INTEGRATING STORM COVERAGE IN THE MANAGEMENT OF HOUSEHOLDING INSURANCE IN ROMANIA

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ABSTRACT

This study relies on the information regarding the predictable evolution of a natural phenomenon, i.e., the storm, in the context of the climate changes we are witnessing. This evolution triggers the need for a new approach with regards to the insurance coverage against this risk in Romania. The main challenge in shifting perspective on the coverage of this risk resides in the fact that no suitable database that can be used for storm modeling purposes in insurance has been built so far. The authors advocate the opportunity of including the storm risk among the risks covered by the mandatory householding insurance in Romania. To this end, a model has been built, in keeping with the solvency II framework that the European Insurance and Occupational Pensions Authority (EIOPA) has already applied in certain states in the same geographical area. The model allows for the estimation of the probable maximum loss (PML) for the mandatory homeowners' insurance portfolio of the company managing this type of insurance in Romania, but also for the entire housing stock.

Keywords: *natural disasters, risk management, probable maximum loss (PML), Romanian insurance protection, storm.*

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1. INTRODUCTION

The purpose of this paper is to allow the stakeholders to anticipate the impact of potential natural disasters of the type of future storms over the residential system in Romania, before they occur, so that they are prepared to take realistic measures. Particularly, considering the proposal to include this risk in the mandatory householding insurance policy, this study could also be used for the estimation of the capital requirements of the company managing the mandatory insurance system to provide coverage against this risk.

In writing this paper, the author has set a number of premises, such as: the estimation of the storm risk weighted factors corresponding to the CRESTA (Catastrophe Risk Evaluation and Standardizing Target Accumulations) zones for Romania, the estimation of the storm risk factor for Romania, with features similar to those of a member state neighboring Romania for which the storm indicators have been assessed, and, last, but not least, the storm risk-related climate trends observed both in Europe, and in Romania, discussed in detail in this scientific paper.

2. SOLUTIONS FOR NAT CAT MANAGEMENT RISK IN ROMANIA

Natural disasters, such as earthquakes, floods and landslides, have a devastating effect in Romania. The World Bank has taken the initiative of conducting a study focusing on the three high impact risks for Romania and developed a regulatory framework for the mandatory homeowners' insurance.

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This, in 2008, the Government of Romania translated the results of the study conducted by the World Bank in a special law on the mandatory homeowners' insurance, which also provided for the establishment of the company managing the mandatory householding insurance system in Romania, *i.e.*, the Insurance Pool against Natural Disasters – PAID S.A. This system provides insurance coverage for the residential stock in Romania, against three high impact natural risks: earthquake, floods and landslides. Twelve years after its establishment, it can safely be stated that it is (and will continue to be) a success story, as the company can finance and pay natural disaster-related indemnities.

Considering the relatively high frequency of natural disasters on the territory of Romania, as well as the citizens' need to protect their assets, the mandatory property insurance is a must for each homeowner, contributing, in time, to the education of the population towards the large-scale use of insurance products.

An issue of utmost importance that concerns the management of this company is the relatively low rate of insurance coverage of the housing stock in Romania, which is now situated at approximatelly 20%. This article aims to investigate the possibility of improving this *status quo* by broadening the policy coverage with multiple risks, so as to increase the interest of the homeowners for this product. The authors explore the potentiality that the risk associated with the weather phenomena included under the generic name of storm to be added above the already existing risks that are covered by mandatory policy. This working hypothesis is considered reasonable having the specificity of this insurance company correlated with the new status of Romania's exposure due to latest development of climate change.

However, the decision of underwriting a new risk in this policy depends on the level of the maximum possible loss associated with the corresponding risk. In this particular case, the main difficulty lies in the lack of databases at the national level, that could allow a more granular assessment of the frequency and intensity of the storm risk occurrence. Therefore, the only feasible and reliable data resources come from the scientific works elaborated by professionals in meteorology and hydrology, but also from pertinent reports registering these extreme phenomena during time. Using these resources could lead also to develop a "country profile" to be compared with one of the EU Member states models already considered by Insurance and Occupational Pensions Supervisory Authority (EIOPA) within the storm solvency capital requirement.

In estimating the claims specific to these high-impact risks, the company managing the mandatory insurance system and the other Romanian underwriters rely on models developed by globally renowned modeling companies, *i.e.*, RMS (Risk Management Solution, Inc.), AIR (Applied Insurance Research) and IF Elements (Impact Forecasting Elements).

At the same time, Romania is as impacted as any other country by the global climate change. The idea that storms are going to represent a new high impact natural risk for Romania is validate by both reality, and scientific forecasts. Hence, an even greater need arises for the modeling of the storm as a natural disaster event, so as to assess the way in which it can be added to the insurance policy. The model presented in this paper relies on the probabilistic method to estimate the capital requirements under the Solvency II regulatory framework applicable in Europe, as transposed through the Commission Delegated Regulation (EU) 2015/35.)

3. PAST AND PRESENT CLIMATE VARIABILITY IN ROMANIA

A wealth of studies has been published in recent years on climate changes triggered by global warming and on their economic effects.

The impact of climate change lead to the establishment of the Intergovernmental Panel on Climate Change (IPCC) by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), in 1988. The role of IPCC is to objectively and transparently review the relevant scientific, technical, social and economic information, so as to allow for an understanding

of the scientific bases of the human-triggered climate change risks, of the possible effects caused by the climate change and for the identification of strategies to adapt and mitigate these effects.

The ESPON "Inspire policy making by territorial evidence" published in 2012, on the assessment of climate changes in Europe, has provided specific results for the area, including indicators for a climate change responsive European policy. The key conclusion reveals the fact that climate changes are detrimental to territorial cohesion and that, at the same time, they intensify the social and economic unbalances between Central and Southern and South-Eastern European regions, the latter being regarded as the most vulnerable ones to climate changes. The enhancement of territorial cohesion will require the development of customized adaptation strategies for the various regions and the capitalization of the new opportunities brought by the climate change.

3.1 Storm – NAT CAT Risk and Insured Risk

According to Encyclopedia Britannica, a storm consists of violent atmospheric disturbance, characterized by low barometric pressure, cloud cover, precipitation, strong winds, and possibly lightning and thunder. Storm is a generic term, used to describe a large variety of atmospheric disturbances, ranging from ordinary rain showers and snowstorms to thunderstorms, tornadoes, tropical cyclones, and sandstorms (Britannica, n.d.).

European storms are so strong that they can have a devastating social and economic impact, such as power outages, the damaging and closedown of transportation networks, power plant failures, damages for the agriculture sector, damages for buildings, and last but not least, loss of lives. For instance, the windstorms that hit Anatol, Lothar and Martin in December 1999 caused damages of \$14 billion (Swiss Re, Sigma). In Europe, XWS' digitalized "eXtreme Wind Storms" catalogue (JRC, 2020) was developed for the period 1979-2013. It represents an important resource both for the academic environment, and for the insurance and reinsurance sector.

According to JRC PESETA IV (JRC, 2020), windstorms range among the most devastating natural perils in Europe. The yearly losses they cause amount to approximately EUR 5 billion in the EU and Great Britain.

The recording of storm-related loss considers the following: the frequency, the nature and dynamics of storms, the risk vulnerability of the value, the geographical distribution of these values and the particular risk transfer-related conditions. In this regard, the assessment of the impact of climate change is an important element in the estimation of future storm risk-related loss.

The storm risk is included in the property insurance policies, covering the financial losses caused by such events. According to EIOPA, the countries that are significantly impacted by the storm risk, for which insurance companies estimate the solvency capital requirements as part of the NAT CAT module are: Austria, Belgium, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Iceland, Lithuania, Luxembourg, Norway, The Netherlands, Poland, Sweden, Slovenia and Hungary.

3.2 Extratropical Cyclones – High Risk Weather Phenomena of Average Duration

Extratropical cyclones constitute major risk probability hazards for the temperate climate zones, as they can affect areas with large demographic densities and numerous economic objectives.

Extratropical cyclones tend to form and move in certain regions – the so-called *storm tracks*. A challenge when it comes to the analysis of the extratropical cyclones is the history of event dates, *i.e.*, the lack of quality data over long periods of time. An analysis of the atmospheric pressure data at several stations in northern Europe was unable to identify significant trends in the variability of extratropical cyclones in the past hundred years. The features of the extratropical cyclones in the Atlantic European area are closely related to the variability of the North Atlantic Oscillation (NAO), due to the fluctuations of the differences between the abnormalities of the atmospheric pressure in the Iceland Low and the Azores High (Bojariu & Gimeno, 2003a).

If they hit territories with large demographic densities, these storms can cause important damages (destroy or damage forests, economic objectives, electricity networks, buildings, disturb transportation networks etc.) and even deaths.

In Romania, the evolution of extratropical cyclones can be strongly influenced by the presence of the Carpathians, which induce the *Carpathian orographic cyclogenesis (Ecaterina Ion-Bordei, Rolul lanţului alpino-carpatic în evoluţia ciclonilor mediteraneeni, 1983)* or by the vicinity of the Black Sea, responsible for the *Pontic cyclogenesis (Draghici, I., 1988)*.

The evolution of climate on the territory of Romania has registered a number of extratropical cyclonerelated extreme events. In May 1970, Crisana, Transylvania, Maramures and Northern Moldova were hit by the greatest 500-year floods. A number of *cumulative factors* (excess precipitation during the previous period, high soil humidity, very thick snow layer in the mountain area) have led to the *triggering factors* – the massive warming between the 8th and the 11th of May, followed by the sudden melting of the snow in the mountain areas, and by heavy rain between May 12th to 14th, caused by a baric depression, which evolved in Transylvania, and by a retrograde cyclone wave in the South-East of the country. The month of October of 1972 was marked by exceptionally high flooding on the rivers on the South of Romania.

In August 2001, the South and South-East of Romania were hit by a number of weather events, *i.e.*, a windstorm with hail and thunders, which destroyed the overhead power lines, damaged more than 900 households and several thousands of hectares of farming land.

Another event with significant local consequences occurred on the night of August 3rd-4th 2006, in Toplita, *i.e.*, an extremely violent gale, with a duration of 15 minutes and wind speeds above 140 km/h, which, among other things, took down 150 ha of trees (România liberă, 2006).

3.3 Wind - Weather Phenomenon of Average Duration

Wind is a physical phenomenon that manifests through the movement of air in a pattern relative to the planet's surface. On the territory of Romania, the wind regime is determined both by the general peculiarities of the atmosphere, and by the peculiarities of the active surface, with the obvious orographic barrier of the Carpathians, which, through their orientation and altitude cause regional wind peculiarities. The most well-known Romanian winds are: Crivatul (Icy North Wind) (blowing from the N-E to the S-W, at speeds that sometimes exceed 30-35 m/s), Nemirul (present in Brasov Basin and blowing at speeds of 10-20 m/s), Austrul (dry and warm Western wind during summer, and accompanied by frost and no precipitations in wintertime (meteo, 2021).

Depending on the thermal specifics of these winds, which are, in turn, determined by the physical processes generating them, katabatic mountain winds may be warm, like the *Foehn*, or cold, like the *Bora*. In Romania, March 7th 2002 could be called "the day of wind and fire", because, on the background of exceptionally high wind speeds, no less than 332 fires occurred, which also caused three victims.

Another synoptic event characterized by very strong winds in Europe, was the one of October 28th 2002, with disastrous effect in Romania, as well, *i.e.*, people were injured and there were important property losses in Cluj, Sibiu, Targu Jiu, Arad, in Alba County etc. (Murarescu, n.d., p 7).

3.4 Tornadoes - High Risk, Short-Lived Weather Phenomena

Tornadoes are violent atmospheric disturbances, associated to to cumulonimbus clouds that manifest as a rotating column of air, much smaller than cyclones, occurring on the continents between 20 and 60° Northern and Southern latitude.

In 1971, Theodore Fujita, a meteorology professor at the University of Chicago, specializing in tornadoes, developed a system of classifying tornado intensity based on the damage to structures. However, because the Fujita Scale relies on damages and not on the wind speed or pressure, it is not flawless. The main issue is that a tornado can only be measured on the Fujita Scale after it occurred. Secondly, the tornado cannot be measured if there are no damages, in case the tornado occurs in an

area that has no structures that could be damaged. Nonetheless, the Fujita Scale has provided reliable tornado resistance measurements.

Fujita Scale	Wind speed (km/h)	Damage caused to medium-sized (brick) structures in
		Europe
F0	64 - 116	almost no damage
F1	117 - 180	small and moderate roof damage
F2	181 - 253	considerable roof damage/
		roof thorn off the house
F3	254 - 332	thorn roof / collapsed walls
F4	333 - 418	almost all walls collapsed
F5	419 - 512	completely destroyed house

 Table 1. Climatology of tornadoes for European region

Source: The Fujita -Pearson Scale or the Fa-Scale of tornado intensity and related damages in Europe (apud Bojariu et al, 2015, p 68)

In Romania, small, but quite dangerous tornadoes occur in Banat, in Northern Moldova, in the South and South-West of the Wallachian Plain and Transylvania Basin.

Records of tornadoes exist ever since the 19th century. Thus, between 1822 and 2013, there are records of a number of 129 tornadoes occurring on 112 days (*Antonescu &Bell, 2014*).

The strongest of all the 129 tornadoes occurring in Romania over the past century is by far the one in Facaeni, which was caused by the important temperature difference between two masses of polar and tropical air, which came into contact on the territory of the country. On August 12, 2002, Făcăeni Village was hit by a tornado, an uncommon natural phenomenon for the region. The tornado destroyed more than 300 houses and the forest in the East of the village. It also caused two deaths. Towards the end of May 2017, almost 15 years after the 2002 disaster, the phenomenon reoccurred. Just as in 2002, the tornado came on the Borcea Branch of the Danube and moved up the hill, reaching the village. The damage was less severe and there were no human victims (Wikipedia). Făcăeni Village remains the only locality in Romania with tornado events. It was declared that a danger zone formed there, which means that such disasters can reoccur anytime. The severe atmospheric convection of April 30, 2019 manifested through perilous natural phenomena, including torrential rain, heavy hail and the intensification of terrestrial near-surface wind speeds. The high temperatures favored the development of cumulonimbus clouds with heights reaching 13-14 km. (Tudor, n.d.). These severe weather phenomena culminated in a tornado formed on the territory of Calarasi County, in the area of Dragalina-Constantin Brancoveanu localities. The estimated wind speed was of above 90 km/h, the tornado being classified as F0 on the Fujita Scale. It caused the leveling of some of the wooden fences, the snapping of fruiters and trees, the peeling off of tile and fiber cement sheet roofs. The tornado catalogue developed by Bogdan Antonescu (Institute for Research and Development in Optoelectronics) and Aurora Bell (Bureau of Meteorology) is a contribution to a pan-European tornado dataset that will facilitate the understanding of the tornado threat in Europe. The projections for the future climate changes relying on global climate models that were included in the 2007 Intergovernmental Panel on Climate Change Report are more credible for certain variables (e.g., temperature) as compared to others (e.g., precipitations), as well as for broader spatial scales and time periods. Hence, the development of properly scientifically documented studies is absolutely necessary, considering the adaptation measures to be taken at a national level, which also is the case of Romania. (Busuioc et al., 2014). An analysis of the storm risk was carried out on the facultative insurance market in Romania, and it has been found that this risk has a low coverage level throughout the country.

4. FUTURE CLIMATE VARIABILITY IN ROMANIA

Significant progress has been made in the study of tornadoes over the past decades. Nonetheless, the forecasting and early warning on tornadoes continue to raise permanent challenges for most European national meteorological services, as special skills and expertise in the field are required. Moreover, tornado warnings can cause panic among the population. Hence, it may be noted that the main challenges are, on the one hand, related to the forecasting of the genesis of tornadoes and, on the other hand, to the identification of the most efficient way to inform the public on the possible occurrence of tornadoes. On June 25, 2015, a meeting addressing decision-makers was held, to present the model and the results of the economic and macro-sectoral analysis on the costs and benefits of Romania's climate policies and the scenarios for the 2020-2030-2050 horizon. The meeting was moderated by senior World Bank macro-modeling experts and by a representative of the consortium that prepared the 2015 EU Reference Climate Scenario, developed by the European Commission. According to these scenarios, the climate change trends will accelerate in the 21st century. On the long-term, the increase of the average temperature in Romania is estimated at approximately 3 °C-4 °C during summer months between 2061-2090, as compared to 1961-1990. In so far as the precipitations are concerned, a decrease in the yearly precipitation quantity is expected during summer months, which will be more important in the case of higher carbon emission scenarios and stronger towards the end of the 21st century. Storm events that will generate heavier and localized precipitation are expected, even though the rain pattern could also become more chaotic and more difficult to forecast.

For a higher intensity wind (exemplified for 100 years), considering a global warming of 3° C, a number of robust models may be identified: a greater wind peril is forecasted in the mountain areas is Scandinavia and the Alpes, as well as in Southern Italy and in scattered areas of Central and Eastern Europe (*e.g.*, Hungary *and Romania*). (JRC PESETA IV, 2020). These studies clearly show that climate change will impact the territory of Romania and the company managing the mandatory insurance system will have to pro-actively tackle climate change analysis and be prepared to cope with all these changes, participating in the adaptation of the legal and organizational framework for the insurance coverage of these risks, in order to be able to provide suitable financial support to the insurers.

5. QUANTIFICATION OF THE PROBABLE MAXIMUM LOSS FOR THE STORM RISK

The Probable Maximum Loss (PML) is the maximum loss expected by an insurer for the insured policy portfolio and it helps determine the indemnities it will have to pay in relation to the same, as well the insurance and reinsurance premium. In determining PML, insurers use various models and data, relying on complex/stochastic statistical formulas, frequency and intensity/severity distribution tables, in order to determine policy underwriting-specific risk/loss. One of the most important natural hazard management risk factors is the inclusion of the insured asset in the CRESTA zones.

The NAT CAT risk is the result of extreme and irregular natural events, with a high level of uncertainty with regards to the hypothesis based on which the premiums and technical reserves are set. Reffering to the housing stock in Romania, the statistical data available on the website of the National Institute for Statistics reveals an ascending trend for it over the past years, following the building of new dwellings, and the transformation of premises previously used for other purposes into dwellings.

Table 2. The housing stock in Komama						
Total dwellings*	* Urban	Rural	Private property	State-owned		
				property		
9,092,963	4,965,090	4,127,873	8,980,795	112,168		

Table 2: The housing stock in Romania

Source: *Dwelling number data source: National Institute for Statistics. TEMPO Online_2019 query

The Probable Maximum Loss for Nat Cat Storm Risk

Comparing to floods and earthquakes, storms are events affecting smaller areas, with a high frequency, but with a relatively low impact. The amount of the loss may increase if they are accompanied by hail, torrential rain and lightning.

In order to estimate the probable maximum loss, the core source in the storm risk modeling process was the residential structure portfolio divided into two areas, urban and rural, and considering an average insured amount determined based on the coverages provided by PAD policies.

The weighting factors for the storm risks corresponding to the CRESTA zones in Romania were estimated based on the Monte Carlo Method, which generates numerical results for a specific scenario by building a statistical process whose parameters (the average, probability/frequency of an event) are equal to the sizes sought for in the respective scenario. This method is also known as the *random sampling or statistical simulation method*.

Most operational insurance models rely on historical data. Sampling techniques, such as Monte Carlo, are then applied to obtain a comprehensive dataset. Since we hold no historical data for the storm phenomenon at the country level, we have used the statistical experiment method in order to obtain numerical solutions, and the results of the process thus derived were randomly applied to phenomena of the storm risk type. With this method we aimed to replace a real process with a statistical experiment, by randomly generating 13,419 iterations. The 95% percentile resulted for the probable maximum loss provides information on the deterministic solution.

To get the results, we worked under the assumption that the random variables used during the experiment to emulate as close as possible the actual random variables, which was done by firstly generating a random number which was subsequently used to extract a value from the random variable's distribution. Specifically, we managed to replace the random variables' values with a finite set of values following the same distribution, based on repeated random sampling and statistical analysis, by following the normal uniform distribution.

The weighted insured amount for the storm risk is calculated according to the EIOPA formula: $WSI_{storm, i} = W_{storm, i} \cdot SI_{storm, i}(1)$

The sum is calculated based on all possible (i, j) combinations.

WSIstorm, i – the weighted insured amount for the storm risk corresponding to zone i.

 $SI_{storm, i}$ – the insured amount for the storm risk corresponding to dwellings located in CRESTA zone i (equivalent to Romanian counties)

 $W_{\text{storm, i}}$ – weighting factor for the storm risk corresponding to zone i, estimated in this scenario

The loss specified for the storm risk is:

$$L_{\text{storm}} = Q_{\text{storm}} \cdot \sqrt{\sum_{(i,j)} \text{Corr}_{\text{storm},i,j} \cdot \text{WSI}_{\text{storm},i} \cdot \text{WSI}_{\text{storm},j}} (2)$$

L_{storm} – probable maximum loss for storm according to EIOPA formula

 Q_{storm} – storm risk factor estimated in the scenario for the geographical area. For Romania, this factor is not determined in the literature, for insurance purposes. In this respect, while analyzing the storm event in European countries with features similar to those of Romania, and comparing the landforms and the meteorological phenomena, we took over the coefficient established by EIOPA in the PML estimations for the Czech Republic, 0.03.

 $Corr_{flood, i, j}$ – the correlation coefficient for the storm risk in zones i and j is presumed to be 0; we have considered independent events among the counties of Romania.



Source: Grafic obtained pursuant to the author's calculations

Table 3: Estimated storm risk possible maximum loss for the residential sector

EUR	PAD insured portfolio	Extrapolation to the total number of dwellings PAD insured amount
Number of dwellings	1,753,520	9,092,963
Aggregated insured amounts	33,896,376,048	174,953,910,711
Probable Maximum Loss (PML) - STORM	4,482,882*)	22,725,398*)

Source: Statistical data <u>www.paidromania.ro</u> 30.12.2020 *) Data obtained pursuant to the author's calculations

- *Column 1*: the results of the calculations carried out based on the standard formula for solvency capital requirement according to EIOPA, for the PAD insured portfolio as on 31.12.2020
- *Column 2:* the results of the calculations carried out using the standard formula for the entire housing stock of Romania, the insured amount being determined by multiplying the average PAD insured amount in the county by the number of dwellings in the county.

6. CONCLUSION

In order to mitigate the negative consequences of the risks due to cyclones/tornadoes/violent storms and to limit the possibility of their impacting on other environmental factors, sound knowledge of the typology of these events is required, which should consider the on-site *monitoring and control* of risk climate factors, *the synoptic monitoring of the territory; pro-active measures for the mitigation, fighting and control of the consequences of climate risks, as well as steps meant to protect the population, the environment and, last but not least, the economy in the face of such events.*

The authors believe that the integration of the storm risk in the mandatory household insurance policy could help:

- \checkmark to raise awareness among the general public, since the storm is seen as a risk of high frequency
- \checkmark to use storm as a trigger so that to increase the penetration insurance rate for housing stock

Accepting this solution requires the definition of this catastrophic risk, and the determination of extremes as defined by the Fujita Scale (for tornadoes) or the Beaufort and Saffir-Simpson Scales (for cyclones), so that the event acknowledgement mechanism does not raise any challenges when it comes to opening claim files. The underwriting of the storm risk within the mandatory insurance policy, as a measure of social protection, is a moral duty that helps protect the population, but also help to manage more efficiently the state budget.

Nonetheless, ensuring the adequacy of the insurance premium depending on the risk level is still mandatory, so that the system to remain sustainable. For comparison, the facultative insurance system could apply the principle of selection, insurers being entitled to refuse policies for areas with greater storm risk exposure or for properties of an appreciable age (more than 50 years) or properties made of adobe or similar materials (dispersion being of use in case they issue facultative insurance policies in areas with a lower exposure). Hence, the inclusion of the storm risk on a mandatory insurance policy would be a suitable solution, considering the social purpose for which this compulsory system was established.

Meanwhile, the modeling of the storm risk for Romania is the core of establishing of insurance and reinsurance premium, which must suit NAT CAT risks, so that the model abides by the solvency capital requirements. The modeling will be required in order to avoid the solvency issues following major events, where losses can always exceed the anticipated ones, since we do not hold this historical storm dataset. Another matter to be considered is that the introduction of a storm risk can significantly change the reinsurance renewal terms and implicitly lead to higher than anticipated reinsurance costs. Hence, the integration of the storm risk in the mandatory homeowners' insurance in Romania is a challenge for the executives of the company managing this system.

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