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Review article

Earthquake Risk and Insurance in the Banking System

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Abstract

Although sophisticated instruments for measuring the magnitude of earthquakes and their effects exist today, there are still no devices capable of accurately predicting the place and time of an earthquake. It is well known that, among all natural disasters, earthquakes tend to be the most destructive, deadliest, and cause the greatest material damage. Modern society depends on numerous infrastructures without which everyday functioning would be impossible. Developed countries have defined their critical infrastructure sectors, among which the banking sector is included. There is no doubt that the functioning of society is impossible without the continuity of banking operations in the event of an earthquake. Issues related to risk and insurance, as well as the analysis of the vulnerability of the banking sector of the Republic of Serbia in the event of an earthquake, are examined in this paper.

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Keywords

Banking sector, earthquakes, critical infrastructure, risk management, insurance

1. Introduction

Whilst globally the death rate from natural disasters such as flooding and drought has declined dramatically in the past century, the fatality rates from earthquakes have remained persistent. It is a target of the Sendai Framework for Disaster Risk Reduction to reduce the global disaster mortality rate (along with those affected and economic losses) for this coming decade compared to the past decade (Elliott, 2020).

Earthquakes occur due to major movements of tectonic plates in the lithosphere and are among the few natural disasters that cannot be predicted in advance. Although sophisticated instruments for measuring the magnitude of earthquakes and their effects exist today, there are still no devices capable of predicting in advance the exact place and time of an earthquake. However, it is known that, among all natural disasters, earthquakes tend to be the most destructive and deadliest, causing the greatest material damage (Đorđević, 2018).

In addition, the occurrence of earthquakes leads to numerous secondary negative effects that complicate emergency management and prolong the period required for community recovery. Numerous earthquakes around the world during recent decades have killed thousands, and even hundreds of thousands, of people, as in the case of the Sumatra-Andaman earthquake, which claimed 275,000 lives in 2004. Besides the large number of human casualties, stronger earthquakes usually cause damage measured in billions of dollars and disrupt significant economic and business activities essential for normal life and functioning (Ćerčan, Ristanović, Miljković, 2009).

Today, the normal functioning of modern and organized states is unimaginable and impossible without numerous sectors that provide products and services. These infrastructures are recognized as critical, and each country defines them according to its own priorities. However, in almost all developed countries, critical infrastructure systems include: energy, transportation, water and food supply, healthcare, the financial sector, telecommunications and information technologies, and the functioning of state institutions (Škero, Ateljević, 2015).

The functioning of critical infrastructures and their continuous operation are essential for the normal functioning of society and the performance of

everyday activities within a country. The interruption of any of these sectors would have negative effects on society and the state. The interdependence of critical infrastructures makes them even more vulnerable, which is why their protection is a priority in modern societies. According to the American Cybersecurity and Infrastructure Security Agency (CISA), the protection of infrastructures defined as critical sectors is considered an obligation because it is clear that disruption or malfunction of these sectors, especially in times of crisis, would have significant negative effects both on other critical infrastructures and on the state as a whole (CISA, 2019).

The banking sector is defined as a critical infrastructure system whose functioning is essential for normal life and work. In addition, the banking sector plays a major role in the development and functioning of the overall economy (Golubović, 2016). Today, all business entities operate in a dynamic and uncertain environment, making risk almost inevitable. The banking sector, as part of the financial sector, is primarily exposed to financial risks and therefore invests great efforts in managing this type of risk (Tadić, 2018).

However, the devastating effects of natural disasters around the world have damaged or disabled numerous critical sectors, including financial ones, preventing their further operation. Such a scenario usually leads to disruptions in community recovery, the inability to restore normal functioning, threats to the operation of other sectors, and ultimately endangers national security (Zhang et al., 2021).

In the banking sector, as in other sectors, risk management is carried out based on risk identification and assessment (Matić, 2007). When it comes to earthquake risk management, the process is very complex. Earthquakes cannot be predicted, the damage caused by earthquakes depends not only on their intensity but also on protection measures and resilience, and earthquakes most often cause numerous secondary negative effects. The banking sector, especially institutions located in seismically active areas, should have a detailed natural disaster risk management plan, particularly for earthquakes. This, of course, requires significant efforts, adequate assessments, and control functions. Another form of business protection in the banking sector is earthquake insurance and business interruption insurance. Although these measures cannot prevent earthquakes, they can significantly mitigate their negative effects (Savić, 2019).

2. Earthquakes: Concept and Impact on Critical Infrastructure

Seismic hazards are generally considered among the most terrifying natural forces precisely because they occur suddenly and cause enormous disasters. In just a few minutes, an earthquake can completely alter the landscape, bury existing lakes and create new ones, change entire river courses, and even completely wipe out an entire city (Ćerčan, Ristanović, Miljković, 2009).

In certain regions of the Earth's crust, stronger or weaker tremors, that is, earthquakes, occur very frequently and are usually short-lived. According to the most widely used definition, an earthquake is "any form of ground oscillation caused by natural factors" (Arabadži, Miljeničuk, 1998:19). Earthquakes are actually caused by the movement of tectonic plates, which generates waves capable of traveling enormous distances and manifesting on the Earth's surface. When these waves reach the surface, they can cause incredible destruction. Violent shaking may last for several minutes and often occurs in a series, leading to the destruction of buildings, bridges, and most other critical infrastructure facilities (Cvetković, Milojković, Stojković, 2014).

There is no more terrifying natural disaster than a powerful earthquake. According to statistical data, more than 9,000 earthquakes occur on Earth every year, of which around 115 are strong and about 110 are destructive. This means that, on average, an earthquake occurs somewhere in the world almost every hour. Fortunately, most of them are very weak and can only be detected by seismographs, which are sensitive even to the slightest vibrations of the Earth (Marković, 1956:22).

The modern era has brought an increase in challenges, risks, and threats, making it clear that it is impossible to protect everything at all times. For this reason, it became necessary to determine which infrastructures are critical, that is, of essential importance, and why. It is clear that critical infrastructure refers to those segments that are significant for human and national security. However, the changing perception of threats and the growing interdependence of different infrastructures have caused critical infrastructure to become broader in scope and more complex (Milosavljević, Vučinić, 2021).

Natural threats are most commonly understood as any negative climatic impacts, meteorological, geological, and geographical hazards, or more broadly, natural disasters. For example, the earthquake that struck Kobe, Japan, in 1995, which claimed a large number of lives and was the strongest in magnitude in the previous 1,200 years, caused severe damage to almost all critical infrastructures. Some were completely destroyed, while others became incapable of functioning. The main highway was heavily damaged,

which disabled road transportation, while the main port in Kobe (the largest port for import and export by water transport) was rendered inoperative. The chemical and steel industries suffered major losses and equipment damage, forcing them to suspend operations for a long period. Nuclear power plants within a radius of several hundred kilometers were shut down. Following the earthquake, fires broke out, destroying more than 150,000 buildings, while 300,000 people were left homeless. The economic loss resulting from this earthquake was estimated at 200 billion dollars (Holzer, 1995).

When it comes to the vulnerability of critical infrastructure to natural disasters, the strength or intensity of the event plays a crucial role. In general, high-intensity disasters have enormous potential to cause destructive consequences for people and their material assets, including critical infrastructure. Therefore, the greater the intensity of the disaster, the more likely the negative consequences for critical infrastructure become.

The consequences of natural disasters for critical infrastructure should also be considered from the perspective of the duration of the disaster. For example, a natural disaster may last only a few seconds (such as an earthquake or landslide), several hours or a day (as is often the case with hurricanes), several days (in the case of floods), or even several years (in the case of droughts). Accordingly, in addition to the intensity of the disaster, there is also a correlation between the duration of the disaster and its consequences. This is particularly devastating for older and already damaged infrastructures, which are unable to withstand negative impacts for extended periods of time (Cvetković, 2014).

3. Banking System – role and function

Banks play a leading role in providing all types of financial services. The banking industry consists of thousands of private institutions, as well as state-owned institutions, and it has the greatest influence on the development of all other economic activities (Rose & Hudgins, 2005). The central bank is a state institution, or it operates under the supervision and influence of the state. It is responsible for the stability of the national currency, financial discipline, the control and regulation of money circulation, as well as the liquidity of the banking system, both domestically and in relation to foreign countries (Milojević, 2003).

3.1. Importance of the Banking System for the National Economy

The financial system plays a key role in resource allocation and holds a special place in the modern market economy. From an institutional perspective, the financial system includes financial organizations, primarily banks and non-bank financial intermediaries, which, by acting as financial intermediaries between economically surplus and deficit entities, collect and allocate financial resources. The existence of the financial system enables the creation of appropriate instruments and mechanisms for holding and safeguarding assets of entities and for organizing efficient payment transactions. By performing these functions, financial institutions influence the level of economic activity, lead to changes in the economic structure, contribute to increased employment, and so on (Golubović, 2016).

The importance of payment systems is manifested through their extremely significant role in every market economy. Payment systems are primarily seen as a vital component of the financial infrastructure of the economy, an essential channel for the successful management of the economy, particularly through monetary policy, and they are also important as a means of improving its efficiency (Rose, Hudgins, 2005).

The payment system affects the amount of money required. If the payment system in a country is inefficient and slow, this leads to an increase in demand for money, meaning that a larger amount of money is needed to carry out payments normally. The payment system also has a significant impact on a country's financial stability. If disruptions occur in the functioning of the payment system, this would cause a breakdown in the settlement of obligations among participants in the payment system (Sredojević et al., 2018).

4. Earthquake risk and banking system insurance

Today, all business entities operate in a highly dynamic economic system, which means that risk is always present and unavoidable. From a financial perspective, particularly in financial institutions, risk always represents the possibility of loss. Market changes, developments in banking and politics, as well as the global economic crisis that severely affected the banking sector in 2008, have led to increased attention on the impact of risk and ways to properly manage risks in the banking sector (Tadić, 2018).

Risk is the possibility of an adverse event occurring. It is understood as any possibility within a specific system that, with a certain probability, can cause an unexpected change in quality, or lead to a change or loss of the system. In this sense, it is necessary to undertake appropriate measures and

actions aimed at adequate risk management, including: preventive action, risk neutralization, reduction of negative effects of risk, transfer, and acceptance of risk depending on its form, duration, and intensity of manifestation (Keković et al., 2011).

In modern conditions of global business, banks face numerous risks that threaten individual banking operations, as well as the functioning of the entire banking system in cases of large-scale extraordinary events. Risks most commonly considered in the banking sector refer to the possibility of capital loss or loss in business performance, as well as a reduction in the bank's ability to achieve its goals and strengthen its business and financial position. Important determinants of risk are that it is possible, causes material damage, and is uncertain and random. Accordingly, two main groups of risks to which banks are exposed are distinguished (Matić, 2007):

- financial risks related to the bank's role as a financial intermediary (primarily liquidity risk, as well as credit risk, market risk, and interest rate risk);
- non-financial risks, which are not specific only to financial institutions and are the result of inadequate procedures, the human factor, as well as external factors.

Due to the potential losses that both types of risks may cause, the banking sector in every country must calculate and allocate the required capital as an optimal defense relative to aggregate exposure. In this regard, in addition to risk identification, monitoring, and control, exposure analysis is also very important. In other words, without measurement there is no adequate risk management (Matić, 2007).

It is therefore of crucial importance for the banking sector to investigate all risks arising from the environment as well as from its own operations, in order to determine the level of risk it can bear and control, and thus keep it within realistically acceptable limits. For this reason, bank management must identify, assess, and control risks. Preventing and eliminating high risks that may cause losses in the bank or lead to operational disruptions is one of the priorities of banking management. In other words, in order for a bank to successfully defend itself from challenges, risks, and threats, it must develop various defensive strategies (Jovanović, 2018).

For the successful functioning of society today, the operation of the financial system is essential. The financial system is considered a critical infrastructure system, and its interdependence with other critical infrastructures creates the need to establish adequate protection. Today, more than ever, a dynamic, proactive, and strategic approach is required in planning the pro-

tection of critical infrastructure in conditions of various types of crisis and emergency situations (Škero, Ateljević, 2015).

By maintaining its operational capacity, i.e., by ensuring normal functioning, the banking sector enables the functioning of the entire financial system in a country, thereby influencing economic growth. The United States experienced, albeit temporarily, the effects and consequences of the collapse and disruption of the banking sector in its daily financial system functioning when, on September 11, 2001, a tragedy struck the nation's leading financial center, New York. The destruction of the World Trade Center temporarily shut down all major financial operations of several leading banks and securities companies, creating uncertainty among thousands of investors regarding the time needed to recover their investments. This had a direct negative effect on economic activity, and a shortage of money circulation was felt in almost every sector (Rose, Hudgins, 2005).

For successful functioning, the banking sector must, among other things, manage various risks to which it is exposed. Traditionally, banks have focused mostly on financial risks (Matić, 2007). However, increasingly frequent natural disasters that disable numerous sectors introduce much more complex questions regarding risk management. Of all natural disasters, earthquakes have the potential to be the most destructive, both in terms of loss of life and material damage (Savić, 2019).

Natural disasters affect financial sector activities in various ways. They directly threaten or completely interrupt operations due to loss of life and destruction of facilities and equipment, and indirectly through their impact on transactions. After the catastrophic earthquake of March 11, 2011, with a magnitude of 9.0 on the Richter scale, almost all households, businesses, and companies in the Tohoku region of Japan experienced some form of material damage. A study conducted in Japan in 2012, one year after the catastrophic earthquake in the Tohoku region, showed that after the earthquake, companies primarily sought bank loans or requested the withdrawal of deposited funds in order to repair the damage they had suffered. The study confirmed that about 65% of companies in the Tohoku region suffered direct damage from the earthquake, while 35% suffered indirect damage because their suppliers, partners, or clients were affected. A large number of these companies stated that, after the earthquake, banks were their most important source of financing in order to resume normal operations as quickly as possible. Many companies submitted loan applications, and some requested the withdrawal of their deposits from their main banks. However, the banking sector did not have the capacity to finance a large number of clients, as it also suffered significant losses. Due to these financial constraints, companies were unable to resume normal operations within an optimal timeframe, investment financ-

ing declined, and export volumes decreased significantly. The economic consequences were felt throughout almost the entire country (Miyakawa, 2014).

4.1. Possibility of earthquake insurance in the banking sector

According to the broadest definition: "insurance is an institution, i.e. an insurance company, that compensates damage to economic entities and individuals caused by the action of destructive natural forces or accidents" (Stojanović, Krstić, Janjić-Baduli, 2016:143). It is therefore a matter of risk transfer, i.e. potential loss, from the insured to the insurer, and the agreement itself is defined by an insurance contract. In this way, individuals, companies, and organizations transfer certain risks to an insurance company by paying an insurance premium. In the event of an insured event occurring, the insurance company pays the insured sum to the insured party (Taylor, 2012).

Today, insurance is a highly developed service activity that protects individuals, economic entities, and their property from the consequences and effects of numerous risks. The main function of insurance is security, that is, the creation of a situation of safety for both natural and legal persons exposed to certain types of danger that may cause damage. Insurance is, in this sense, a form of protection, and today it can also be considered an economic necessity for anyone concerned with safety in both business and everyday life and work (Stojanović, Krstić, Janjić-Baduli, 2016).

In western economies, insurance is the primary method of mitigating possible financial losses caused by unwanted events. In most cases, insurance does not directly reduce the causes themselves, as, for example, flood prevention plans do. Its role is to compensate the insured for financial damage once the negative effects of the insured risk have occurred. Risks of natural disasters cause tens of thousands of victims annually and damage measured in tens of billions of dollars each year. Insurance against natural disasters has been available for many years, and the first insurance payouts related to natural disaster risk were made in 1906 after the San Francisco earthquake. At that time, the insurance company "Lloyd's," based in the United Kingdom and also the first established insurance company, was ordered to pay the full amount of damages to all insured parties. The San Francisco earthquake claimed 3,000 lives and caused multimillion-dollar damage and is still considered one of the deadliest natural disasters to have struck California. This payment of insured sums created long-term trust in the insurance market and insurance companies as providers of catastrophe coverage (Taylor, 2012).

Earthquakes, as natural disasters, have the potential to cause enormous losses. Infrastructure worldwide is vulnerable to collapse or damage in the event of seismic activity, resulting in human casualties and major economic losses. Numerous studies and experience have clearly shown that building collapse is the main cause of deaths and injuries, as well as the primary driver of economic damage. As early as the beginning of the 20th century, more developed countries began designing earthquake-resistant structures. However, most residential and commercial buildings were constructed before seismic design standards were introduced, and in many less developed countries construction is still carried out without adequate seismic assessment (Zhang et al., 2021).

In the banking sector, besides financial risks to which it is most exposed and which it primarily insures against, it also recognizes pure risk and cumulative risk. In banking operations, pure risk refers to uncertainty and consequences of unforeseen and independent harmful events (such as destruction of buildings or property due to natural forces like floods, earthquakes, etc.). Cumulative risk (risk accumulation or catastrophic risk) refers to the accumulation of losses caused by a single unwanted event such as an earthquake, flood, storm, etc. (Stojanović, Krstić, Janjić-Baduli, 2016).

Insurance against natural disasters may cover a single peril (one type of natural disaster) or multiple perils. Such insurance is usually concluded as additional coverage. In other words, in addition to other types of property insurance, the insured also concludes a contract for protection against specific natural disasters as supplementary insurance. Through such "insurance packages," insurers aim to avoid adverse risk selection, and only clients located in high-risk areas would purchase insurance. Insurance against natural disasters may be voluntary or mandatory. Voluntary insurance is chosen by those aware of risks and their consequences. Legal entities that properly manage risks should include such insurance in their risk management strategies. Mandatory insurance, on the other hand, is prescribed by law and aims to reduce pressure on the state budget after disasters (Doganjić, Paunović, 2021:47).

In China, authorities have raised the issue of mandatory earthquake insurance in the banking sector. Earthquakes frequently occur across China and can cause severe material damage. Banks and other enterprises are exposed to significant losses in such events. Risks in the banking sector include damage to assets and the risk of business interruption and credit risk. The Chinese government has recognized that banks lack adequate tools for managing catastrophic risks such as major earthquakes. Therefore, mandatory earthquake insurance has been identified as a potential protective mechanism for risk management in the banking sector (Xing, 2018).

In addition to natural disaster insurance, business interruption insurance is also an important form of protection in the banking sector. Emergency events can disrupt organizational functioning at any time, and organizations must be able to respond and resume operations as quickly as possible (Stojanović, Krstić, Janjić-Baduli, 2016). Business interruption insurance aims to cover losses when an insured event occurs (such as fire, infrastructure failure, or natural disasters like floods and earthquakes). Damage to property and equipment affects not only assets but the entire functioning of a legal entity. After major events such as earthquakes, fires, or pandemics, the issue arises of how to maintain business continuity. Business interruption leads to temporary cessation of operations, while costs remain but revenue stops. This can result in greater losses than the physical damage itself. Such insurance compensates for lost profit and fixed operating costs during the interruption period (Belanić, Baretić, 2021).

5. Vulnerability of the banking sector of the Republic of Serbia to earthquakes

In developing countries, such as Serbia, governmental organizations and a large part of critical infrastructure are most often located in large cities, which are usually also the most densely populated. In this sense, major damage to critical infrastructure systems in such cities would have a significant negative impact at the national level. For this reason, it is necessary to set priorities for protection and recovery (in the event of risk occurrence). It is important to define the difference between the vulnerability of critical infrastructure and the vulnerability of its individual parts (sectors). In this context, earthquake protection measures and adequate risk management are of crucial importance, because infrastructure with minimal to moderate earthquake damage may continue to function or, in the worst case, suspend the operation of certain parts for a short period. On the other hand, critical infrastructure with severe damage will not only be unable to function but will also endanger the operation of other critical infrastructure sectors whose functioning is essential, especially in emergency situations such as earthquakes (Manić, Lukić, Prokić, 2013).

It is well known that the functioning of the economy today cannot be imagined without banks and other financial institutions. Banks, as intermediaries in financial transactions, issue various financial instruments that are further allocated into appropriate investments. In this way, banks influence the level of economic activity, employment levels, and overall economic stability (Golubović, 2016). In the Republic of Serbia, financial and

banking systems are recognized as critical infrastructure, whose disruption or interruption would have negative effects on the functioning of the state. The interdependence of critical infrastructures is even more pronounced in smaller countries and transition economies. The functioning of such sectors becomes even more important in emergency situations. Issues of protecting such systems from operational disruptions are a priority in natural disaster risk management (Škero, Ateljević, 2015).

In the Republic of Serbia, a legal entity develops its own risk management plan after identifying and assessing the risks to which it is exposed. Insurance against natural disasters for legal entities in Serbia is still voluntary. The majority of banks manage risks by taking into account the characteristics of the specific environment in which they operate (political, economic, geographical factors, climate conditions, population, etc.).

Although Serbia is not considered a highly seismic area, meaning that large-scale seismic hazards are not expected, the risk is still present. Many risks cannot be prevented, but through adequate management and protection measures, their consequences can be minimized. Recent history shows that natural disasters such as earthquakes, storms, and floods frequently occur even in areas that are not considered high-risk (Radovanović, 2018).

6. Conclusion

In developed economies, the banking sector is defined as critical infrastructure. Alongside energy, transport, healthcare, food production and distribution, and water supply, the banking sector is essential for the normal functioning of society. The disruption of any of these sectors would endanger the operation of others and produce significant negative effects on the functioning of society, ultimately manifesting as a threat to national security (Škero, Ateljević, 2015).

A large number of natural disasters worldwide, as well as their negative effects, have demonstrated the importance of critical infrastructure, i.e. the extent of additional consequences that their damage or destruction can cause. Since critical infrastructure systems are necessary in almost all countries for normal functioning, and their importance increases even further in times of crisis, the protection of these sectors is imposed as an obligation in all states.The banking sector holds a special place in national economies, and its functioning is not possible without banks as financial intermediaries. For this reason, banking operations must be protected from all forms of threats, both external and internal (Rose, Hudgins, 2005).

War has long ceased to be the dominant security threat, and its place has been taken by natural disasters, terrorist attacks, pandemics, and cyberattacks. All these new types of risks undermine security and threaten citizens, economic entities, the state, and even entire regions. In recent decades, natural disasters have taken a particularly important place among security threats. Earthquakes, among all natural disasters, cause the highest number of fatalities and the greatest material damage (Đorđević, 2018).

Numerous devastating earthquakes around the world have caused the deaths of a large number of people, inflicted enormous material damage, disabled critical sectors, and in some cases led to consequences from which communities have been recovering for years. Earthquake risks are ubiquitous, even in countries that are not considered highly seismic regions. Given the impossibility of predicting them, great emphasis is placed on adequate earthquake risk management. Numerous experiences following natural disasters, including earthquakes, have shown that recovery and the restoration of normal functioning in all sectors depend on previously implemented protective measures. In order to minimize the consequences of earthquakes and reduce their impact on business continuity, economic entities must manage earthquake risks.

In the banking sector, this primarily involves risk identification and assessment, followed by the adoption of plans and strategies. Above all, risk understanding is necessary. The banking sector, especially in seismically active areas, should consider earthquake risks as primary risks, immediately after financial risks. In earthquake risk management, it must be taken into account that such events cannot be predicted, meaning there is no optimal time for preparation before the occurrence of an unwanted event. For this reason, it is crucial to establish the most effective course of action during the occurrence of an earthquake (Đorđević, 2018).

Protective measures play a significant role. Most buildings in almost all countries were designed before seismic resistance standards were introduced. Today, older buildings can be reinforced using special seismic insulation and similar techniques, while new buildings must be designed in accordance with standards appropriate to their seismic zone.

The banking sector must also take into account that, after the occurrence of negative effects of earthquakes, the majority of enterprises, companies, and individuals turn to banks for assistance in the form of credit and similar financial support. The normal functioning of the banking sector during and after a disaster is of great importance for the re-establishment of normal economic activity (Stojanović, Krstić, Janjić-Baduli, 2016).

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