Global processes of economy`s sustainable development, information society, systems and technologies

Nata Bibiluri [1], Gia Surguladze [1], Giorgi Tsaava [1], Malkhaz Bibiluri [1] and Maksim Iavich [2]

[1] *Georgian Technical University,77 Kostava Street, Tbilisi, 0108, Georgia*
[2] *School of Technologies, Caucasus University, 0102 Tbilisi, Georgia*

Abstract

The work has studied the factors revealed in the world economy regarding the transformation processes, which encourage the transformation of the modern economy into an information nature. We considered it expedient to focus on a brief characterization of each factor. The financial globalization process is characterized by the extension and diversification of the global securities market, the development of international bank credits, and the implementation of modern information technologies, communication means, and information into financial processes.

Keywords

Economy, transformation process, globalization, glocalization, integration, informatization, information economy, information society, business informatics, software application, economic and Agile development method

1. Introduction

The modern stage of economic development is characterized with existence of global processes, which covers all the social reproduction layers. During the industrial-base system`s transformation process into new global information-network economic system the implementation of its deep basics and qualitative changes of organization principles are being implemented. As a result of study of Georgian and foreign scientists regarding the world economy`s transformative processes, we have revealed a factors, which promote the modern economy to transform into information one (table 1).

Table 1

Factors transforming the modern economy into information economy

Factors	Meaning
Globalization	Increase the movement of financial, informational, human and material flows
Glocalization	Transformational expansion of regional banks of one country, making allies with banks on the territories of adjacent countries
International economic integration	Economic integration of countries into one common market and unification of economic policy
Informatization	Mixing of economic activity from production of goods to production of service
	Information economy

We considered it expedient to briefly describe each of these factors.

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EMAIL: bibiluri@gmail.com (N. Bibiluri); g.surg@gmail.com (G. Surguladze); tsaava.g@gmail.com (G. Tsaava); miavich@cu.edu.ge (M. Iavich)
ORCID: 0000-0002-4070-3718 (N. Bibiluri); 0000-0003-1185-459X (G. Surguladze); 0000-0002-6909-8718 (G. Tsaava); 0000-0002-3109-7971 (M. Iavich)

2. Globalization

As a result of globalization or universal economic, political and cultural integration and unification, a unified world market economy and its infrastructure is being formed, national sovereignty of countries are being abrogated, during of many centuries which constituted the key subject of international relations. Besides, globalization`s main character is the increase the movement of financial, information, human and material flow. Financial globalization impacts the aims of monetary and credit policy of the governing bodies (including internal prices and the currency exchange rate dynamics) and as a whole - it affects the mechanism of transferring the monetary warning (signal) to the economy. Financial markets, by themselves, play the catalyst`s role in economic interdependence. The significant acceleration of financial markets` international integration was approximately started in 1980s, whilst the turnover of trade with securities and currency market were increased, those collective investment institutions (including the hedge funds) have activated their operations. Since that period, the mentioned processes have been actively studied and examined by different authors. For instance, indicator like the "Globalization index" was developed to assess the national economy`s involvement quality in global processes. The above-mentioned process measures globalization according to the economic, political and social indicators of social life. It foresees such indicators, like economic integration, personal contacts, integration in international policy and information technologies.

Generally, coming out of an international condition of bank financing might be stated, that the rapid development of information technologies, which was formed right exactly at the beginning of the 1990s and their implementation in the financial markets became one of the locomotive powers for globalization. The financial globalization process is characterized by the extension and diversification of the global securities market, the development of international bank financing, and the implementation of modern information technologies, communication means, and information into the financial processes.

3. Glocalization

Along to the globalization process, the glocalization or economic, social, and cultural development is increased, which is characterized with the coexistence of tendencies in different directions. Thus, instead of expected disappearance of regional differences, they are maintained and strengthened. Instead of merger and unification, the following type of trends are formed and reinforced: separatism, sharpened interest towards the local differences, and increased interest of national traditions. According to R. Robertson (English sociologist), global couldn`t be confronted with the local and universal - with private. The local itself constitutes the globalization aspect, besides the global creates the local. As an example of glocalization on financial markets, the trans-border expansion of one country`s regional banks can be brought in, which by using the merger and devour instruments, create the alliances with banks on the territories of adjacent countries and by this they move the financial borders. For example, in 2000, the Norway Bank - "Spare Bank" was merged with Russian Bank - "АКБ" and in order to ensure the tight economic connection among the enterprises of two countries, it has opened its branch office in Murmansk - adjacent territory in Russian Federation. Glocalization covered an international tax system as well. For example, touristic fields in Turkey, which are very popular among the citizens of Russian Federation, made possible to pay for goods and services in Russian ruble (RUB). Thus, globalization and glocalization processes progress at the same time on modern financial markets and they fill each other.

4. International economic integration

International economic integration by itself leads the country`s economy to integrate in common market, while cancellation of tariff and non-tariff limitation leads us to unified economic policy. At the same time, according to opinion of prof. L. A. Mierin, the integration of the country in the global innovative economy is difficult not only for complex foreign economic circumstances, but because the left behind of number of innovative fields of national industry. we have to agree an author that optimal combination of closed and open models of innovative processes, application of export-oriented and import-substituting industry specialization at a time, maintenance of self-sufficient economy, independence in those technologies, which ensure the country`s national and economic security in

crucial fields, are demandable for country`s successful integration into global innovative economy and should encourage the country`s high position throughout the global market.

It should be mentioned, that sanctions from EU countries and U.S. have accelerated the processes of import-substitution and development in number of fields; especially in agriculture, processing industry, machinery, communications and telecommunication, information technologies.

The following significant factor of modern economy`s transformation which we should underline is the Informatization of all economic, social and political processes.

5. Informatization

Informatization has reached all of the structural circles of social development at its modern development stage. The mentioned processes on state level is already established and acknowledged. For example: an organic law on information, informatization and protection of information was adopted, which bring in the basic notions in scientific and business turnover, which by themselves are related to informatization processes. According to law, informatization by itself presents "an organizational, social-economic and scientific and technical process of creation of optimal conditions to meet information needs and to exercise rights of the state power bodies and institutions of local government, all enterprises, institutions, and organizations regardless of their organizational - legal forms and a form of ownership, and citizens based on formation, submission and use of information resources".

Besides the official definitions related to information processes, there are plenty of scientific and practical works, the aim of which is to study the information and establish its role in the modern economic system`s development.

Main part: Information economy like a scientific subject, studies the impact of information and information systems on economic decision-making and generally over the economy`s sustainable development processes.

Regarding this, in order to successfully implement the world globalization and glocalization processes one of the significant urgent trends is the formation and development of an Information Society [1, 2]. This is obvious today on the background of "Covid-19" pandemic. The countries and nations of the world have faced the survival problem; it became necessary to activate the 24/7 control points of the healthcare field (doctors), and transport (airports, land borders), which led to restricted operation of state and private structures and organizations or suspension at all. This process (pandemic) is situated also under the globalization format.

The number of internet consumers was significantly increased. Informatics specialists and non-specialists, which possess computer technology and mobile device technology, information technologies, and operational software - perform their official functions via online mode. Information and communication technologies is the "salvation key" for many business objects.

The necessity of the global population`s informatization is connected to the creation of a number of new generation software, which will ease non-professional informatics specialist-consumers to master and use the information technologies. The axiom is, that as easy and flexible the user interface of the software package is - as much work is done and user experience is provided for it by system designers software engineers, and developers [3-5].

Thus, the development of a new generation of information and communication technologies (ICTs), their production, broad usage, and operational accompaniment requires the preparation of especially highly qualified specialists, that firstly is a challenge for the university educational system for certain. The computing programs of technical higher education institutions require fundamental changes, which will allow the graduates to fulfill "the industry 4/5" requirements [6]

For the creation of software applications to further perfect the management processes of corporate business objects, flexible methods (in particular - Agile Software Development [ASD]) are intensively used [7]. On the fulfillment stage of software products` (projects`) vital cycles, it becomes possible to reveal its sensitive areas in the early stages, thus ensuring a higher quality product or service.

The foregoing article suggests the study of information system software creation issues for the management of corporate business processes on the basis of Agile / Kanban methods and the theory of rows [8-11].

As it is known, Kanban – is the lean method of software development [12]. In the thrifty environment, those actions or processes that cause such costs of effort or/and resources to reach the aims, won`t bring the benefit to the customer. In fact, the economy is focused on maintaining the value having the less work.

The lean trends are often called as Six-Sigma or Just-In-Time (JIT). The mentioned concept was developed in 1986 year in Motorola Corporation and it was first time used in General Electric. The essence of „6σ“ concept is in necessity of the outcome quality development of each process in production, in minimization of defects in operational activity and statistical deviations. It uses quality management methods including statistical methods, requires the usage of measurable aims and results, also covers the creation of special workgroups in the entity, which implement the projects to fix the issues and perfect the processes [13, 14].

The word “Kanban” in the Japanese language means “signal card” (“kan” - signal, “ban” - card). It is the firm technology of Toyota cars production, which was created to ensure the production`s stable flow and decrease the level of reserves. Such explanation is also used for “elimination of unfinished production`s value”) (work in progress - WiP). David Anderson is considered as the founder of Kanban`s usage in the information technologies field. He was the first man, who has submitted the general concept of this method in 2007. He has formed 4 basic principles and 6 main practices, which are integrative and applied by companies in their activities on Kanban`s basis [12, 15].

In order to assess the perfection (improvement) of the IT processes the following models are used: “Lean IT” (Lean IT – value, flow, decrease of residue) or Edward Deming model PCDA (Plan-Do-Check-Act). This method is based on the understanding of knowledge theory and is used in quality management [3, 16].

Kanban`s visualized approach and WiP restrictions are easy means, by which rapidly becomes obvious how fast move the cards in different nodes and where they crowd. Those nodes, where they crowd whilst the next node is free, are called “narrow places”. According to the Kanban board`s analysis, it is possible to apply measures to reach maximally equal flow. In such a case, it is possible to use the theory of rows on the basis of Markov`s processes.

In order to decrease the restriction of Work in Progress (WiP) and time for order of the product (including the software application), lots of entrepreneurs use Kanban systems. Let us discuss the production line (Fig. 1) [8]. It consists of some devices and a warehouse (storage) of finished parts [8,9].

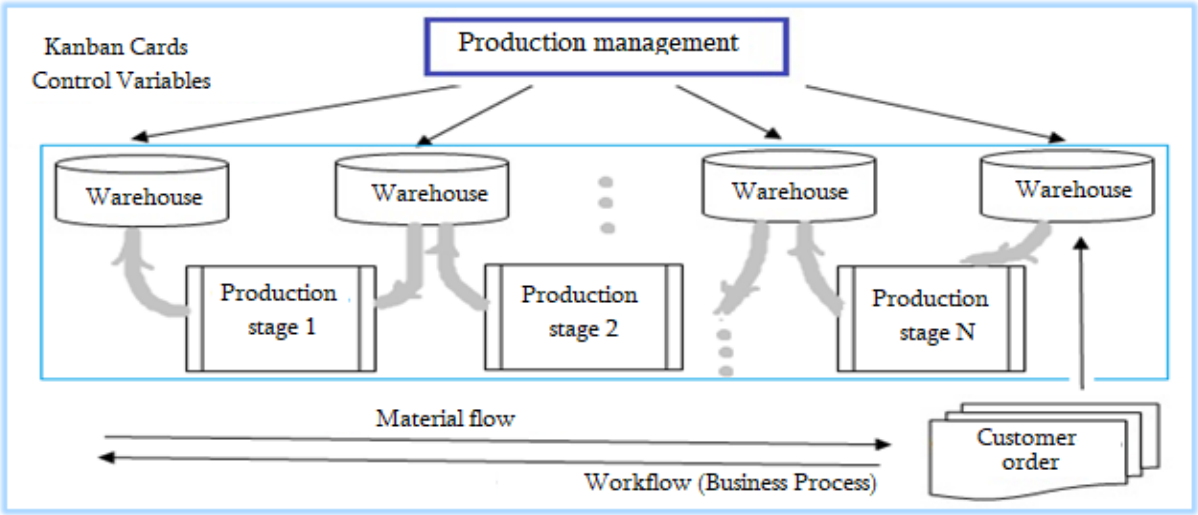


Figure 1: Kanban system principle (Warehouse or Repository)

Kanban management organizes the production in a way, that each particular part will be marked with card. Every time, when the finished part will be taken out from the warehouse (storage), the relevant card will be taken also and a new part will be marked on it. The processing of production line parts is only possible if it is indicated on the card (Fig. 2) [7]. Thus, Work in Progress (WiP) is efficiently limited by Kanban cards (Fig. 2 for visualization).

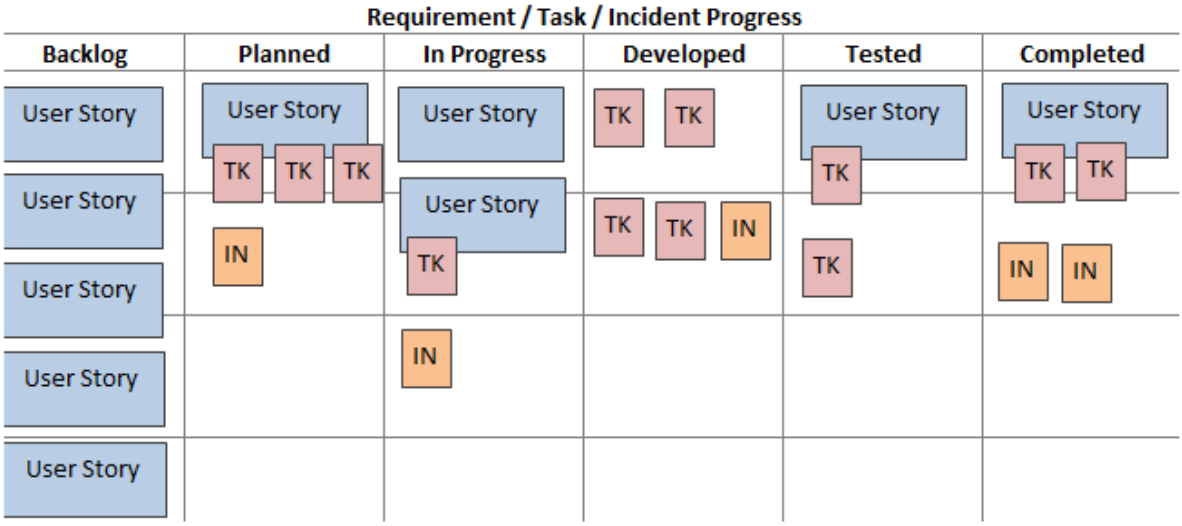


Figure 2: Kanban board (uses Software Development Life Cycle)

The devices are grouped according the sectors, the production into which is being controlled with Kanban system. Material flow covers the sectors and the number of Kanban cards have crucial importance in definition of productive capability.

The adjustment of very small amount of Kanban cards implies the loss of capacity (power) and the weak space is being formed because of insufficient planning. Otherwise (big amount of cards) means very high rate of work in progress (WiP), which leads to an excess in waiting time and order`s fulfilment time.

The reflection of tasks via Kanban cards allows us to perform production line modelling, which will be managed via Kanban as mass service close network [8]. The impact of amount of Kanban cards on the manufacturing capability (fulfilment indicators) might be assessed by using the analytical numerical methods.

The network of rows (queues) consist of particular queues and service objects. The queues awaiting the service might be imagined as an idle system or node [9]. The queue network and the queue system (node) is given in the Figure 3. The orders are being transferred from one node to another. Each node has particular strategy, which organizes if how like the order should stand in the queue and how it should be edited.

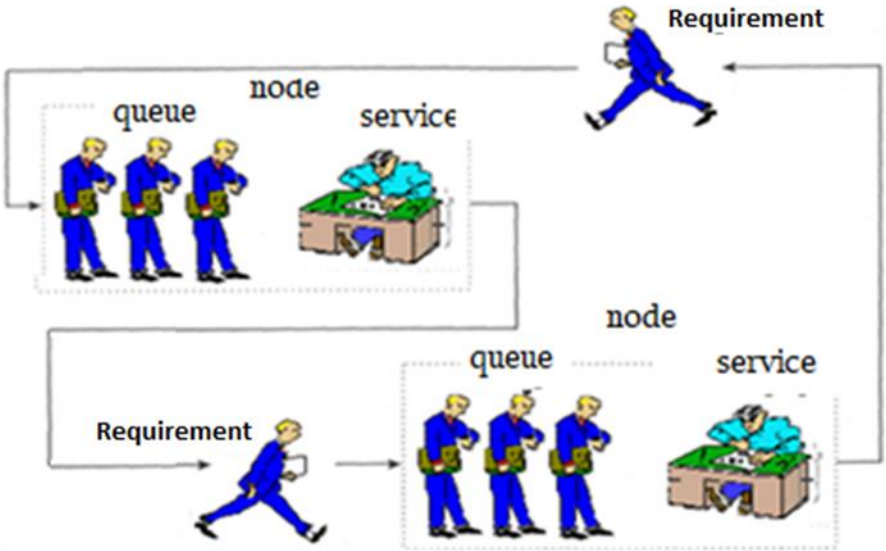


Figure 3: Queue network and system

In case of temporary suspension of the given request, the service object describes the distribution of service time in every node, which is described with special parameters. The network where the different types of orders are placed is consolidated in task class, which is divided into two class: a) closed class: in such case, none of the new request will enter the network and also none of the request will leave the

network. The network permanently maintains the equal amount of requests; b) open class: the network consists of source of starting (initial) and final requests, which is subject to regulation.

The service scheme build by WinPepsy - instrumental mean of the theory of rows (queues) are presented on 4-th figure.

Under the analysis of the network built, which is implemented by software calculation part of WinPepsy package, is established the optimal amount of Kanban cards and capacity of work in progress (WiP) [8, 9].

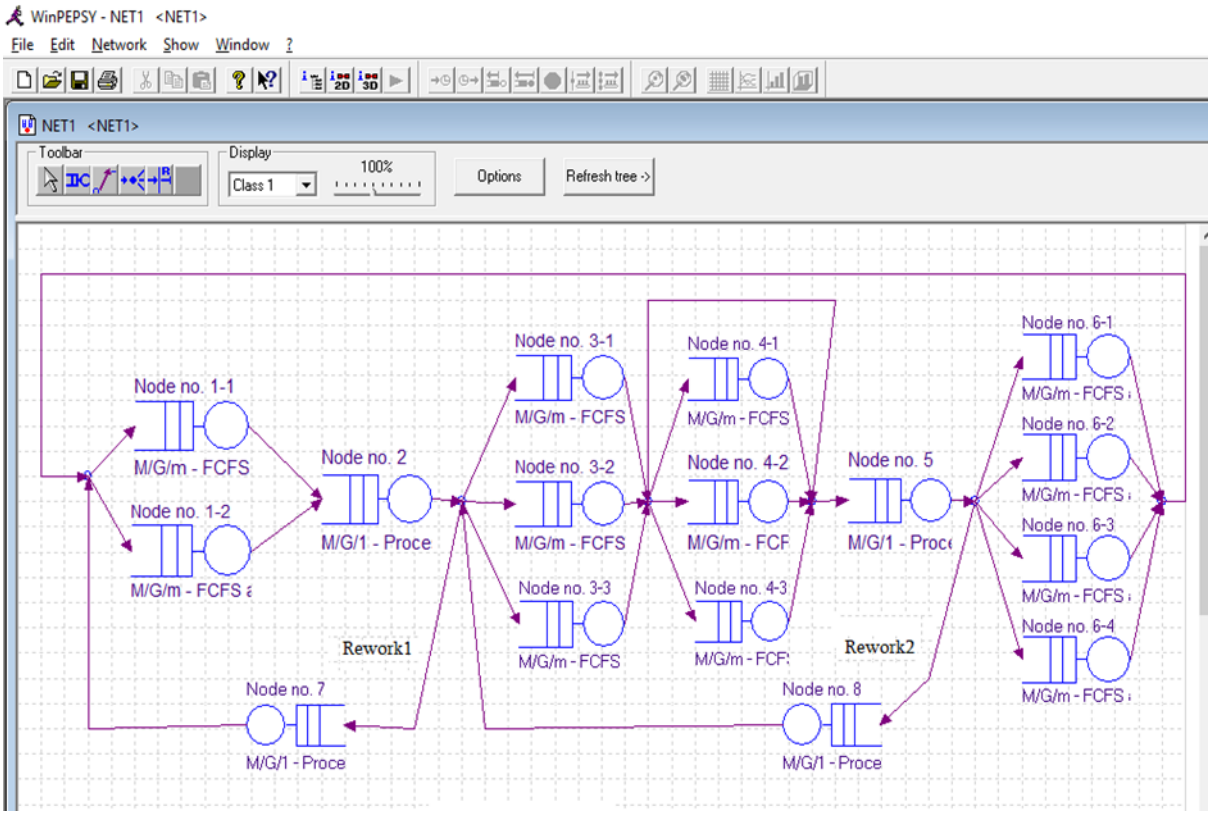


Figure 4: Scheme in WinPepsy desktop

Alternative Models: Queues Theory and Petri Stochastic Networks. Fig. 5 represents corporate network example with 5 Servers: MainS (MainS') is one corporate server of M/M/m type and with FIFS service (First-Come, First-Served). It is associated with local S1 , S2 ,…, Sn servers of departments switched on in Intranet. One can see an open network, in which a requirement may arrive from any (1..n) network block. Requirement source, i.e. arrival node operates independently of each other according to the principle of G1 , G2 ,…, Gn random numbers generator. This node is of M/M/m type and with FIFS service, as well. Arrival intensity (λ) is indicated in the open class [8,9]. M/G/1-system is characterized by the intensity of such processes, as Poisson intensity, with λ requirements per second.

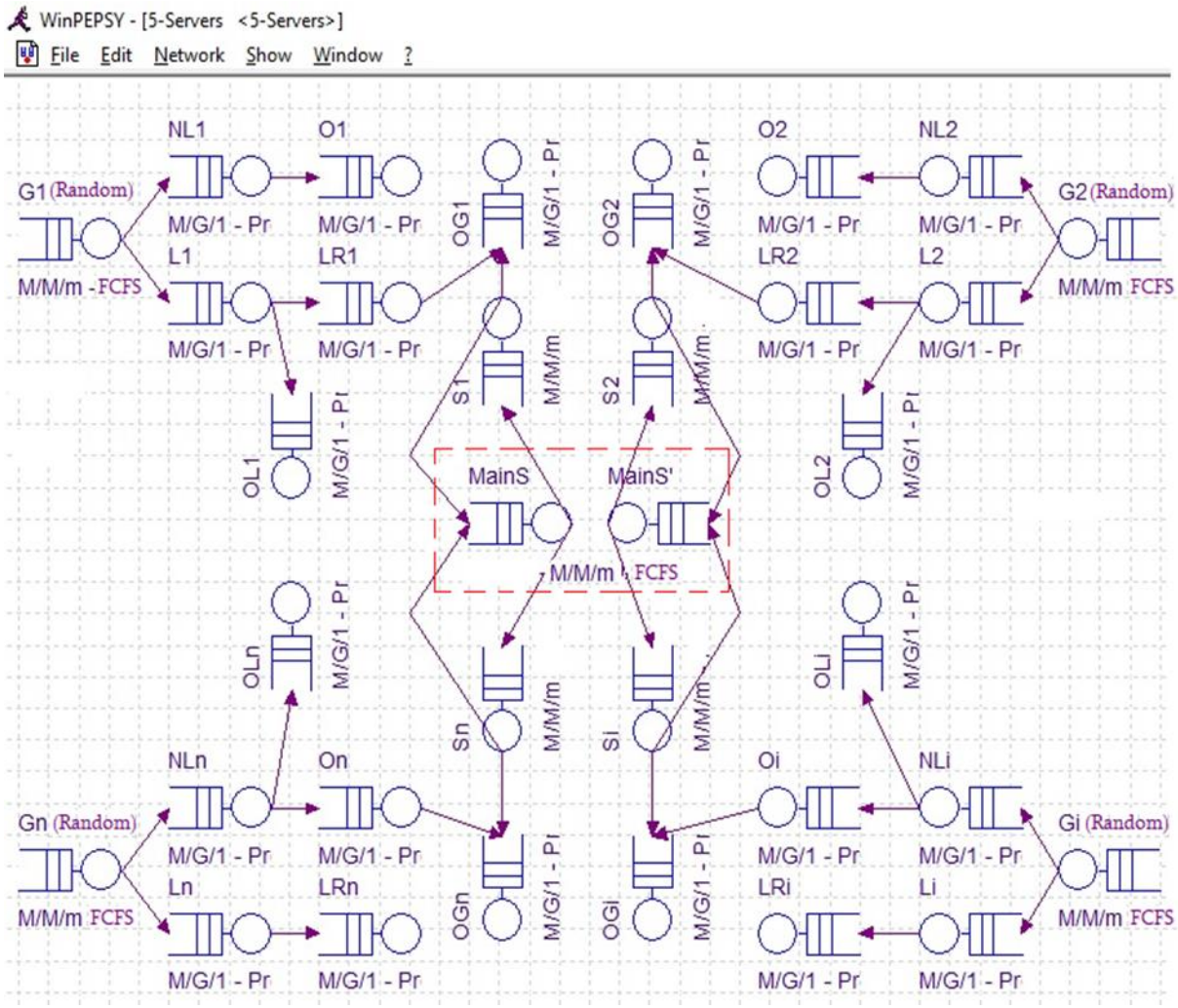


Figure 5: Corporate Network Model with WinPepsy Queues Theory Tool

In the Table of Fig. 6 there are shown the methods used in WinPepsy tool for processing of constructed network model.

Available methods

Methods	Explanation
MVA	Mean value analysis for closed product form networks with several classes
BIPHASE	BIPHASE analysis for closed networks without classes
Simulation	Simulation for mixed networks with classes and general service time distributions
OPFN analysis	OPFN analysis for open networks with classes and single server nodes
SOPFN analysis	SOPFN analysis for open networks without classes and with multi server nodes
Marie	MARIE analysis for closed networks without classes with general service time distributions
DECOMP	Decomposition analysis for open networks with classes and general service time distributions
STATESP	Statespace analysis for closed networks with classes (not implemented yet: mixed networks with classes and finite queues)

Figure 6: Methods used in WinPepsy tool

In Fig. 7 there is shown an alternate model of corporate network management with Petri stochastic network. It is constructed using Visual Object Net++ graph-analytic redactor and is implemented in the form of cause-and-effect predicative Petri network. It assures the management of sequential and parallel processes and fixation of time parameters of their execution.

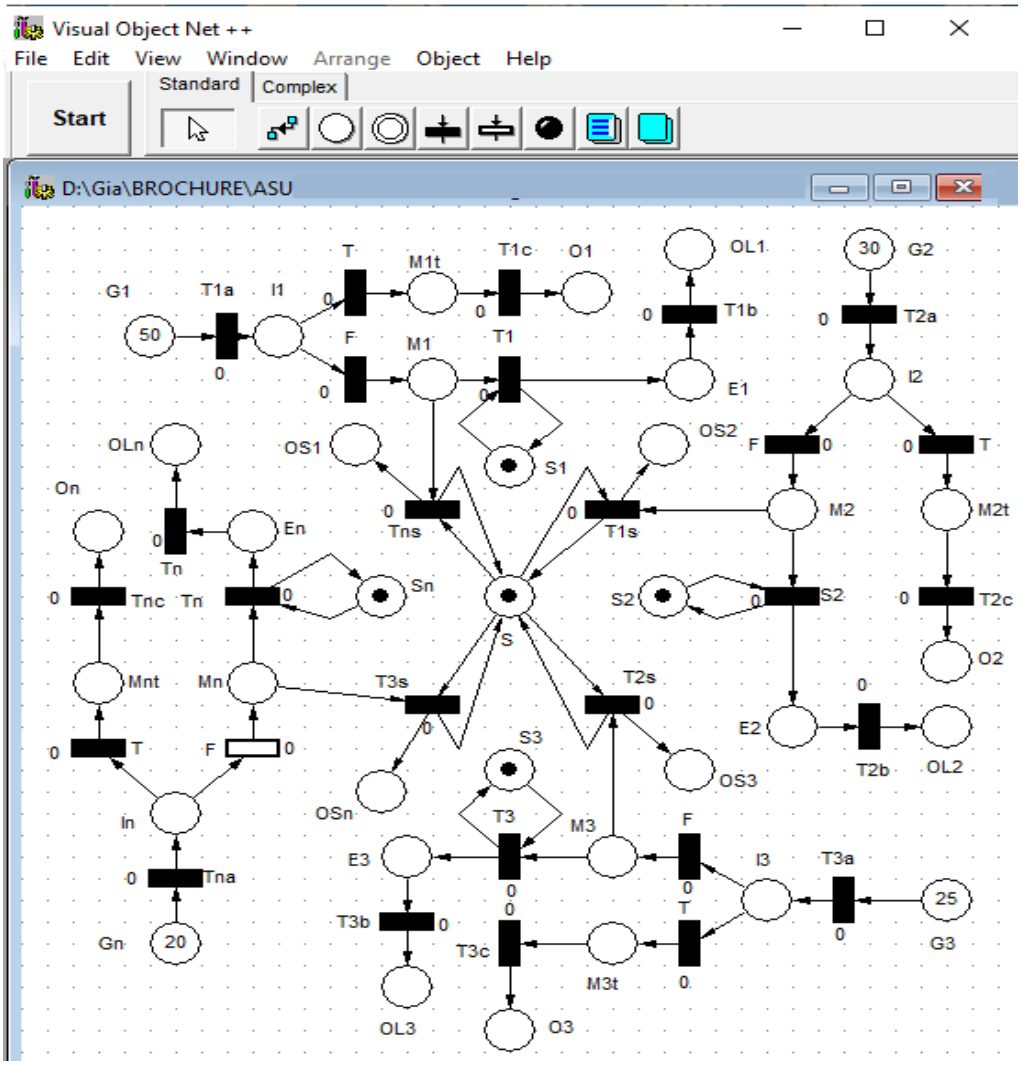
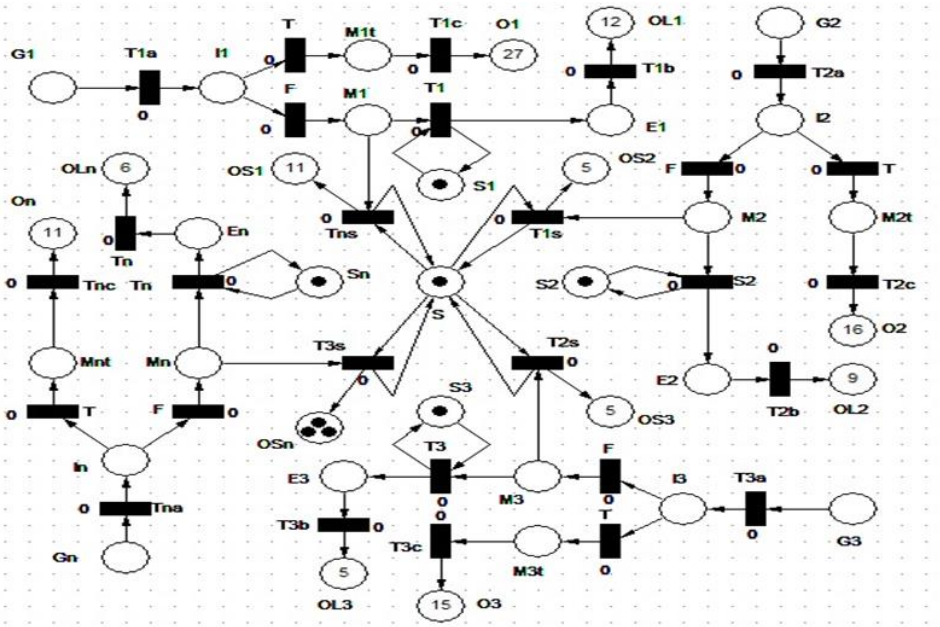


Figure 7: Corporate network model with Petri network tool



	O	OL	OS
1.	27	12	11
2.	16	9	5
3.	15	5	5
...			
n.	11	9	3

Figure 8: 15th step of the imitation process (by moving markers)

A Server of System's main office is modeled by Petri network position (S). Random-generators (G) are entered for formation of the requirements (let's assume that is satisfies Poisson distribution). Results of requirement analysis (I) and its processing are displayed in positions (Oi-results are obtained without shared local resources, OLi-results are obtained by shared global resources). Imitation process launching by Start button is shown in Fig. 8.

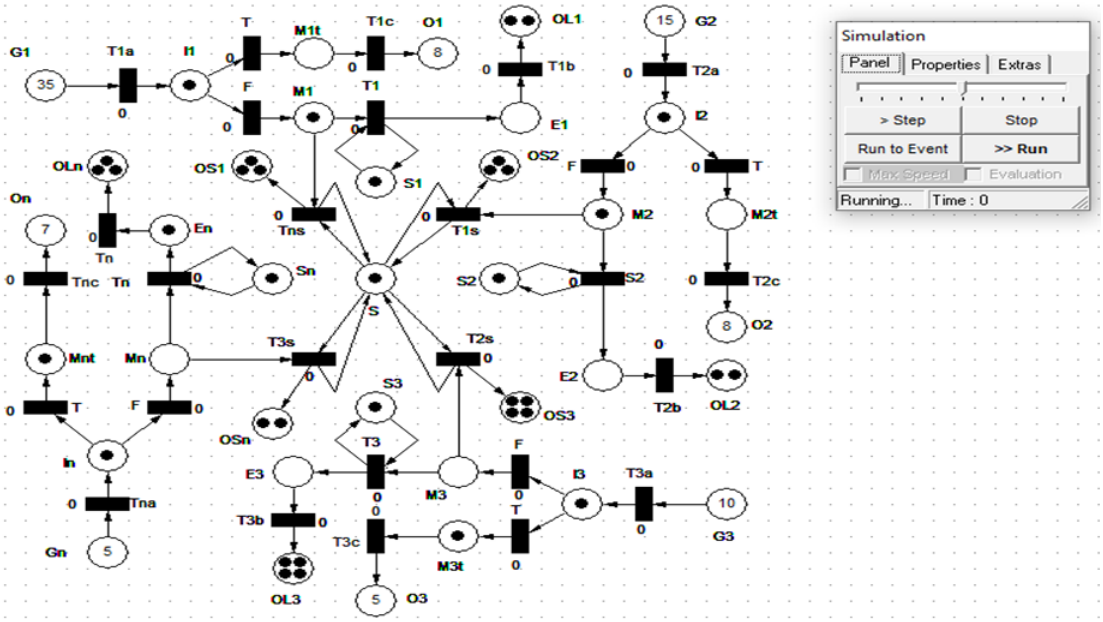


Figure 9: Complete the imitation process (with results table)

Implementation. Scientific view of information economy, creation of information systems supporting taking of optimum economic decision that improves the processes of sustainable development of economy, at the last stage substantially depends on determination of such system infrastructure and its software implementation. Modern digital technologies provide variety of opportunities for that end.

From this viewpoint, in our work an attention is pinpointed, for example, on the use of microservice architecture by commercial companies (Service Core) [17]. Microservice core is written in C# language, is built on NET CORE platform, uses StackExchange Redis, NewtonSoft JSON and Puppeteer-Sharp libraries. Object-oriented programming opportunities, communication between microservices and queue management are numerously used in this project. A foundation was laid for transfer from monolithic applications to module (service) architecture. Each service has a communication with other services through common interface, such as API and REST interfaces [18].

Microservice is kept in a Docker, which is a program and enables *virtualization* at the *level of operational system*. The advantage of Docker is that in case of switching their containers off all programs entering its composition will be erased from random access memory. Therefore, program "remaining" and random access memory overflow are excluded. This fact eliminates service uncontrollability and necessity of its reload due to problems related to random access memory.

From the viewpoint of database use we prefer databases of NoSQL-type, e.g. Redis, Mongo DB etc. [17,19]. Redis supports diverse types of data. Among them are: Lists, Sets, Hashes, HyperLogLogs, Streams, etc. These datatypes make it possible to take from any programming language such data, as variable, array or object [20]. The base has Publish/Subscribe method support, which looks like client/server sockets. A customer is able to create Channel, on which some customer application publishes information. The second app, which is a Subscriber, receives and processes this informaiton [21]. Redis is considered as the quickest one.

Below is given the example of recording:

{
"Ident": "B9CK2DLCH7JSH6XH4",
"StatusId":0,
"Data":{
[

{ “Name”:”Giorgi Mgebrishvili”, “Email”:”giorgimgebrishvili@outlook.com”}, {“Name”:”Gia Surguladze”, “Email”:”g.surguladze@gtu.ge”}
]
},
“OptionalMessage”:””,
“ErrorMessage”:””
}

This record includes a unique identifier, status of its state (0 means processing requiring), Data, which are individual for every microservice (in this case it refers to the name and the array of e-mails), text and error text.

Frequently it is necessary to retrieve information directly from a browser (parsing), when a web-site has no API (or it changes very often). Puppeteer-Sharp library is used for the solution of this problem. It contains the cores of different web browsers [22]. It allows us to manipulate on the websites. In particular: program navigation, simulated launching (injection) of JavaScript, picture memorizing etc. Puppeteer-Sharp library is distinguished by quickness and flexible error handling.

Analysis of the smooth operation of program application and elimination of errors revealed in this process is a very important issue. That makes it inevitable automatic save or logging of information on different events, processes, and errors during program operation. This information may include dates, quantities, some status, text, object etc. For instance, logging record in the base is of the following type:

{
“Ident”:”NC6LDC9KC1LC”,
“LogLevel”:0,
“ProgramName”:”MailSender”,
“DateTime”:”2019-10-24 10:15:49”,
“Message”:”Program started succesfully”
}

This record includes a unique identifier, log level (0 means informative), name of that program, from which it was added to the base, addition date, and info text.

Microservices of Service Core process data according to the queue principle. For every microservice it is prescribed in the parameters, what table it processes in the bases, and on what channel it obtains the published data. First, a customer (either some program, physical person, or other microservice) has to add the record to a base and publish the command. The microservice, which is permanently launched in the Docker, receives a signal and reads out the record from a base based on the corresponding identifier, converts it from JSON format to corresponding classes, and starts processing.

A test application called Redolph is intentionally created for microservices by the ServiceCore library. Text templates are predefined here. It is possible to add a new template and generate Redis queue names. For instance, in order to check value-added tax (VAT) it is necessary to enter such text in JSON format in the base:

{ “Data” : { “tin” : “123456789” } }

Thanks to Redolph a tester has just to correctly enter the company identifier and to push a button (key).

6. Conclusions

On the basis of the above mentioned matters, the following brief conclusions can be drawn:

1. In modern - post-industrial society, the source of productivity and enhance becomes such knowledge, which is used in all the economic activity fields and in such society the scientific-productive economic component covers the priority „information“ and the „knowledge“.
2. Informatization promotes economic activity`s transfer from production of goods to production of services, which constitutes one of the property of transfer to post-industrial and information society.
3. Theoretical studies performed relating to originalities of globalization, glocalization, international economic integration and Informatization makes possible to draw the conclusions regarding the fact, that mentioned factors have led the civilization to its development`s modern condition - to the information economy.
4. Information society is the significant component of information economy and its active user, the final formation and further development of which is XXI century task. The special role in

development of these innovative processes belongs to the modern information and communication technologies.

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