingly, the majority of the answers on whether there were difficulties in finding the appropriate people was Neutral, however, it is recognised that there is a difficulty since the second largest percentage was the Agree option. At the same time the majority of the respondents believe that their organisation has commenced the process of Digital Transformation and at the same time they are suitable prepared for it.

To investigate whether there is a relationship between the difficulty to find appropriate people and if the organisation has started the process of DT, a chi-squared test was performed. The null hypothesis is formulated as follows:

H0_5: The answer to whether the organisation has difficulties in finding appropriate applicants is independent of the answer of whether the DT of the same organisation has commenced.

The results are summarised on table 7 below

Table 7 Results of the chi-square test: H0_5: The answer to whether the organisation has difficulties in finding appropriate applicants is independent of the answer of whether the DT of the same organisation has commenced.

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_5	244.92	36	50.998	6.67242E-33

As it can be observed, the calculated value is larger than the critical value which means that the null hypothesis can be rejected. Therefore, it is clear there is a relationship between the two questions, which is not unexpected. If an organisation cannot find the appropriate people, then the process of Digital Transformation will face a lot of difficulties.

Q13: Please indicate which of the following barriers you believe are those that obstruct the successful Digital Transformation of your organisation (*You can tick* <u>more than one</u> answers).

An important question focused on what the respondents believe were the most important factors that hinder the successful Digital Transformation of their organisations. The respondents were given a list of factors and they could vote the ones they believed were the most important (each respondent could cast more than one vote). The results are summarised in Table 8 below.

Factor that could hinder DT	Count
a. Underestimation of the effort to push innovation	97
b. Missing skills by employees	94
c. Missing skills by employers/managers etc.	146
d. Technical/Technological barriers	92
e. Security issues	58

Table 8 Factors that hinder DT

f. Individual employee barriers (fear of job loss, fear of demotion etc.)	59
g. Individual manager barriers (fear of losing traditional roles, no clear vision etc.)	53
h. Tax rates and tax administration of the country	13
i. Political instability of the country	10
j. Access to finance	51
k. Labor regulations	11
1. Corruption	9
m. None of the above	19

As it can be observed, missing skills by the employers, managers etc. (21%) is considered by far the most important factor that could limit the extent of an organisation's Digital Transformation and it is followed by the Underestimation to push innovation (14%), missing skills by the employees (13%) and finally Technological barriers (13%). Consequently, the responses indicate that Digital Transformation is affected more by the skills and vision of management and less by the missing skills of the employees, and any failures with regards to DT are considered to be related more to management or organisational inadequacies and less to the surrounding circumstances (Figure 22).



Figure 22 Barriers for Digital Transformation (Overall)

Furthermore, to investigate the situation at the project's partner countries, the responses from Cyprus, Greece, Italy, Ireland and Germany are summarised on Figure 23 below.

As it can be observed in Germany, Greece and Italy the missing skills of the employers are more important than those of the employees. However, for Cyprus and Ireland the situation is reversed. Another interesting insight is that apart from Germany, all the other countries do not consider corruption, labor regulations and political instability as important factors; in fact in most of the partner countries they received zero or very few votes. Finally, only for Cyprus and Greece access to finance seems to be a relatively important barrier.



Figure 23 Factors that could hinder DT in partner countries

Q14: Please indicate which of the following competencies are currently missing from your organisation that prevent a successful Digital Transformation

Finally, to assess the current skills gap, a question about which competencies are missing was asked and the respondents were given the following options:

a. Literacy Competence (The ability to identify, express, understand, create and					
interpret concepts, facts and opinions. It implies the ability to communicate and					
connect effectively with others.)					
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
b. Multilingual Comp	etence (The abili	ty to use differ	ent languages	appropriately and	
effectively.)					
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
c. Critical Thinking a	nd Problem Solv	ing competence	es (The ability	to develop and	
apply critical thinking	g and insight in o	order to solve a	range of prob	olems in everyday	
situations.)					
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
d Compotence in goi		and an ain a anin		in acience nefena	
to the ability and will	ingnass to avplai	una engineerin n the natural w	g (Competent vorld Compet	e in science rejers	
and engineering are	ingliess to explain application of know	n the natural w owledge of scie	oria. Compete ence in respon	se to human wants	
and needs.)		swieuge of sele	nee in respon	se to numun wants	
	L		I .		
Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
e. Digital Competenc	e (It involves the	confident, criti	cal and respo	nsible use of, and	
engagement with digital technologies for learning at work and participation in					
society.)					
society.)	0,	for rearring ar	<i>r</i>	ncipation in	
society.) Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
society.) Strongly disagree	Disagree	Neutral	Agree	Strongly agree	
society.) Strongly disagree f. Personal, social an	Disagree d learning to lean	Neutral	Agree	Strongly agree	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way remain resilient	Disagree d learning to lear unage time and ir	Neutral rn competences oformation, wo	Agree s (The ability t rk with others	Strongly agree to reflect upon in a constructive	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way, remain resilient	Disagree d learning to lean unage time and ir and manage one	Neutral rn competences oformation, wo 's own learning	Agree s (The ability t rk with others g and career.)	Strongly agree to reflect upon in a constructive	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way, remain resilient Strongly disagree	Disagree d learning to lean unage time and ir and manage one Disagree	Neutral rn competences iformation, wo 's own learning Neutral	Agree <i>s</i> (<i>The ability t</i> <i>rk with others</i> <i>g and career.</i>) Agree	Strongly agree to reflect upon in a constructive Strongly agree	
society.) Strongly disagree f. Personal, social an oneself, effectively may way, remain resilient Strongly disagree g. Citizenship Compe	Disagree d learning to lean mage time and ir and manage one Disagree tence (The ability	Neutral rn competences aformation, wo 's own learning Neutral y to act as resp	Agree <i>s</i> (<i>The ability t</i> <i>rk with others</i> <i>g and career.</i>) Agree <i>onsible citizer</i>	Strongly agree to reflect upon in a constructive Strongly agree	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way, remain resilient Strongly disagree g. Citizenship Compe participate in civic an	Disagree d learning to lean anage time and ir and manage one Disagree tence (The ability ad social life base	Neutral rn competences oformation, wo 's own learning Neutral y to act as resp ed on understan	Agree s (The ability i rk with others g and career.) Agree onsible citizer ading of socia	Strongly agree to reflect upon in a constructive Strongly agree and to fully l, economic, legal	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way, remain resilient Strongly disagree g. Citizenship Compe participate in civic an and political concept.	Disagree d learning to lean unage time and ir and manage one Disagree tence (The ability ad social life base s and structures.)	Neutral rn competences oformation, wo 's own learning Neutral y to act as resp ed on understan	Agree s (The ability t rk with others g and career.) Agree onsible citizer nding of socia	Strongly agree to reflect upon in a constructive Strongly agree and to fully l, economic, legal	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way, remain resilient Strongly disagree g. Citizenship Compe participate in civic an and political concept. Strongly disagree	Disagree d learning to lean anage time and ir and manage one Disagree tence (The ability ad social life base s and structures.) Disagree	Neutral rn competences aformation, wo i's own learning Neutral y to act as resp ed on understan	Agree s (The ability to rk with others g and career.) Agree onsible citizer ading of socia	Strongly agree to reflect upon in a constructive Strongly agree a and to fully l, economic, legal Strongly agree	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way, remain resilient Strongly disagree g. Citizenship Compe participate in civic an and political concept. Strongly disagree h. Entrepreneurship	Disagree d learning to lean anage time and ir and manage one Disagree tence (The ability ad social life base s and structures.) Disagree Competence (The	Neutral rn competences iformation, wo 's own learning Neutral y to act as resp ed on understan Neutral capacity to ac	Agree s (The ability t rk with others g and career.) Agree onsible citizer nding of socia Agree t upon opport	Strongly agree to reflect upon in a constructive Strongly agree and to fully l, economic, legal Strongly agree unities and ideas	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way, remain resilient Strongly disagree g. Citizenship Compe participate in civic an and political concept. Strongly disagree h. Entrepreneurship C and transform them in	Disagree d learning to lean unage time and ir and manage one Disagree tence (The ability ad social life base s and structures.) Disagree Competence (The nto value.)	Neutral rn competences iformation, wo 's own learning Neutral y to act as resp ed on understan Neutral capacity to act	Agree (The ability i rk with others g and career.) Agree onsible citizer nding of socia Agree t upon opport	Strongly agree to reflect upon in a constructive Strongly agree and to fully l, economic, legal Strongly agree unities and ideas	
society.) Strongly disagree f. Personal, social an oneself, effectively ma way, remain resilient Strongly disagree g. Citizenship Compe participate in civic an and political concept. Strongly disagree h. Entrepreneurship C and transform them in Strongly disagree	Disagree d learning to lean anage time and ir and manage one Disagree tence (The ability ad social life base s and structures.) Disagree Competence (The nto value.) Disagree	Neutral rn competences aformation, wo 's own learning 's own learning Neutral y to act as respected on understant Neutral capacity to act Neutral capacity to act	Agree s (The ability f rk with others g and career.) Agree onsible citizer nding of socia Agree t upon opport Agree	Strongly agree to reflect upon in a constructive Strongly agree and to fully l, economic, legal Strongly agree unities and ideas Strongly agree	

respect how ideas and meaning are creatively expressed and communicated in different cultures.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
<i>j. Business Management Competence (The ability to manage successful people and projects.)</i>						
Strongly disagree	Disagree	Neutral	Agree	Strongly agree		

The results are summarised in Figure 23 below. As it can be observed, Digital Competencies, Competences in Science, Technology and Engineering and Learning-to-learn competencies are the ones that are considered to be missing to the largest extent from organisations in order to achieve a successful Digital Transformation.


Figure 24 Results of which competencies are missing for DT

In conclusion, a number of lessons were identified from the answer on the issue of Digital Transformation of organisations. The lessons are:

- 1. The majority of the respondents comprehend the full scope of what Digital Transformation is and do not consider that it merely means digitisation of products and/or services.
- 2. In the question of whether Digital Transformation could offer a competitive advantage to the organisation and themselves, the majority of the answers either agree or strongly agree with the statements.
- 3. All types of employees, employers, teachers etc. in all sectors recognise that Digital Transformation could be beneficial for their organisation.
- 4. It could be argued that while DT is seen as a clear advantage for an organisation, the same clarity does not apply when it comes to the individual.
- 5. Neither the sector nor the position has a dependency with the answer to whether DT offers a competitive advantage to the respondents themselves.
- 6. The majority of the respondents believe that their organisation has commenced the process of Digital Transformation and at the same time they are suitable prepared for it.
- 7. The answer to whether the organisation has difficulties in finding appropriate applicants is dependent on the answer of whether the DT of the same organisation has commenced. If an organisation cannot find the appropriate people, then the process of Digital Transformation will face a lot of difficulties to begin.
- 8. Digital Transformation is affected more by the skills and vision of management and less by the missing skills of the employees. Any failures with regards to DT are considered to be a management inadequacy of the organisation and less the surrounding/environmental circumstances.
- 9. Apart from Germany, all the other countries do not consider corruption, labour regulations and political instability as important factors; in fact in most of the partner countries they receive zero or very few votes.
- 10. Only for Cyprus and Greece access to finance seems to be a relatively important barrier.
- 11. <u>Digital Competencies, Competences in Science, Technology and Engineering</u> <u>and Learning-to-learn competencies</u> are the ones that are missing to the largest extent from organisations in order to achieve a successful Digital Transformation.

Answers regarding Sustainable Development

Q15: What do you believe that Sustainable Development means for your business/organisation? (*You can tick <u>only one</u> answer*)

The second part of the questionnaire focused on the issue of Sustainable Development. For the question: "What do you believe that Sustainable Development means for your business/organisation?", the respondents answered:

- 38% Economic growth and social developments while respecting environmental boundaries
- 11% Economic growth while promoting green solutions
- 8% Continuous economic growth
- 35% All of the above
- 2% None of the above
- 6% Did not respond (Figure 25)



Figure 25 What does sustainable development mean for the organisation?

Consequently, the vast majority of the respondents comprehend the multi-dimensional nature of sustainability. It was mentioned in the Introduction that no two definitions of Sustainable Development coincide, however, the results indicate that despite the vagueness, first people understand its complexity and multi-dimensional nature and most have internalised the three-dimensional structure that is common in policy cycles.

Q16: Do you feel that Sustainable Development will offer your organisation a competitive advantage? (*You can tick <u>only one</u> answer*)

In the question of whether Sustainable Development could offer a competitive advantage to the organisation, the majority of the respondents either agree (48%) or strongly agree (31%) with the statement (Figure 26).



Figure 26 Sustainable development as a competitive advantage for the organisation

In addition, it was investigated whether there is a relation between the sector or role that a respondent has in the organisation and whether Sustainable Development is seen as a competitive advantage. The null hypotheses are stated as follows:

H0_6: A respondent's answer on the question whether Sustainable Development can offer a competitive advantage to their organisation is independent of their sector

H0_7: A respondent's answer on the question whether Sustainable Development can offer a competitive advantage to their organisation is independent of their role in the same organisation

The results of the tests are summarised on table 9 and show that both null hypotheses cannot be rejected. As a result, all types of employees, employers, teachers etc. in all sectors recognise that Sustainable Development could be beneficial for their organisation.

Table 9 Results of the chi-squared tests: H0_6: A respondent's answer on the question whether Sustainable Development can offer a competitive advantage to their organisation is independent of their sector/H0_7: A respondent's answer on the question whether Sustainable Development can offer a competitive advantage to their organisation is independent of their role in the same organisation

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_6	153,824	198	231,82	0.99
H0_7	35,95	35	45,88	0.42

Q7: Do you feel that Sustainable Development of your organisation will offer YOU a competitive advantage? (*You can tick <u>only one</u> answer*)

Similarly, the majority of the respondents believe that Sustainable Development would not only be beneficial for the organisation but also for themselves (Figure 27). However, compared to the previous question, the Strongly Agree percentage is lower and the Neutral was higher. Consequently, it could be argued that while Sustainable Development is seen as a clear advantage for an organisation, the same clarity does not apply when it comes to the individual.



Figure 27 Sustainable Development as a competitive advantage for the respondents themselves

Furthermore, two chi-squared tests were performed to investigate whether the sector or the role of the respondents influenced the answer to the question. The null hypotheses are formed as follows:

H0_8: A respondent's answer on the question whether Sustainable Development can offer a competitive advantage to themselves is independent of their sector

H0_9: A respondent's answer on the question whether Sustainable Development can offer a competitive advantage to themselves is independent of their role in the same organisation.

The results are summarised on Table 10 below.

Table 10 Results of the chi-squared tests: $H0_8$: A respondent's answer on the question whether Sustainable Development can offer a competitive advantage to themselves is independent of their sector/ $H0_9$: A respondent's answer on the question whether Sustainable Development can offer a competitive advantage to themselves is independent of their role in the same organisation.

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_8	164,15	198	231,82	0.96
H0_9	28,71	35	45,88	0.76

Similar to the previous results, the null hypotheses could not be rejected which means that neither the sector nor the position have a dependency with the answer to whether Sustainable Development offers a competitive advantage to the respondents themselves.

Moreover, the next three questions focused on the process of Sustainable Development itself and are:

- Whether the organisation has experienced difficulties in finding appropriate people to achieve sustainable development (Q18)
- Whether the respondents themselves believe that they are suitably prepared (Q19)
- Whether their organisation has commenced the process of DT (Q20)

Figure 28 summarizes the results.



Figure 28 Answers on the process of Sustainable Development

Interestingly, the majority of the answers on whether there were difficulties in finding the appropriate were Neutral, however, it is recognised that there is a difficulty since the second largest percentage was Agree . At the same time the majority of the respondents believe that their organisation has commenced the process of Sustainable Development and they are suitable prepared for it.

To investigate whether there was a relationship between the difficulty to find appropriate people and if the organisation has started the process of Sustainable Development, a chi-squared test was performed. The null hypothesis is formulated as follows:

H0_10: The answer to whether the organisation has difficulties in finding appropriate applicants is independent of the answer of whether the Sustainable Development of the same organisation has commenced.

The results are summarised on table 11 below

Table 11 Results of the chi-square test: H0_10: The answer to whether the organisation has difficulties in finding appropriate applicants is independent of the answer of whether the Sustainable Development of the same organisation has commenced.

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_10	389,42	36	50.998	6.9977E-61

As it can be observed, the calculated value is larger than the critical value which means that the null hypothesis can be rejected. As a result, it is clear there is a relationship between the two questions, which is not unexpected. If an organisation cannot find the appropriate people, then the process of Sustainable Development will face a lot of difficulties to begin.

Q21: Please indicate which of the following barriers you believe are those that obstruct the successful Sustainable Development of your organisation (*You can tick <u>more than one</u> answers*)

An important question focused on what the respondents believe were the most important factors that hinder the successful Sustainable Development of their organisations. The respondents were given a list of factors and they could vote the ones they believed were the most important (each respondent could cast more than one vote). The results are summarised in Table 12 below.

Factors that could hinder DT	Count
a. Underestimation of the effort to push innovation	84
b. Missing skills by employees	96
c. Missing skills by employers/managers etc.	120
d. Technical/Technological barriers	78
e. Security issues	21

Table 12 Factors that hinder Sustainable Development

f. Individual employee barriers (fear of job loss, fear of demotion etc.)	39
g. Individual manager barriers (fear of losing traditional roles, no clear vision etc.)	44
h. Tax rates and tax administration of the country	17
i. Political instability of the country	32
j. Access to finance	46
k. Labor regulations	10
1. Corruption	12
m. None of the above	41

As it can be observed, missing skills by the employers, managers etc. (19%) was considered by far the most important factor that could limit the extent of an organisation's Digital Transformation and it is followed by the Underestimation to push innovation (13%), missing skills by the employees (15%) and finally Technological barriers (12%). Consequently, the responses indicate that Sustainable Development is affected more by the skills and vision of management and less by the missing skills of the employees, and any failures with regards to Sustainable Development are considered to be more related to management or organisational inadequacies and less to the surrounding circumstances (Figure 29).



Figure 29 Barriers for Sustainable Development (Overall)

Furthermore, to investigate the situation in the project's partner countries, the responses from Cyprus, Greece, Italy, Ireland and Germany are summarised on Figure 30 below.



Figure 30 Factors that could hinder Sustainable Development in Partner countries

As it can be observed, missing skills by employees is considered the most important barrier for Cyprus, and Ireland. On the other hand, for Greece and Italy, the missing skills of the employers are those that pose the biggest barriers for a successful Sustainable Development. Furthermore, only for Germany Technological barriers are the biggest barrier.

Access to high finance receives a lot of votes in Greece compared to other countries, while the options of corruption and None of the above receive almost 10% of the votes in Germany.

Q22: Please indicate which of the following competences are currently missing in your organisation that prevent a successful Sustainable Development

Finally, to assess the current skills gap, a question related to which competencies are missing was asked and the respondents were given the following options:

a. Literacy Competence (The ability to identify, express, understand, create and interpret concepts, facts and opinions. It implies the ability to communicate and connect effectively with others.) Strongly disagree Disagree Neutral Agree Strongly agree b. Multilingual Competence (The ability to use different languages appropriately and effectively.) Neutral Strongly disagree Disagree Strongly agree Agree c. Critical Thinking and Problem Solving competences (The ability to develop and apply critical thinking and insight in order to solve a range of problems in everyday situations.) Strongly disagree Disagree Neutral Agree Strongly agree d. Competence in science, technology and engineering (Competence in science refers to the ability and willingness to explain the natural world. Competence in technology and engineering are application of knowledge of science in response to human wants and needs.) Strongly disagree Disagree Neutral Strongly agree Agree e. Digital Competence (It involves the confident, critical and responsible use of, and engagement with digital technologies for learning at work and participation in society.) Strongly disagree Disagree Neutral Agree Strongly agree f. Personal, social and learning to learn competences (The ability to reflect upon oneself, effectively manage time and information, work with others in a constructive way, remain resilient and manage one's own learning and career.) Strongly disagree Disagree Neutral Strongly agree Agree g. Citizenship Competence (The ability to act as responsible citizen and to fully

participate in civic and social life based on understanding of social, economic, legal and political concepts and structures.)

Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
h. Entrepreneurship Competence (The capacity to act upon opportunities and ideas and transform them into value.)						
Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
<i>i.</i> Cultural awareness and expression Competence (The ability to understand and respect how ideas and meaning are creatively expressed and communicated in different cultures.)						
Strongly disagree	Disagree	Neutral	Agree	Strongly agree		
<i>j. Business Management Competence (The ability to manage successful people and projects.)</i>						
Strongly disagree	Disagree	Neutral	Agree	Strongly agree		

The results are summarised in Figure 31 below. As it can be observed, Business Management, Cultural awareness, Entrepreneurship, Learning-to-learn, Digital and Competences in science are the ones that are considered to be missing (Agree or Strongly Agree) to the largest extent from organisations in order to achieve a successful Sustainable Development.

		I				
Business Management Competence	10%	14%	30%	24%	10%	14%
Cultural awareness and expression Competence	12%	19%	23%	26%	5%	15%
Entrepreneurship Competence	70/	210/	249/	26%	69/	1 C 0/
	/ 70	2170	2470	2070	070	1070
Citizenship Competence	12%	19%	25%	25%	3%	16%
Personal, social and learning to learn competences	8%	19%	29%	25%	5%	14%
Digital Competence	10%	15%	27%	26%	5%	16%
Competence in science, technology and engineering	9%	17%	25%	27%	8%	14%
	370	1770	20/0	2770		
Critical Thinking and Problem Solving competencies	9%	21%	25%	23%	7%	14%
Multilingual Competence	13%	22%	23%	22%	5%	13%
Literacy Competence	120/	220/	250/	210/	F 0/	4.00/
Literacy competence	13%	22%	<u></u> 25%	21%	5%	13%
	0%	20%	40%	60%	80%	10
	Etronaly Di			Strongly Agroo PN/A		
	 strongly DI 	sagree Disagree	Neutral Agree	Strongly Agree N/A		

Figure 31 Results of which competencies are missing for Sustainable Development

In conclusion, a number of lessons were identified based on the answers regarding Sustainable Development of organisations. The lessons are:

- 1. Despite the vagueness of the definition of Sustainable Development, people understand its complexity and multi-dimensional nature and most have internalised the three-dimensional structure that is common in policy cycles.
- 2. In the question of whether Sustainable Development could offer a competitive advantage to the organisation, the majority of the respondents either agreed (48%) or strongly agreed (31%) with the statement.
- 3. All types of employees, employers, teachers etc. in all sectors recognise that Sustainable Development can be beneficial for their organisation.
- 4. It could be argued that while Sustainable Development is seen as a clear advantage for an organisation, the same clarity does not apply when it comes to the individual.
- 5. Neither the sector nor the position has a dependency with the answer to whether Sustainable Development offers a competitive advantage to the respondents themselves.
- 6. The majority of the respondents believe that their organisation has commenced the process of Sustainable development and at the same time they are suitable prepared for it.
- 7. The answer to whether the organisation has difficulties in finding appropriate applicants is dependent on the answer of whether the Sustainable development of the same organisation has commenced. If an organisation cannot find the appropriate people, then the process of Sustainable development will face a lot of difficulties to begin with.
- 8. The responses indicate that Sustainable development is affected more by the skills and vision of management and less by the missing skills of the employees.
- 9. Missing skills by employees is considered the most important barrier for Cyprus, and Ireland. On the other hand, for Greece and Italy, the missing skills of the employers are those that pose the biggest barriers for a successful Sustainable Development. Furthermore, only for Germany Technological barriers are the biggest barrier.
- 10. Business Management, Cultural awareness, Entrepreneurship, Learning-tolearn, Digital and Competences in science are the onesconsidered to be missing (Agree or Strongly Agree) to the largest extent from organisations in order to achieve a successful Sustainable Development.

Synergy between Digital Transformation and Sustainable Development

Finally, the questionnaire offered the possibility to investigate whether there were synergies between Digital Transformation and Sustainable Development; in other words to analyse whether the answers of one issue affect or are affected by the other. For that reason, a series of statistical tests was performed.

The first null hypothesis concerns whether the two issues offer a competitive advantage for the organisation and is stated as follows:

H0_11: The answer to the question of whether Digital Transformation offers a competitive advantage to the organisation is independent of the answers to the same question on Sustainable Development.

The results of the chi-square test are summarised on table 13 below.

Table 13 Results of the chi-square test: H0_11: The answer to the question of whether Digital Transformation offers a competitive advantage to the organisation is independent of the answers to the same question on Sustainable Development.

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_11	102,58	36	50.998	2.58959E-08

The result of χ^2 is larger than the critical value which means that the null hypothesis can be rejected. As a result, it is obvious there is a relationship between Digital Transformation and Sustainable Development. Respondents that consider that Digital Transformation is advantageous for an organisation are more likely to see Sustainable Development as equally advantageous.

Another issue that merits investigation is whether the missing skills for Digital Transformation are related to missing skills for Sustainable Development. The null hypothesis can be stated as follows:

H0_12: The answer to the question of whether the organisation has experienced difficulties in finding appropriate people to achieve Digital Transformation is independent of the answer to the same question for Sustainable Development.

The results of the chi-square test are summarised on table 14 below.

Table 14 Results of the chi-square test: H0_12: The answer to the question of whether the organisation has experienced difficulties in finding appropriate people to achieve Digital Transformation is independent of the answer to the same question for Sustainable Development.

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_12	114,81	36	50.998	3.69478E-10

The result of χ^2 is larger than the critical value which means that the null hypothesis can be rejected. Therefore, respondents that consider that their organisation has difficulties in finding appropriate people for Digital Transformation are likely to answer that they face the same difficulty for Sustainable Development. Consequently, since there is an overlap between those skills, training people could offer a double advantage for any organisation.

Furthermore, it was investigated whether there is a relationship between the answers to the question if the organisation has commenced the processes of Digital Transformation and Sustainable Development. The null hypothesis can be stated as follows:

H0_13: The answer to the question of whether the organisation has commenced the process of Digital Transformation is independent of the answer to the same question for Sustainable Development.

The results of the chi-square test are summarised on table 15 below.

Table 15 Results of the chi-square test: H0_13: The answer to the question of whether the organisation has commenced the process of Digital Transformation is independent of the answer to the same question for Sustainable Development.

	χ^2	Degrees of freedom	Critical value for 5%	p value
H0_12	91,77	36	50.998	9.15089E-07

The result of χ^2 is larger than the critical value which means that the null hypothesis can be rejected. Therefore results indicate that respondents who consider that their organisation has commenced the process of Digital Transformation are likely to answer the same for Sustainable Development.

In conclusion, the series of tests illustrate that Digital Transformation and Sustainable Development share many similarities for organisations. People see both processes as advantageous, they both share the same set of skill-lacking and if an organisation has commenced the process of Digital Transformation, then it is likely that they have also engaged in activities that could foster sustainable development.

Finally, as it can be seen on Figure 32 below, the respondents consider that the same barriers that hinder Digital Transformation are almost the same as those that hinder Sustainable Development. However, there are two notable differences:

- 1. Security issues are more important in Digital Transformation than Sustainable Development. Issues of privacy, loss of data etc. may stop an organisation from achieving a successful Digital Transformation. This has not been neglected from policy makers. Laws and regulations such as GDPR attempt to address the specific gap even if it has not gained the widespread attention that it deserves.
- 2. Political instability of the country is more important in Sustainable Development than in Digital Transformation. An organisation's attempt to

achieve sustainable development is not independent from the country's effort. As a result, an unstable country could hinder private initiatives towards that goal.

These differences illustrate that Digital Transformation is seen more as an internal/organisational effort and any effort to achieve it depends largely on the organisational skills, vision etc. On the other hand, Sustainable Development is linked with the political/regional environment and any effort to achieve it depends on it.



Figure 32 Barriers that hinder Digital Transformation and Sustainable Development

CONCLUSIONS

The purpose of the current document was twofold:

1) The SYSTEMA partnership reviewed the literature to reveal how System Dynamics and Systems Thinking have been used for Digital Transformation and Sustainable Development.

2) Assess the current educational needs with regards to Digital Transformation and Sustainable Development.

The literature review revealed several gaps:

- Although Systems Thinking and System Dynamics are suitable to study Digital Transformation, a limited number of papers was found that address the issue explicitly
- Systems Thinking and System Dynamics have been recognised as valuable educational resources which can assist in understanding the behaviour of complex systems over time. However, more practical applications are necessary in the domain of Digital Transformation. A SD course/curriculum/training could assist managers, students, employees etc. to better understand how Digital Transformation can help them and their organisation, thus equipping them with the skills to better structure their decision-making process
- As for SD and Sustainable Development, the literature revealed that social dimensions weren't as extensively explored as the economic and environmental ones. Societal and individual values could be important parts of the model and help in designing better policies
- Similar to Digital Transformation, more efforts to integrate Systems Thinking in the education about SusDev are necessary
- One important issue of the use of System Dynamics models is their validity. Consequently, more efforts are necessary, either in the form of participatory model building, the use of big data or the integration of SD with other methodologies that could increase the robustness of the models
- Finally, the two CLDs in the report revealed that Digital Transformation and Sustainable Development could be connected. As a result, more models are needed in ordered to explore the extent and nature of that connection/relationship.

To assess the current educational needs and investigate people's opinion on the issues of Digital Transformation and Sustainable Development, a survey was developed and disseminated across different countries. The main lessons from the analysis of the results are summarised on table 16 and the figures below.

Table 16 Lessons from the analysis of the results

	Digital Transformation	Sustainable Development
Respondents comprehend the full scope of the issue	Yes	Yes
Competitive advantage to the organisation	Yes	Yes
All types of employees, employers, teachers etc. in all sectors recognize that the issue could be beneficial for their organisation	Yes	Yes
Neither the sector nor the position have a dependency with the answer to whether the issue offers a competitive advantage to the respondents themselves	Yes	Yes
Difficulties in finding appropriate applicants	Yes	Yes
Barriers	Skills and vision of management and less by the missing skills of the employees, Security issues	Skills and vision of management and less by the missing skills of the employees, Political Instability
Missing skills	Digital Competencies, Competences in Science, Technology and Engineering and Learning-to-learn competencies	Business Management, Cultural awareness, Entrepreneurship, Learning-to-learn, Digital and Competences in science











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