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MANAGEMENT OF INNOVATION PROCESSES

Abstract. *In the article, it has been studied models of **"**1G-Technology Push", 2G-attracting the market", "3G-R&D and market coupling","4G-Integrated Business Processes","5G-system integration and network" on the one hand. Consecutive phases of failure and development of the essence of artificial intelligence from its origin to the present day on the other hand. It`s been analyzed the convergence of the development of innovation process models with the phases of formation and development of artificial intelligence.*

"6G-open innovation model" of innovation process has been reviewed as an actual issued in the article, the formation and development of which is related to the period of popularization of artificial intelligence, and recognition of the advantages of artificial intelligence, which takes into account the generation and rapid processing of large and varied data in a short time interval.

Based on the results of research, existing and expecting trends of the development of artificial intelligence in the world market has been analyzed, which are characterized by significant growth trends and can have a positive impact on achieving the rates of economic growth of the country, region, on increasing the level of employment, developing the business sector, gaining competitiveness.

The research determined the existing level of development of artificial intelligence, factors, conditions and opportunities for hindering the development.

Keywords*: innovation, innovative processes, artificial intelligence, management.*

***JEL classification:** O.03.032.*

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ინოვაციური პროცესების მენეჯმენტი

აბსტრაქტი. სტატიაში შესწავლილია ერთი მხრივ ინოვაციური პროცესების „1G–ტექნოლოგიური ბიძგის", „2G–ბაზრის მოზიდვის", „3G-R&D და მარკეტინგის დაწყვილების", „4G–ინტეგრირებული ბიზნეს პროცესების", „5G–სისტემური ინტეგრაციის და ქსელის" მოდელები. მეორეს მხრივ ხელოვნური ინტელექტის არსის წარმოშობიდან დღემდე წარმომატებლობის და განვითარების თანმიმდევრული ეტაპები. გაანალიზებულია ინოვაციური პროცესების მოდელების განვითარების თანხვედრა ხელოვნური ინტელექტის ჩამოყალიბების და განვითარების ეტაპებთან.

სტატიაში აქტუალურ საკითხად განიხილება ინოვაციის პროცესის „6G– ია ინოვაციის მოდელი", რომლის ჩამოყალიბება და განვითარება უკავშირდება ხელოვნური ინტელექტის პოპულარიზაციის პერიოდს, და ხელოვნური ინტელექტის იმ უპირატესობების ადიარებას, რომლიც ითვალისწინებს დიდი და მრავალფეროვანი მონაცემების გენერირებასა და სწრაფ დამუშავებას მცირე დროის შუალედში.

კვლევის შედეგებით გაანალიზებულია ხელოვნური ინტელექტის განვითარების არსებული და მოსალოდნელი ტენდენციები მსოფლიო ბაზარზე, რომლებიც მნიშვნელოვანი ზრდის ტენდენციებით ხასიათდება და შეუძლია დადებითი ზემოქმედება მოახდინოს ქვეყნის, რეგიონის ეკონომიკური ზრდის ტემპების მიღწევაზე, დასაქმების დონის ზრდაზე, ბიზნეს სექტორის განვითარებაზე, კონკურენტუნარიანობის მოპოვებაზე.

კვლევებით დადგინდა საქართველოში ხელოვნური ინტელექტის განვითარების არსებული დონე, განვითარების შემაფერხებელი ფაქტორები, პირობები და შესაძლებლობები.

საკვანძო სიტყვები: *ინოვაცია, ინოვაციური პროცესები, ხელოვნური ინტელექტი, მენეჯმენტი.*
JEL კლასიფიკაცია: *O.03.032.*

Introduction and review of literature

There is no unified approach of scientists about innovative processes and the peculiarities of its consistency, which is clearly reflected in the business process models of innovation. B. Sitvis (1989) [14] discusses the innovation process from the emergence of an idea to its realization, which combines science, technology, economics and management. According to I. Cooper (1990) [4] innovative process requires management, control and effort.

British sociologist R. Rothwell (1994) made a significant contribution to the understanding of the essence of management of innovative processes and based on the results of research on high-tech innovative startups, he has studied five generations of innovation: "1G-technology push", "2G-attracting the market", "3G-R&D and market coupling", "4G-Integrated Business Processes", "5G-system integration and network" models. Based on the analysis of existing models, he created "descriptive model" of how (manufacturing) companies organize simple radical and incremental innovation processes in order to adapt to market changes. Scientist Rothwell stated that the complexity of innovative process models and justified the parallel and chain integration of elements/mechanisms in each subsequent model and their effective realization in practice. Researchers M. Kotesmir and D. Meissner (2013) suggest that the "6G open innovation model" represents the closest model of the innovation process [8]. According to Chesbrough (2003), "open innovation is the use of purposeful inflows and outflows of knowledge to accelerate innovation internally, which also expands markets for the external use of innovation" [2].

Methodology

The observational method of empirical research has been used in the article to guide the research process correctly, according to which the existing level and future trends of development of open innovation and artificial intelligence in Georgia has been analyzed, which should necessarily be responded to global trends of development of artificial intelligence. In the paper, management models of innovative processes and their key features have been studied by taking into account the methodical principles of analysis and synthesis, scientific achievements in management models of innovative processes, practical technological failures, existing problems and achievements have been analyzed. By using a statistical method, the current and future trends of the artificial intelligence market around the world have been analyzed; The global artificial intelligence (AI) robots market size over the world; The global explainable AI market size over the world; The increase in the number of people employed by artificial intelligence. Taking into account the methodological principles of induction and deduction, the existing level and opportunities for the development of artificial intelligence in the private sector under the conditions of open innovation in Georgia have been evaluated. Activation of the role of the state for the creation of an open innovation space and environment was named as a necessary condition.

Results

Since the 70s of the 20th century, the introduction of innovations in the world's global space has a continuous character and it is not only an integral part of the progress of the society, but also it is an important factor for the development of each country, that's why the economy of the world's advanced countries is called an innovative economy, which is based on knowledge, innovation flow, technology, information, etc. continual improvement, intellectual work of scientists and innovators and not just capital.

Innovation is the process by which an invention or an idea acquires an economic content [5]. Aspiration to create an innovation or be an innovator, all of these start with a "great" business idea, which

is not an accidental and it is possible to base on specific principles of elimination of problems existing in the product, service, process.

The current process from the origin of the idea to its commercialization is called the innovation process, the history of which has been analyzed by R. Rothwell since the 1950s and laid the foundation to form the scientist Rothwell's "descriptive model", what gives us an opportunity that innovation process management and development trends related to AI should be the subject of joint step-by-step evaluation according to the years, which covers the period from the 50s of the 20th century to the 20s of the 21st century.

Even in the 50s-60s and 70s-80s of the 20th century in the field of artificial intelligence and innovative processes management, by analyzing the achievements of scientific innovations and results of scientific research, it has been determined that formulating of the essence of the concept of "artificial intelligence" by Stanford University professor J. McCarthy (1956) contributed to the formation of the first generation innovative 1G-"technology push" model from 1950s to the mid-1960s and in the late 1960s, the second generation innovative - "2G attracting the market " model was established. In the 1G and 2G models, innovation processes were represented as simple, linear sequential processes and the focus was on research and science (on R&D). As for one-way communication model of "3G-R&D and market coupling", he theoretically described the need for feedback between "society and market needs" on the one hand and he considered the generation of new ideas and their realization using new technologies as a necessary condition on the other hand. 3G-models combined many internal functions and the need for interdependence between processes.

In contrast to "3G-R&D and marketing coupling" model established in 1980s [until the mid-90s] the "4G-integrated business processes" model reflected the integration between internal features and external (with suppliers, customers, universities and government agencies) entities and the parallel consistency of continuous innovation processes.

Thus, 1G, 2G, 3G, 4G models created as a result of scientific research and inventions were only the subject to theoretical study of the issue, because the commercial applications created by the results of scientific research were practically unrealizable simple radical and incremental innovations i.e. the mentioned models belonged only to such technical inventions, in which network interaction and interconnection were not subject to any technological tools.

The failure of "3G-R&D and marketing coupling" model in 20-70s was due to the extensive but unsuccessful research into artificial intelligence by James Lighthill (1973) in England. The period of failure to establish the model of "4G - integrated business processes" was connected with the "artificial intelligence winter" of the 1980s, which refers to a period of time in which research and development in the field of artificial intelligence (AI) has considerably been slowed down, what was caused by a significant decrease in funding for AI research on the one hand and a general lack of interest from investors and the public on the other hand. This was the reason to a significant reduction in the number of developed AI projects and suspension of many ongoing research projects due to lack of financial resources.

1980s showed both the restrictions and the challenges of development in artificial intelligence research. This caused state interest to increase funding on innovative projects for AI development and create an investment environment for the development of the sector. The mentioned process led to the formation and development of the "5G-system integration and network" model from 90s of the 20th century to the end of the 20th century, which was focused on effective distribution of network processes

and system integration. The advantage of the 5G model was flexibility and rapid development, which was reflected in the use of information systems in automated business processes.

It has been established by scientific research that scientists in 4G and 5G models, in 4G and 5G models, scientists prefer not the consistency of technological innovation processes, but the multi-functional cross-functional nature, i.e. the integrated and network model emphasized the fact that technological innovation is cross-functional and multifactorial, but not coherent. In contrast to the 4G and 5G generation models, in the previous generation models of innovation processes, innovation was considered as a distributed network process, which required constant changes in the firms, and system integration was not the subject of discussion.

At the beginning of the 21st century, "6G- open innovation model" was being discussed by the researchers of the model of innovative processes, which is the latest wave of innovation process models and reflects: generation and development of internal and external ideas, development of new technologies for unification and simplification of internal and external ways to the market and creation and development of a continuous chain of innovative processes.
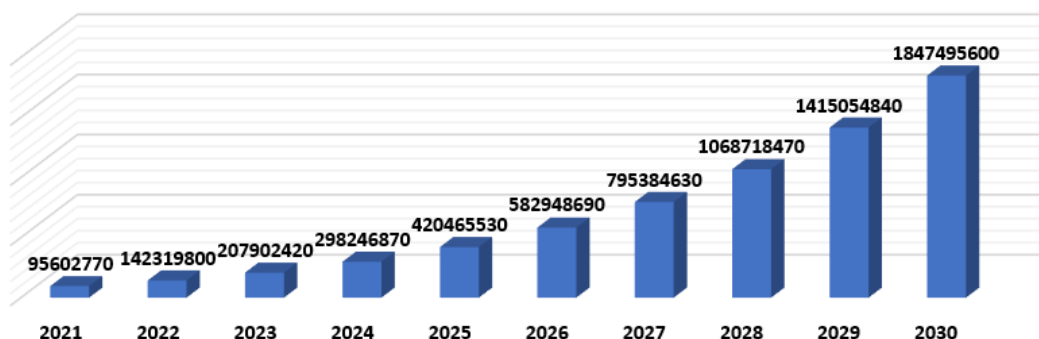
The formation of the "6G-open innovation model" is connected with the period of popularization of AI, in other words, the period when artificial intelligence was given priority: 1. scope of data, 2. speed, 3. the variety of data. i.e. AI has been subject to technological achievements in data storage and processing. However, it should also be noted that the amount of data generated at the modern stage is increasing significantly, and in the future, the role of big data in AI will become more important. Therefore, AI is one of the most interesting (and controversial) technological trends of the 21st century. But the controversial issue for scientists is how big is the AI space? An how fast can it be developed? The current and predictable world statistical data show the mentioned tendencies.

According to the research, it`s been determined that the global artificial intelligence market size has been evaluated from 2021 to 2030 and it is characterized by a tendency to grow. In 2023, the global artificial intelligence market size has increased by 46% compared to 2021 and it consists of 207,902.42 million US Dollars. The market volume is expected to increase by 514% and amount to 1,068,718.47 million US Dollars by 2028 compared to 2023, and it can be increased with 888,6% - by 2023 and amount to 1,847,495.6 million US Dollars (Diagram 1).

The growth of the global AI market with 112,299.65 billion US Dollarsin 2023 compared to 2021 is due to the increase in practical use cases of artificial intelligence technology, from creating the content to self-driving cars. The global AI market is expected to reach $1.81 trillion by 2030, what according to research, artificial intelligence could potentially bring an additional $10-15 trillion in economic benefits by 2030. And together with it, by using AI, it is possible to expand economic and performance boundaries between countries and businesses. 83% of companies report that AI is a top priority in their business plans. 48% of businesses are using any forms of AI to use big data effectively. 38% of medical providers use computers as part of their diagnosis [10].

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Diagram 1. Artificial intelligence (AI) market size worldwide in 2021 with a forecast until 2030 (in million U.S. dollars)


Source: https://www.statista.com/statistics/1365145/artificial-intelligence-market-size/

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The global AI-guided robots market size in 2023 will be 12,825.12 million US Dollars, what has been increased with 186.8 % compared to 2021. The global AI-guided robots market size is expected to grow with 399.3% by 2028 compared to 2023, what will be 51,216.99 million US Dollars (Diagram 2).

The global Explainable artificial intelligence (AI) market size consisted of 5.1 billion US Dollars in 2022 and it consisted of 6.28 billion US Dollars by 2023. The mentioned indicators are characterized by an increasing trend in dynamics from 2022 to 2030 and it is 5.44 % by 2023, what is expected to be 14.6 % by 2028 and 21.3 % - by 2023. Thus, according to preliminary research, the global Explainable AI market size is expected to increase to 24.58 billion US Dollars by 2030 (Diagram 3).

Diagram 2. Artificial intelligence (AI) driven robots market size worldwide in 2021 with a forecast until 2030 (in million U.S.dollars)
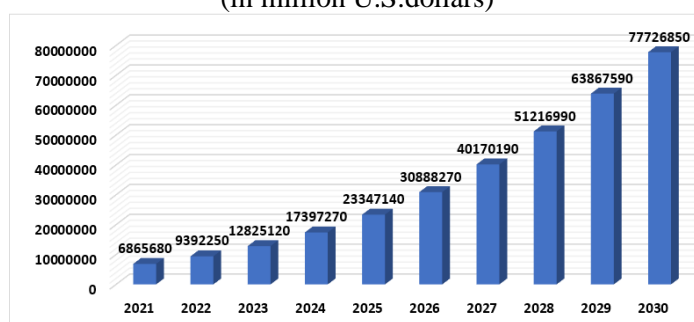
Source: https://www.statista.com/statistics/1366499/artificial-intelligence-robotics-market-size/

By 2025, there will be 97 million people working in the AI space. The AI market size is expected to grow at least 120% per year. According to the research, analyzing the results of the survey of age groups, it is determined that 42% of respondents aged 18-44 (17% aged 18-29, 25% aged 30-44) believe that many jobs will be created and 18% (age 18-29-9%, age 30-44-9%) assume fewer jobs.

Diagram 3. Size of explainable artificial intelligence (AI) market worldwide from 2022 to 2030 (in billin U.S. dollars*)*


Source: https://www.statista.com/statistics/1256246/worldwide-explainable-ai-market-revenues/
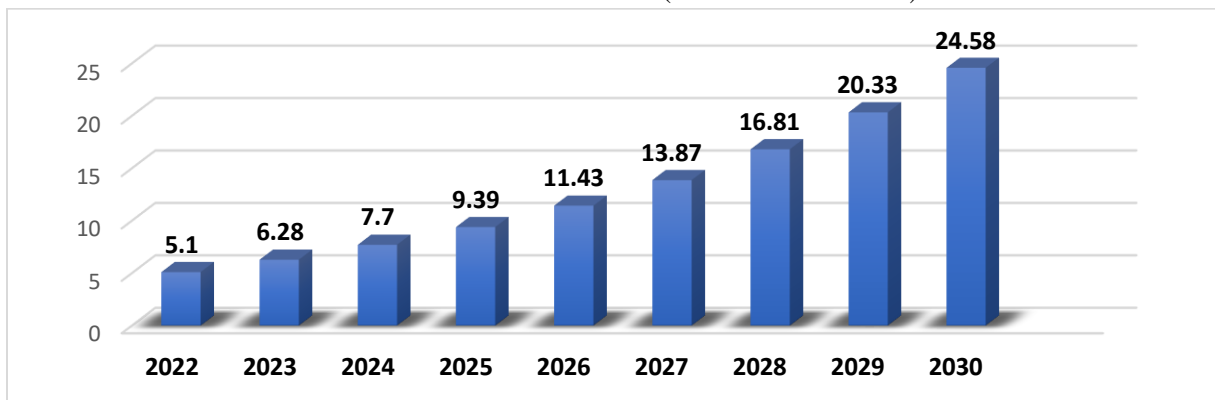
6% of respondents aged 45-65+ (age 45-64-3%, age 65+-3%) believe that many more jobs will be created, and 48% (age 45-64-29%, age 65+-19%) assumes fewer jobs.

Artificial intelligence is predicted to replace more than 800 million jobs worldwide by 2030, we will see how important it is for countries to respond quickly and use the full potential of artificial intelligence (**Diagram 4**).

Diagram 4. Do Americans think artificial intelligence will lead to there being more jobs for people or fewer jobs

Source:https://www.statista.com/statistics/1357711/opinions-on-artificial-intelligence-impact-on-jobs-by-age-us/
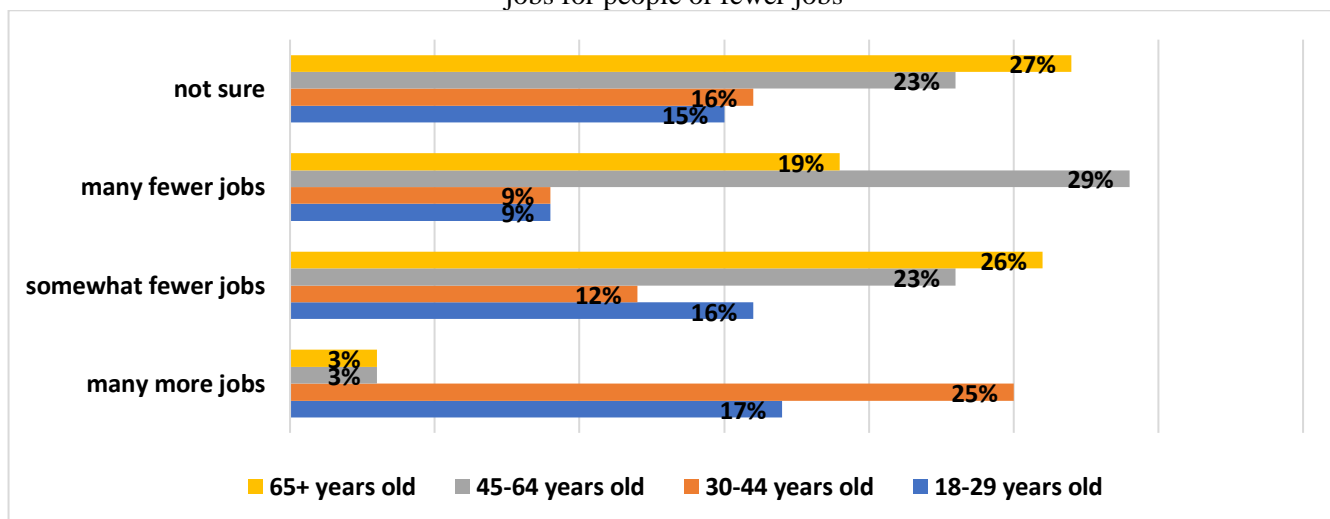
At the modern stage, without artificial intelligence, there is no future, nor it is possible to develop any country, including our country Georgia. However, it should be noted that despite of functioning of "**Georgia Mind**" – business association of artificial intelligence, artificial intelligence and other modern technologies are being developed rather slowly. There is no legal basis for regulating artificial intelligence, national development concept, strategy and action plan. Examples of artificial intelligence can be found in both the public and private sectors, however, issues of their functioning and development are carried out in a narrow organizational context.

According to the research ("Innovation and Startup Ecosystems") organized by DG NEAR and DG CONNECT in 2018 for Eastern Partnership (EaP) countries, from the artificial intelligence development point of view, Georgia was significantly behind the countries of the Eastern Partnership, such as Armenia and Moldova, and is only slightly ahead of the average rate of EaP. The leader of the region in this regard was Armenia, where many startups working on artificial intelligence were being operated.

According to the research - AI Readiness Index 2020, conducted by OXFORD INSIGHT, 172 countries have been evaluated for their artificial intelligence characteristics according to 10 directions and 33 indicators. In this index, Georgia has 72nd position globally and 5th out of 16 countries regionally (South and central Asia) and it`s behind such countries of the region as Turkey, Azerbaijan, Kazakhstan is.

The results of Georgia, according to individual indicators, are distributed as follows: view - 0.00 (out of 100 points); governance and ethics - 59.32; digital capabilities - 52.02; ability to adapt - 52.09; share in the economy - 11.13; Innovative capabilities - 40.35; human capital - 33.50; infrastructure - 43.32; Data availability - 68.69; Data representation - 70.91. The region of South and Central Asia with its 16 countries is also behind the world average rate (South and Central Asia - 39.03, world average - 44.25). Among the countries of the region, only India is included in the category of the first 50 countries of the world and it has 40th position. The countries of the region do not have an AI strategy, and this issue has been named as the main barrier for the development of this sector. Only India has an AI strategy, and in the South Caucasus and Black Sea countries, Turkey and Azerbaijan have initiatives to create a strategy (Diagram 5).

Diagram 5. Results of Georgia according to the artificial intelligence indicator
(Among 172 countries. Assessment 100-points)
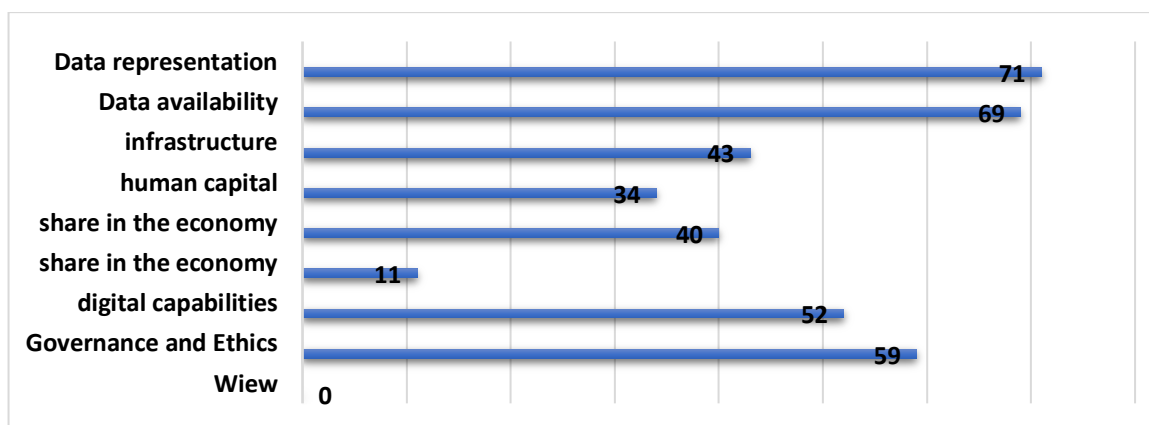
Source: https://www.aigeorgia.ge/

Georgia is distinguished by the mentioned initiatives as well, which is pointed out by the operation of Georgia Mind - business association of artificial intelligence, the first and main mission of which is to promote and popularize the implementation of artificial intelligence in the private sector, as well as ensuring the initiation of dialogue between business, executive and legislative authorities. The aim of the association is to increase the awareness of artificial intelligence in the private sector; local and international research production; finding talented people, retraining; providing assistance in formulating the legal base for the state; Creating and sharing business operations transformation cases in various industries from traditional methods to the use of artificial intelligence.

The national strategy of artificial intelligence involves the formation of a research infrastructure, preparation of the legal base, deepening of international partnership, adapting the educational system to the new systems, supporting sectors of strategic importance for the economy with new technological solutions and preparing the workforce for the ongoing changes in the labor market within the 4th industrial revolution. In order to start this process, it is important to involve the educational system, conduct research and disseminate it with the interested co-society. The negotiation process, in parallel with the research, has already been started and the first results will be announced soon [12].

Conclusions

"Artificial Intelligence" is on the agenda of the world, and therefore the development of technologies should become a priority for all countries, including Georgia.

Digital transformation is not optional, rather, it is an inevitable way for modern developed countries to progress and succeed. Modern technologies, including artificial intelligence, cannot become a positive influence and a prerequisite for public welfare, If the state does not ensure the implementation of the reforms of digital transformation with high ethical principles of the state, by keeping the balance of conflicting interests, with the involvement of all interested parties, considering best practices and international regulatory standards, with transparent procedures and a transparent management system.

Services powered by artificial intelligence can bring many benefits to humanity, with the large-scale use of this technology in the public or private sector of Georgia, we will get a proven rate of efficiency, resource saving and high performance. For this, together with technological readiness, it is critically important to establish enabling frameworks and gain public trust, which can only be achieved through open, transparent and accountable processes, it`s critically important to establish supporting framework and gain public trust, and this can only be achieved through open, transparent and accountable processes. The public sector of Georgia should actively take care to stimulate the use of modern technologies, including artificial intelligence, both in the public agencies and on a large scale - throughout the country. Georgia should timely and efficiently use all the benefits that come with the introduction of artificial intelligence, in order not to fall far behind economic and social transformation inspired by artificial intelligence and not lose the benefits provided by this process.

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