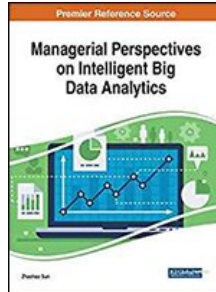


Chapters *To Go*



Managerial Perspectives on Intelligent Big Data Analytics

by Zhaohao Sun

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ptiwari30@dx.com

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Chapter 2: Is Artificial Intelligence a New Dawn or Challenge for Corporate Decision Making?

Maria I. Nikishova,
TopCompetence,
Russia

Mikhail E. Kuznetsov,
Moscow State University,
Russia
<https://orcid.org/0000-0002-8089-1899>

ABSTRACT

The Fourth Industrial Revolution provides companies with new opportunities, and business picks up allies represented by technologies that can change mechanisms of corporate decision making in corporations. Rapid development of technologies, which allows working more efficiently with information, can lead to the creation of a new system of stakeholder interaction, thanks to better analytics, transparency, and speed of decisions. In this regard, the analyst based on big data with the use of artificial intelligence (AI) is able to significantly affect the quality of decisions. How can the application of AI for analysis of big data be able to influence the decision-making process and to what extent can it influence the system of corporate relationships? To answer this question, the authors will try to describe how transformation of decision-making methodology at the Board of Directors level under the influence of the Fourth Industrial Revolution and the development of AI technologies and big data, and what are the opportunities, limitations, and risks of the decision-making process with AI.

INTRODUCTION

In today's corporate world, the speed of change is increasing rapidly and the length of a business cycle, from initial idea to profit gain, has shrunk from several years to a couple of months. Taking all this into account, businesses have to incorporate principles of quick, flexible and intellectual enterprise. This type of development should be founded in intellectual approaches to managing the most vital resource of the 21st century – information. The size and complexity of information, however, becomes both an opportunity and a big challenge. That's why classic algorithms aren't coping with Big Data, and that's why machine learning and artificial intelligence (AI) technologies are rising to the top of the agenda.

The digital economy and corporate transformation put pressure on existing mechanisms and management systems. Pressure from stakeholders, along with increasing competition, are accelerating challenges at the level of the Board of Directors – a corporate governance body instituted mainly to represent the interests of financial investors and formed for the most part by the principle of representation. In this new environment, the Board of Directors will have to transform as well; reorganizing the principles and approach to how it functions. If it doesn't do this, top management could become the weak link in the chain of business relations, due to an inability to bear the increased load of information.

As a result, companies have started to pay more attention to new technologies that allow them to process more and more information in an efficient and independent way, to avoid the phenomena of "group thinking" and "following the leader". Among these technologies, the one that stands out the most is AI-based big data analysis, which could become an effective tool for Boards of Directors in the corporate decision-making process.

Alongside this, it is necessary to manage significant unpredictable risks that arise in the application of such technology. For corporate governance, this can mean the loss of human control over algorithms during the corporate decision-making process, excess confidence in recommendations developed by AI, and dilution of the decision-making responsibility.

This begs the question: what are the conditions for the efficient implementation of AI-based big data analysis in making effective corporate governance decisions? The main goal of this research is to find the best approach to the big dilemma of the nearing future: what is the optimal structure and process for making decisions in the "new digital era" of AI-based big data analysis being used by Boards of Directors?

The need and high demand for such research has been proven by the rising interest of regulators and large corporations in IT governance issues and the use of new informational technologies and cybersecurity at the level of the Board of Directors. We can see more and more Corporate Governance Codes, regarding IT governance, cybersecurity issues and requirements for more IT expertise at the Board of Directors level ([Singapore \(2012\)](#), [South Africa \(2016\)](#), [Netherlands \(2016\)](#), [Hong Kong \(2016\)](#)). One of the key issues in the discussion of IT governance is the role of the Board of Directors in controlling key technologies used by a company.

- What is the role of the Board of Directors and what are the specifics of decisions made by the Board of Directors in the "new digital era"?
- How different are the human-based and AI-based decision-making processes, what are the conditions for effective decision-making models?
- What are the applicable risks associated with AI technologies for new corporate governance technologies based on AI and big data are there? How will the fundamental "prisoner's dilemma" applied to competition based on AI be solved?

In this chapter, we are not trying to give the "final answers" to these complicated issues, but rather to set the right questions, which could become a guide to further research and practical experiments.

This topic is targeted at top managers, Board Members, company shareholders, as well as regulators and a range of professionals interested in deepening their expertise in the practical applications of AI-based big data analysis.

In this context, this chapter will consider the topic of transformation of decision-making methodology at the level of the Board of Directors under the influence of the Fourth Industrial Revolution and the development of AI technologies and big data.

BACKGROUND

Transformation of Management Systems and Corporate Governance in the Fourth Industrial Revolution

As mentioned by the researchers [K. Schwab \(2016\)](#), [E. Toffler \(2004\)](#), [J. Haskel & S. Westlake \(2017\)](#), [J. Ito & J. Hui \(2017\)](#), all of whom are engaged in the study of management transformation in the era of the Fourth Industrial Revolution, many researchers agree that the knowledge and technologies mastered over the last decades have brought humanity closer to the point at which traditional modes of production, economy, and society will undergo breakthrough changes. The hallmark of the new era — the era of the Fourth Industrial Revolution — is the high speed of such changes.

Experts such as [T. Kerikmäe \(2016\)](#), [B. Libert \(2013\)](#), [E.P.M. Vermeulen \(2015\)](#), [W. Visser \(2008\)](#), [F. Möslin \(2017\)](#), [V.D. Milovidov \(2017\)](#) and [A.E. Molotnikov \(2017\)](#), who deal with issues related to changes in the system of corporate relations and the role of the Board of Directors at various stages of the Industrial Revolution, are optimistic about the possibility of advanced technologies being used in corporate governance and emphasize their enormous potential and prospects, mentioning that companies are now faced with a choice: quickly adapt to the changes of the era, or die. However, many futurologists, including J. Lesli, F. Fukuyama (1992), V. Vindge (1993), [N. Bostrom \(2016\)](#) and [E. Kuznetsov \(2017\)](#), analyze opposing views, often not so optimistic about the possibilities and consequences of technological shifts in the Fourth Industrial Revolution, and pay special attention to the risks and threats posed by disruptive technologies, particularly regarding AI, which is being used by more and more companies.

For example, in 2014, the Hong Kong Venture Foundation – Deep Knowledge Ventures – was the first company to include AI in its Board of Directors, the task of which was to evaluate and rate projects being considered by the Investment Committee. The evaluation of projects is carried out simultaneously by both Members of the Board of Directors and AI, which analyzes large data sets. If votes coincide, the project is adopted, but if opinions differ between the directors and AI, an analysis is carried out, taking into account new information provided by AI, and voting is conducted until the differences are exhausted. The fact that AI is used to analyze big data at the level of the Board of Directors is testament to, as a minimum, the vast potential and prospects for the use of advanced technologies in the XXI century, and is a sign of future changes in decision-making processes at the top-management level in companies that have to adapt to the Fourth Industrial Revolution and to increasing competition. These issues are partly covered in the article "*Corporate Governance 2.0: evolution of the corporate relations system in the information society*" by [V. Milovidov \(2017\)](#), focusing on the future of corporate governance under the influence of various advanced technologies. But F. Möslin was the closest in studying the possibilities, prospects and risks of using AI in corporate governance. [F. Möslin \(2017\)](#), in his article "*Robots in the Boardroom: Artificial Intelligence and Corporate Law*", considers the problems of introducing robots and AI into corporate governance through a "legal prism". We will try to look at the problems of using AI-based intelligent big data analytics from the point of view of managerial perspectives and risks.

And nevertheless, throughout history, with each industrial revolution, companies have had to adapt to changing conditions, but now the rate of change in accordance with The Law of Accelerating Returns has increased exponentially. As [T. Urban \(2015\)](#) describes, according to [R. Kurzweil's \(2005\)](#) calculations, the speed of progress in 2000 is 5 times faster than the average speed of progress throughout the 20th century. Furthermore, the degree of progress achieved over the course of the entire 20th century had already been reached from 2000 to 2014, and the next iteration of 20th-century-scale progress will be passed as early as 2021. As a result of the implementation of The Law of Accelerating Returns, over the course of the 21st century, the degree of mankind development will exceed the degree of mankind development in the 20th century 1000-fold.

In order to imagine the scale of the current changes, let us turn to history and recall what happened with the development of corporate relations during the industrial revolutions. [A. E. Molotnikov \(2017\)](#) describes how the development of management systems during each of the industrial revolutions was related to the existing technological order and the needs that it brought, and the development of production forces influenced the emergence of various forms and ways of doing business.

As several researchers note, among them the founder of the World Economic Forum, [K. Schwab \(2016\)](#), the 21st century is bringing the world to the stage of the Fourth Industrial Revolution, also called Industry 4.0. What changes can be expected in corporate relations?

As noted in research conducted by the [World Economic Forum & Accenture \(2017\)](#), breakthrough technologies that could have a significant impact on society and business in the Fourth Industrial Revolution are AI, big data analytics and cloud technologies, robots and drones, self-driving vehicles, the Internet of Things (IoT) and connected devices, social media and associated platforms, custom manufacturing and 3D printing.

The reduction in the cost of digital technologies and their availability is the most important feature of the Digital Revolution, and the combinatorial effects of technological incorporation, such as AI and big data analytics, accelerate progress exponentially. In this regard, the use of advanced technology is capable of reshaping industries by disrupting existing business and operational models. But it is also having a profound impact on society, thereby presenting a series of opportunities and challenges for businesses. What changes are expected in corporate relations?

According to McKinsey's research Digital Russia: [The New Reality \(2017\)](#), the top 10% of the most effectively digitized companies already bring in 2-3 times more income for shareholders and provide higher rates of growth in revenue. Thus, the results of a questionnaire survey and interviews with 51 directors and top-managers conducted by the authors showed that 64% of these expect investments in digital technologies to allow them to increase the efficiency of business processes, 60% expect to be able to improve the quality of existing products and services thanks to AI, and 48% invest in order to stay competitive ([Figure 1](#)).

Moreover, according to the authors' study, directors and top managers, in the next 2-3 years, companies' strategy will be affected to a greater extent by technologies such as the Internet of Things, AI and big data robotics

The key benefit in applying these three most promising technologies is that they involve unique opportunities to work with information – its collection, processing and more efficient application – which, thanks to better analytics, ultimately entails a new system of interaction between participants, greater transparency and increased speed in making decisions. However, analytics based on digital technologies will inevitably lead to an increase in data volume and the need to increase the speed of decision-making.

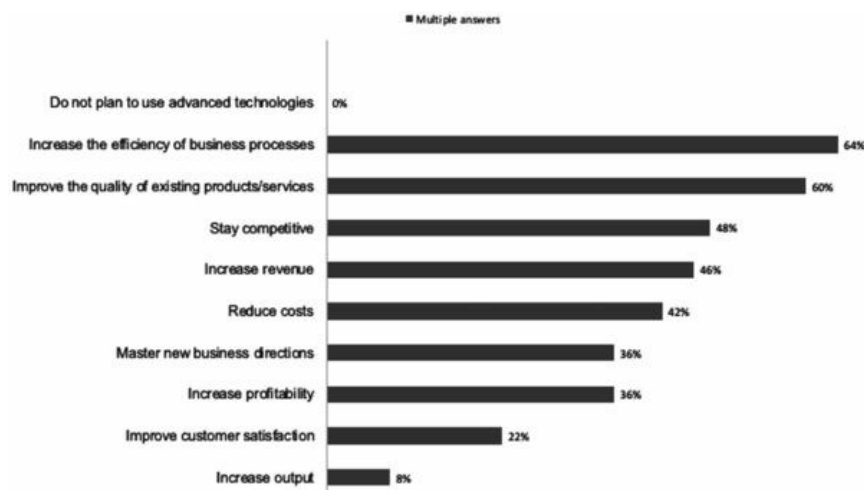


Figure 1: The benefits that managers expect from digital technology investments, according to the authors' research "Is your company ready for digital transformation in the era of the Fourth Industrial Revolution?" (compiled by the authors)

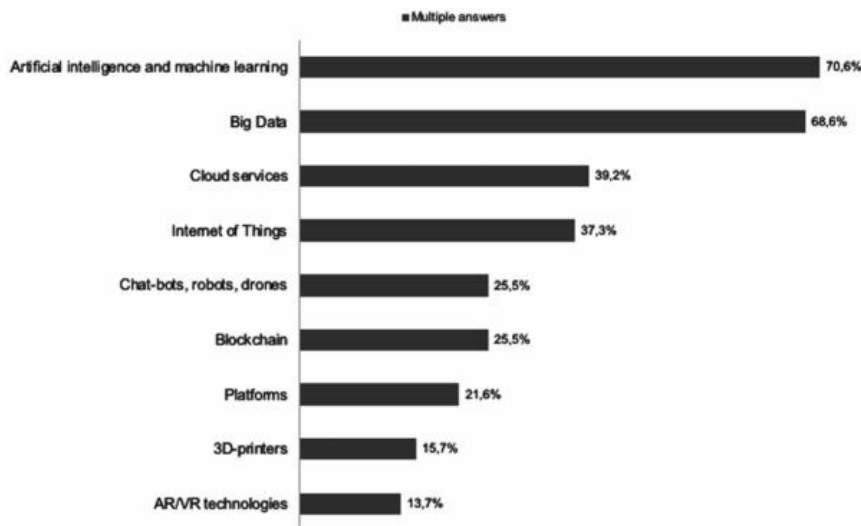


Figure 2: Technologies that will affect companies' strategy in the next 2-3 years, according to the study (compiled by the authors)

The branches of the economy and companies with access to big data that can adapt to its effective processing will have the opportunity to radically improve the quality of decisions made on the basis of big data and AI. It is expected that by 2035, AI technologies will boost corporate productivity in 16 industries in 12 countries by an average of 38%. This was shown by the Allianz Global Corporate & Specialty survey conducted in different countries in 2018. According to the survey, 66% of companies are already implementing AI in one way or another.

The introduction of the term "big data" is associated with Clifford Lynch, editor of the *Nature* journal, which, by September 3, 2008, had prepared a special issue on the topic "How can technologies that open up the possibilities for working with large volumes of data affect the future of science?" (2008). In this issue, materials were collected on the phenomenon of explosive growth in the volume and variety of processed data and the technological prospects in a paradigm rocketing "from quantity to quality". The term was suggested by analogy with the metaphors "big oil" and "big ore" in the English-speaking business environment.

The emergence of the term "artificial intelligence" after the Turing test and the beginning of the scientific field development is associated with Joey McCarthy, who first gave a definition of AI in 1956 at the Dortmund Summer Conference, according to which AI is the science and technology of creating intelligent computer programs. And despite the fact that research directions in the field of big data and AI appeared in the middle of the 20th century, technical opportunities for the wide application of these technologies only appeared in the 21st century.

It is expected that by 2035, AI technologies will boost corporate productivity in 16 industries in 12 countries by an average of 38%. This was shown in the Allianz Global Corporate & Specialty survey "*The rise of AI: Future Outlook and Emerging Risks*" (2018) conducted in different countries in 2018. According to a survey by MIT Sloan & BCG (2017), 66% of companies are already implementing AI in one way or another.

Nevertheless, there are different expectations and points of view on the use of AI technologies. Some authors pay more attention to the risks associated with its use.

For example, according to [N. Bostrom \(2016\)](#), the application of AI in management in general entails two major risks: loss of control over the technology and the risk of such technology being used with negative consequences for humanity.

As stated in the research conducted by Allianz Global Corporate & Specialty, the use of high-powered AI leads to risks in five problem areas. In the author's opinion, such risks should be fully taken into consideration when developing instruments and technologies based on AI for the support of the Board of Directors.

The authors found that the most significant risks, in the opinion of top-managers, are that of excessive confidence in AI systems, a lack of transparency in business processes, decrease in stakeholder confidence and deterioration in the level of safety ([Figure 3](#)).

Despite the risks, the authors note that world investment in the development of AI is still growing. According to the analysis conducted by *PWC's Strategy and Part* (2018), in the first three months of 2018, a record was set for financing in the field of AI – the total investment volume exceeded US\$1.9 bil. Compared to the same period in 2017, this amounts to growth of 69%. And at the same time, according to the *NVP Big Data Executive Survey* (2017), 37.2% of executives say their companies have

invested more than US\$100 mil on big data initiatives over the past 5 years, with 6.5% investing over US\$1 bil.

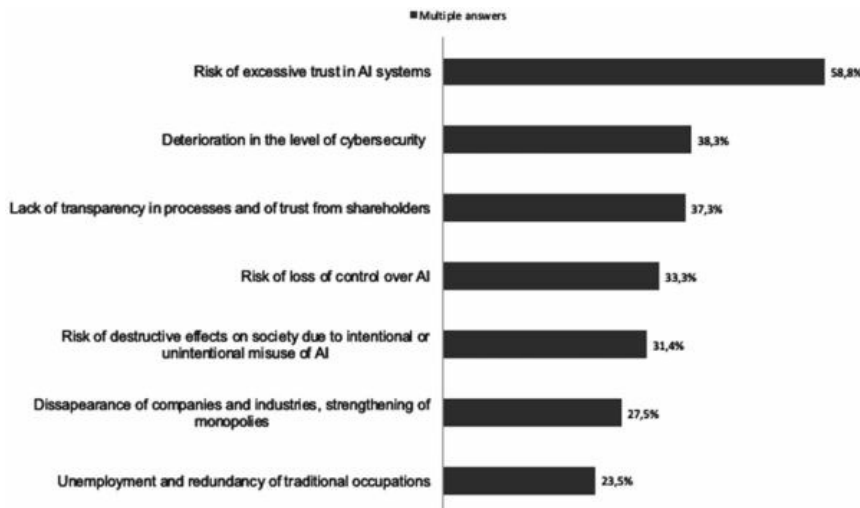


Figure 3: The most significant risks for companies associated with the use of AI (compiled by the authors)

Given such high rates and development prospects, AI technology combined with big data analytics can significantly influence the mechanisms for corporate decision-making, since these are associated with the processing of big data which AI can handle most effectively. This can serve as a good foundation for managers, who can shift some of the analytical functions that machines are better able to cope with over to AI, leaving them to concentrate on less routine tasks. The results of the McKinsey Global Institute study *A future that works: automation, employment, and productivity, US* (2017) confirm that professions and activities related to data processing could soon be automated. At the same time, according to this research, management and director activity is less likely to be automated in the near future.

However, there are also opposing points of view. According to a study by the International Expert Council of the World Economic Forum (2015), 45.2% of the directors surveyed believe that AI (a robot) will be able to become a member of the corporate Board of Directors by 2025.

But regardless of contrasting views on the possibility of automating the activities of company managers and directors, Boards of Directors and top management will have to change the principles of decision making in order to remain competitive. The authors came to the conclusion that this is the greatest benefit AI-based innovation can bring.

Analyzing procedures for making corporate decisions, the authors identified several levels: the level of the shareholders, of the Board of Directors, and of top management. In this regard, it is necessary to recall the classic problem of corporate governance – "information asymmetry".

So, if top management, as a classic "insider", sees the company and all its processes from within, then the Board of Directors and shareholders are often limited in their access to information about the company, which lays the ground for corporate conflict and increases the costs of miscommunication between participants in corporate relations.

At the same time, decisions made at the shareholder level are clearly structured, (the competence of shareholders is limited by law), and less complicated in the sense that they consist of previously worked out and proposed (usually by the Board of Directors) options, for example, approving amounts of dividends (yes/no), approving a transaction (yes/no), etc.

Meanwhile, decisions made by the Board of Directors are usually based on a large amount of conflicting information coming from top management, often involving a conflict of interest. At the same time, the decisions of the Board (for example, approval of a development strategy, the budget, hiring/firing of managers) are complex and structured, and involve risk taking and a higher level of responsibility compared to shareholders.

The decisions made by top management are similar to the decisions made by the Board in terms of complexity, but top managers have incomparably greater information support, time and personnel resources for making decisions in comparison with decisions of the Board and shareholders. In addition to this, the "error cost" of operating decisions made by management is usually much lower than the cost of strategic errors made by the Board of Directors.

In this regard, it is most likely that AI at the level of the Board of Directors can be used primarily as a tool to overcome the asymmetry of information and as predictive analyst.

Therefore, at the level of corporate directors, the need has arisen to adapt processes to new technological developments. In

this regard, at all levels of management there will be need to rebuild decision-making mechanisms, using advanced technologies that allow faster and more efficient analysis of information, ensuring the independence and objectivity of decisions. So, what could be the optimal structure and process of decision making in the era of AI and big data supporting management and directors in decision making?

The question remains open: in which decisions undertaken by Boards of Directors and under what conditions will AI and big data analysis be most effective?

APPLICATION OF AI BASED ON BIG DATA ANALYSIS IN CORPORATE GOVERNANCE

The Role of the Board of Directors and Specifics of Decisions in the "New Digital Era"

Considering the increasing attention of regulators to the topic of IT governance, reflected in the national Corporate Governance Codes of countries such as Singapore (2012), South Africa (2016), Netherlands (2016) and Hong Kong (2016), the role of the Board of Directors on issues of disruptive technologies and digital trends in the "new digital era" is evidently strengthening. Taking into consideration the development of big data technology, which is most effectively handled by AI, the Board of Directors needs to look to the future, basing their decisions on predictive analytics, and not on analyzing disparate data from the past. Advanced technologies therefore change the role of the Board of Directors to a proactive one in the development, application and search for opportunities to use advanced technologies. Thus, as respondents to the authors' study note, technologies, such as AI and big data, will soon be able to be used as a tool to support the Board of Directors in making decisions.

Table 1: Areas of decisions made by the Boards of Directors at present and possibilities for their algorithmization (compiled by the authors)

Main Areas of Decisions Made at the Level of the Board of Directors	Possibilities for Algorithmization of Decision Areas
Strategy	<ul style="list-style-type: none"> • Conducting competitive analysis • Conducting consumer analysis
Investment policy	<ul style="list-style-type: none"> • Evaluation of investment projects • Analysis of investments
Internal control and audit	<ul style="list-style-type: none"> • Internal control • Audit
Risk management	<ul style="list-style-type: none"> • Compliance • Risk analysis
Personnel actions regarding top management	<ul style="list-style-type: none"> • Evaluation of activities, taking into account KPIs • Recommendations on amounts of remunerations for top management based on remuneration policy
Material deals control	<ul style="list-style-type: none"> • Analysis of stakeholder affiliation • Analysis of counterparties • Analysis of the connectivity of transaction
Issues of sustainability and CSR	<ul style="list-style-type: none"> • Issues of sustainability and CSR

Summarizing the best practice of corporate governance presented in the OECD Principles of Corporate Governance and National Corporate Governance Codes, the authors identified the main areas of decisions made at the level of the Board of Directors. In a survey of 51 Board Members and top managers of large and medium-sized companies, the leaders were given recommendations with possible areas of algorithmization of decision making. [Table 1](#) shows the areas that can be automated, according to the leaders.

From [Table 1](#) we see that some of the decisions of the Board can potentially be entrusted to AI. In addition to this, AI is able to react quickly to various kinds of events. Therefore, in order to make decisions in difficult structured situations, it might be useful for company Board Members to be able to receive effective independent grounded answers to questions posed about the company's activity and the real situation on the market. The last thing is to determine the conditions for effective decision

making by a human and by AI.

If we turn to history and recall the cases of the largest corporations collapsing after incorrect decisions were made by Board Members of the well-known companies Enron, WorldCom, Vivendi, and Parmalat, described in detail by M. Beare, we find that the causes of wrong decisions were associated with various factors that influenced decision making:

- The Board of Directors made decisions under the strong influence of the owner, that is, it was not independent in making decisions.
- Members of the Board did not have sufficient information; some data were hidden from them.
- Directors did not have enough time to analyze all the necessary information.
- Directors relied on the opinion of top management, not making their own assessment of the state of affairs in the company on strategically important issues.
- Stakeholders who influenced the adoption of corporate decisions differed in their values and interests; they had a desire to own a certain resource.

All these factors indicate the impact of characteristically human elements on the decision-making process: a high degree of suggestibility; significant influence of emotions, habits and customs on decision making; loss of independence due to resource constraints; and limited ability to process a large body of information over a small period of time.

Furthermore, group and personal values and corporate culture have a significant influence on decision making. The "tunnel effect", described by [D. Kahneman & A. Tversky \(1987\)](#), intertwined interests of shareholders, and the "pressure of intuition" also have a big impact.

Is the "human" method of making decisions, taking into account the above factors, the most effective in the current and potential conditions of the unfolding Fourth Industrial Revolution, the resulting global uncertainty, the "information storm" and the unpredictable development of technology?

It is obvious that, under modern conditions, at the level of the Board of Directors, the processing of more and more data is required in decision making, while independent interpretation and a high level of reliability of both data and of the analysis based on them are important. Moreover, the more complex the decision is, the more data is needed to adopt it on a rational, independent basis. The amount of new factors, ideas and other information that a person can assimilate and analyze in a certain period of time is limited.

And since AI is especially suited to processing large volumes of data, it would be able to help improve the efficiency of decision making, reducing all kinds of uncertainties through forecasting. Thus, issues related to the automation of information flows and intensification of intellectual activity at the level of the Board of Directors require special attention.

To make sure that AI is able to increase the efficiency of the decision-making process, let us examine in more detail some of the limitations in decision making that are typical of Boards of Directors in [Table 2](#).

The limitations in making decisions listed in [Table 2](#) are "human" limitations only. In this regard, the question is can AI completely replace a person as a Member of the Board of Directors. To answer this question, we should consider the field of decisions made by Boards of Directors today and compare them with the possibilities of their algorithmization.

Table 2: Restrictions in decision making typical of Boards of Directors (compiled by the authors)

Cognitive and Behavioral Characteristics of a Person	Limitations Related to the Professional Activities of Director and the Activities of the Company
<ul style="list-style-type: none"> • The slow reaction to various kinds of events as a consequence of slow information flows. • Decision making is influenced by emotions, human values, and expectations of personal gain. • Decision making is influenced by the "group thinking phenomenon" (I. Janis, 1972). • Decision making is influenced by the "tunnel effect". 	<ul style="list-style-type: none"> • Board Members have a small amount of time available for solving problems. • A large amount of "white noise" prevents them from seeing and understanding the risks in time. • There is the need to regulate the interests of stakeholders and make decisions taking into account their expectations. • The values and corporate culture of a particular company can influence decision making. • Over-reliance on management.

Table 2: Restrictions in decision making typical of Boards of Directors (compiled by the authors)

Cognitive and Behavioral Characteristics of a Person	Limitations Related to the Professional Activities of Director and the Activities of the Company
<ul style="list-style-type: none"> A person's confidence in their intuition and competence, failure to understand the limits of their professional skills (D. Kahneman, 2014). 	<ul style="list-style-type: none"> There is a high level of both cost and redundancy in internal control and reporting systems for providing high-quality analytics to the Board of Directors There is an inability to obtain additional expertise and involve consultants and experts to make better decisions on specific issues at the company's expense.

Specifics of Decisions Made by the Board of Directors in the "New Digital Era"

In the opinion of the futurologist Ian Pearson, the ability of people to think creatively could protect their profession from being replaced by AI. Company management is among those professions requiring creative thinking.

In the opinion of the managers surveyed by the authors of the survey ([Figure 4](#)), by 2025, AI will most likely only perform the functions of an analytical assistant to top management (66.7% of the surveyed managers) and look for bottlenecks in business processes (64.7%).

However, the fact that AI AlphaGo was able to win a game of weiqi, which requires non-standard creative and improvisational solutions (the withdrawal of some symbolic logic from the statistical system), suggests that "machines" may be able to learn creativity in the near future, and thereby replace managers.

In this case, in order to prevent the risks associated with the use of AI in management, we examine the dilemma: which model of decision making will be more effective – one with a person at its center, or one which at its center, instead of a person, has AI analyzing big data and actually making the basic decisions?

In systems using AI to analyze big data, the authors distinguish two main applications for this technology in the process of corporate decision making: it could potentially be used as a decision support system for the Board of Directors, or it could become a full member of the Board of Directors, alongside the human Directors. However, before implementing AI in the process of making corporate decisions, let us compare the main characteristics and the degree of effectiveness of decisions made by a human, made by AI, and made by a human using a system based on AI and big data for making decisions.

We will compare these using existing research (*Management Sciences in the Modern World* (2018), which outlines the following unique features in making decisions characteristic of humans and AI respectively:

Human:



Figure 4: Functions that managers believe are most likely to be performed by AI by 2025, according to the authors' study (compiled by the authors)

- Able to solve unformalized tasks.
- Able to think critically, make nontrivial conclusions.
- Able to communicate interpersonally – negotiate, develop common views and values.

- Able to understand shareholders' interests intuitively.

AI:

- In a number of cases, instant decision-making.
- Great manageability with big data – the ability to produce more accurate results, operating in millions of variables and searching for the most optimal solutions.
- Absence of fatigue.
- Independence in decision-making.
- Can produce a more creative result by using patterns uncharacteristic of a person.
- Low costs – there are no costs for employee leave, days off, medical insurance, bonuses, etc.

Based on these characteristics, we can assume that the decisions made by human and those made by AI will each have their pros and cons.

Next, in [Table 3](#), let us consider the degree of effectiveness of a human, a human using a decision support system based on AI, and AI as a Member of the Board of Directors. The analysis of the effectiveness of decision-making processes was conducted on the basis of a survey of 34 leaders of medium-sized and large Russian companies on a 3-point scale. 0 – inefficient, 1 – minimally efficient, 2 – averagely efficient, 3 – highly efficient.

From [Table 3](#) and the comments of leaders we can conclude that a person using a support system for decision making based on AI is able to improve the process of making decisions and demonstrates better results in comparison with decisions made by a person not using such support systems, as AI demonstrates considerably better performance in collecting and processing information, finding unconventional correlations, comparing with decisions that have already been made, and selecting alternatives, and performs these tasks with a higher operating speed than a person who is not using any additional systems based on AI and big data.

Table 3: The degree of effectiveness at each stage of the decision-making process (compiled by the authors)

The Degree of Effectiveness at Each Stage of the Decision-Making Process	Human	Human With Decision Support System Based on Big Data and AI	AI-Director
Ability to identify a problem	2	2	2
Ability to collect information	2	3	3
Ability to handle large amounts of data	1	2	3
Development of new solution	2	2	2
Ability to find ready-made solutions	2	3	3
Ability to find unconventional correlations and solutions	1	3	3
Ability to compare various alternatives, evaluate and select	2	3	3
Ability to negotiate	3	3	1
Ability to approve and be accountable for decisions	3	3	0

However, AI faces some problems in negotiating, regarding taking into consideration and correlating shareholders' interests, and in being accountable for decisions made. A person will do a better job in dealing with these issues, therefore, at this stage, AI operating without a human is less effective. Quite often, when assessing the needs of the shareholders, a person acts on intuition, whereas AI is likely to make a decision, for example, about reorganization based on the notion that it would be more economically effective, ignoring the interests and wishes of the owners.

Thus, in the process of decision making by a Board of Directors, AI will be most effective as an assistant-analyst.

In this case, the process of making decisions will differ from the "classic" model. In [Figure 5](#), the authors present the stages of a Board of Directors in making decision by adding stages involving learning AI (a neural network) to G. Mintzberg's algorithm of decision making (1976). It should be taken into consideration that before using AI, an intelligent system needs to be made and "set". This should include a preliminary stage, which consists of three substages:

1. Collection of all possible specifications and their interrelations, which will then be analysed by the AI: base materials, which the AI will use to learn, are uploaded to the system - these materials could be the minutes of all previous Board

meetings together with all the approved and dismissed decisions, examples of logic behind the decisions, budgetary and other limitations, performance results of competitors and any other information which has an effect on the process of decision making.

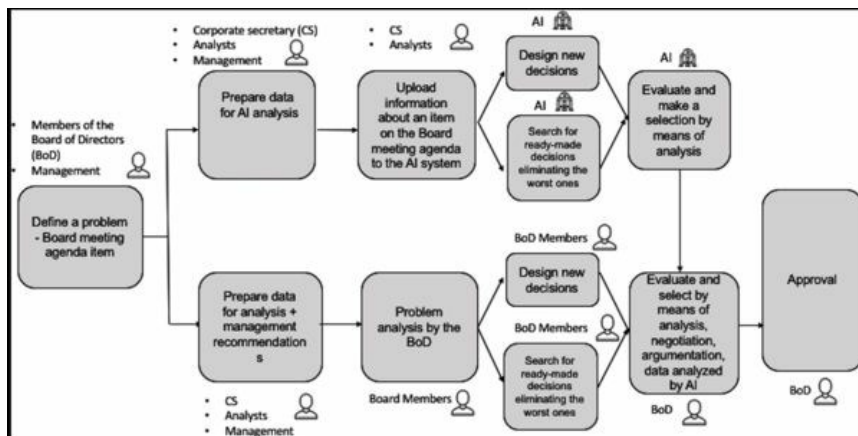
2. Then all the methods of machine learning should be sorted and, after selecting the optimal approach, machine learning can begin.
3. After the results have been interpreted and by testing on the actual objectives of the Board, the system is applied to the process of making decisions.

After going through the preliminary stage, the "classic" decision-making process can be supported by parallel analytics and recommendations given by AI, however it is still the Board of Directors who should make all the final decisions (Figure 5).

Based on current practice of the application of AI technologies, the crucial role in its introduction and development is played by the work of analysts and data scientists. Essentially, the effectiveness of the whole system of decision making, as well as the risks and respective limitations related to the application of AI, all depend on their actions and interpretations.

Thus, one of the promising applications of AI technologies by Boards of Directors is its application in an intellectual decision support system that works in parallel with the Board of Directors.

Thus, some questions arise: how reasonable is it to introduce AI into the management corporate governance system? What are the risks of its application in corporate governance?



Source: M. Nikishova. *AI application in the system of corporate governance (Unpublished PhD dissertation thesis). Financial University under the Government of the Russian Federation. Russia, 2018.*

Figure 5: The process of making decisions by the Board of Directors using AI according to the authors' research "Is your company ready for digital transformation in the era of the Fourth Industrial Revolution?" (compiled by the authors)

Risks Associated With AI Technologies Based Big Data in Corporate Governance

Looking at AI implementation, we could state that the biggest corporations, such as Google, Microsoft, IBM, Apple etc. are competing to develop AI platforms, and thereby moving the technology forward.

And if we multiply this situation by rising competition between nations, we find ourselves in the classic "prisoners' dilemma". But what will happen in the future if the key players in the field (big nations and large international corporations), according to the "prisoner's dilemma", always prefer competition to cooperation?

Oxford philosopher [N. Bostrom \(2016\)](#), in his famous book on AI, has already raised this discussion.

He analyses a hypothetical arms race in the use of AI, where several teams compete to be the first to create super-intelligence. What risks does this situation lead to?

In this case, suggests [N. Bostrom \(2016\)](#), If the competitors cannot reach a consensus (due to the differences in their positions and failure to control compliance with their agreement) the race can become fatal, with each team spending only minimal resources on safety.

Moreover, the level of danger of such a race increases with the number of competing teams, as vicious competition increases participants' exposure to risk. In this case, according to Bostrom, teams may accelerate the development of "super intelligence", decreasing their investments in safety. Under these circumstances, when "the winner takes all" and the cost of falling behind is the existence of a player, the safety of such new technology can in fact become less of a priority.

And so, according to classic "prisoner's dilemma" theory, in competitive markets all the companies will inevitably turn to the use of AI, because constant improvement of AI will become the only logical strategy for survival in a competitive environment. And the decision making by the board of directors will be carried out taking into account the competition based on the more prepared predictive analytics based on big data.

The use of AI in management and corporate governance also raises another a critical issue - that of accountability. Although in practice "intelligent agents" can take responsibility for a large number of decisions that used to be made by humans, according to law the final responsibility for such decisions still lies with people - usually with the developers or users of the systems. Let's imagine a situation in which a Board of Directors makes a decision based on a recommendation from an AI system. In this hypothetical situation, the Board approves a decision following a recommendation from AI, but, in the end, this deal leads to financial losses. Who is responsible in this situation? The Board of Directors, the system creators, its customizer, the CEO? A legal conflict can arise. The most difficult task is to determine who exactly holds responsibility and what the legal basis for working with AI is, before such software is released on the market.

Moreover, when dealing with AI, ethical issues become more and more relevant. Ethical issues with "intelligent agents" arise from the fact that AI has difficulty distinguishing between good and bad. Decisions made by an "intelligent agent" may be more precise and proficient, however, in many cases an optimal decision depends on ethical principles and the behavior of the parties involved. The human brain has "social intelligence", which has been evolving for millions of years, and is capable of making such decisions, while an "intelligent agent" is not - it cannot take into consideration such abstract notions as conscience, honor, happiness, values, and therefore it may sometimes act in contradiction with the interests of people or a company.

Any Board of Directors will deal with complex decisions on a regular basis. For example, an "intelligent agent" can rationally make a decision about the dismissal of a significant number of employees, about the reduction of expenses on the development of a product or about its "appropriate" decrease in consumer performance, solely from the perspective of the value maximization function. "Human" Boards of Directors, when making a decision, are more likely to take into account ethical and behavioral nuances.

A whole range of risks in applying AI have a direct influence on business.

According to research conducted by the authors ([Figure 6](#)), constraining factors for the introduction of AI in business are the lack of competent staff, budget constraints, limitations of technological capabilities, inflexible processes in organization, and lack of a clear understanding of the processes.

[The PWC study \(2017\)](#) adds a number of barriers to this list: increase in volatility caused by "groundbreaking technologies"; increase in the risk of potential mistakes and the lack of transparency and certainty in the ability to control AI; as well as moral dilemmas such as the trust of shareholders, potential destructive effects on society and a lack of adequate regulations.

Another set of risks is related to the specifics of applying AI in management practices. Let's define some of these.

When we talk about "making AI (a neural network) behave in sensible way, like a human being" we usually mean the left brain hemisphere working independently of the right one. The left side of the brain, as noted by [S. Springer & G. Deutsch \(1983\)](#), is responsible for abstract logic, analysis and verbal thinking. The application of AI as a wide-spread support system may cause a decline in "management diversity". Nowadays, it is commonly accepted that "diversity" at the level of Directors improves the quality of their decisions and the effectiveness of management. Generic decisions suggested by AI could contribute to "tunnel" thinking at the level of the Board and management.



Figure 6: Constraining factors for the introduction of AI in business (compiled by the authors)

Moreover, solutions and decisions suggested by AI could lead to "a self-fulfilling prophecy", as described in 1949 by [R.K. Merton \(1949\)](#) and further studied by [G. Soros \(2013\)](#), who suggest that a prophecy directly or indirectly influences reality in such way that the prophecy eventually turns out to be true. This can happen if an inaccurate understanding of a situation causes new forms of behavior, which transform the initial false assumption into reality. Imagine a situation in which a glitch in a "self-confident" system based on AI causes mass sales on the stock market, which in its turn, acts as a "trigger" to an "automatic" financial crisis.

One more, strictly psychological, risk is caused by the possibility of suffering from the "syndrome of superfluous trust" toward AI systems.

Other risks specific to the use of big data, such as lack of infrastructure, culture of data storage, duplication and mismatch of data sources, unstructured information, statistical mistakes etc., from our point of view are less significant relative to the use of AI, and could be minimized with the further development of the technologies.

Consequently, all risks related to the use of AI based on big data should be governed, and the management of such risk can not be designated to AI itself. In each system using AI, there should be an analogue of the "red button overriding autopilot", which is able to switch the system to "human" mode.

It is worth mentioning that, on the state level, several countries have already made some attempts to regulate the spheres of robotics and AI.

The first approaches to dealing with such issues were developed in South Korea. In 2007, the development of the Robot Ethics Charter was announced, and later the "Intelligent Robots Development And Distribution Promotion Act" (2008) was implemented.

China has also already developed a detailed "New Generation of Artificial Intelligence Development Plan" (2017) on promoting the development of a new-generation of AI technologies, which includes some ambitious plans to be fulfilled by 2030. It's also been indicated that the country intends to create the first laws dedicated to the regulation of this sphere by 2020.

In 2016, the European Parliament accepted for consideration a resolution on the "Civil Law Rules on Robotics" (2016). It consists of several sections: general understanding of robots; their classification; responsibility issues; and establishment of a code of ethics for developers of robots.

At this point, all the listed documents are nothing more than general principles on robotics and AI. However, with the development of practical application in business, more elaborate regulation will be required.

Corporate law allows the Board to delegate their decision making rights to algorithms, however with certain limitations. Moreover, the law can even force the application of algorithms as a mean of control of the decisions made by the Board. But the other side of the question should also be discussed: can Directors demand the right to delegate their decision-making authority to algorithms, at least under certain circumstances?

In terms of legislation it is also important to consider the questions of guilt and accountability of the people who regulate the configurations of algorithms in companies, developers of software, and Directors, when making decisions using AI or refusing to do so. This question is especially important in complex situations, often involving ethical issues or issues related to corporate social responsibility.

SOLUTIONS AND RECOMMENDATIONS

In the 21st century, the corporate world is experiencing changes at a drastically increasing pace. Digital technologies are rapidly developing and the length of business cycles is decreasing from several years to several months. Companies therefore need to react quickly and adapt to such changes by becoming agile and increasing the effectiveness of their work with information.

The growth rate of innovations and the scale and the diversity of existing information create the need to change approaches in management and in decision-making processes. Under such conditions, AI technology is capable of assisting management in processing the large amounts of information required for making corporate decisions, taking into account the increasing competition and pressure from shareholders.

Decisions made by a person and by AI each have their limitations, advantages and disadvantages, which leads to the fact that the most ideal option for improving the effectiveness of such decisions is the use of AI for analysing Big Data as a support system in making such decisions.

Based on the authors' research, Board Members and top managers could be advised to pay attention to the following issues:

- Every company is becoming more and more dependent on new digital technologies; big data technologies provide opportunities only to those who have the appropriate technologies, including AI.
- The role of the Board of Directors is shifting from a "compliance only" approach to a more comprehensive and proactive approach based on setting visions and managing risks.
- Decisions made by Boards of Directors are characteristically based on big data and at the same time include a lot of "subjective noise", which could be decreased by the professional implementation of AI based on big data.
- At the same time, Boards of Directors should pay attention to the risks associated with AI based on big data, including rising volatility, complexity and unpredictability of the consequences of a decision.
- Every board should raise the personal and collective competence in AI and big data technologies and their applications, including "digital experience" in the perspective competence model of the Board of Directors.
- Regulators should pay attention to the amendment of the law about the application of AI based on big data. Corporate Governance Codes should include basic principles for application and ways to manage the risks associated with processing big data and applying AI.

The application of AI based on big data will allow companies to change the process of making decisions by introducing parallel analysis of issues to the agenda of Board meetings and developing alternative independent solutions. However, the decision itself and the responsibility for it should remain with the Board of Directors.

At the same time, when introducing the most effective analysis technology of big data— AI - all risks and possibilities should be thoroughly evaluated, and questions of responsibility and regulations should be thought through both on a state and corporate level.

FUTURE RESEARCH DIRECTIONS

In the 21st century we could witness the Fourth Industrial Revolution, which has been felt since the end of the 20th century, and now the digitalization of the society, technological development, and the transformation of corporations both challenge us and at the same time lead us to new changes in business models and in the processes of how decisions are made, which brings us to intellectualization and higher transparency of management, as well as to the modification of potential conflicts of interest, which lay at the base of corporate governance.

Consequently, the authors will continue their research on the following subject: analysis of the tendencies and perspectives of the corporate governance system in the "digital era"; its transformation to Corporate governance 2.0; and technical aspects of the use of big data technologies and AI in corporate governance.

CONCLUSION

In this study, the authors aim to find an approach to the question 'What is the optimal structure and process for decision making using AI based on big data to support Boards of Directors in decision making in the "new digital era"?', while not focusing on the methods of processing information and other technical aspects of the issue, which have been left for the continuation of this study. Due to higher quality analytical abilities, the increase of transparency and the ability to speed up the decision-

making process using AI technologies and big data, corporate governance models will transform, and, in doing so, will create new systems of interaction between shareholders, and will change the methods and business models used in making corporate decisions. In the face of constantly increasing amounts of information and technology development, Boards of Directors need to look to the future, basing their decisions on predictive analytics, rather than analyzing past unstructured data.

Analyzing the system of decision making used by the Board of Directors, it can be concluded that there is a certain set of limitations arising from qualities associated only with human behavior. In order to avoid such limitations, a part of Board's decisions and processes can potentially be automatized and complemented/replaced by analytic systems using AI based on big data. However, full replacement, contrary to the opinions of some authors, and fortunately for humanity, is very unlikely, as the nature of some decisions requires not only analytical abilities (in which AI based on big data can be superior to the human brain), but also emotional and "social" competencies, which AI does not and will not possess in any foreseeable future.

At the present moment, comparative assessment of the effectiveness of AI and people in different types of managerial activities leads to the conclusion that partial automatization is possible when the decision-making process is related to analytic thinking, and that AI is incapable of balancing the interests of shareholders, holding negotiations, approving decisions and taking responsibility for them. Thus, the most effective approach at this point is the introduction of AI in management and corporate governance systems as a support system for making decisions.

However, it should not be forgotten that competition, as one of the most important triggers for the further involvement of AI in management, could lead to major development of AI up to an unpredictable point of singularity. So before such new technology is applied, it is crucial to assess all possible risks and create a control system for these.

Moreover, the risks of using AI should be taken into consideration on governmental, legislative and corporate levels. On the governmental level, it is important to regulate questions of responsibility for decisions made using AI. On the corporate level, internal acts should regulate algorithms of new processes, means of verification, accountability of those responsible for setting up the support system and for the decisions made, and potential consequences and risks.

Consequently, taking into account the possibilities and risks of using AI in corporate governance, AI, which is capable of analyzing big data, could become an effective ally to the Board of Directors in the process of making decisions, by providing them with high-quality, objective information in a short period of time.

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KEY TERMS AND DEFINITIONS

Artificial Intelligence:

Systems able to independently react to signals from the outside world (i.e., signals not directly controlled by programming specialists or anyone else), which therefore cannot be foreseen, in comparison with systems based on algorithms.

Big Data:

A means of identifying structured and unstructured data of large volumes and considerable diversity which is hard to process using traditional methods, including structured data, media, and random objects.