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DIGITAL TRANSFORMATION TO UNIVERSITY 4.0: A ROADMAP

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Abstract: The required skills and knowledge expected from human capital is affected by Industry 4.0. In order to keep up with this movement and graduate qualified human resources, universities need to update themselves and transform to University 4.0. In this study, research was conducted on the sample selected from large and small universities with different characteristics. In this research, first, the structural characteristics of the universities and the information management systems used which concern all the stakeholders in that institution were examined. Also, a roadmap is proposed to help the digital transformation process of universities. The flow of the elements in this model is logically determined to form a basis for the whole transformation process. This study contributes to the literature by introducing a new model to the researchers in this field and to all employees who will endeavor in this transformation process.

Keywords: Industry 4.0, Education 4.0, Learning management system, Digital transformation

Üniversite 4.0'a Dijital Dönüşüm: Bir Yol Haritası

Öz: Beşeri sermayeden beklenen gerekli bilgi ve beceriler Endüstri 4.0'dan etkilenmiştir. Bu harekete ayak uydurabilmek ve nitelikli insan kaynaklarını mezun edebilmek için üniversitelerin kendilerini güncellemeleri ve Üniversite 4.0'a geçmeleri gerekmektedir. Bu çalışmada, farklı özelliklere sahip büyük ve küçük üniversitelerden seçilen örneklem üzerinde bir araştırma yapılmıştır. Bu araştırmada ilk olarak üniversitelerin yapısal özellikleri ve bu kurumdaki tüm paydaşları ilgilendiren bilgi yönetim sistemleri incelenmiştir. Ayrıca, üniversitelerin dijital dönüşüm sürecine yardımcı olacak bir yol haritası önerilmiştir. Bu modeldeki elemanların akışı, tüm dönüşüm süreci için bir temel oluşturmak üzere mantıksal olarak belirlenmiştir. Bu çalışma, bu alandaki araştırmacılara ve bu dönüşüm sürecinde çalışacak tüm çalışanlara yeni bir model getirerek literatüre katkıda bulunmaktadır.

Anahtar Kelimeler: Endüstri 4.0, Eğitim 4.0, Öğrenme yönetim sistemi, Dijital dönüşüm

1. INTRODUCTION

Internet and information technologies developed rapidly during the past few years and this brought major changes to our economy. Currently, the economy is going through a remarkable transformation (Puncreobutr, 2016). It is getting important to be connected globally since the

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lifestyle of people is changing and becoming more digitalized. This brings forth the society to a point where people and machines are connected to Internet all the time. Additionally, this creates a tendency to rely on information systems for everything such as processing payments in the banks, treating patients in the hospitals or registering students to classes (Gupta, 2016).

The world is changing drastically since the midst of 18th century. This all started with the Industry Evolution, which can also be called Industry 1.0 era, and slowly evolved to Industry 4.0 today (Puncreobutr, 2016; Aybek, 2017). Industry 4.0 is the period of innovations and knowledge. The term, Industry 4.0, was first used in Germany in 2011 in the world's biggest industry expo in Hannover Messe (Mosconi, 2015; Aybek, 2017). It was actually a project based on high-technology strategies and started by the German government. It includes cyber-physical systems, Internet of things (IoT), Internet of services (IoS), augmented reality, big data analytics and cloud information systems (Lasi et. al, 2014; Ning and Liu, 2015; State of Maturity Report, 2017).

The required skills and knowledge expected from human capital will be affected by Industry 4.0 (Puncreobutr, 2016; Aybek, 2017). In accordance with the need of the developing digital environment, the skill sets and the understanding of individuals need to be updated (Sinlarat, 2016; Weber, 2015). Higher standard of skills will be needed contrary to the previous periods (Bonekamp and Sure, 2015). According to the World Economic Forum, the skills needed for future are "people skills, strong oral communication and persuasion skills, critical thinking, coordinating with others, emotional intelligence, judgement, service orientation, negotiation and cognitive flexibility" (2016). The European Parliament and Reference Framework, however, found the following eight skills critical for the future. These are; "communication, mathematics, basic science and technology competencies, digital competencies, learning to learn, social and civic competencies, being able to take initiative and entrepreneurship and finally, cultural awareness and expression" (2006). Therefore, in order to equip youth with all these new skills, there should be a transformation in higher education institutions and universities. This leads us to Education 4.0.

This study aims to propose a roadmap for the digital transformation to University 4.0. It focuses on the current situation of Turkish Universities in terms of how they integrate information systems into their current processes and what they should do in order to transform digitally. In the next section, Education 4.0 and current state of the universities will be explained. Afterwards, the methodology of the study will be discussed in addition to the findings. In the findings section, the results will be mentioned. Finally, in the last section conclusions, limitations and future work opportunities will be presented.

2. BACKGROUND: OVERVIEW OF THE CURRENT STATE

Education 4.0 will be more than an education. Education 4.0 will change the emphasis from teaching to learning by placing the student at the center of the process unlike Education 3.0, where education utilizes the advantages of the developing technology and becomes more digital through the forms of online teaching materials (Ficci and Ernest-Young, 2018). In other words, the education will change from the traditional instructor-led model to a student-led model (Ficci and Ernest-Young, 2018). In this model, the role of the teacher is also changing and the teacher is becoming a mentor (Jaakkola, et. al., 2016). The purpose of this is to make students gain knowledge and capabilities that will allow them to grow for their entire lives (Sinlarat, 2016). Education was once focused on learning, meaning gaining new knowledge but now, it is important to have research skills. The important thing is not knowing the answer but knowing where to look for it (Tecim and Goksen, 2009).

Moreover, students are expected to draw their own paths independently and be the best of themselves, while learning the required subjects of their professions (Puncreobutr, 2016; Ficci and Ernest-Young, 2018). Thus, the university journey of each student is supposed to be unalike

although all of them take the same courses defined in their curriculum. Below is Table 1 for presenting the differences between Education 3.0 and Education 4.0 models.

Table 1. Shifting to a studentlLed model (Ficci and Ernest-Young, 2018)

Parameters	Education 3.0	Education 4.0
Faculty	Full-time teachers	In addition to full time faculty, industry participants act as part-time faculty for classroom and online courses. They also act as mentors to students.
Curriculum and pedagogy	Minor flexibility in pedagogy; massive learning	Subject matter decided by the learner; personalized learning
Research	Transition towards collaborative research using technology	Ease of data sharing has removed the geographical barriers to collaboration. Students need to learn where to look for the answers.
Funding	Fee based funding systems at degree level	Fee-based funding systems in both online and classroom program
Infrastructure	Majority of investment in physical infrastructure	Investment in technological infrastructure to support blended learning

Education 4.0 brought new approaches to teaching. These approaches can be listed as:

•Blended Learning: Learning with mixed methods both via face-to- face lectures as well as online class materials and video lectures. It is considered a hybrid teaching methodology (Jaakkola, et. al., 2016).

•Flipped Learning: Flipped learning reverses the traditional learning in which the class material is introduced before the lectures. This method supports students' self-learning because it requires students to work independently outside of the classroom as well.

•Massively Open Online Courses (MOOC): These are courses made available to masses via online platforms such as Coursera, Udacity, EdX and Khan Academy. However, the dropout rates for MOOC are very high. Currently, the average completion rate of the courses is approximately 15%.

•Groupware Facilities: It is a collaborative learning method via chat, online group sessions, network supported collaborative problem solving and with a variety of tools for distributed development (Jaakkola, et. al., 2016).

The role of the teacher is changing and the teacher is becoming a mentor with the new Education 4.0 teaching methods. However, students still prefer traditional ways of studying and they study at home using a PC or a book. According to them, this will hardly change in the future (Thoring, et. al., 2015). Internet and Industry 4.0 have brought two different definitions to the current literature in terms of digital transformation. These are digitization and digitalization. Digitization is the process of converting physical materials into digital (Roblek et al, 2016; Aybek, 2017). These materials are the change of text, picture, audio and etc. into digital files through the help of computers. On the other hand, digitalization is the conversion of the business model, processes and operations using digital technologies (digitalization, 2017). Digitalization can be assumed as a strategy to change a business in order to provide new values and value-producing opportunities (Gartner's glossary). In order to transform a business to the digital world, the materials of the business should be digitized initially and then, a healthy digitalization process can be recognized (Clerck, 2017). However, according to a study made by the students of University of Münster, the students understand the digitalization as making the lecture notes digital and having online interaction possibilities with the university such as registering for

classes. They do not ask for a digital revolution in teaching (Thoring, et. al., 2015). They mainly ask for all the systems to be integrated with each other for ease of use and the systems should let them collaborate with their classmates and lecturers. Therefore, during the digitalization process universities need to ensure that their information systems meet the needs of the students. Universities integrated several information systems into their practices. Similar to other organizations, information systems have become the backbone of universities as well (Gupta, 2016). Especially, universities integrated student information systems and employee information systems. Student information systems help students register for classes, submit their homeworks and see their grades and class participations. Some universities prefer to buy software packages made by third party organizations and while others prefer to develop their own systems. Nonetheless, as the technology improved and the more information systems universities started to use, they felt the need to reorganize these systems in order to prevent disintegration and data repetition. Therefore, it is necessary to integrate all the systems under one roof (Balki, 2010). Universities in Turkey, according to their size and resources, either develop their own software or buy packaged software. However, they still cannot combine all of their systems and prefer to use separate systems for some of their operations. These are usually for library services or distance learning programs. Researchers Housewright & Schonfeld, 2008; McCarthy, 2011; Dahlström & Doracic, 2009; Sennyey, et al. 2009; Hufford, 2013; Cheong Choy, 2011 made studies related to the digitalization of libraries in universities. Others including Erguzen, 2012; Ozan, 2008; Coban, 2016; Aydin and Birogul, 2008 studied the e-learning environment of universities and these are called Learning Management Systems (LMS) which are used in distance learning programs or in massive open online courses.

LMS is a software application designed to administer, manage and report education activities (Ellis, 2009). There are three types of LMS. These are proprietary or closed source, in-house developed systems and open source systems (Erguzen, 2012).

•Proprietary (Closed Source) Systems: Closed source systems means that the source code is not available to the public. The reason of this is that they are developed by private corporations. Therefore, the source code belongs to the company. Examples of closed source LMS include Blackboard, Webct, Enocta, eCollege, Desire2Learn and Angel_Learning. The most widely used one of these is Blackboard. Also, Webct is acquired by Blackboard in 2005. It is needed to pay a certain licensing fee to use these systems and due to their fees, they are less popular compared to open source counterparts. Moreover, studies mention that there may be security issues involved using these systems due to the end users do not know what the source code is doing while working on the system (Aydin and Birogul, 2008).

•In-house Developed Systems: In-house developed system means that the institution itself builds up the necessary system with its own resources. Some institutions have the necessary resources with regards to software developers and budget and thus, prefer to develop their own LMS from scratch according to their explicit needs. However, developing a LMS from the beginning is not an easy task due to the system development life cycle. System requirement analysis, feasibility analysis, information management, data flow design, code development and test steps are needed when developing a new system. Regardless of all these difficulties, studies show that some institutions choose to develop their own systems (Paulsen, 2003).

•Open Source Systems: Open source LMS means that the source code is available to the public. These systems are generally free and distributed with its source code (Reis et al., 2012). Examples of these systems are Moodle, Illias, Sakai, dotLRN, Claroline and Atutor. While open source systems are easier and faster to develop and cheaper to use, they have problems in terms of user support, maintenance and system upgrade. There is a lack of experts in terms of helping the end users for solving system problems (Martinez and Jagannathan, 2008; Reis et al., 2012).

•Some studies state that there are security and privacy issues in open source systems since they cannot provide the requirements of information security. Unexpected events may occur such as accessing the confidential information of students and instructors, changing or deleting

information such as the grades of students or personal information of students, enhancing the system rights of students so that they can reach to the pages which only admins can reach (Reis, et al., 2012). On the other hand, some researches claim that open source systems are very dependable. The reason of their statement is that the development of open source systems is contributed by many software developers and system admins. As a result, they become free from any security errors (Reis, et al., 2012).

Coban made a study in 2016 with 25 universities in Turkey and found out that open source systems are more popular compared to their proprietary counterparts. This study mentions that open source LMS are used by 15 universities and among these 15, 11 of them uses Moodle. 6 of these universities use proprietary LMS and 4 of them developed their own LMS. Table 2 below presents which university uses which LMS.

Table 2. The LMS of universities in Turkey (Coban, 2016)

LMS Type	Name of the Software	University
		Afyon Kocatepe
		Akdeniz
		Ankara
		Bartin
		Bilgi
	Moodle	Bilkent
		Canakkale 18 Mart
Open Source		Istanbul
		Kocaeli
		Plato College
		Usak
	Academic LMS (This LMS is specifically designed for Turkish universities)	Ataturk
		Marmara
		Sakarya
	Sakai	Dokuz Eylul
		Cukurova
	Enocta	Okan
		Suleyman Demirel
Proprietary		Trakya
	WSLMS	Bitlis Eren
	Didn"t state the name of the system	Cumhuriyet
	eLrmPoint	Anadolu
	Mudes	Maltepe
In-house Developed	Metu-Online	METU
	Didn"t state the name of the system	Istanbul Aydin

Other systems that are frequently used in universities are student information management systems, document processing management systems and scientific research project management systems. Student information management systems (SIMS) provides an interface for keeping track of student related information such as the registered classes, class attendances, exam grades and etc. Therefore, it can be considered as one of the backbone systems of any university. According to a study made by Ergin and Akseki (2012), Ankara University, Gazi University and Bahcesehir University in Turkey prefer to develop their Graduate SIMS in-house. In addition to SIMS, electronic document management systems (EDMS) and scientific research project management systems (SRPMS) started to be more widely used recently compared to previous years. EDMS is the integration of information technologies for scanning, filing, making changes, processing, storing and recovering documents (Jadid and Idrees, 2005). In Turkey, these systems are first started to be used in public universities in line with the e-government project and then, expanded to private universities. On the other hand, SRPMS which help to track the application and implementation process of scientific projects of the academic personnel in universities, still are not widely used in many universities as the other information systems. These systems are generally only used in public universities funded by the government and not by the private universities. The reason of this is that private universities are smaller in size and have less academic personnel compared to public universities. Therefore, the university doesn't really need a system to follow the academic projects and they can follow them via traditional methods such as using spreadsheets.

E-learning activities, LMS, SIMS, EDMS and SRPMS are a good start for helping universities transform into Education 4.0 model and become University 4.0. However, these are the model of Education 3.0 and if universities want to adapt to the changes in the new era, they need to adapt to a student-led model and encourage faculty and students to participate in joint research initiatives, joint degree programs and joint academic exchanges (Ficci and Ernest-Young, 2018). Providing online platforms for course materials, homeworks, exams and projects is not enough by itself but also students should be supported to learn by cooperating with each other outside of the classroom in virtual environments (Reis, et al., 2012). Moreover, students should be encouraged to work on projects and do research not only by themselves and with their classmates but with students from other universities in other parts of the world as well to become globally prepared professionals once they graduate. Industry 4.0 brought new skills for professionals to become successful and these are technological skills, research abilities, problem-solving skills, systems thinking skills and the most important of all is being digitally literate and know where to look for solutions once you have problems (State of Maturity Report, 2017). Therefore, universities first need to integrate all of their systems under one roof and then, change the system of their education in order to better prepare the future generation to the workforce.

3. METHOD

3.1. Data Collection

In this study, research was conducted on the sample selected from large and small universities with different characteristics. In this research, first, the structural characteristics of the universities and the information management systems used which concern all the stakeholders in that institution were examined. Student information management system, learning management system, electronic document management system and scientific research project tracking and management systems were investigated as information systems. It was investigated whether the information management systems used were developed within the university or whether they were purchased as a packaged software product, and if so, which company / product was preferred. Universities that are located in different cities along with different characteristics in terms of the

number of students and academic recognition were selected as samples. Based on the research on this sample, a road map is proposed for the realization of digital transformation in universities.

Instead of taking random steps to realize the digital transformation process in universities, acting within a specific plan is directly related to the success of the digital transformation process. The objectives and targets to be defined according to the strategic plans to be created require changes in the organizational structure and the technological infrastructure. In the process of digital transformation, management activities are carried out on one hand and transformation activities related to hardware and software are carried out in parallel on the other. A roadmap for administrative and information technology (IT) activities is presented below in Figure 1.

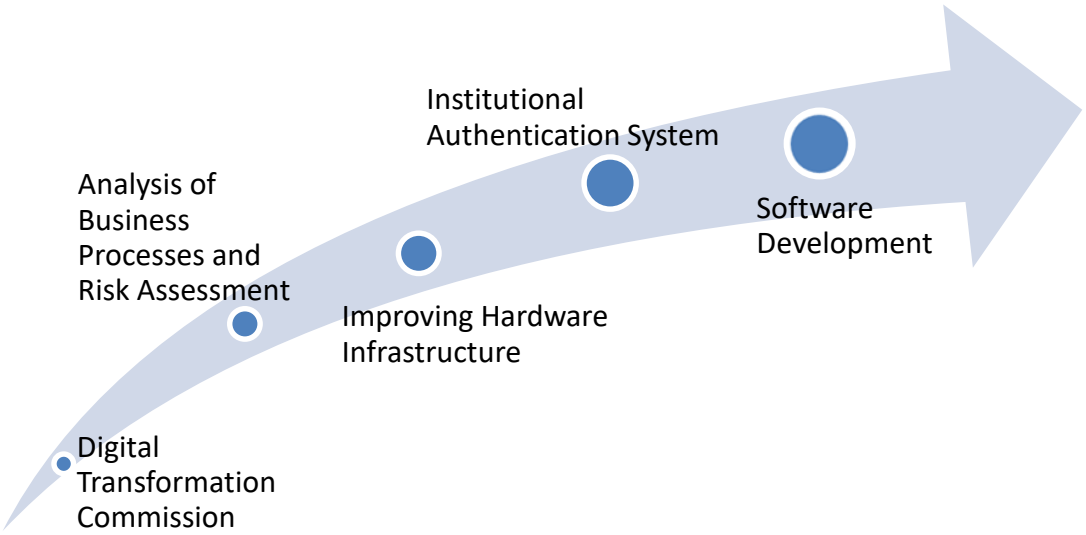

Figure 1:
Digital transformation process steps

3.2. Digital Transformation Commission (DTC)

In addition to the top management of the university, a commission needs to be formed which will be responsible for the first degree of the execution and supervision of all activities in the digital transformation process. This is the 1st step of the roadmap as can be seen in Figure 1. Among the academic and administrative staff of the university, experts in software development, electronic communication, process management and organization are selected as members of the commission. The vice- rector of the top management who is closest to the relevant field is appointed as the chairman of the commission. The tasks of the digital transformation commission (DTC) can be seen in Figure 2. They are as follows:

•Determines the necessary policies and strategic plans for this transformation.

•It forms the working groups necessary for the implementation of these plans at various levels within the university.

•Determines the task authority and hierarchy of the working groups established within the university and recommends necessary organizational changes to the senior management.

•Performs the necessary corrective and preventive actions in spite of the disruptions that occur or will occur during the process.

•Ensures the successful completion of the digital transformation process by requesting the required authorization from the university top management.

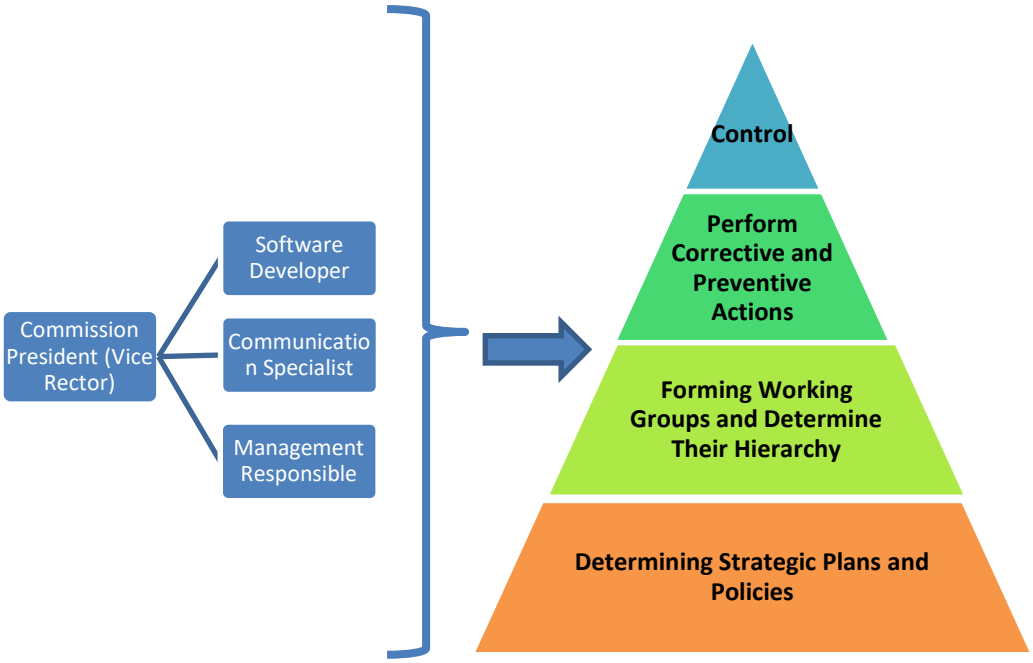

Figure 2:
Digital transformation commission and duties of the commission

3.3. Analysis of Business Processes

This phase, which is the 2nd step in the roadmap seen in Figure 1, is carried out with a team of analysts consisting of system analysts, software development specialists or industrial engineers. The analyst team analyzes the business processes carried out in the academic and administrative units of the university and identifies the business processes carried out through information management systems and manual procedures. With the analysis report to be produced as a result of the analysis process, the following issues become clear.

•Business processes carried out with information management systems in the units,

•Business processes carried out manually in the units,

•Existence of an information management system where manual business processes can be adapted,

•Software to be developed or purchased for manual business processes,

•Integration of existing software with the new software

•Web services that need to be established among information management systems based on the Internet of Things (IoT) in order to prevent data duplication, ensure data integrity, and automate processes,

•Hardware, software and human resources, etc. required for information management systems and data warehouse, which are expected to be available in the final situation.

3.4. Feasibility and Risk Assessment

At this stage, after the analysis of business processes carried out by hand and knowledge management systems in universities, necessary feasibility studies are carried out for the system to be reached in the final situation. This step can be done together with Business Processes stage as can be seen in Figure 1. In this feasibility study, human resources and financial needs of the project are taken into consideration and necessary assessments are made with the facilities of the institution. In the digital transformation project, weaknesses and strengths of the organization are

revealed and any risk that may lead to the failure of the project is evaluated. The success of the project will be clearly demonstrated if possible measures are identified for improving weaknesses and other risks.

3.5. Improving Hardware Infrastructure

In the 3rd step of the roadmap as can be seen in Figure 1, new software to be developed, existing information management systems, web services, e-mail server, web server and all other digital components needed to operate in an uninterrupted and efficient environment. Strengthening of the hardware and the communication infrastructure required for this is done at this stage. In this context, it will be easier and more efficient to manage all electronic services by virtualizing the existing servers, new server and hardware resources.

In addition, the necessary storage units to accommodate the big data that will eventually occur in the project are reinforced. By establishing the cloud computing infrastructure of the organization, the security of big data is ensured.

3.6. Institutional Authentication System

Instead of using separate user accounts to log in to the information management systems used for different purposes in universities, it would be very beneficial to establish a central and single user account based authentication system as the 4th step of the roadmap, which can be seen in Figure 1. Different user accounts used for different automation systems have difficulties in password processing. In addition, when it comes to file and folder sharing, accessing to web directories and managing different web pages, using an enterprise authentication system is an inevitable need. For this purpose, authentication can be performed with e-government user data in institutional information systems. As a more comprehensive infrastructure, LDAP (Lightweight Directory Access Protocol) can be installed. LDAP is an application layer protocol that is used for querying, updating and authenticating identity by working on TCP / IP protocol (Wikipedia, 2019). It is possible to perform role- based querying (search and comparison), change (rename, add, delete, change) and authentication services within the directory using LDAP. All types of directory services and access to information systems can be centrally managed through this protocol within a university network.

3.7. Software Development

After the analysis and feasibility stages, the necessary works for the superstructure can be carried out along with these processes in the institutions whose hardware and network infrastructure is strengthened. At this stage, which is the last step of the roadmap as can be seen in Figure 1, the transformation of the work, that arises from the analysis of processes and is still carried out manually, is realized. The critical point to consider here is instead of developing completely different and new software, it is necessary to integrate business processes into the closest possible information systems. For example, the processes such as assigning classrooms and syllabuses into courses, calculating additional courses, which are routine needs in universities, should be developed on the student information system where student and course information are available.

Another critical issue in the software development process is the services of the information systems when using the products of different companies. If the data and authorizations are not centrally managed, the same definitions and updates are repeated in each information system. This creates difficulties in obtaining accurate and up-to-date data. As an example of this situation; CVs of academic and administrative staff are available in the employee information system of universities. The same data are used in many different information systems such as in the student

information system, learning management system, scientific research and project tracking system. When these information systems are products of different companies, in order to manage the data centrally, it is necessary to develop web services with the Internet of Things (IoT) logic from data source to other systems. The data of all employees working in the university should be taken from the employee information system. Administrative changes such as title changes, job promotions, duties of department head and dean, and corporate authentication system can only work properly by receiving data from such a central system. Otherwise, in case of a change of title or task, all individual software used within the institution will need to be updated one by one, which will impair data integrity and accuracy.

In summary, the most critical points in the digital transformation of manual processes in the software development are the adaptation of processes to the nearest system and the development of web services for data integrity between systems.

4. FINDINGS

In the study conducted with the sample universities, the findings including the demographic characteristics of the universities are presented in Table 3. There are 30 universities in total. 23 of these universities in Table 3 are public universities and seven are private universities. When Table 3 is examined, the youngest among these universities are Gaziantep Islam, Science and Technology University. The oldest university is Istanbul University, whose foundation dates back to 1453 and is 86 years old in terms of its legal status after the declaration of the Turkish Republic. The average age of the universities included in the research is 33.13. In Turkey, universities generally include institutes, faculties, two year colleges and vocational schools within itself. Institutes only offer graduate degree level education. Faculties offer four-year Bachelor's degrees. Two year colleges and vocational schools are similar to community colleges and only offer two year degrees. According to Table 3 below, the number of graduate institutes of these universities varies between one and 13. Ankara University has 13 institutes. The average number of institutes at universities is 5.16. The number of faculties varies between three and 23. While the average number of faculties of universities is 12.3, the university with the most faculties is Selçuk University with 23 faculties. The number of colleges varies between zero and 22 and the average number of colleges is 5.13. The number of vocational colleges varies between zero and 12 and the average number of them is 4.1. The university which has the lowest number of students in terms of total number of associate, undergraduate and graduate students is Gaziantep Islam, Science and Technology University. The university with the highest number of students is Istanbul University with 305,830 people. The average number of students at the universities is 42,145 (CoHE, 2019).

The most widely used information management systems in the universities are presented in Table 4. Products obtained from private companies are indicated by company name or product name. The software developed by the university itself is called "ISD" (Internal Software Development). When Table 4 is examined, it is seen that 13 out of 23 public universities have developed at least one software in- house. It is understood that 11 universities, 10 of which are public and one is private, do not develop any software in the institution and supply their needs from various companies. These universities are; Adiyaman University, Firat University, Gaziantep Islam Science and Technology University, Gaziantep University, Harran University, Inonu University, Kilis 7 Aralik University, Kirsehir Ahi Evran University, Mustafa Kemal University, Yozgat Bozok University and Izmir University of Economics. The reason for this situation is the lack of sufficient human resources to develop comprehensive software within the institution due to the geographical disadvantages of the universities (except Izmir University of Economics). The research and development activities in the IT sector in Turkey are mostly carried out under the leadership of metropolitan cities such as Istanbul, Ankara and Izmir. Izmir University of Economics, which does not have a disadvantage of location, may have preferred to buy their needs from corporations since they may not want to invest more IT employees in this

field. Considering Table 4, it is seen that Ankara University, Dokuz Eylul University and Izmir Katip Celebi University have developed all the related systems internally.

Table 3. Demographic characteristics of universities

No	University	Est. Year	Age	Type	# of Institutes	# of Faculties	# of 2 year Colleges	# of Vocational Schools	# of Students
1	Adiyaman	2006	14	Public	3	13	4	6	20,417
2	Ankara	1946	74	Public	13	18	6	6	63,659
3	Bogazici	1971	49	Public	7	4	2	0	16,410
4	Bursa Uludag	1975	45	Public	4	15	15	3	70,607
5	Cukurova	1973	47	Public	4	18	5	12	54,737
6	Dokuz Eylul	1982	38	Public	10	17	4	6	70,331
7	Ege	1955	65	Public	9	17	10	5	59,162
8	Erciyes	1978	42	Public	7	19	1	2	50,283
9	Firat	1975	45	Public	5	16	9	3	41,378
10	Gaziantep	1987	33	Public	5	16	4	11	44,815
11	Gaziantep Islam, Science and Technology	2019	1	Public	1	3	1	1	150
12	Harran	1992	28	Public	3	14	14	5	25,565
13	Inonu	1975	45	Public	6	14	4	2	39,447
14	Istanbul	1933	87	Public	12	15	2	2	305,830
15	Izmir Katip Çelebi	2013	7	Public	3	13	2	1	13,114
16	Kilis 7 Aralik	2007	13	Public	3	8	2	4	8,833
17	Kirsehir Ahi Evran	2006	14	Public	3	9	7	4	17,412
18	Marmara	1982	38	Public	12	14	4	4	77,492
19	Mersin	1992	28	Public	5	17	8	11	38,993
20	Middle East Technical	1957	63	Public	5	5	1	1	29,402
21	Mustafa Kemal	1992	28	Public	3	12	6	11	23,552
22	Selçuk	1975	45	Public	6	23	22	7	67,225
23	Yozgat Bozok	2006	14	Public	3	13	9	4	19,008
24	Bilgi	1996	24	Private	3	7	4	3	25,264
25	Hasan Kalyoncu	2012	8	Private	3	7	1	1	7,931
26	Istanbul Aydin	2003	17	Private	3	12	2	3	35,999
27	Izmir Economics	2001	19	Private	4	8	3	2	9,322
28	Koç	1993	27	Private	4	7	0	0	7,947
29	Maltepe	1997	23	Private	3	9	0	3	12,025
30	Ozyegin	2007	13	Private	3	6	2	0	8,040
		Average	33.13		5.17	12.3	5.13	4.1	42,145
		Min	1		1	3	0	0	150
		Max	87		13	23	22	12	305,830

Table 4. Management information systems used in universities

No	University	Type	Student Information System (SIMS)	Scientific Research Project Management System (SRPMS)	Learning Management System (LMS)	Electronic Document Management System (EDMS)
1	Adiyaman	Public	Proliz	Talent	Advancity	Envision
2	Ankara	Public	Kampus Bilgi Yonetim Sistemi (In-house)	In-house	In-house	In-house
3	Bilgi	Private	SIS (In-house)	Do not exist	Bilgilms (Moodle)	Envision
4	Bogazici	Public	BOUN (In-house)	Metaform	-	Envision
5	Bursa Uludag	Public	In-house	Talent	Advancity	In-house
6	Cukurova	Public	CUBIS (In-house)	Abis- Bapsis	OLIVES (In-house)	Envision
7	Dokuz Eylul	Public	DEU (In-house)	DEU (In-house)	DEU (In-house)	DEU (In-house)
8	Ege	Public	In-house	Abis- Bapsis	Advancity	In-house
9	Erciyes	Public	Erciyes (In-house)	Abis- Bapsis	Advancity	Envision
10	Firat	Public	Proliz	Talent	Advancity	Envision
11	Gaziantep Islam, Science And Technology	Public	IKCU UBYS	IKCU UBYS	IKCU UBYS	IKCU UBYS
12	Gaziantep	Public	Proliz	Talent	Moodle	Envision
13	Harran	Public	Proliz	Talent	Moodle	Envision
14	Hasan Kalyoncu	Private	Kampus Bilgi Yonetim Sistemi	-	PHI	In-house
15	Inonu	Public	Proliz	Abis- Bapsis	Advancity	Envision
16	Istanbul	Public	Aksis (In-house)	Abis- Bapsis	AUZEF (In-house)	Envision
17	Istanbul Aydin	Private	UBIS (In-house)	Do not exist	Moodle	Exists
18	Izmir Economics	Private	OASIS	Do not exist	Blackboard and Panopto	Do not exist
19	Izmir Katip Celebi	Public	IKCU UBYS (In-house)	IKCU UBYS (In-house)	IKCU UBYS (In-house)	IKCU UBYS (In-house)
20	Kilis 7 Aralik	Public	Proliz	Metaform	Advancity	Aymeet
21	Kirşehir Ahi Evran	Public	Proliz	Talent	Aydep	Plenus
22	Koc	Private	Kusis (In-house)	Do not exist	KULMS (Moodle)	Exists
23	Maltepe	Private	Mubis (In-house)	Do not exist	MUDES (In-house)	Seneka
24	Marmara	Public	In-house	BAPKO Online	Advancity	In-house
25	Mersin	Public	Mersin-OBS (In-house)	Mersin - BAP (In-house)	Moodle	Mersin- EBYS (In-house)
26	Mustafa Kemal	Public	Proliz	Talent	Advancity	Envision
27	Middle East Technical	Public	ODTU (In-house)	Abis- Bapsis	ODTU (In-house)	ODTU (In-house)
28	Ozyegin	Private	SIS (In-house)	Do not exist	LMS (Moodle)	Ebys-Ebelge (In-house)
29	Selçuk	Public	OBIS (In-house)	Talent	In-house	Envision
30	Yozgat Bozok	Public	UNIPA	Talent	Google Classroom	Kamusis

If we examine Table 4 one by one in terms of information systems; 18 of the 30 universities are developing their own student information systems. Eight of the remaining 13 universities meet this need with Proliz product and the remaining ones use Oasis and Unipa. It is

seen that private universities do not use any kind of system for tracking the scientific researches and projects. This suggests that the relevant private universities do not have sufficient budget to support scientific research or that the procedures are easy to track by hand because of the small number of applications. While four of the public universities meet the needs of the SRPMS system through in-house development method, six universities meet this need by using Abis-Bapsis product, nine universities by Talent product, two universities by Metaform product and one uses Bapko. As an e-learning platform, six of the universities use Moodle, which is open source and free of charge. Eight universities developed their own e-learning software, nine are using Advancity products, one is using Blackboard and Panopto products, one is using Google Classroom and one is not using any e-learning software. The university, which does not use any e-learning software, is Bogazici University, which takes a cautious approach to distance learning. As an electronic document management system, 12 universities prefer enVision products. Nine universities developed their own products in-house. Three universities are using Aymeet, Plenus and Seneka products consecutively, one public university is using Kamusis and finally, no information is available that two private universities are using which document management system.

5. DISCUSSION

In this study, a roadmap for universities which want to transform their processes to University 4.0 is explained. Aybek made a similar study in 2017 which explains the transition to University 4.0. However, Aybek only mentioned human resources, support services and lifelong learning topics. In addition to the topics stated in Aybek's article, this study also emphasizes the importance of managing the hardware and software processes correctly and efficiently. Other than Aybek's study, Ficci and Ernest-Young published a report in 2018 presenting examples from the universities in the US about their efforts to become University 4.0. Other publications related to the information systems in universities located in Turkey are Ergin and Akseki's (2012) study about graduate SIMS. In their study, they proposed new designs to make SIMS more efficient and effective. Another study related to the information systems in universities was published by Tecim and Goksen (2009). In this research, authors analyzed the central ERP information systems in Dokuz Eylul University. Finally, Coban made a study with LMS in different universities in 2016. In his study, Coban compares the LMS of different universities whether they use in-house developed systems, open source or closed source systems.

Successful implementation of digital transformation projects in higher education institutions depends on many factors. Although the studies seem to be the improvement activities on information systems; human factor, which includes the end users and developers of the systems, is critical for the success of the projects. Access to adequate and competent human resources by the universities, the creation of effective working groups and the corporate internalization of digitalization are the steps to be overcome before any technological activity. Many universities do not have the opportunity to employ sufficient number of competent software development experts due to their geographical locations, budgets or for other reasons. For these reasons, it is very difficult for universities located in smaller cities of Turkey to develop their own information management systems, except for the universities located in the metropolitan areas with a longer history of education. When the findings of this study are analyzed, it is seen that even İzmir University of Economics, Gaziantep University and Mustafa Kemal University have not found the opportunity to develop any software within the institution, although they are located in a metropolitan city. In such a case, it would not be right to expect universities in small provinces such as Kilis 7 Aralik and Adiyaman to develop their own software. As a result of this situation, universities meet the information management systems they need by purchasing software products from companies.

As a result of the software services provided by the corporations, new developments needed for digital transformation will bring a serious financial burden to the institutions. Adapting manual business processes to the closest appropriate system in the institution will also increase the dependency on the related firm, and this dependency will have a direct impact on the fees demanded by the firms. However, web services to be established among packaged software products to ensure data integrity and prevent data duplication will incur serious costs for university institutions. Considering all these prospects, the gaps or binding conditions in the contracts made with the corporations regarding the improvements to be made in the system and the additional services to be received will also affect the universities as an advantage or disadvantage. Unusual situations, such as saving regulations implemented in 2019 in Turkey, make it impossible for this kind of investment in the resource planning of public universities. In addition to software services, enhancements in hardware and network infrastructure will also bring a significant financial burden to digital transformation projects.

After the necessary budget is met by various grants and support programs, universities may have to face various technical problems in the products they obtain from the corporations. During the adaptation of products obtained from different companies to work with the same corporate authentication system or integration and services to be established between different products, it is possible that there will be problems due to technical impossibility and incompatibilities. Such technical problems can create various additional financial burdens, such as replacing the product.

6. CONCLUSION

Facing human, financial and technical problems in the digital transformation processes of universities is seen as an inevitable fact when the universities examined in the research are considered. However, in this case, universities with a longer history in metropolitan areas, which meet their software needs by developing them in house, seem quite advantageous. These universities, with their competent human resources, can successfully complete their transformation processes without too much financial burden and technical problems in developing their institutional needs. However, universities that do not have sufficient infrastructure and resources for enterprise software development will have many obstacles to overcome, especially because they use the products of different companies. These universities need to carry out a very detailed analysis before they start any digital transformation process and they need to demonstrate their needs very carefully. For the emerging needs, they are required to conduct technical and financial feasibility studies by conducting interviews with the software companies which they use their products already. If there is no obstacle in the provision of human resources and material resources that will be needed in the process of digital transformation and if the integration of all technically used products seems possible, then digitalization activities should be started. Otherwise, the labor, time and money for a transformation that will fail will be a waste and a public loss. Since the private universities will be more cautious about feasibility due to their limited resources, it is predicted that the digitalization process of private universities will be easier and more efficient.

In the study, a road map which can be applied in the process of digital transformation of universities is proposed. Demographic characteristics of the selected universities are investigated and it is presented how the need of the most widely used information systems in universities is met. Also, the comparison of information systems will help other universities planning to adapt new information technologies to make a benchmarking. Possible barriers to the proposed digital transformation process model and various suggestions to overcome these obstacles are shared via the universities within the scope of this research. In addition, with the emerging Industry 4.0 and Education 4.0 trend, which has also started to be applied in Turkey recently, the aim of this research is to contribute to the scientific studies, researchers and experts working in this Education 4.0 digitalization transformation process and to help all employees who will attempt to transform

to University 4.0. Limitations of this study is that it only takes into account the transformation of educational processes of universities and not the transformation of automation or business processes. Also, it only focuses on universities located in Turkey. Future studies may benefit to the knowledge and experience in this area by not only addressing the digital transformation in universities from the perspective of learning but also from the perspective of all business processes carried out by the universities. Also, researchers may perform a similar study with universities in other countries and even make a comparative analysis with several countries.

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