

## **Digitalization security as a marker of modern mechanical engineering technology implementation in the context of ensuring strategic economic security of enterprises**

**IEVGENIIA MISHCHUK**

Department of Accounting, Taxation, Public Management and Administration  
Kryvyi Rih National University  
11, Vitaliy Matusevych Str., Kryvyi Rih, 50027  
UKRAINE

**SVITLANA REBROVA**

Department of mechanical engineering technology  
Kryvyi Rih National University  
11, Vitaliy Matusevych Str., Kryvyi Rih, 50027  
UKRAINE

**PETRO KRUSH**

Department of Economics and Entrepreneurship  
Igor Sikorsky Kyiv Polytechnic Institute  
37, Victory Avenue, Kiev, 03056  
UKRAINE

**DMYTRO ZINCHENKO**

Department of Economics and Entrepreneurship  
Igor Sikorsky Kiev Polytechnic Institute  
37, Victory Avenue, Kiev, 03056  
UKRAINE

**KATERYNA ASTAFIEVA**

Department of Enterprise Economics, Organization and Management of enterprises  
Kryvyi Rih National University  
11, Vitaliy Matusevych Str., Kryvyi Rih, 50027  
UKRAINE

*Abstract:* - The article demonstrates the impact of digitalization security on implementation of modern engineering technologies, substantiates their connections with provision of the strategic economic security of an enterprise, presents enhanced methods of assessing the current economic-information security of an enterprise's interests. The developed methods of digitalization security assessment have been tested at machine building enterprises of Ukraine. The security level has proved to be medium or low at most enterprises under study. The work substantiates that absence of the systematic personnel policy aimed at personnel's acquiring competences 4.0, deficit of financing technologies 4.0 implementation, a low level of IT capital make it impossible to ensure a high level of strategic economic security at Ukraine's machine building enterprises.

*Key-Words:* - economic security, economic evaluation, IT capital, strategic security, technologies 4.0.

## 1 Introduction

Similar to the third industrial revolution, Industry 4.0 is based on information-computer technologies, and therefore it is sometimes treated as the next phase of the third industrial revolution which is still under implementation in many world countries including Ukraine. However, Industry 4.0 provided for just computerization and automation, but important elements of a new production type include cyber-physical systems, big data, artificial intelligence, 3D printing, etc. Moreover, evolution of business models is at issue as well. That is why, one may talk about change of the paradigm in production and a new industrial revolution.

The digitalization process which not only enhances current production processes but also changes current technologies is an integral attribute of Industry 4.0. Business practices prove that maximum digitalization of all business processes is the key to a high level of strategic economic security.

In scientific literature, the concept of digitalization in terms of economy is treated as digital-economy and dealt with in works by Kolomiets H. M., Hlushach Yu. S. [1], Hojehhan, S. B., Esfangareh A. N. [2], Gaspareniene L., Remeikiene R., Schneider F. G. [3], Kadar M., Moise I. A., Colomba C. [4], Khan B., Alghathbar K. S., Nabi S. I., Khan M. K. [5] Scholz T. [6], Perederii T. S. [7], Karpunina E. K., Konovalova M. E., Shurchkova J. V., Isaeva E. A., Abalakin A. A. [8] and others.

In particular, investigations by Kolomiets H. M. and Hlushach Yu. S. actualize transformation stages of digital technologies defining their role in business as auxiliary ones; as an important factor of achieving business-results of activities; as the basis for providing a business strategy; and, finally, as a business-model identifier [1]. This is important for understanding significance of digitalization at the current stage of development of individual industries. Thus, Hojehhan S.B. and Esfangareh A.N. show impacts of the digital economy on the tourism industry [2]. Investigations of this kind are important in revealing the necessity of considering the specific character of each industry while analyzing the digitalization level at corresponding enterprises.

It should be noted that there are many practical researches into impacts of digital technologies on the current state of mechanical engineering (Table 1).

**Table 1**

Researches into impacts of digital technologies on the state of mechanical engineering

Source	Content
McKinsey's report "How to success: Strategic options for European machinery"	Focuses on strategic changes by 3 directions: 1. Change of growth patterns – in geography (inclusion of income growth zones) and the value creation chain simultaneously. As for the latter, the shift from products to services is a definite trend. Further on, growth to digital services is observed. 2. Growth of digitalization rates – this queries durability of current business models. 3. Acceleration of organizational changes necessary for implementation of the two above mentioned directions of growth.
<i>Quest Trend Magazine</i> report	In 2016, questioning of over 150 engineering employees showed that 66% of them were on the way to Industry 4.0, 28% were planning such changes. Only 6% stated that they were not planning any movement in that direction.
<i>Quest Trend Magazine</i> report	Easy network interaction of men, machines and systems is a cornerstone of Industry 4.0. The results demonstrate great employees' awareness of networked interaction technologies and focused movement towards horizontal and vertical integration.
<i>Hampton analytical report</i>	Shows large companies' interest in take-overs and acquisitions of technological representatives in the mechanical engineering sphere. Acquisition of the robotic leader <i>Kuka</i> by the Chinese <i>Midea</i> is the most demonstrative case

Source: developed by the authors on the basis of the analytical report by the Association of Industrial Enterprises of Ukraine (APPAU) [9]

However, the analyzed works do not consider the necessity of digitalization security. The authors of [3] attempt to factor into threats in digital economy development. They list drivers of shadow digital consumption which are identified as individual threats. As is rightly said in [4], revolution 4.0 has resulted in emergence of new forms of competitiveness. This is an important statement as

increased competition is accompanied by increase of current threats and dangers and emergence of new ones. Management of any enterprise should realize this fact; however, research into a human factor in digitalization security processes is narrowed to realizing information security, as is remarked in [5]. Even such a significant contribution to the digital economy as [6] by T. Scholz focuses on digital work, legal zones and other issues but does not look upon the necessity of providing digitalization security. We believe that digitalization security would widen the current view of the digital economy.

“Digitalization security” is a relatively new term. In the present work, we take it to mean as the state of digitalization at an enterprise that promotes its economic and information interests in the current time period and its strategic economic security in the long-term period on the basis of technologies that correspond to the current state of the industrial revolution (i.e. Industry 4.0 within the given context).

In terms of establishing economic security of enterprises in the strategic period, technologies cannot be a decisive factor. They are an important but not the only component of an enterprise’s strategic economic security. During the current period, they greatly impact the level of economic-information interests security, thus determining the level of IT capital and income obtained due to the use of the capital, cash flows, etc.

So, digitalization security is a marker of technologies 4.0 implementation, thus ensuring strategic economic security of an enterprise. This can be illustrated by the following chain:

High level of digitalization security → Fast implementation and efficient use of technologies 4.0  
→ High level of strategic economic security of an enterprise (in the field of its economic and information interests).

## 2 Problem Formulation

Application of digitalization in mechanical engineering most often means work with PC-based data and automation of production, sales, marketing, communication with customers and partners. These trends are the most promising for technological startup realization. For instance, due to LIDAR (Light Identification Detection and Ranging), the world mechanical engineering leaders enhance their autonomous models. Real time pulses process signals, measure distance to objects and survey the road in front of them. At Ford, they mount sensor panels with lidar scanners into automobile roofs.

Lidars work within the range of 1000 m and collect data into a point cloud. Then the points create a 3D map which is displayed on the dashboard. During testing, the company received a proposition from the National Association for Stock Car Auto Racing (NASCAR) to develop 3D race track scanners. A similar project – the Aeva startup – is based on application of a compact lidar for autonomous vehicles. The product allows getting rid of expensive sensors and, similar to Ford, analyzes the road situation. Analysis of a 3D model enables operating costs reduction and production modernization.

On opinion of most of Ukrainian engineers and designers, there is no “digitalization problem” if their machines are automated and connected to the Internet. It is obviously not so. Ukrainian mechanical engineering enterprises are far behind foreign competitors. For instance, at Novokramatorsky machine building works (NKMZ), digitalization consists in scanning employment record books for employees who will soon retire as this facilitates and automates pension assignment. Leading European and American enterprises introduced e-paperwork many years ago.

So, inability of management of Ukrainian enterprises to understand the actual level of digitalization security makes it impossible to implement and efficiently use technologies 4.0. The problem like that impacts negatively provision of strategic economic security of enterprises and requires solution. Development of valid methods of assessing digitalization security and its further implementation in practical activities of enterprises should become the key aspect of this process.

Thus, the article aims to study digitalization security as a special marker of implementing modern engineering technologies in the context of providing strategic economic security of an enterprise.

## 3 Problem Solution

The analytical report of the Association of Industrial Enterprises of Ukraine (APPAU) declares the following technologies 4.0 to be the most necessary for mechanical engineering [9]:

1. Predictive analytics (servicing). This is a new type of servicing machines and equipment and replaces traditional methods as scheduled-preventive maintenance. Suspension of production (i.e. machines or lines) may cost from several thousands (FMCG) to 2.5 million US dollars (the automobile industry). At present, smart machines themselves can submit information on why and

when a particular part or unit may break and prevent failures in this way. Application of predicative analytics with new methods and models of data processing may save up to 40% for maintenance and decrease unscheduled downtime up to 50%. SmartEAM uses the RCM method which is the next stage in maintenance to scheduled-preventive works. It is implemented at: Interpipe, Zorya-Mashproekt and others including mechanical engineering ones.

2. Product Lifecycle Management (PLM) is a well-known category of software products. It is of special relevance for mechanical engineering when it comes down to innovations and continuous changes. Designers have long been using various CADs. Industry 4.0 has introduced digitalization to all processes throughout the lifecycle. Major trends in this sphere deal with transferring PLM to the cloud environment, emergence of Product-Data-as-a-Service (PDAAS) transforming product data into valuable assets, collaborative platforms, micro-services, integration with blockchain.

3. Generative design. When developing products, it is always important to improve methods of designing parts, their optimization in order to create a product with the best weight-durability-cost correlation. Thus, there is much concern about optimal design, the technology of generative design being one of its versions. Generative design is a general concept describing new tools in computer-aided design systems. The advantage of this technology is integration of CAD / CAE-systems that enables changing the process of designing itself. Generative design integrates knowledge from various spheres (designing and calculation), thus producing a synergetic effect as the calculation module is engaged at the stage of shaping a product (or its part). At that, functionality generated by designing enables immediate optimization of the product based on analysis of its construction and working conditions.

In addition to application generative design tools, production of metal products on industrial 3D printers requires introduction of certain changes into the process of designing 3D models itself considering a widened range of materials used in additive production.

4. Cloud platforms and services. Digitalization is impossible without IT-infrastructure. Its two key elements are the network and data processing centers. For most enterprises, their own modern data processing center is a great expense. That is why, they start using cloud services and platforms. Producers should know that use of finished platforms-as-a-service (PaaS) is a trend in Industry

4.0. Almost every producer of CAE/CAD/PLC/SCADA and even field devices offers integration into them. Mindsphere (Siemens), Predix (GE), Ability (ABB), Ecostruxure (Schneider Electric) and many similar platforms are gaining popularity (at mechanical engineering enterprises as well).

5. OPC UA-based vertical and horizontal integration of machines. If the above integrations are characteristic of Industry 4.0, then the question arises about the way they are implemented. Method №1 of interoperability – both vertical and horizontal (along the value chain) – is the standard of OPC UA (standard International Electrotechnical Commission (IEC) 62541). This is also a de facto standard for 4.0 projects (included in RAMI) and supports a number of other protocols and mechanisms – TCP, HTTPS, UDP, AMQP, MQTT. There are available implementations in Java, .Net, ANSIC/ C++. OPC Foundation consists of over 500 companies that support and implement the above mentioned in their projects.

6. Virtual and augmented reality. To introduce, operate and maintain new machines, operating personnel would use pdf or printed manuals. However, this is not practical when it comes to fast search for necessary information as this process requires much time. But it is much more convenient when a necessary unit or part is 3D-visualized with all related data on the mechanism state in the real time mode. This is the way the technologies of virtual and augmented reality (VR & AR) work. Application of AR results in significant reduction of costs for personnel training and equipment maintenance as well as in reduced unscheduled downtime.

7. Manufacturing Execution System (MES). Nowadays, this is in reference to the 4<sup>th</sup> generation of MES – software for managing production processes in real time. From autonomous, local solutions through integrated and module ones – it is time now for platform-based solutions enabling easy integration of extraneous solutions and apps.

8. Smart devices and mobile apps. Intelligence at any devices is characteristic of 4.0. Cheapening of sensors and many other field devices enables significant growth of intelligence of physical objects which they are integrated into. Better monitoring of equipment, tracking of vehicles and mobile personnel, optimization and enhancement of production management etc. are typical examples of that.

9. Simulation, virtualization and digital twins. Virtualization and simulation technologies are becoming widely used during new product

development in machine building. As a result, costs are decreasing greatly and development rates are increasing. That is why, all kinds of digital simulation are becoming a must-have component of Product Development Process (PDP). Simulation and digitalization are involved during the entire lifecycle, e.g. from the stage of designing a mechanical product to programming the machine that manufactures it and its implementation into production [10].

Thus, more openness is associated with more vulnerability. Actually, the Internet of Things is sometimes called the Internet of Threats. Cyber-attacks, viruses (e.g. "Petya" and others) are an eloquent manifestation of Ukrainian customers' vulnerability. The Mobile World Congress 2019 (Barcelona) stated that the entire world is moving on to cloud technologies and the industrial Internet of Things [1; 11]. With this in view, the digitalization security issue is one of the priorities. IEC 62443 is obligatory for producers to make their systems and products secure. For mechanical engineering enterprises, an important standard is also IEC 62451 (OPC UA) that enables secure building of the OPC server into a machine.

Thus, digitalization security is a vital tool for implementation of technologies 4.0 at mechanical engineering enterprises. The key indicators of this type of security are:

- the index of the financing and investment level (If). Implementation of technologies 4.0 is impossible without proper financing of appropriate measures and software of both operating and strategic levels. The index is measured by the relation of the amount of finance for technologies 4.0 implementation to the total amount of capital expenditures;

- the index of involvement of employees with competences 4.0 (Ie). Technologies cannot exist without employees capable of implementing and applying them. Some Ukrainian mechanical engineering enterprises have been implementing obsolete technologies for years due to their conservative personnel. The index is measured by the relation of the number of personnel with competences 4.0 to the total number of main employees of the enterprise (including management);

- the index of the IT capital use level (Iit). Availability of IT capital at mechanical engineering enterprises is the starting position of the digitalization process. The index is measured by the relation of the total value of IT capital at the enterprise to that of its competitor. It should be noted that IT capital use enables conclusions about

the level of current security of economic-information interests of an enterprise. For this, the liminal value of IT capital should be measured which is the amount where the IT capital share as a sum of fixed assets and intangibles equals to the determined liminal value:

$$ICl = L(Iic) \times (FAa + NCIa), \quad (1)$$

where  $ICl$  is the liminal value of IT capital determined by the IT capital share in the sum of fixed assets and non-current tangibles, money units;

$L(Iic)$  is the liminal value of the IT capital share in the sum of fixed assets and non-current tangibles, unit fractions;

$FAa$  is the actual amount of the primary cost of fixed assets, money units;

$NCIa$  is the actual amount of the primary cost of non-current intangibles, money units.

The liminal value of the IT capital share can be designated in various ways depending on analysis tasks and the situation: the maximum value among enterprises-competitors including foreign ones, as the arithmetic mean, as the weighted average etc. In case of  $ICl > ICa$ , the conclusion is drawn about IT capital deficiency ( $\Delta IC$ ) which is calculated from the expression:

$$\Delta IC = ICl - ICa. \quad (2)$$

Further, using the three-factor production function, developed in the work of [12], the elasticity coefficient for IT capital is determined. This coefficient characterizes the percentage of change in the volume of production when IT capital changes by 1%. The amount of production that the company will not receive due to the lack of IT capital is determined by the formula:

$$\Delta V(Iic) = \frac{\Delta IC}{ICa} \times Iel \times Va, \quad (3)$$

where  $\Delta V(Iic)$  is the shortfall in the volume of sales of products, money units;

$Iel$  is the coefficient of elasticity for IT capital, unit fractions;

$Va$  is the actual volume of sales, money units.

When assessing deficiency of the earnings before tax indicator, the following adjustments should be made:

$$\Delta EBT(Iic) = \frac{Mla}{Va} \times \Delta V(Iic), \quad (4)$$

where  $\Delta EBT(Iic)$  is the earnings before tax deficiency by the IT capital share in the sum of fixed assets and non-current tangibles, money units;

$Mla$  is the actual amount of marginal income, money units.

The smaller the earnings before tax deficiency is, the higher the level of security of economic-information interests of an enterprise is.

Correspondingly, a very high level of this security may be observed at  $\Delta EBT(Iic)=0$ .

More detailed assessment of the level of security of economic-information interests of an enterprise with application of the earnings before tax indicator is presented in [13; 14].

Thus, we suggest measuring the digitalization security level ( $S_{digital}$ ) according to the formula:

$$S_{digital} = I_f \times C_f \times I_e \times C_e \times I_{it} \times C_{it}, \quad (5)$$

where  $C_f$ ,  $C_e$ ,  $C_{it}$  are the weight coefficients of the indices of the financing level, the level of involvement of employees with competences 4.0, the level of IT capital use respectively.

Weight coefficients of individual indices are determined applying the expert-based method with calculation of the experts' opinion concordance coefficient. Weight of a separate index depends on the current financial state of an enterprise and priorities of the period under assessment.

Table 2 presents Harrington's scale of assessing digitalization security levels.

**Table 2**

Digitalization security levels

Digitalization security level	Description
$0.8 \leq S_{digital} \leq 1$	Very high (VH)
$0.63 \leq S_{digital} < 0.8$	High (H)
$0.37 \leq S_{digital} < 0.63$	Medium (M)
$0.2 \leq S_{digital} < 0.37$	Low (L)
$0 \leq S_{digital} < 0.2$	Very low (VL)

Source: based on Harrington's scale and adapted by the authors

The suggested technique was tested on the data of some mechanical engineering enterprises of Ukraine, the calculation results are given in Table 3.

**Table 3**

Results of digitalization security assessment at some mechanical engineering enterprises of Ukraine

Security level	Years			
	2016	2017	2018	2019
<b>State-owned Production Association Yuzhny Machine-Building plant named after O.M. Makarov</b>				
Value	0.32	0.51	0.54	0.61
Description	L	M	M	M
<b>PrJSC "Kalynivsky Machine Building Plant"</b>				
Value	0.35	0.56	0.61	0.62
Description	L	M	M	M
<b>JSC "Drogobych machine-building plant"</b>				
Value	0.2	0.24	0.28	0.31
Description	VL	L	L	L
<b>TOV "Kherson machine building plant"</b>				
Value	0.60	0.61	0.61	0.63

Description	M	M	M	M
<b>PJSC "Hrebinky machine building plant"</b>				
Value	0.64	0.68	0.71	0.79
Description	H	H	H	H
<b>PrJSC "Krasylivskiy machine building plant"</b>				
Value	0.19	0.23	0.27	0.30
Description	VL	L	L	L
<b>PrJSC "Verkhnodniprovs'k machine building plant"</b>				
Value	0.22	0.26	0.33	0.36
Description	L	L	L	L

Source: calculated by the authors on the basis of the suggested approach

A low level of digitalization security at the "State-owned production association Yuzhny Machine-Building plant named after O.M. Makarov" was conditioned by loss of the key management personnel without their replacement (caused by late payment of wages, low wages); loss of consumers from the Russian Federation, decreased production of units, landing gears for AN-140, AN-148, AN-158 planes; problems with workforce (qualified employees outflow due to late payments, low wages, unsatisfactory work schedules); lack of important resources (necessary supplies from the Russian Federation).

Increase of the security level was caused by the fact that in April, 2017 the plant concluded a contract with S7 Sea Launch Limited for production of 12 launch vehicles "Zenit". In general, the future development strategy of the plant provides establishment of a world-class enterprise with the full cycle of job-lot and custom high-tech and knowledge-based production for the aerospace industry capable of efficient functioning in conditions of market economy establishment and manufacturing competitive products. Its security is impossible without solving personnel problems.

Unlike the above enterprise, the human resources program of the PrJSC "Kalynivsky Machine Building Plant" aims at ensuring its employees' qualification level that meets production requirements. The program consists in proper and timely payments, provision of social and material benefits that gets employees interested in enhancing their knowledge and qualification level. This produced a positive impact on the digitalization security level. However, due to the fact that major markets for the enterprise are Ukraine, the Russian Federation, the Republic of Belarus and Turkey, i.e. countries with the difficult and instable economic situation, the PrJSC "Kalynivsky Machine Building Plant" is not always able to finance technology 4.0

implementation. The main problems affecting the strategic economic security are: a downward business trend in economy on the whole; decreased consumer purchasing power; a considerable inflation level; instable economic and taxation legislation, instable financing and currency markets; increased competition in the industry; downsides in the production sphere; miscalculations in supply; deficits in financing; a low marketing level and loss of sales markets; very high dependence on legislative and economic limitations.

The low digitalization security level at the JSC “Drogobych machine-building plant” during the whole period of analysis is conditioned by a number of factors. Among those, the following should be mentioned. The average number of registered employees is 82. There is no human resources program. Major sales markets include Ukraine and Russia. There are no product sales on the prospective and receptive market. The largest share of sales belongs to the product group “drilling equipment”, the smallest share belongs to “gas equipment”. Besides, strategic security is on the low level. This is caused by the fact that in the recent years there have grown risks of capturing many markets (the Russian Federation, Uzbekistan) by Chinese producers of drilling equipment such as Jiyuan Sanhe Zhengyuan Petroleum Machinery Co., Ltd.; TIANHE OIL GROUP Co., Ltd.; China Xi'an Landrill Oil Tools Co., Ltd.; Shenyang Weiping Machinery @ Equipment Co., Ltd. and others.

Digitalization security at the TOV “Kherson machine building plant” is on the medium level. The enterprise is a reliable supplier of agricultural machinery to Poland, Ukraine, Bulgaria, Serbia, Montenegro. In 2008, the International Academy of rating technologies “Golden Fortune” awarded products of the enterprise with the diploma “UNIVERSAL QUALITY” in nomination “Leaders in Mechanical Engineering of Ukraine”.

The PJSC “Hrebinky machine building plant” possesses a high level of digitalization security during the entire period of study. The enterprise is among the leading ones in mechanical engineering in the sugar, distilling, chemical and power industries and is part of “Techinservice”. Production facilities, modern equipment and highly qualified engineering and development personnel enable production of custom equipment for various industries as well as for reconstruction and building of whole factories and production enterprises. The equipment is certified and meets international quality standards. Technological equipment of the enterprise demonstrate a high level of quality, reliability, long service life, absence of errors due to

detailed before-production technological modeling and best delivery time.

One of the negative factors adding to a low digitalization security level of the PrJSC “Krasylivskyi machine building plant” is a small number of employees with competences 4.0. The average number of registered employees in 2018 was 26. The qualification level of employees only meets operation requirements of the enterprise. In recent years, there have been no steps undertaken to increase the qualification level. No such measures are planned for the near future. Among the problems impacting strategic economic security of the enterprise the following should be mentioned: no own working capital for execution of its obligations and urgent payments; the global economic crisis; deteriorated financial conditions of customers; inflation; the increased tax burden.

The low level of digitalization security is conditioned by limitations connected with financing technologies 4.0 implementation. Deficiency of finances is caused by the fact that the main sales market of the PrJSC “Verkhnodniprovsk machine building plant” is Ukraine. Major customers are enterprises of Dnipropetrovsk, Poltava, Lviv, Kyiv, Zaporizhzhia and Kharkiv regions of Ukraine. The enterprise exports 43% of its products to its main foreign customers in the Republic of Guinea, the Russian Federation, Serbia. The enterprise is planning to eliminate negative impacts of market risks on its strategic economic security through product diversification and quality enhancement. Other negative effects are produced by the instable economic and political situation in the country, changes of the competitive environment and demand, production and technological risks, increase of power and raw material costs.

Thus, analysis of a small number of mechanical engineering enterprises concerning the digitalization security level shows its unsatisfactory level at most of them. Therefore, in this context the conclusion made by the Association of Industrial Enterprises of Ukraine on sufficient backwardness of Ukrainian machine building enterprises in terms of technologies 4.0 implementation that may negatively impacts the level of strategic economic security of these enterprises in future.

## 4 Conclusion

Thus, the research conducted shows that many mechanical engineering enterprises of Ukraine purchase automated equipment, some of them are equipped with modern metal working centers and other computer-controlled equipment. However, the

level of digitalization and digital technology application is significantly lower than that of western companies. The developed methods of digitalization security assessment have been applied to calculations at some mechanical engineering enterprises of Ukraine. The level of this type of security at most of the enterprises has proved to be unsatisfactory. This is explained by the fact that, firstly, cheap workforce and resources have long been substituting for the necessity of automation in reaching competitive prices and obtaining the revenue. At present, these resources, including wages of employees, have become considerably more expensive. Secondly, Ukraine faces very high credit resources costs and small choice of long-term financing, this making investment in technologies 4.0 impossible in some cases and in mechanical engineering as well as. In its turn, the above said impacts negatively provision of strategic economic security of Ukrainian mechanical engineering enterprises. The present situation demands high priority measures at the level of not only enterprise management but also that of the government.

Thus, we suggest the following steps to increase digitalization security at the enterprise level:

1) introduction of the suggested methodology of assessing digitalization security into practical activities of enterprises and its systematic fulfilment. This will enable enterprise management to realize the real situation and get them make relevant decisions as majority of managers of Ukrainian mechanical engineering enterprises do not consider the low digitalization level to be a problem. For those who understand importance of digitalization (including managers of foreign companies) its security assessment will provide an opportunity to see the achieved level on-line at any moment. So, introduction of the suggested methods of assessing digitalization security at national and foreign companies broadens opportunities of business analytics and facilitates more coordinated corrective activities.

2) Elaboration of the enterprise digitalization strategy and innovations development. This document should contain all the important measures for enhancement of business processes digitalization, its interaction with internal and external stakeholders as well as all potential benefits and advantages of their implementation. This is of especial importance as non-understanding of the total digitalization effects impacts negatively enterprise managers' motivation in terms of digitalization security provision.

3) Increase of investment in digital technologies and IT capital on the whole. This will facilitate

growth of the IT capital share in the structure of enterprise assets.

4) Financing measures for IT training and retraining of personnel. This will facilitate personnel's obtaining competencies 4.0, and lead to increased efficiency of IT capital use and, as a result, to increased production volumes.

5) Selection of personnel with the already formed level of competencies 4.0. In this case, use of interviews through Skype, GoogleHangouts or Zoom instead of traditional oral interviews will be very helpful as applicants will be able to demonstrate their level of the technology proficiency. Also, it is necessary to apply digitalization achievements to the HR sphere – filling of applicants' profiles in LinkedIn, computerized personnel selection applying Applicant Tracking System, application of ZohoPeople, Bamboo HR Hurma System for recruiting.

6) Integration of the digitalization strategy into the general strategy of the enterprise.

Thus, opportunities to enhance key activity indicators through implementation of the above mentioned digitalization measures may create a gap between an innovative enterprise and a lagging one.

In this connection, implementation of the suggested methods and measures is recommended for both national and foreign companies.

In terms of governmental measures, it should be noted that in 2019 Ukraine started structural transformations with digitalization being the key driver. In particular, the ministry for digital transformation of Ukraine has been established one of main goals of which is increase of the IT share in the GDP up to 10% by 2024; complex programs have been developed to facilitate introduction of digital technologies in activities of Ukrainian enterprises. Enterprises should be more active in participating in such governmental programs.

Directions for future research involve development of the long-term digitalization strategy of an enterprise considering the governmental digitalization program.

#### References:

- [1] Kolomiets, H. M., Hlushach, Yu. S., The Digital Economy: The Controversy of Content and Impact on Economic Development, *Biznes Inform*, No. 7, 2017, pp. 137-143.
- [2] Hojehhan, S.B., Esfangareh, A.N., Digital economy and tourism impacts, influences and challenges, *Procedia – Social and Behavioral*

- Sciences*, Vol. 19, 2011, pp. 308-316, URL: <https://doi.org/10.1016/j.sbspro.2011.05.136>
- [3] Gaspareniene, L., Remeikiene, R., Schneider F. G., The factors of digital shadow consumption, *Intellectual Economics*, Vol. 9, 2016, pp. 108-119, URL: [https://www.researchgate.net/publication/295086297\\_The\\_factors\\_of\\_digital\\_shadow\\_consumption](https://www.researchgate.net/publication/295086297_The_factors_of_digital_shadow_consumption)
- [4] Kadar, M., Moise, I. A., Colomba, C., Innovation management in the globalized society, *Procedia - Social and Behavioral Sciences*, Vol. 143, 2014, pp. 1083-1089, URL: <https://doi.org/10.1016/j.sbspro.2014.07.560>
- [5] Khan, B., Alghathbar, K. S., Nabi, S. I., Khan, M. K., Effectiveness of information security awareness methods based on psychological theories, *African journal of business management*, Vol. 5 (26), 2011, pp. 10862-10868, URL: <https://doi.org/10.5897/AJBM11.067>
- [6] Scholz, T., *Overworked and Underpaid: How Workers Are Disrupting the Digital Economy*, Polity Press, Cambridge, UK, 2017, p. 226
- [7] Perederii, T. S. Strategy of digital security of enterprise as a driver digital transformation of economic Ukraine, *Visnyk ekonomichnoi nauky Ukrainy*, Vol. 2 (37), 2019, pp. 201-204, URL: [https://doi.org/10.37405/1729-7206.2019.2\(37\).201-204](https://doi.org/10.37405/1729-7206.2019.2(37).201-204)
- [8] Karpunina, E.K., Konovalova, M.E., Shurchkova, J.V., Isaeva, E.A., Abalakin, A.A. Economic Security of Businesses as the Determinant of Digital Transformation Strategy, *Digital Economy: Complexity and Variety vs. Rationality*, Vol. 87, 2020, pp. 251-260, [https://doi.org/10.1007/978-3-030-29586-8\\_30](https://doi.org/10.1007/978-3-030-29586-8_30)
- [9] Industry 4.0 in mechanical engineering: state and prospects in Ukraine, *Analytical report*, Vol. 1, 2018, p. 39, URL : <https://industry4-0-ukraine.com.ua/2018/10/18/аналітичний-звіт-індустрія-4-0-в-машино/>
- [10] Yurchak, O., 10 key 4.0 technologies for mechanical engineering and transport, *Journal "Railway Supply"*, No. 2, 2019, URL: <https://rws.in.ua/10-klyuchovikh-tekhnologiy-4-0-dlya-mashinobudu/>
- [11] Ostrolutska, L., The future is happening today, *Ukrinform*, 2020, URL: <https://www.ukrinform.ua/rubric-technology/2688184-majbutne-vidbuvaetsa-sogodni-koli-ukraina-zmoze-perejti-na-5g.html>
- [12] Lobov, S.P., IT capital as a factor of production in industrial enterprises and its role in combating threats, *Modern problems of economy and entrepreneurship*, No. 24, 2019, pp. 172 – 176.
- [13] Mishchuk, Ie. V., Improvement of the methodology for assessing the safety of the economic and information interests of the enterprise, *Technology audit and production reserves*, T. 1, No. 4(51), 2020, pp. 37–40.
- [14] Mishchuk, Ie., Zinchenko O., Zinchenko D., Dariusz P., Pohrebniak A., Differences in the Assessment of Economic Security of Personnel and Security of Enterprise Staff Interests, *WSEAS. Transactions on Environment and Development*, Vol. 16, 2020, pp. 454-463.

#### Author Contributions:

Mishchuk Ievgeniia ideas; formulation or evolution of overarching research goals and aims, developed a methodology for assessing the level of current security of economic and information interests based on the amount of IT capital and determined the impact of digitalization security on the strategic economic security of enterprises;  
Rebrova Svitlana analyzed modern technologies of mechanical engineering and performed approbation of the technique according to the data of individual engineering enterprises of Ukraine;  
Krush Petro carried out the general coordination of scientific work;  
Zinchenko Dmytro determined the impact of modern mechanical engineering technologies on the level of digitalization security;  
Astafieva Kateryna reviewed the literature, organized and visualized the presented data.

#### Creative Commons Attribution License 4.0 (Attribution 4.0 International, CC BY 4.0)

This article is published under the terms of the Creative Commons Attribution License 4.0

[https://creativecommons.org/licenses/by/4.0/deed.en\\_US](https://creativecommons.org/licenses/by/4.0/deed.en_US)