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Development of The Cloud Services (AWS) Courses for The Higher Education Institutions in Georgia

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Abstract:- The article covers the creation and implementation of the first-ever Georgian language taught practical courses in modern cloud services - Cloud Services (AWS) and Additional Services in Cloud Services (AWS). The courses teach about the growing trend of using cloud services worldwide and the rise of business needs in the specialists that can operate in this field.

The topics covered are: what are some of the main services that cloud services offer and what are their advantages for the business - IAAS model, a variation of different learning and certification pathways in studying cloud services, and which one of those was chosen in the above-mentioned courses, working with AWS Educate environment and the reasons behind choosing AWS cloud services rather than its competitor Microsoft Azure and GCP services.

The article also emphasizes the challenges that inspired creating Georgian language taught courses in this field. The work details the steps that were implemented to launch theoretical and laboratory courses. There's also information on the services that have been included in the courses, Finally, the article gives an overview of the first cohort of students: the quantity and attendance statistics with respective conclusions for the university and the business.

Keywords:- *Cloud Services; Cloud Education; AWS; Cloud Services; Course Development.*

I. INTRODUCTION

Changes in technology are very frequent in the modern IT industry. The vast majority of the companies are trying to follow the modern information technologies and are implementing, testing, and using them in their business to maintain the place in the highly concurrent market. At the same time, the introduction and usage of new technologies require appropriate knowledge and competencies.

Companies are facing the problem of educating their personnel to give them new competencies. If the company will not follow this road and does not introduce the knowledge possibilities to the personnel, it will lose the market leadership positions and become the chaser to other businesses.

One of today's information systems top positions are held by cloud systems and their services. They have many obvious advantages over the traditional approach to using information technologies. Using cloud services is one of the trends. "With the support of important industry stakeholders like Google, Amazon or Microsoft, cloud computing is being widely adopted in different domains. Cloud services such as Google Mail or Dropbox have become everyday tools for millions of people. Many companies currently use cloud-based applications such as Salesforce3 and small and big businesses are embracing virtual infrastructures offered, for instance, by Amazon Web Services (AWS) or Microsoft Azure" [1]

"Cloud computing is increasingly becoming a springboard for digital innovation and organizational agility. Higher education institutions (HEIs) are facing the problems with the increasing of participants, growing need of IT and infrastructure, education quality of provision, and affordable education services" [2]

As the use of cloud systems ultimately turns out to be much cheaper for the business than creating and supporting its own physical IT infrastructure, many advanced organizations around the world or companies are slowly moving to the use of cloud services, in this regard, Georgia is no exception.

It should be noted that the process of transition to cloud systems is gradual and is not instantaneous at this stage. Besides, companies still store confidential data in local data centers or on their physical servers, explaining by "higher security reasons." However, more cloud services are being used for other operations. "Cloud computing represents a major shift in providing information-technology services and managing computing infrastructure. Unlike other innovations that appeared first in academic laboratories, cloud computing emerged as a commercial response to competitive needs. Interest in cloud computing has grown significantly as users and organizations recognize the benefits of computing-as-a-service" [3]

Goldman Sachs forecasts that demand for cloud services has been growing from year to year and will continue to grow steadily in the future:

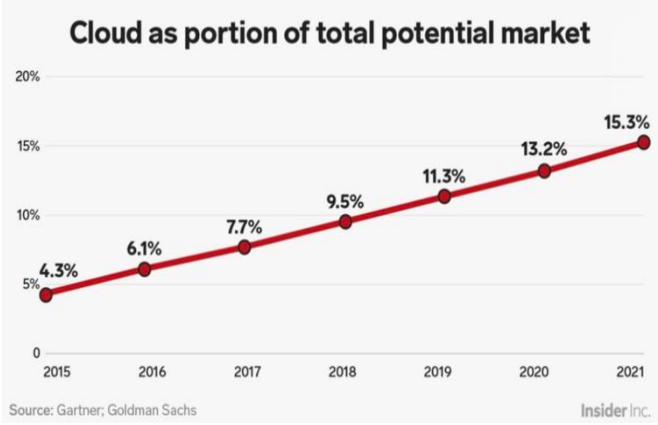

Fig. 1:- Cloud as a portion of the total potential market (Source: https://www.businessinsider.com/goldman-sachs-cloud-computing-market-forecast-aws-microsoft-azure-google-cloud-2018-11)

	2019	2020	2021	2022
Cloud Business Process Services (BPaaS)	45,212	43,438	46,287	49,509
Cloud Application Infrastructure Services (PaaS)	37,512	43,498	57,337	72,022
Cloud Application Services (SaaS)	102,064	104,672	120,990	140,629
Cloud Management and Security Services	12,836	14,663	16,089	18,387
Cloud System Infrastructure Services (IaaS)	44,457	50,393	64,294	80,980
Desktop as a Service (DaaS)	616	1,203	1,951	2,535
Total Market	**242,697**	**257,867**	**306,948**	**364,062**

Table 1:- Public Cloud Services Revenue (in USD) Worldwide Forecast
(Source: https://www.gartner.com/en/newsroom/press-releases/2020-07-23-gartner-forecasts-worldwide-public-cloud-revenue-to-grow-6point3-percent-in-2020)

According to [4] Cloud Computing tracking poll from the International Data Corporation indicates that USD 370 bn in Cloud Computing will be used by 2022, corresponding to an increase of 22.5% in terms of 5-year compound annual growth

➢ *Offers and benefits of cloud services*

Today, the main business offer of cloud services for the client is "IAAS" service - "Infrastructure as a Service". Which offers the customer/business to build the physical IT infrastructure of their company, organization completely on the side of the virtual cloud service provider.

When using the IAAS service, the user/business does not care about the physical condition of the devices (eg processors, RAM, etc.) and the connection between them (eg network wiring, network devices), nor the building where the trademark/server is located. The cloud service provider assumes responsibility for the maintenance of the cooling systems and the provision of uninterrupted power supply. All that is left for the customer side is to properly plan, run and manage the logical infrastructure for the business as needed.

Public cloud services are based on the OPEX (Operating expenses) type business model. Unlike the CAPEX (Capital expenses) type business model, the OPEX business model has the following main advantages:

- Billing is based only on resource usage
- Speed of expansion
- Ease of organization of test and development environment
- Flexibility to changes
- Elasticity
- Full automation

All of this makes it very attractive for medium and large businesses to operate on cloud services for a fee, as many of the issues that require the operation of their own physical data center are resolved on the part of the cloud provider.

➢ *Cloud service offers and types*

In addition to the IAAS service, other services are available in the IT market, e.g. These are: SAAS (Software as a Service), DAAS (Database as a Service), PAAS (Platform as a Service). However, IAAS service provides the most operational freedom and flexibility. IAAS includes other service capabilities.

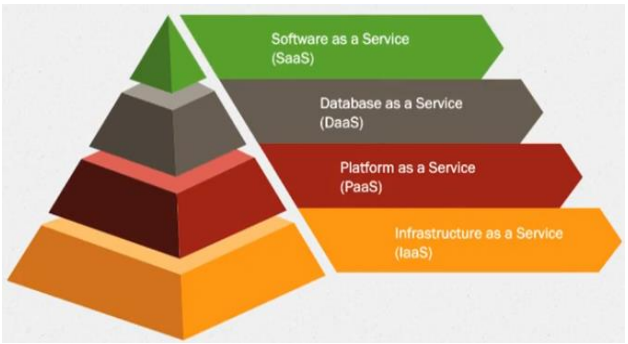

Fig 2:- Available Cloud Services

It should be noted that when talking about cloud systems and services it is necessary to determine what type of cloud models we are talking about. NIST designates 3 types of cloud model. [5]

- Private Cloud - a kind of "own/private" cloud, built by the company/organization independently and mostly closed to public access. Used for corporate purposes;
- Public Cloud - Public cloud (eg AWS, Azure, GCP). Created by global cloud providers worldwide and accessible to anyone with Internet access. Used to solve any type of task;
- Hybrid Cloud - a combination of "own/personal" cloud (s) with a public cloud, a kind of hybrid cloud;

The information in this article discusses the use of public cloud, in particular, the Amazon Web Services (AWS) cloud service platform.

II. RELATED LITERATURE

On one hand, there are a lot of benefits of cloud computing for academic institutions: economics, scalability, durability, elasticity, enhanced availability, lower environmental impact, concentration on core basics. [6] conclude a cloud computing as a new model of providing IT services and indicates the need for educating and motivating students about cloud applications and services. [7]. On the other hand, similar to other areas of science or medicine, it has some risks such as security [6] "Cloud computing services are typically categorized into three main types: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS)" [8]

Another research outlines the growing use of cloud computing technologies in education. Research finds a great interest of researchers in these themes. Especially learning environment, collaboration platforms, virtual laboratories are falling in the interest scope [9].

Another research suggests cloud computing as a technology that is "being rapidly deployed and becoming an internal part of the institution experience", they have made a systematic review of contributions of Cloud computing for HEI. In their research, they conclude that cloud technology "leads to change in the work of teachers, educators, and HEIs" [10].

Group of researchers pays attention to the security issues of cloud computing technology and suggests a method for cloud data storage security by utilizing the homomorphic token with distributed verification of erasure-coded data [11].

Another group discuss the possibilities of using cloud computing in learning management systems (LMSs) and see the solution as an "affordable resource that enables fast processing, large data-storage capacity, and the sharing of resources." [12]

Recent Paper indicates the cloud computing technology having a "potential to provide computation and storage resources as services. Both the public as well as the private institutions can use cloud computing to deliver better services with limited resources" [13]

Some of researchers have reviewed the experience of using cloud computing in teaching a graduate-level networking course. It had been used to share references, to create collaborative environments, to hold virtual discussions, to manage projects, and to deploy web applications. [14]

Usage of cloud systems in education was demonstrated in the paper by researchers where the design, analysis, and evaluation of a cloud service, referred to as Cybersecurity Lab as a Service (CLaaS) was done. [15]

"In education, cloud computing caters for desirable properties to provide e-learning services, especially in scenarios where these services are computer-intensive (virtual worlds, simulations, video streaming, etc.), or are offered in a high-scale way, as in Massive Open Online Courses (MOOCs). The cloud can provide students and teachers with tools to deploy computing resources on-demand for lectures and labs according to their learning needs. [16].

Some educational institutions are already using cloud computing to outsource email services, to offer collaboration tools and data storage for students, and to host institutional Virtual Learning Environments (VLEs). Other affordances of cloud computing may yield new learning scenarios where ubiquity, advanced online tools, and collaboration come together to create innovative opportunities for education. On the other hand, cloud computing brings new risks when compared to the conventional IT model such as security, performance, or interoperability that now have to be considered" [17]

"Cloud computing provides both learners and educational practitioners with a great number and variety of online applications that can be employed to support a wide range of learning scenarios. These applications are usually web-based, accessible anywhere, anytime over the Internet, thus extending the exposure time to learning of students" [18]

"The broad degree of configurability of many cloud-based services and resources gives teachers and students new opportunities to create rich environments for teaching and learning. Different cloud services and applications can often be mixed using their available Application Programming Interfaces (APIs) into completely customized learning environments suited to the needs and preferences of students, facilitating the creation of Personal Learning Environments (PLE)" [19]

III. PROBLEM AND AIM

Many progressive, medium, and large companies in Georgia see the potential of using cloud services, both in terms of business (economy) and technology (modern services with the latest IT technologies). Accordingly, Georgian companies try to follow this trendy process as much as possible and launch more products in the cloud. But working with cloud systems requires the appropriate competence to ensure that the task set by the business is correctly implemented, implemented, and protected in the cloud. In this regard, there is a significant shortage of cloud systems engineers in the market. As before, there was no practical course for any public cloud service in the highest institutions of Georgia. As a result, companies have had to independently find those rare shots that have sufficient competence to work with clouds. Time and financial resources were spent on this.

The purpose of this article is to describe the methodology of introducing cloud-based practical solutions courses in higher education institutions.

IV. RELATED WORKS

❖ *Methodology for development and implementation of a practical full course of cloud services in higher education institutions*

The course was developed and implemented in one of the most advanced higher education institutions in Georgia.

An appropriate cloud service provider was selected in the first stage to implement this course. The choice has been made at this point for the undisputed leader, Amazon's offering Amazon Web Services. Currently, innovative solutions for the market for public cloud services are rightly dictated by Amazon, while Microsoft's Azure and Google's GCP cloud services are more of a follower.

Besides, Amazon's choice to create the cloud course necessitated the provision of a free learning-experimental environment for students and lecturers, as the theoretical material of the course was mastered and put into practice. Consider the fact that students do not have a large financial resource, and the use of cloud services requires some financial outlay.

Importantly, Amazon offers AWS Educate learning environments to university lecturers and students, where they are given a certain amount of credit for using the services (in the form of an allocated amount) to master this or that study material in practice. It is noteworthy that lecturers will be given renewable credits - on request each semester.

Every education institution is eligible to apply for AWS Educate, which is used by more than 200 counties and territories and 2400 institutions. (Source: AWS Educate 2020).

University lecturers and students at the university where the course was introduced had been enrolled in the above-mentioned program. Corresponding accounts were created and validated for the lecturers, who can themselves create a classroom, request educational credits for a class, and invite students.

➢ *AWS Pathways*

AWS Has different professional directions and its certification program:

➢ *Main modules*

- *Cloud Practitioner* – an introduction level to cloud systems
- *Solutions Architect* (Associate, Professional)
- *SysOps Administrator, Developer, DevOps* engineer

➢ *Additional modules*

- *Advanced Networking*
- *Security*
- *Machine Learning*
- *Alexa Skill Builder*
- *Data Analytics*
- *Database*

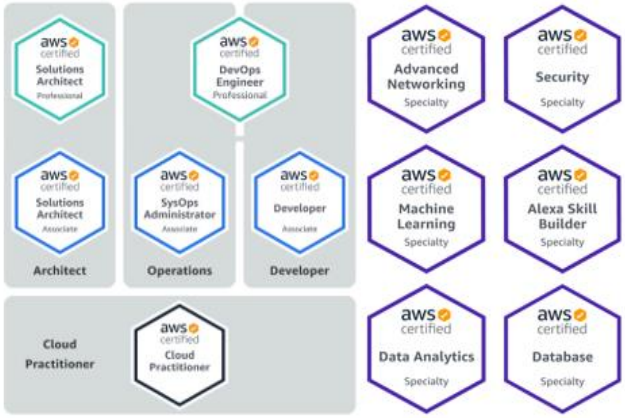

Fig 3:- AWS certification (source: https://aws.amazon.com/certification)

During the creation of the course syllables, the high reputation and value of the AWS Certification were taken into account, so the courses would allow students to apply for AWS official certification exams by spending few additional independent learning hours.

Task was defined so the students would gain about 70% of the knowledge that is needed to pass the exam. The remaining 30% is knowledge that is frequently changed and updated and is related to new cloud services introduced by the service provider that need permanent independent involvement of the student with the system. These topics could not be included as a part of an understandable concept of fundamental cloud services in base courses.

Two Georgian language-based course syllables were created named as: Cloud systems (AWS) and Cloud systems additional service (AWS). Courses were integrated into the existing program of Information technologies at one of the Georgian universities. Courses were offered as electives to the II- and III-year students. Two prerequisites were defined for the intro course of Cloud Systems (AWS) as “Introduction to the Computer networks” and “Linux operating system”.

AWS offers more than a thousand services and microservices, while the semester at the university allocates 30 contact hours to the course. So, the 30 hours course was created based on core services that are necessary for students to work with cloud services.

Before starting a course, a lecturer is applying for AWS Educate classroom and is choosing three services from the course services template. (fig. 4)

Fig. 4:- AWS Educate environment, templates of available services

As a next step, the lecturer defines the course name and gives a description, course duration, amount of credit given to each student, and the estimated number of students. (Fig. 5)

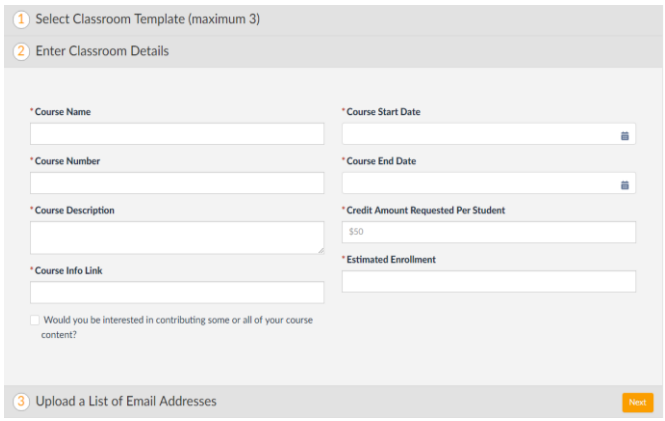

Fig 5:- Defining Course details at AWS Educate Environment

The last step in the creation of the AWS Educate course is to submit a list of students email addresses that are created within the university domain.

The administration of the AWS Educate service takes an average of 2-3 business days to review, and if the decision is positive, then the students will be credited and the relevant notification will be emailed. Students, in turn, must register for the AWS Educate service with the same authorized email address that the lecturer provided to the Educate Service administration. After receiving the credits, students were already able to make full use of the basic resources of AWS within the amount of credits provided.

V. RESULTS AND DISCUSSION

➢ *Created and integrated Cloud services courses in the Georgian language*

For the first, the introductory course - Cloud Systems (AWS) - defined the study of the following key services of AWS in terms of both theoretical and practical application:

- Cloudy object storage service S3 and its included microservices;
- Cloud Block Storage Service EBS;
- Cloud file system service EFS;
- CloudFront cloud caching service;
- Cloud computing service EC2 and its included microservices. Building and managing servers;
- Infrastructure and personal cloud building and management service VPC, as well as work with its included microservices;
- Auditing and monitoring service CloudTrail;
- Customer and access level management service IAM;

It is noteworthy that the above-mentioned course topics were not considered separately from each other, but after passing the basic theoretical and practical material, all the interactions of these services were understood and implemented. Because for the most part when working on real tasks it becomes important to interact between cloud services rather than using them casually, the main focus of the training courses was o**n orchestrating the services in a single context.**

The second course of Additional services of cloud systems (AWS) was created as the next level of the first course, so the pre-requisite Cloud Services (AWS) was defined accordingly.

In this course, significant attention was paid to the joint orchestration-use of services.

The following key AWS services and topics were selected for the second course:

- Auto-scaling in the cloud Auto Scaling;
- Cloud load balancers ELB;
- Cloud relational database service RDS;
- DynamoDB cloud non-relational database service;
- Route53 cloud DNS management service;
- Cloud computing serverless technology service Lambda;
- The concept of vertical and horizontal scaling;
- High Availability and Fault Tolerance architectures;

As a result, students significantly increased the knowledge gained from the first basic course, and after completing both courses, they could already make real architectural decisions/planning and, most importantly, their practical implementation.

It is noteworthy that in addition to acquiring specific services and their orchestration skills, students were provided with theoretical and practical knowledge of which architecture to use which is optimal for different tasks. For example, **High Availability** and **Fault Tolerance** architectures. Described by [20] Thus significantly raising their level of awareness.

The course has been run based on the methodology suggested by [21] where Current trends, factors were identified for these subjects and a stereotype of their future identification was formed. Relevant objectives were set for the identified factors, with a strict definition of their priorities. The next step is to execute the objectives with appropriate priority by involving a specific structural unit or units. Finally, the ongoing learning process was monitored with feedback from previous semesters, allowing us to improve it permanently.

At the same time, each service was given a certain number of lectures, where theoretical material was delivered from the 2 hours allocated for the lecture to the first hour and, most importantly, understanding - with appropriate infrastructure planning/delineation, and the second lecture hour was fully devoted to practical implementation of the theoretical material in AWS Educate environment.

Topics for midterm and final exams were also developed for both courses. Intermediate and exam issues included topics quite close to the actual AWS SAA (Solutions Architect Associate) certification exam. The issues were designed in such a way that the student was able to solve any of the described problematic situations by further preparing the students for the future AWS International Certificate, majoring in Decision Architect.

Since the above-mentioned courses: Cloud Services (AWS) and Cloud System Services (AWS) were elective (non-compulsory) courses at the University, it was interesting for students to be active in this area as well. At the already announced admission, more than 75 students took it in the first run of the course, which shows great interest as well. It is noteworthy that after taking these courses the number of students increased more and more.

VI. CONCLUSION AND RECOMMENDATIONS

The newly introduced courses - "Cloud Services AWS" and "Additional Cloud System Services AWS" have already been taken by 11 groups, with a total of 198 students.

Student attendance at these courses is recorded as quite high. Statistically, on average, 60% overcomes the minimum course threshold, while 10-15% complete it on a fair basis. It should be noted that the involvement of students during the lecture is large (> 80% of students in the group are constantly active) due to the practical features of the course.

It should be noted that the introduction of these courses at the University has significantly contributed to the practical understanding of the course materials of other bordering IT areas in terms of their application to each other. For example, the knowledge gained in the Computer Networking (CCNA) course for students was actively used in the study and implementation of the AWS VPC (Virtual Personal Cloud) service.

Also, the knowledge gained in the courses of "Computer Architecture", "Linux" and "Windows Server" operating systems was used while working with the "AWS EC2" (virtual server management) service.

And the knowledge gained in the Python programming courses helped the students to work with the AWS Lambda (server technology, coding) service, where they integrated these different areas and fully automated them.

On the other hand, the companies that the university cooperates with to provide students with internships and employment clearly express satisfaction as they hire staff with knowledge of modern topics, which helps their business significantly. The companies also expressed a desire to work more closely with the university, not only in the field of "cloud systems solution architect", but also in terms of training DevOps engineers that resulted in the development of a new master's program in information systems – DevOps.

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