Original Contribution

PROGRESS IN THE USE OF INNOVATION IN RISK MANAGEMENT. CASE STUDY ON NATURAL GAS AND SERVICE SECTORS IN BULGARIA

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ABSTRACT
In recent years, companies are facing more and more types of risks with different levels of complexity. Inevitably this reflects also on the way how the risk is identified, evaluated and managed. One of the innovative risk management solutions is the use of artificial intelligence (AI). Artificial intelligence will create a foundation for more resilient, sustainable, adaptive, and well-prepared companies which could face environmental changes without being impacted so heavily. The purpose of the study described in this paper is to conduct empirical research to examine the progress of intelligent risk management implementation and the attitude towards it in companies from two sectors of the Bulgarian economy – services and gas. The two sectors will be compared and it will be statistically validated if there is a difference in how the companies from the gas and services sectors see the artificial intelligence and its benefits. Based on the results, at the end, a proposal for improved and innovative risk management will be made. The results of the survey and the empirical study will show what will be the future direction of the research in the field of artificial intelligence and its implementation in risk management.

Key words: intelligent risk management, artificial intelligence, risk, business process management, innovation

INTRODUCTION
The strong dynamics of the environment in recent years require more and more business organisations to pay higher attention to risk management. It proves to be a strong mechanism for ensuring better flexibility, adaptability, and resilience to changes, a source for minimising losses and maintaining a positive reputation. A proper risk management strategy can become a competitive advantage and significantly influence on the companies' growth (1). A proper understanding and usage of modern risk concepts requires innovative mechanisms for its management (2). Numerous academic researchers observed the risk innovation in different directions. Mishchenko et al. (3)

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examine risk management innovations in financial institutions. Osborne et al. (4) focus on risk innovations in public services. Stocz & Williams (5) talk about innovative, proactive risk management, and Al-Nimer et al. (6) consider the importance of risk management in the overall business model of organisations. The risk management areas in which innovations are most often introduced relate to the management process, techniques, and tools, strategies, practices, etc. In this material, we focus on innovations related to the use of artificial intelligence (AI) in the risk management process. The motivation of the author team is related to the ongoing widespread penetration of AI in all kinds of activities, as well as to the strategic development vision of the Federation of European Risk Management Associations (7) for the introduction of AI. Our aim is to examine the extent of innovation in risk management related to the use of artificial intelligence. We seek to

answer the question of to what extent business organisations have travelled the path and are ready for intelligent (AI-based) risk management (IRM). In order to achieve this, we conducted a survey among the natural gas sector and large organisations from the service sector in Bulgaria. The selection of these organisations is based on their high level of risk and good level of innovativeness. To obtain the desired results, the following sections sequentially present literature review, research methodology, results, discussion of results, and conclusion.

LITERATURE REVIEW

As a basis of innovative risk management, this material examines the use of artificial intelligence. First of all, this requires clarifying its essence and its place in the risk management process. Artificial intelligence (AI) allows machines to supplement, even replace the role of experts in decision-making or certain actions (8) related to risk identification, assessment, treatment, and monitoring. This often involves gathering and analysing data from structured or unstructured databases, drawing inferences based on sophisticated algorithms, and advancing machine learning (ML). AI automates most redundant tasks, thereby increasing employee engagement and productivity in other areas (9).

AI risk management started getting the attention of governments, non-governmental organisations, and scientists. They are making efforts to promote and develop normative guidelines related to regulating the application of artificial intelligence in various fields (10). A number of studies are being conducted by the scientific community. Barrett et al. (11) developed recommendations for practical guidance on AI risk identification, risk factors in the scope of risk assessments and impact assessments, etc. Vyhmeister et al. (12) developed a concept of trust in AI based on continuous demonstration of sustainability over time from a technical and social perspective and compliance with regulatory requirements. They argue that trust in any AI agent should be based on the lowest risk of adverse outcomes. Various methodologies are being developed for the integration of artificial intelligence in the risk management process. According to one of them,

quantitative risk analysis can be performed through neural networks and Monte Carlo simulation (13). According to another, different AI tools find a place in each of the stages of risk management (14).

The most widely used artificial intelligence-based tools in risk management are of a different nature, but at their core are the following:

- Machine learning, having a wide range of algorithms and modelling tools used for a huge range of data processing tasks (15), and multiple methods to apply it in the different stages of risk management.
- Neural networks are based on the same way as biological neurons process information. They are built from multiple interconnected groups of artificial neurons that connect to each other through mathematical computational models (16). They are suitable for modelling complex relationships between data.
- Semantic artificial intelligence combining different methods and tools for accurate classifications, data linking, and automated data quality management. It enables high accuracy of prediction and classification (17).

The possibility to integrate the different tools in each of the stages of risk management is a guarantee of more effective management based on accurate results from many different databases, unbiased selection, optimisation of time, minimisation of costs, and other benefits. Another major contribution of intelligent risk management (IRM) is related to the possibility of being integrated into each of the business processes in the respective organisation. Thus, in addition to visualising the risk in the relevant process, it will be possible to trace its chain effect in any other interconnected process (18), which will result in improved general management and competitive positions of the organisation.

RESEARCH METHODOLOGY

The object of the research in this paper is gas companies and business organisations from the service sector in Bulgaria. The choice of the object is related to the high level of risk and dynamics in both types of organisations. They are

characterised by good competitiveness, so the authors decided to centre the research question "What is the degree of innovation in risk management and how far have they travelled the path to intelligent (AI-based) risk management?", around them. The distribution of the observed organisations is 1:2 or 33.3% from gas companies to 66.7% from the service sector. The period in which the research was conducted (in the form of a survey) is the second quarter of 2022. This period is characterised by major upheavals in the gas sector: greatly deteriorated geopolitical relations; war between Russia and Ukraine; suspension of natural gas supplies; need to secure alternative suppliers at higher prices; high levels of inflation and tension in the gas sector. In this environment, the gas companies face many difficulties, and this presented significant difficulties in conducting the survey. Another difficulty the team encountered was finding the right experts with intelligent risk competencies. Regarding respondents from the service sector, the survey did not meet such difficulties; large business organisations with knowledge and capacity to implement large business projects and business integrations were examined. The main methodological tools used to process the results are based on descriptive statistics and statistical testing of hypotheses.

RESULTS
As a starting point, the analysis of the results examines the attitude of organisations towards risk management and checks for differences in the two sectors. The results show the percentage of enterprises in the service sector which answered that risk management is integrated at all management levels and refers to the direct responsibilities of the given employees (45.2%). For comparison, 33.3% of enterprises gave this answer in the gas sector. In the gas sector, the highest percentage of companies answered that each employee has clear responsibilities, reduced to the specifics of their duties (42.9%), while in the service sector, this percentage is 35.7%. Most rarely, enterprises have an independent risk management department with functional authority at all levels of the organisation. With a slight margin of 23.8%, this response is in favour of gas companies compared to 19.0% of companies in the service sector. In this regard, attitudes towards introducing innovations in risk management are considered. The largest percentage of enterprises in the service sector answered that the attitudes are positive and the responsible risk managers follow the innovations that would be suitable for the organisation and present them to the top management (45.7%). The smallest percentage of them indicated that they do not need to introduce innovations in risk management, because the procedures established so far function well (11.4%). In the gas sector, companies are equally torn between having managers monitor innovations that would be relevant to the organisation and present them to senior management (38.1%) and introducing risk management innovations to respond to changes in legislation and/or the environment (38.1%).

The analysis of the results focuses on the propensity to use artificial intelligence (AI) in the risk management activities of the organisation. The respondents were given the opportunity to assess the need of using artificial intelligence by choosing between 1 and 5, with 1 being "no need at all" and 5 being "there is a great need".

Since the data are located on an ordinal scale ranging from 1 to 5, an average was conditionally calculated, which serves as a comparative value. The higher the average (closer to 5.00), the more imperative and more agreeable the enterprises are to the use of artificial intelligence in the given direction.

Currently the use of artificial intelligence is below average (2.28 for the service sector and 2.20 for the gas sector). The remaining responses state that artificial intelligence will be implemented in the sector at a later stage and that it is not applicable according to the specific activity of the organisation. The latter statement has a mean value of 3.06 for the service sector and 3.24 for the gas sector.
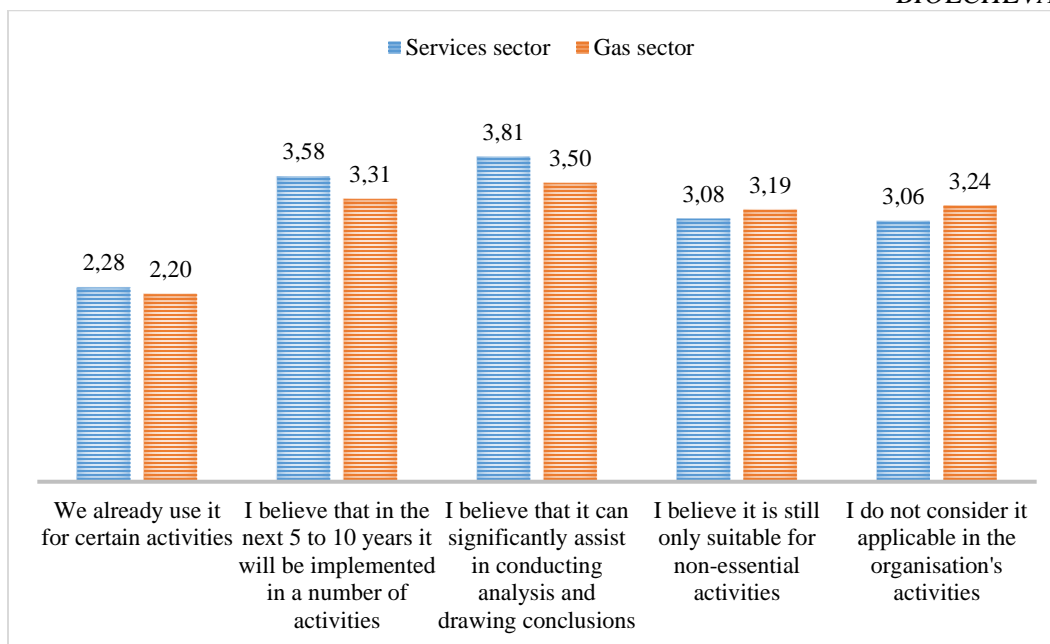
Figure 1. Attitude towards the use of artificial intelligence

The observed differences between the two sectors are not large, but a check is made here for the existence of a difference between them. Statistical hypothesis testing is applied.

H_0: The attitude in the gas sector and the service sector to the use of artificial intelligence in the organisation is the same.

H_1: The attitude in the gas sector and the service sector to the use of artificial intelligence in the organisation is not the same.

Since the responses for the attitude to use artificial intelligence are located on a weak scale and the responses of gas companies are not related in any way to the responses of companies in the service sector, a non-parametric test on independent samples is used to examine the difference between the two sectors (Mann-Whitney Test). The results of the test are presented in **Table 1.**

Table 1. *Results of the testing of the difference between the attitude towards the use of artificial intelligence in enterprises in the gas sector and the service sector*

Examined groups **Attitude towards the use of AI**	**Charac-teristic**	**Sector**		**Mann-Whitney Test**
		Services	**Gas**	
We already use it for certain activities	Average	2.28 [A]	2.30 [A]	**p=0.879**
	N	36	15	
I believe that in the next 5 to 10 years it will be implemented in a number of activities	Average	3.58 [A]	3.31 [A]	**p=0.317**
	N	38	16	
I believe that it can significantly assist in conducting analysis and drawing conclusions	Average	3.81 [A]	3.50 [A]	**p=0.404**
	N	37	16	
I believe it is still only suitable for non-essential activities	Average	3.08 [A]	3.19 [A]	**p=0.736**
	N	36	16	
I do not consider it applicable in the organisation's activities	Average	3.06 [A]	3.24 [A]	**p=0.657**
	N	35	17	

*For groups with the same letter, no statistically significant difference was reported.

The level of significance in all tests is greater than the accepted risk of error (α=0.05), therefore the null hypothesis that there is no difference in attitude towards using artificial intelligence in gas and service sector enterprises cannot be rejected. If a difference is observed, it is due to irregular activity. This conclusion can be asserted with a certainty of 95%.

Next, the analysis examines the need to integrate risk management into the individual business processes of organisations. Over 50% of the companies in the service sector believe that risk management should be integrated into business processes. In the case of the gas sector, the predominant answer (47.6%) states that it is good to integrate risk management into strategically important processes. The answers are arranged in ascending order from lower to higher integration, so an average value of the need for risk management to be integrated into the individual business processes in both sectors can be calculated. In the service sector, the average need amounts to 2.49 (out of a maximum value of 3.00), and in the gas sector to 2.33.

The benefits of being able to track and visualise the chain effect of risk in each individual business process, through the capabilities of AI, are also analysed. The most common answer to this question in both sectors is "rather yes" (52-55%). In the service sector, 35.7% said "definitely yes",

and in the gas sector 19.0%. On the other hand, 23.8% from the gas sector and 9.5% from the service sector responded with "it is difficult to say". There are 4.8% of enterprises in the gas sector that stated that risk tracking and visualisation would rather not have an effect. Conditional means differ with a slightly higher opinion about usefulness in the service sector (4.26). Statistical hypothesis testing is used to examine whether there is a difference between them.

H_0: The opinion in the gas sector and the service sector about the usefulness of tracking and visualising the chain effect of risk in individual business processes is the same.
H_1: The opinion in the gas sector and service sector about the usefulness of tracking and visualising the chain effect of risk in individual business processes is different.

Since the responses for the opinion on the usefulness of monitoring the risk chain effect are located on a weak scale and the responses of gas companies are not related in any way to the responses of companies in the service sector, a non-parametric method is used to test the difference between the two sectors for a difference between two groups in independent samples (Mann-Whitney Test). The results are presented in **Table 2.**

Table 2. *Results of the opinion on the usefulness of tracking and visualising the chain effect of risk in enterprises in the gas sector and the service sector*

Examined groups / Test Variable	Characteristic	Sector		Mann-Whitney Test
		Services	**Gas**	
The usefulness of tracking and visualising the chain effect of risk	Average	4.26 [A]	3.80 [B]	**p=0.048**
	N	42	21	

*For groups with the same letter, no statistically significant difference was reported.

The level of significance (p=0.048) is less than the accepted risk of error (α=0.05), therefore the alternative hypothesis that there is a difference in the opinion about the usefulness of tracking and visualising the chain effect of risk can be accepted. By comparing the two averages, it becomes clear that enterprises from the service sector have a higher belief in the usefulness of tracking and visualising the chain effect of risk in

individual business processes than enterprises in the gas sector. This conclusion can be asserted with a certainty of 95%.

The opinion of the respondents regarding the integration of risk management in business processes, as a guarantee mechanism for higher stability and efficiency, was analysed. The most common answer to this question in both sectors is

"rather yes" with the same percentage of 47.6%. 40.5% said "definitely yes" in the service sector, and 28.6% in the gas sector. On the other hand, "it is difficult to say" was marked by 23.8% from the gas sector and 9.5% from the service sector. There are 4.8% of enterprises in the gas sector stated that risk tracking and visualisation would rather not have an effect. Conditional means differ with a slightly higher opinion about the guarantee in the service sector (4.26).

The analysis also examines the benefits of having intelligent risk management in the business process management of the organisation. To this end, it was explained to the respondents that intelligent risk management (IRM) implies that risk is managed in an autonomous "intelligent" way, relying on the capabilities of artificial intelligence. They are asked for their opinion on whether they find it useful to manage business processes in their organisation by having this tool which visualises the results for identified and analysed risks across individual processes. Approximately half (47.6%) of enterprises in the gas sector indicated "rather yes". In the service sector, they are more categorical and the "definitely yes" category has the highest percentage with 45.2%. A similar percentage of companies also answered the other positive answer "rather yes" (42.9%). There are 2.4% of enterprises in the service sector and 9.5% in the gas sector which stated that it would be rather not useful for their organisation to have intelligent risk management implemented in the management of business processes. The conditional mean is higher for the service sector (4.31), which means that they consider it more useful to have such a system.

Another question concerns the sources of basic information for using intelligent risk management. Each source is rated by its importance from 1 to 5, with 1 being "no need at all" and 5 being "highly needed".
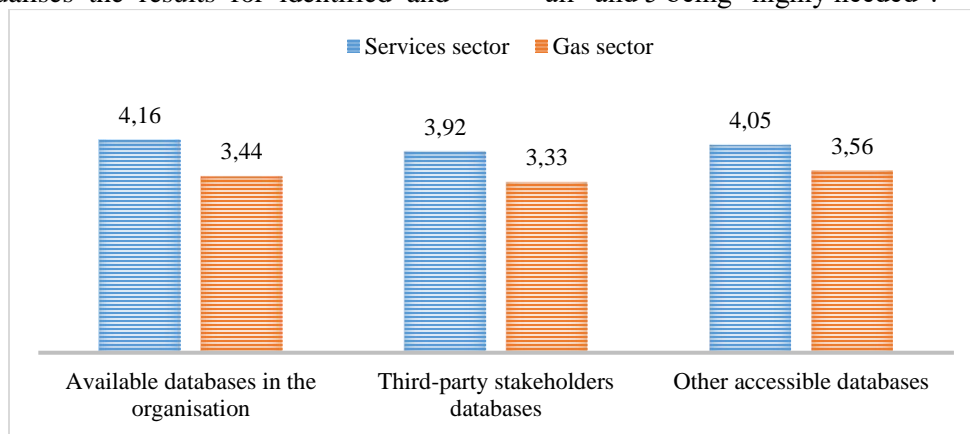

Figure 2. Basic sources of information in the pre-project phase

As the most important source, the service sector determines the available databases of the organisation, but in general, all averages from this sector are very close. Gas sector averages are also about the same, with the difference that they are slightly lower than service sector averages.

The respondents' general opinion on the benefits of artificial intelligence is also explored here. For this purpose, it was explained to the respondents that intelligent risk identification is based on the use of the following artificial intelligence (AI) tools: AI analysis of the information from the defined risks; AI analysis of deviations in activities, and processes; applying semantic analysis to build knowledge databases; Analysis of available data and knowledge from ML (machine learning) and neural networks; Applying ML and neural networks to generate inferences and decisions about potential risks. After that, they were asked what they think about the main benefits of the tools mentioned. Each tool is rated for its usefulness from 1 to 5, with 1 being "not at all useful" and 5 being "very useful".
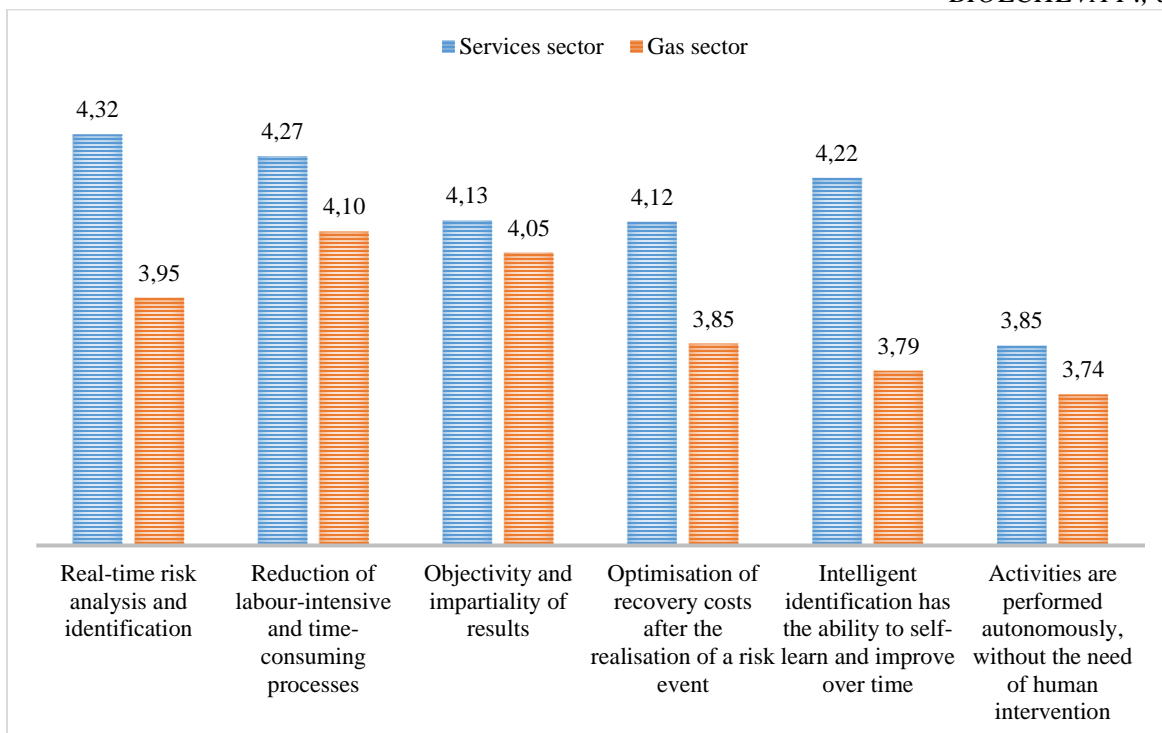
Figure 3. AI benefits by individual tools

As the most important tool, the service sector defines "Real-time risk analysis and identification" (4.32). The scores for all tools are above 4.00 except for the tool "Activities are performed autonomously, without the need of human intervention". It is the lowest-rated instrument from the service sector with an average of 3.85. Scores in the gas sector are more sceptical. Only two of them exceed an average benefit of 4.00. These are the tools "Reduction of labour-intensive and time-consuming processes" (4.10) and "Objectivity and impartiality of results" (4.05). The lowest scored tool is the same as the one indicated by the service sector – "Activities are carried out autonomously, without the need of human intervention" (3.74). The gas sector is more sceptical about the benefits of artificial intelligence than companies in the service sector. However, whether there is a

statistically significant difference will be shown by statistical hypothesis testing.

H_0: The importance of artificial intelligence tools in the gas sector and the service sector is the same.
H_1: The importance of artificial intelligence tools in the gas sector and the service sector is different.

Since the responses on the importance of tools are on a weak scale and the responses of gas companies are not related in any way to the responses of service sector companies, non-parametric testing will be used to identify the difference between the independent samples composed of two sector groups (Mann-Whitney Test). The results are presented in **Table 3.**

Examined groups / Attitude towards the use of AI	Charac-teristic	Sector		Mann-Whitney Test
		Services	Gas	
Real-time risk analysis and identification	Average	4.32 [A]	3.95 [A]	p=0.453
	N	41	21	
Reduction of labour-intensive and time-consuming processes	Average	4.27 [A]	4.10 [A]	p=0.825
	N	41	20	
Objectivity and impartiality of results	Average	4.13 [A]	4.05 [A]	p=0.828
	N	40	19	
Optimisation of recovery costs after the realisation of a risk event	Average	4.12 [A]	3.85 [A]	p=0.695
	N	41	20	
Intelligent identification has the ability to self-learn and improve over time	Average	4.22 [A]	3.79 [A]	p=0.103
	N	41	19	
Activities are performed autonomously, without the need of human intervention	Average	3.85 [A]	3.74 [A]	p=0.856
	N	39	19	

Table 3. *Results of the importance of the basic sources in the Pre-project stage on an enterprise level in the gas sector and the service sector*
*For groups with the same letter, no statistically significant difference was reported.

The level of significance in all tests is greater than the accepted risk of error ($\alpha=0.05$), therefore the null hypothesis that the two sectors attach the same importance to AI tools cannot be rejected. If a difference is observed, it is due to irregular activity. This conclusion can be asserted with a certainty of 95%.

The next question is about the main benefits of the overall integration of intelligent risk management in organisations. Most beneficial for the service sector are "Ensuring the continuity of business processes in the organisation" and "Real-time risk management" (3.33). All service sector averages range between 3.10 and 3.33, which means that enterprises in this sector see an above average benefit (2.00) from the integration of intelligent risk management into business processes. For the gas sector, the ratings vary between 2.78 and 3.24. Gas companies see the highest benefit in "Objectivity and impartiality of results" (3.23), and the lowest in "Reducing activities related to risk management" (2.78). Here all mean values are above the mean level (2.00) too.

A test for statistical difference between the means is conducted.

H_0: The benefits of integrating intelligent risk management into business processes in the gas and service sectors are no different.
H_1: The benefits of integrating intelligent risk management into business processes in the gas and service sectors differ.

Since the benefits of the integration of intelligent risk management are located on a weak scale and the responses of gas companies are not related in any way to the responses of service sector companies, a non-parametric method will be used to test the difference between the two sectors which are grouped in independent samples (Mann-Whitney Test). The results are presented in **Table 4.**

The level of significance in all tests is greater than the accepted risk of error ($\alpha=0.05$), therefore the null hypothesis that the two sectors attach the same importance to the benefits of intelligent risk management integration cannot be rejected. If a difference is observed, it is due to irregular activity. This conclusion can be asserted with a certainty of 95%.

Table 4. *Results of the benefits of the integration of intelligent risk management in enterprises in the gas sector and the service sector*

Examined groups / Attitude towards the use of AI	Charac-teristic	Sector		Mann-Whitney Test
		Services	Gas	
Cost optimisation	Average	3.10 [A]	2.95 [A]	**p=0.608**
	N	41	20	
New competitive advantages	Average	3.10 [A]	3.00 [A]	**p=0.697**
	N	40	19	
Reducing activities related to risk management	Average	3.18 [A]	2.78 [A]	**p=0.084**
	N	40	18	
Ensuring continuity of business processes in the organisation	Average	3.33 [A]	3.06 [A]	**p=0.254**
	N	40	17	
Real-time risk management	Average	3.33 [A]	3.24 [A]	**p=0.662**
	N	40	17	
More accurate risk analyses and conclusions	Average	3.18 [A]	3.13 [A]	**p=0.647**
	N	40	16	
Objectivity and impartiality of results	Average	3.23 [A]	3.28 [A]	**p=0.949**
	N	40	18	
Better execution of business processes	Average	3.10 [A]	3.05 [A]	**p=0.657**
	N	40	19	
Reducing the chain effect of risk in dependent business processes and activities	Average	3.18 [A]	3.21 [A]	**p=0.896**
	N	40	19	

*For groups with the same letter, no statistically significant difference was reported.

DISCUSSION

The results of the conducted empirical research show that, in most cases, enterprises from the service sector attach greater value to the implementation of risk management innovations. However, after statistical testing of the differences with the enterprises from the gas sector, it turns out that the differences are not statistically significant. This means that both sectors have the same behaviour towards intelligent risk management. The values obtained are almost always above the average propensity to agree.

All surveyed respondents confirmed the need for effective risk management in their organisations. For all of them, it would be beneficial for the risk management to take into account the

Interconnected nature of the risk in, and between the individual business processes taking place in the organisations. In confirmation of the trends in business management, this should happen through the use of modern tools and intelligent systems. While there are still some reservations regarding the use of artificial intelligence in overall management, the survey shows a positive attitude among respondents. The overall idea of risk integration in all business processes of the organisation and the functioning of a fully integrated business mechanism combining successful and efficient management of all business processes have been met with approval by the examined experts.

In summary of the results, **Figure 4** illustrates the progress in the individual directions showing the way to innovative risk management.
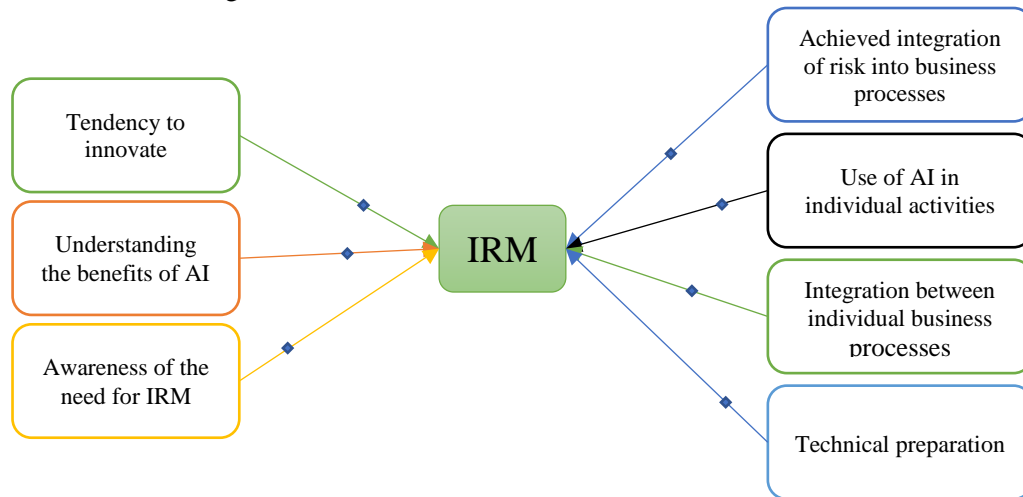
Figure 4. Level of readiness for innovative risk management

On their basis, it can be determined that according to the data from the natural gas and service sectors in Bulgaria, half of the way to achieve intelligent risk management has been completed. The need for increasing digitalisation and optimisation, along with the pace of implementation of new intelligent technologies, will accelerate the process, and within the next few years, innovation in risk management will be a competitive imperative.

CONCLUSION
The topic related to sustainable, adaptive, and modern management of business organisations in conditions of high dynamics and a series of environmental shocks is particularly relevant. It requires looking for scientific and applied solutions which are returning good results and guaranteeing the competitive positions of business organisations. One such solution is uncovered in the present work. It is a proven fact that effective risk management protects organisations from losses, shocks, and bankruptcies. For this reason, an innovative solution related to the use of artificial intelligence in this activity is proposed here. In this way, risk management will be integrated into all business processes in organisations. This is a guarantee of better resilience. On the basis of an empirical study, the progress of intelligent risk management implementation is shown here, using for this purpose two sectors with a good propensity for innovation, which are functioning on the territory of the still low-innovative Bulgaria.

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