IMPLEMENTATION OF DIGITAL TRANSFORMATION IN CURRICULA – INSIGHTS BASED ON ANALYZING LEADING UNIVERSITIES

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Abstract

Digital transformation (DT) is already a well-known term in various industries. DT methodologies, determinants, pillar, drivers, technologies etc. are some of the keywords representing concepts in this prosperous discipline. Knowledge and skills needed to implement all these concepts into real life organizations are hard to get, since their acquisition implies an interdisciplinary approach, including business and technology related aspects. For Universities, this fact can be seen as an opportunity for developing new interdisciplinary study fields, covering knowledge and skills related to DT. DT within the curriculum implies accomplishment of learning outcomes that contribute to building individual capabilities to successfully management and improvement of business processes in the digital environment using contemporary digital technologies, manage change, and empower the innovation culture.

In this paper we select and analyse leading Universities in Europe (according to one of the existing ranking lists) which offer “Computer Science” and “Business & Management” related education programs and studies. The analysis is based on publicly available information, and it is performed for investigating the penetration of DT in study programs, courses and/or course contents offered by the selected Universities.

The objectives of this paper are:

1. to explore if and to which extent DT has entered the curriculum of the selected universities (as a study program, course or content of a course);
2. to determine whether the implementation was made on the bachelor, master or doctoral level of the study;
3. to investigate if it covers a more technological approach or is it seen as a business-related paradigm, and
4. to find any existing correlations between the results within the first 3 objectives and derive some insights about the lessons learned out of them.

The results of the analysis show how leading Universities have recognized DT as an emerging trend in study and research fields, which may be interesting guide for other Universities, or if DT still didn’t reach its intensive application in University curricula.

Keywords: digital transformation, curriculum, leading universities.

1 INTRODUCTION

Digital transformation (DT) implies the use of digital technologies for improving the way organizations create value for customers, either through one or a set of new products, new services, new or changed delivering process to the market or the combination of all these things. Betchoo [1] defines DT as the “profound and accelerating transformation of business activities, processes, competencies and models to fully leverage the changes and opportunities of digital technologies and their impact across society in a strategic and prioritised way”. So, DT is not mainly about technology, it is about choosing and using the right one(s) in places where they can fuel the innovation and improve business performance the mostly [2]. Key determinants of DT [3] include: Strategy orientation, Customer centricity, Information and communication technology (ICT) and process infrastructure, Talent, capability and capacity strengthening as well as Innovation culture and organizational commitment. DT is therefore oriented to “hard” and “soft” concepts.

Knowledge, along with technology and innovation, is seen as core of economy evolution in the last fifty years, and it encompasses the familiarity with or understanding of facts, information or skills [4]. Knowledge and skills needed to implement DT into life, encompass an interdisciplinary approach,
including business and technology related aspects. The Skills Framework for the Information age - SFIA [5], in its newest version, SFIA 7 (issued in June 2018) focuses also on the skills most relevant for digital transformation, changing their existing skill groups related to: Digital strategy, vision and investment, Digital leadership, culture and skills, Digital innovation, governance and change management and Digital technology enablers, architectures, business models and digital services.

Higher education institutions, that provide students with knowledge and skills for the digital age, should adapt to the upcoming trends and changes in labour market, as well as try to affect and shape those trends by teaching the students to think critically about the use of ICT [6]. Universities have to urgently align with DT [7] and show agility as they seek to “re-imagine, transform and innovate”, thereby evolving and embracing the game changing transformations [8]. Modernizing higher education programs is also seen as one of the priorities within the European commission recommendations [9], since a mismatch between the supply of graduates and the knowledge and skills needed by the economy is noticeable.

In this paper we select and analyse leading Universities in Europe according to The World University Rankings list [10] which offer education programs and studies related to ICT and business management, in order to investigate if they recognized DT related knowledge and skills as concepts that should be included in their curricula.

2 METHODOLOGY

Considering that DT is involved in almost all aspects of business and life, this research has been carried out in order to determine the extent to which this emerging concept has entered curricula of universities in Europe. Education programs including DT concepts should prepare students for jobs in the digital age and should provide the knowledge and skills for managing and implementing DT in all or particular business aspects.

For the purpose of the research, we used a reference list of University Rankings [10] of the best Universities in the world and selected top 20 universities in Europe (for year 2019) in the education and research area of "Computer Science" and top 20 universities in "Business and Management" area. The Universities were first selected for each area individually. The selected Universities were then compared, and 15 Universities were identified to be in the top 20 in both areas (Intersection), while 10 of them made the Difference. Our list for analysis so contained 25 Universities (Union) from both areas. The analysis was based on information about curricula and education contents, publicly available online. The selected Universities and the web sources of data are listed in alphabetic order in the Appendix 1 of this paper.

The first objective of this study was to examine whether and to what extent, DT has entered the curriculum of the selected Universities as a study program, course or content of a course. The study program titles were analysed first, with the aim to determine if the selected Universities were performing study programs which include the keyword "digital transformation" in the title. The results have shown that there are no such study programs, so we altered the search terms and all study programs related to "Computer Science", "Business and Economics", "Engineering and Technology" or similar areas were identified. Within this subset of study programs, we explored if their title includes concepts related to DT such as Industry 4.0. (Big Data, Artificial Intelligence, Robotics, Machine Learning, Cloud Computing and other) [11] or concepts related to business-oriented DT (Digital Culture, Digital Strategy and others). The same search criteria were used to analyse courses and course contents of the selected Universities.

The second objective of this research was to determine whether the implementation was made on the bachelor, master or doctoral level of the study, regardless of the extent of DT penetration.

Thirdly, we investigated whether the selected Universities used a more technological approach in DT education contents, or if it is seen more as a business-related paradigm. The key determinants already mentioned in the introduction of this paper [3] were used as a guide to determine which concepts are more technological (ICT and process infrastructure) and which relate more to business aspects of DT (Strategy orientation, Customer centricity, Talent, capability and capacity strengthening and Innovation culture and organizational commitment). This part of research shows on which aspects Universities are focused more and which one of them were recognized as key aspects.

Finally, the last objective was to identify correlations in form of dependencies between the results within the first three objectives. The correlations were identified using the results in pairs, namely:
• The extent of implementation of DT concepts (as study program, course or course content) and the level of study
• The level of study and the kind of approach (technological or business) in DT education contents
• The extent of implementation of DT concepts (as study program, course or course content) and the kind of approach (technological or business) in DT education contents.

All results have been used to draw some insights from leading European universities into lessons learned and concluding remarks.

3 RESULTS

In the following subsections the results of the performed analysis are described, in correspondence to the objectives we have set at the beginning of this research. Since our analysis has some limitations due to the fact that we used publicly available information, which do not have a uniformed structure and are published in different languages, the results cannot be considered as comprehensive, but they show indications and trends that we consider to be convincing.

3.1 DT implementation in curricula as a study program, course or content of a course

As we already stated before, selected Universities do not conduct study programs which include the keyword "digital transformation" in the title, so we expanded our research and analyzed in detail all university study programs, related to "Computer Science", "Business and Economics", "Engineering and Technology" or similar areas.

Out of the 25 selected Universities, all are performing study programs under common recognizable titles like Computer Science, Engineering Science, Computing, Communication System, Electric and Electronic Engineering, Information Technology, Management and Technology and similar. Figure 1 shows the relation of Universities that in addition to common recognizable titled study programs also perform study programs, where DT concepts have been seen as suitable to be used in titles vs. those that don't.

13 Universities perform study programs where DT concepts can be recognized in their title, named Robotics, Machine Learning, Artificial Intelligence, Digital Humanities, Big Data in Culture and Society, Digital Culture, Digital Business and Society, Marketing in the Digital Age and others. It is evident that these study programs deal more closely with the different technological and business concepts related to DT. 12 Universities conduct study programs that were not identified as those which involve DT concepts in their title.
Further analysis was made on course titles offered by all selected Universities, and results show that only one University does not have any courses mentioning DT concepts in their name, while mostly mentioned are Robotics, Machine Learning, Artificial Intelligence and Internet of Things. It is important to note that many common recognizable titled study programs, although their name does not indicate that the program is based on DT contents, include two or three such courses. Study programs that have recognizable DT concepts in their title usually include three or more DT related courses.

Finally, when analyzing course contents, our research shows that all selected Universities have courses with contents related to DT concepts. That lets us conclude that all leading European Universities, that educate and conduct research in the chosen areas have recognized DT to be an important and emerging field.

3.2 DT implementation in curricula on bachelor, master or doctoral level

In previous subsection, we have determined that all selected Universities have at least one instance (study program, course or course content) where DT related concepts are included into the curricula. The total number of study programs that are related to DT either through title, course, course content or their combination is 235.

In this subsection, our goal is to determine on which level of study (bachelor, master or doctoral) each study program is performed. Figure 2 shows the number of study programs for each study level. The total number excides the number of Universities, since the number of study programs per University is between 0 and 24 (the lowest and the highest number of study programs per University and study level), while some programs are also conducted on two levels (mostly bachelor and master).

Results of this analysis indicate that over 50% of all study programs are implemented on the master level, and more than 70% are implemented on master and doctoral level together. These relations let us conclude that leading European Universities see DT as a paradigm that requires some basic higher education knowledge and skills from students before omitting to learn and master concepts related to DT.

3.3 DT implementation in curricula as technological or business-related paradigm

Since DT is by its definition an interdisciplinary field of research and work, our next analysis was performed in order to examine if the leading Universities cover DT in their educational programs as a technological or business-related paradigm. Figure 3 shows the percentages of all 235 identified study programs in regards of their approach to educating DT as a technological concept, a business-oriented paradigm or the combination of both.
The results show that 43% of all study programs are focused on the technological aspect of DT and only 14% are focused on business-oriented DT approach. It is interesting to point out that the remaining 43% of analyzed study programs are focused on both areas, business and technological, showing that DT is seen in the higher education sector, either as a technological paradigm or as an interdisciplinary research and education field.

### 3.4 Correlations between the research results

In order to accomplish the last objective of our research, we tried to identify correlations between the results within the first three objectives. We didn't calculate the statistical significance of our results, since their purpose is to give general insights into implementation of DT concepts into curricula, so the correlations are seen as dependencies between the results as pairs, with no numerical value. In our analysis we came to following findings:

- When comparing the extent of implementation of DT concepts (as study program, course or course content) and the level of study, we didn't identify any correlations. Since almost all study programs have courses and all have course contents related to DT, we looked deeper into the level of studies for the study programs which have titles related to DT and the results show that they are mostly implemented on the master level as well (54%), while the undergraduate level is least present (13%).

  These percentages are similar to the results of the second objective, so we conclude that there are no correlations between the results of the first and second objective.

- When analysing the relation between the level of study and the approach to educating DT as a technological or business-oriented concept or the combination of both, we have identified that on the undergraduate level most study programs are oriented to the technological aspect of DT, while on the master and PhD level, both concepts are considered as equally important. Figure 4 shows the number of study programs within each level and their approach orientation.

  On the bachelor level both concepts are present in 35% of all bachelor programs, business in 3% and technological in 62%. On the master level both concepts appear in 52% of all master programs, business in 6% and technological in 42%. On the PhD level both concepts are included in 46% of all PhD programs, business in 15% and technological in 39%.
When analysing the relation between the extent of implementation of DT concepts (as study program, course or course content) and the kind of approach (technological or business) in DT education contents, we also didn’t identify any correlations. Almost all study programs have courses, and all have course contents related to DT, as we mentioned in the first outcome, so again we looked deeper into difference between the study programs which have titles related to DT and those that don’t. In study programs where DT concepts appear in the program title 54% show importance in both areas, business and technological. The importance of technological concepts has been recognized in about 42%, while 4% of these study programs deal with business related DT concepts.

These percentages are similar to the results of the third objective, so we conclude that there are no correlations between the results of the first and third objective.

4 CONCLUDING REMARKS AND LESSONS LEARNED

In this paper we have analysed to what extent DT, as a contemporary paradigm that is changing the way how organizations do their work today, has penetrated the curricula of leading “Computer Science” and “Business & Management” Universities in Europe.

There are some clear indication that fulfilling of the role of higher education institutions in creating educational contents and fostering and transferring knowledge and skills, needed for implementation of DT is very important and mostly seek by the job market, but it is also evident that there is some disbalance between them in reality.

All leading Universities in Europe, that have been selected for this research, have recognized that DT is an emerging trend, that is “here to stay”, so all analysed study programs are connected to this research field in some way.

In most selected Universities the implementation of DT concepts is visible on the course content level, and it is our opinion that this can be explained by the fact that the course contents are relatively independent of administrative procedures (that usually burden any significant changes in curricula) and are subject of teachers’ freedom and obligation to create, alternate and upgrade the content of their courses continuously. Master level of studies has been identified as the most appropriate for introducing DT related concepts to students as (at that point of studying) they already have some previous basic knowledge about technologies and business matters. Finally, as DT includes business transformation with use of digital technologies, so “hard” and “soft” components, many Universities have chosen the combination of the two concepts for implementation of DT into their curricula. A more technological aspect of DT is included into study programs on bachelor level, while master and PhD programs prefer the interdisciplinary approach.

![Figure 4. Level of study programs related to DT concepts](image-url)
REFERENCES


[9] Communication from the commission to the european parliament, the council, the european economic and social committee and the committee of the regions- a new skills agenda for europe, Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016DC0381&from=EN


APENDIX 1

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