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DISRUPTIVE TECHNOLOGIES RISK MANAGEMENT

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Abstract. Advanced technologies and related business models that disrupt the existing market structure weaken the position of certain professional and social groups at the expense of others, thereby posing significant threats to the efficient operation of businesses. The disruptiveness of technology results in turbulent and chaotic processes in the environment with strong dynamics, rapid changes, increased uncertainty and unpredictability, increased complexity of systems, shorter decision times. Following the 4-dimensional framework of technological and market aspects of disruptive technologies, which evaluates the disruptive potential of technologies, considering the level of novelty addressed in the formulation and solution of a technical problem and the market demand structure with the existing information asymmetry on it, the current paper aims at proposing a model of risk management to assess the risks associated with the development and deployment of disruptive technologies, which in the face of continuous technological change is a must for any economic activity aimed at creating value and competitive advantage.

Keywords: disruptive technologies; evaluation of disruptive potential; risk management; disruption as a risk factor

Introduction

Conducting comprehensive and multidimensional analyses in business organisations in the light of identifying specific threats and vulnerabilities to them is necessary primarily because of the need to manage risk. It is primarily concerned with the mitigation of the various existing and potential risks in the different areas of the companies' operations. In practice, several types of risks emerge as the main ones, namely: strategic risks related to the achievement of the organisations' strategic objectives; operational risks related to the execution of operational processes and activities; economic risks resulting from economic processes; technological risks from the use of outdated and inadequate technologies; the various legal (regulatory) risks underlying legislation at national or community (e.g. EU) level, financial risks caused by insufficient funding or by inefficient, ineffective and uneconomic use of

allocated funds; the management risks caused by failures in the management of the system and of the entities that make it up (incompetence of management and staff), and last but not least the various contractual or 'partnership' risks (e.g. awarding contracts to contractors who are not capable of carrying them out, breaches by failing to include clauses providing guarantees or other indemnities, etc.) (Ministry of Finance of the Republic of Bulgaria 2008)

Of course, political risks should not be overlooked, which in an unstable environment can have a disproportionately high impact on the functioning and development of business organisations. The results of the wars in Ukraine and the Middle East are indicative enough of this fact. In parallel, technological risks come to the fore as key to the success of any organisation.

All these changes require special attention to practical risk management in organisations. And especially in the context of the disruptiveness that advanced technologies and related business models bring.

Advanced technologies and related business models that disrupt the existing market structure weaken the position of certain professional and social groups at the expense of others, thereby posing significant threats to the efficient operation of businesses. The disruptiveness of technology results in turbulent and chaotic processes in the environment with strong dynamics, rapid changes, increased uncertainty and unpredictability, increased complexity of systems, shorter decision times.

Following the 4-dimensional framework of technological and market aspects of disruptive technologies (Molhova 2024), which evaluates the disruptive potential of technologies, considering the level of novelty addressed in the formulation and solution of a technical problem and the market demand structure with the existing information asymmetry on it, the current paper aims at proposing a model of risk management to assess the risks associated with the development and deployment of disruptive technologies, which in the face of continuous technological change is a must for any economic activity aimed at creating value and competitive advantage.

This paper focuses on presenting the developed adaptive risk management model, based on special management system for preventive action against potential organizational crises caused by disruptive technologies.

1. Methodology of the research

This article is the result of an ongoing exploratory study seeking to explain an under-recognized phenomenon – the risks that disruptive technologies bring to the functioning and development of business organizations. The presented research relies on qualitative methods of data collection, designed for contextualization, interpretation and understanding of the perspectives of the studied phenomenon.

The research design phase is based on four main processes: (1) a deductive analytical process defined by the nature of the structural analysis methodology

employed, (2) an inductive analytical process defined by the data gathering process and activities of the system in focus (3) a process of theory matching defined by the abductive reasoning method and (4) an inductive operationalization process defined to maximize internal validity of the study and following a logical sequence constructed by supporting the final output, structured as a response to the stated aim and focus of the study.

Regarding the conceptual methodological model, the approach is based on research that aims at examining the different components of a system to recognize the links between them and determine the value of each of them. The application of this method allows combining a wide range of theories into a relational model. This relational model is put on discussion and on its basis the next stages of the research are continued.

The research question posed in this paper is how disruptive technologies influence companies' models of risk management and if they effectively can deal with the risks posed by the market entry of disruptive technologies on the one hand and on the other what the risks for companies, which have chosen the path of disruptive innovation and leadership, are.

The research hypothesis of this paper is that effective management of risks in a business organization caused by disruptive technologies/or appearing from changing the innovation model of the company into a disruptive one, is possible when an integrated model of organizational risk management is applied, which takes into consideration the specific nature of disruptiveness. A key element of this model is the organisational risk management system. Disruptive technologies and the risks they create should be given special attention by the management of any enterprise wishing to achieve long-term success

2. Influence of disruptive technologies on risk management in the company

Zafirova (2014, p. 391) shows that the management process in organizations and in particular some of its functions are based on probable events, forecasts and assumptions about the external environment and internal resources. Based on them, strategies and plans for their future development are created, making no provisions for unexpected events of a random nature, which, however, invariably accompany them. The question of the nature and management of risk is not a new topic in science and practice, and it is well developed. From Crockford (1976, 1980, 1982) through Reason (1997), Clarke and Varma (1999), Meulbroek (2002), Shenkir and Walker (2006), Walker (2013) till Slatinski (2019) and Ivanov & Biolcheva (2024) has a sufficient theoretical basis for research.

The practice is familiar with many risk assessment tools and methods, each with its advantages and disadvantages. They have the reputation of being able to deal with any risks. The CRAMM method – A Qualitative Risk Analysis and Management Tool or GAR model, each has its specific place and value in the risk management

process. However, not all of them have the capacity to deal with the problem for organisations caused by the disruptive nature of some of today's technologies. It is imperative that the risk management approaches and models applied specifically address the negative impact of disruptive technologies.

In view of current developments in the world, disruption will undoubtedly come to the fore as a key factor in the functioning and development of any business organisation. Accurately distinguishing the risks from disruptive technologies is relevant to businesspeople, investors, and policymakers. Risks of ignoring or underestimating disruptive technologies might be summarized as follows (based on the research of, Coccia and Watts 2020, Coccia 2023, Starbuck and Hedberg 2001, Danneels and Vestal 2018, Ruijters & Stoelinga 2014, Edmondson 2011, Eggers 2012, Faster Capital 2024):

– Overlooked growth opportunities: neglecting disruptive innovation will make an organization miss opportunities for growth and profitability since such organizations cannot capitalize on emerging market trends.

– Competitive disadvantage: overlooking disruptive innovations may place organizations at a considerable competitive disadvantage, as they may find it hard to maintain parity with rivals who adopt those emerging technologies.

– Loss of relevance: neglecting disruptive innovations may lead to a loss of relevance and decreased customer satisfaction because an organization may fail to react to evolving customer needs and expectations.

– Unpredictable disruption: these disruptive innovations can come from very unexpected sources like startups or smaller companies. It is a big risk to overlook such disruptor ideas since big companies might get caught off guard and find it hard to compete.

– Sustained viability: the inability to adjust to disruptive innovations may threaten a firm's long-term sustainability. Industries and technological advancements progress swiftly, and organizations that resist adaptation risk obsolescence.

As a first step in assessing the influence of disruptive technology on risk management models we need to understand how to define the disruptive potential of a technology. Daneels (2004, p. 249) offers his own definition based on the recommendations of Christensen and other researchers: “A disruptive technology is a technology that changes the bases of competition by changing the performance metrics along which firms compete…because they introduce a dimension of performance along which products did not compete previously”. Disruptive technologies might be defined from a market perspective, where a period of trial and error is required so that the uses of technology and market challenge to existing business models and competitive patterns are confirmed, but this should not be the only viewpoint in the framework of disruptiveness. Disruptive technologies need to be defined from a technological perspective as well, where radicalness, degree of novelty, degree of inventiveness (creativity) are important factors in the process

of redefining needs, creating awareness about the specific problem for stakeholders and building trust that this problem can be overcome.

For the reasons above, a 3-dimensional framework of technological and market aspects of disruptive technologies is proposed. The proposed 3-dimensional framework of technological and market aspects of disruptive technologies includes 3 main aspects of disruptiveness potential evaluation: namely novelty of the technical problem solved by the technology, information asymmetry on the specific technology market and consumers' needs definition/predefinition (novelty of consumer needs definition) (see Fig. 1)

Building a model to measure disruptive potential is complex since many of its variables are qualitative by nature. Still, with the suggested framework, we can set the following variables:

– ***Novelty of the technical problem being solved (N):*** It would determine how much of a new problem is solved or how unique it is that the technology is addressing.

– ***Information Asymmetry on the specific technology market (I)***: It has to do with how unbalanced the information is between participants in the market.

– ***Extent to which the technology predefines or defines new consumer needs (C)***: This captures the degree of matching or new development of consumer needs by the technology.

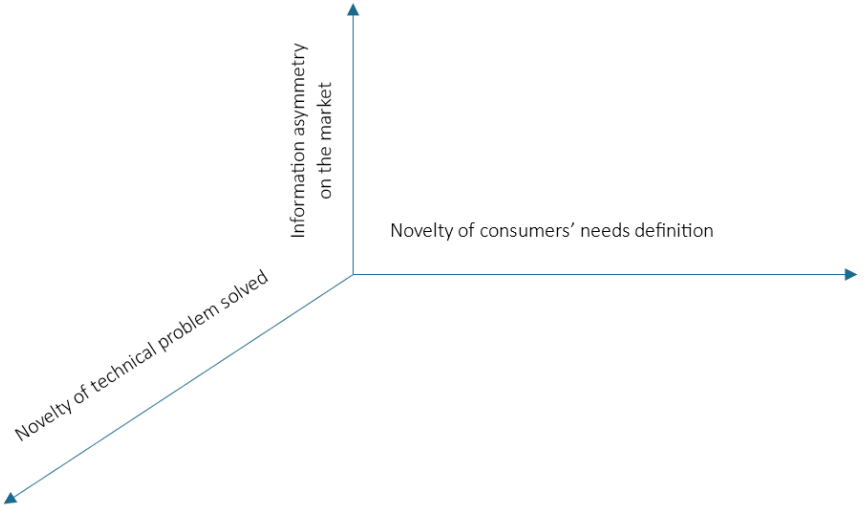

Figure 1. 3-Dimensional framework of technological and market aspects of disruptive technologies

Source: Molhova-Vladova 2024

Variables Weight

Since these variables will have different impacts on the disruptive potential, we need to weigh them. Let the weights be:

– ***Wn***: Weight of Novelty

– ***Wi***: Weight of Information Asymmetry

– ***Wc***: Weight of consumer needs

Developing the model: Disruptive Potential (DP)* = Wn×N + Wi×I + Wc×C

Additional Considerations in the model:

– Scaling: The variables should be on comparable scaling to avoid bias.

– Normalization: The variables should be normalized on a common scale, say 0-1, for easy comparison.

– Other Factors: Other factors one may use to measure disruptive potential include market size, competitive landscape, regulatory environment, and technological feasibility. All these extra factors can always be added to the model either by new variables or manipulation of weights among existing variables.

Based on this 3D framework of assessment of disruptive potential we can add these parameters as factors of the external (e.g. information asymmetry on the market) and internal environment of the company (e.g. novelty of technical problem solved and novelty of consumers' needs definition), which need to be regarded in the risk management process.

In developing a system for managing the risks from disruptive technologies, we build on the principal scheme presented in Figure 2, as well as on the 8-step model for risk-minimizing behaviour "METAPHOR". The model of risk management process as in Zafirova (2014, p. 403), and the 8-step model proposed by Slatinski (2010) are combined to build the understanding that risk management is gradually emerging as a key activity in efforts to qualitatively different management of companies, especially in the complex, high uncertainty fraught difficult predictability, significant dynamics and large-scale challenges global, regional, national and local environment. Integrating the two models under consideration creates an opportunity to effectively manage disruptive risks in the organization. Whenever any activity is undertaken in the organization – whether it is aimed at producing value, or creating competitive advantage, or is radical re-engineering, or aims at the implementation of a project, or is faced with the need to devise and optimize a strategy – an analysis must be made of everything involved:

M – Money (i.e. the finances involved).

E – The environment (in which the activity is taking place).

* This formula assumes a linear relationship between the variables and disruptive potential. Future research will explore non-linear relationships between variables.

T – The technology (that is being applied).
A – The aims (that are being pursued).
P – The people (who are engaged).
H – The hazards (that may arise).
O – The opponents (who may be interested in our failure).
R – The regulations (i.e., the legal documents that must be followed).

Following is the Eight Steps of the METAPHOR Model presented:

Step "**M**" (Step 1) – Money.

E.g. – what will be spent; where will it be spent; what will it be spent on; who will be paid, by whom or to whom will it be borrowed; who will lend to us or whom will we lend to; where can we expect financial damage, failure, overspending, pitfalls, diversions, non-repayment; efficiency of use of funds (achievement of objectives) and effectiveness of use (ratio of objectives achieved: funds invested) etc.

Step "**E"** (Step 2) – Environment.

E.g. – depending on the activity – international environment (global, European, regional, national); external environment; internal environment; political, economic, social, market environmental environment; weather forecasts (if necessary), etc.

Step "**T**" (Step 3) – Technologies.

E.g. – information, management, engineering; equipment, outfits, aids; information processing and protection; personal protection equipment; vehicles, etc.

Step "**A**" (Step 4) – Aims.

E.g. – what we are aiming for; what tasks we are setting; what we want to influence; what impression we want to produce; image; authority; production tasks; increasing value, investment attractiveness, security etc.

Step "**P**" (Step 5) – People.

E.g. – human resources; specialists; outside experts; security; agents of influence, lobby, pressure groups, etc.

Step "**H**" (Step 6) – Hazards.

E.g. – sudden, unforeseen events; natural phenomena; accidents, mishaps, disasters, accidents, catastrophes; "dropped from the sky"; "lurking around the corner"; "narrowly escaped", "about to hit us", "a hair's breadth away", etc.

Step "**O**" (Step 7) – Opponents.

E.g. – competitors; adversaries; enemies; malcontents; slanderers and rumor mongers; saboteurs; "spies"; infiltrators, etc.

Step "**R**" (Step 8) – Regulations.

E.g. – laws, regulations, ordinances, by-laws; standards; internal regulations; Quality Management System; Environmental Management System; safe working conditions, etc. (Slatinski 2010).

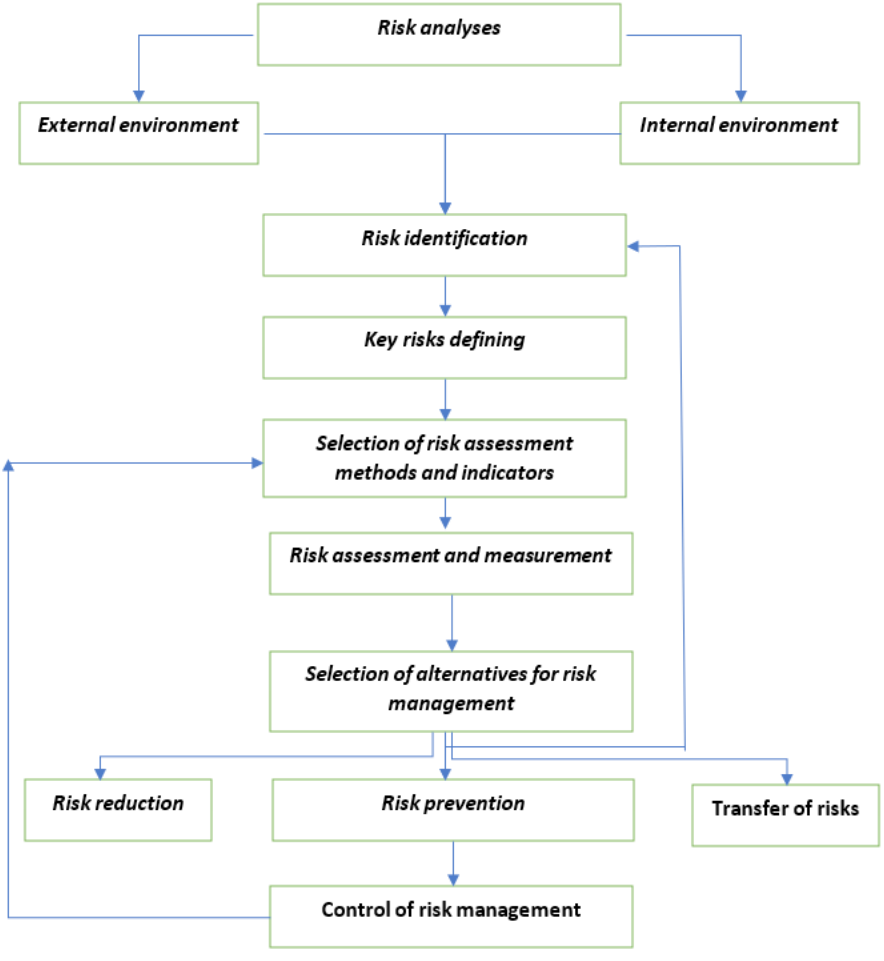

Figure 2. Risk management process in the organisation,
Source: Zafirova 2014, p. 403

3. Disruptive Technologies Risk Management

The METAPHOR model can also be adapted to assess the risk of disruptive technologies entering the market. Here is an illustration how the different components of the model can be applied in this context:

Finance (Money)

1. What are the financial investments required to develop and introduce disruptive technology?

2. How long will it take to recoup the investments?
3. What are the potential losses if the technology fails?
4. Are there sufficient financial resources to address unexpected challenges?
5. How will the long-term development of technology be financed?

Environment (Environment)

6. What is the regulatory environment for this type of technology?
7. What are the social and ethical implications of introducing technology?
8. What has been the market reaction to similar technologies in the past?
9. What is the level of information asymmetry on the market?
10. What are the geopolitical risks associated with technology?
11. What are the environmental impacts of developing and using the technology?

Technologies (Technologies)

11. How novel is the technical problem defined and solved by the technology?
12. How mature is technology and how fast is it developing?
13. How compatible is technology with existing systems and processes?
14. What are the potential technical problems and how can they be overcome?
15. Is there enough research and development in the field of technology?

Aims (Aims)

16. What is the main goal of introducing disruptive technology?
17. What is the strategic importance of technology for the company?
18. How will the success of technology be measured?
19. What are the long-term goals for the development of the technology?
20. How will the technology contribute to the company's competitive advantage?

People (People)

21. Are there enough technical personnel to support and develop the technology?
22. Are there enough qualified specialists to work with the technology?
23. What is the organization's cultural readiness to adopt the new technology?
24. How will employee training be carried out?
25. What are the motivational factors for employees related to the new technology?
26. How will the changes associated with the introduction of technology be managed?
27. How novel is the definition (is there a significant predefinition) of consumers' needs?

Hazards (Hazards)

26. What are the potential technical problems that may arise?
27. What are the cybersecurity risks associated with technology?
28. What are the legal risks associated with patents, copyrights, etc.?
29. What are the reputational risks associated with introducing the technology?
30. What are the ethical dilemmas associated with using technology?

Opponents (Opponents)

31. Who are the main competitors and how can they react to the new technology?
32. Are there regulatory bodies that can hinder the development of technology?
33. Are there social groups that may oppose technology?
34. What are the lobbying groups that can influence the development of technology?

Regulations (Regulations)

35. Does the technology comply with all applicable laws and regulations?
36. Is there a need to change the existing regulatory framework?
37. What are the standards that must be met in the development and use of the technology?

Conclusion

The research on methodological and applied aspects of risk management caused by disruptive technologies in the Bulgarian context is just at its beginning. The traditional risk management models are based primarily on crisis situations that have already occurred. Disruptiveness as a characteristic of some of the technologies shows that there is always a risk of new crisis phenomena and processes, previously unknown. This imposes the difficult task of identifying all possible risks and finding mechanisms to manage them. The identification of possible risks is directly linked to changes in the environment that also lead to organizational crises. For this purpose, it is necessary in each organization to analyse and assess the specific environmental factors, their possible risks and to plan the response to the occurrence of the danger of crisis situations. Risk management is a holistic strategic process. Senior managers need to manage risk to reduce the likelihood of potential losses from crises and to achieve set objectives. Introducing the assessment of specific factors related to disruptiveness (both external and internal for the company) in the risk management process and by systematically analyzing each of these aspects, companies can conduct a more accurate assessment of the risk associated with disruptive technologies entering the market and make better-informed decisions about investments and strategic development.

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