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## **Abstract**

Natural disasters are a low probability and high impact kind of risks. In those cases, businesses tend to ignore the probabilities of their happening and a lot of them end up closing their doors out of lack of good risk management.

In order to be prepared for a natural disaster, one should know the disaster, know the different kinds of outcomes, know what barriers they have. To be aware of a risk is to be conscious about its outcomes.

For natural catastrophes, the transfer of a high impact and a low probability risk is an effective response. A risk transfer in such situations is handled by an insurance that is expensive, especially to small businesses but, when a catastrophe strikes, the economical help offered is a rescue boat for the business.

In addition to the insurance, there are ways to improve the restoration of the building where the business is held. This thesis suggests framework to be considered by the business owners, for a faster resumption, as any time saved counts.

The suggestions are a use of a scenario preparation and analyze steps to follow for each possible situation precising who is responsible of the completion of each step. From this analysis and its outcome, it will be recommended to have a checklist for the different scenarios and steps to go by, including when to contact the insurance company and an approximation of what would be covered according to the contracted schemes. This step will highlight the importance of the risk transfer and will identify if there is a need for contracting extra insurance. Nevertheless, these two suggestions would be lacking an important input if no relationship with the restoration company has been established to perform them adequately; it is helpful to know beforehand what kind of business it run in the premises and the importance of different areas in the building. The insight of a restoration company is also needed to know the restoration steps required for the scenario analysis and checklists.

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# **1. Introduction**

## **1.1 Background**

In 2018 alone, there have been many different natural disasters, like the floods in North Korea, Nigeria and the earthquake and tsunami in Indonesia among others. After natural disasters, businesses need to restore their physical assets; the major one of them being the edifice where the business is run. The restoration of the buildings is time consuming for the business to get back on its feet and disasters often reverse development progress (Syed, 2008).

Natural disasters don't discard nations, in fact, no nation, regardless of its wealth or influence, is so far advanced to even be fully immune from disasters' negative effects (Coppola, 2006), the better prepared the less negative outcome can affect the victims of natural catastrophes.

The insurance is a solution to helping a business recover, cost-wise, that is not taken into consideration by the business owners in their decisions to mitigate the risks of natural disasters. Its importance becomes vital to the business if any natural catastrophe strikes.

Most commonly, businesses, large or small, don't have any restoration plan in place and the companies they hire to do so -after the disasters happen-, don't know the business nor the insurance specifics. That implies a waste of time and money which can lead to a complete loss of business.

## **1.2 Problem**

Natural disasters are not thought of until they are announced to be coming by scientist, media etc., or until they hit, and when a natural catastrophe hits, the damage they cause is huge. A business interruption is not a small detail and disaster preparedness has to be part of the risk management points to be considered by the decision maker so that the recovery is most effective. Constructed items are essential to the pursuit of economic activity for providing the physical space needed for the production of all goods and services by the business (Ofori, 2002).

Also, insurance pays a big deal of the recovery costs, but since they are expensive and such disasters are of a low probability, businesses don't contract them. The other quality of a natural catastrophe is its high impact, without an insurance the business resumption is almost impossible especially for small businesses.

### **1.3 Aim**

The objective of this thesis is to look for the possibilities to improve the business restoration process after natural disasters and suggest a framework for it. The goal is to see what is being done to cope with their aftermath, putting the stress on the understanding of the impacts on the business premises and the importance of insurance. Then, suggest a simple framework to shorten the business interruption and avoid the loss of business.

### **1.4 Limitations**

This thesis is limited to the damage to the buildings of a business after a natural disaster; it will not include non-natural disasters, loss of life, the adjustment capacity of the affected community or buildings other than the business premises.

The thesis is not specific to one area, but the examples are limited to four natural disasters: earthquake, tsunami, hurricane and flood.

### **1.5 Thesis layout**

This thesis is structured into 9 chapters, the first of which being the present introduction chapter and the last, a conclusion of the thesis.

The rest of the chapters are:

- Chapter 2- Environmental risk to constructions: introduces what should be known about the four natural disasters considered in this thesis and their different impact
- Chapter 3- Disaster insurances for natural disasters' damage to building: elucidates the different insurances to be considered for such a risk.
- Chapter 4- Disaster preparedness: insists on the importance to be prepared and planning beforehand for the outcome of a natural catastrophe
- Chapter 5- Restoration/recovery: discusses the restoration process and the considerations to heed.
- Chapter 6- A suggested framework to improve risk management for natural disasters: this framework is meant to be simple to encourage its implementation by businesses.
- Chapter 7- An example of the application of the suggested framework.

- Chapter 8 – Discussion: discussion of the roles and appropriateness of the suggested framework
- An appendix is facilitated with some definitions and a further curve explanations.

## 2. Environmental risk to constructions

Natural disasters are difficult to predict in terms of exactly how much damage they are going to cause and the exact time they are hitting. It is true that science is advancing which helps a great deal in saving lives, but what about existing constructions? The quality of being “natural” makes those environmental risks almost unavoidable and, qualified as disastrous. Getting up after a natural disaster is costly and requires time and human resources.

Natural catastrophes may also provoke other accidents that are not a specific characteristic of it, for example, hurricanes and earthquakes can provoke fires and tsunamis as the tsunami that hit the nuclear plant in Fukushima Daiichi and caused a nuclear accident in 2011.

A first step to dealing with a situation is understanding it and its consequences. In the following, a small definition of the natural disasters that are going to be introduced in this chapter and be mentioned in the upcoming ones: earthquake, flood, tsunami and hurricane.

**Earthquake:** “A sudden movement of the earth's crust caused by the release of stress accumulated along geologic faults or by volcanic activity. Also called seism, temblor.” (earthquake, American Heritage® Dictionary of the English Language)

*Characteristics that increase danger:* sudden and temblor of tectonic plates, direction.

**Flood:** “An overflowing of water onto land that is normally dry.” (flood, American Heritage® Dictionary of the English Language)

*Characteristics that increase danger:* amount, water composition, pressure etc.

**Tsunami:** “A very large ocean wave caused by an underwater earthquake or volcanic eruption.” (tsunami, American Heritage® Dictionary of the English Language)

*Characteristics that increase danger:* strength, water composition, speed, (direction).

**Hurricane:** “A severe tropical cyclone having winds greater than 64 knots (74 miles per hour; 119 kilometers per hour), originating in the equatorial regions of the Atlantic Ocean or Caribbean Sea or eastern regions of the Pacific Ocean, traveling north, northwest, or northeast from its point of origin, and usually involving heavy rains.” (hurricane, American Heritage® Dictionary of the English Language)

*Characteristics that increase danger:* strength, speed, direction.

## 2.1 Earthquake

Apart from the construction specifics, earthquakes, depending on their amplitude, phasing, direction and closeness of the buildings to the epicenter, can cause from no damage to total collapse of a construction.

A construction can be considered partially destroyed if it loses one of its main structure or simply partition walls that are necessary for the proper functioning of the space. Unfortunately, it is not obvious to notice construction mistakes when the building is already standing (which contributes a big deal to the collapse of parts of the structure or its whole).

The damage inflicted on the buildings is influenced by these factors:

- “1. magnitude of the earthquake
2. distance from the center of the earthquake
3. orientation of the locality relative to the fault line
4. depth of earth shock
5. duration of earth shock
- 6, geology of intervening area
7. local ground conditions.” (Friedman, 1972).

Here, some real seism damage caused:

Total collapse:



*Figure 1 Mexico City, Mexico, on Sept. 21, 2017(Jasso/Reuters, 2017)*

A total collapse of the structure does, obviously, create a rebuilding necessity. A collapsed construction also requires removal from the site so that the new building takes place. Both these works are done by construction companies and are time and resource demanding.

Partial collapse:



*Figure 2 NORCIA, PERUGIA, ITALY, on october30,2016 (Nardone, 2016)*

Less damaging than a total collapse, the partial collapse doesn't fall far from the tree of the need of rebuilding. Although some partial damage can look light, it is possible that it touches a part of the structure where a lot of attention is demanded.

Almost no damage to no visible (structural) damage:

“Damage of nonstructural elements, are not limited to the masonry, but to any other enclosure or other type of material that has not been properly designed to withstand earthquakes” (Mejía, 2017). Some earthquakes can cause nonstructural damage as knocking down separation walls for instance



*Figure 3 Anchorage, Alaska, on Nov. 30, 2018. (Joling, 2018)*

or pushing tiles to fall, others, rather “lighter” can just shake furniture. But that does not mean that the building should not be checked for future earthquake strikes, even for the same magnitude, so to avoid the risk of the construction becoming more vulnerable because of the previous hit.

## 2.2 Flood

Flood, is defined by ISO’s CP 10 65 as: “A general and temporary condition of partial or complete inundation of normally dry land areas due to:

- 1) the overflow of inland or tidal waters;
- 2) the unusual or rapid accumulation or runoff of surface waters from any source; or
- 3) mudslides, or mudflows which are caused by flooding (a mudslide or mudflow involves river of liquid and flowing mud on the surface of normally dry land areas as when earth is carried by a current of water and deposited along the path of the current)” (Boggs, 2015)

Flood actions can be caused by energy transfers, forces, pressures, or the consequences of water or contaminant contact according to (Kelman & Spence, 2004), which translates to dynamic and hydrostatic forces. These actions touch upon the structural and nonstructural parts of the



*Figure 4 Physical damage to construction (Karr, 2013)*

constructions (e.g.: making them weak and leading to poor resistance inhibiting the roles expected from the elements of the structure to fully maintain their function).

According to the same source (Kelman & Spence, 2004), we have two forms of hydrostatic actions: lateral pressure and capillary rise, and five hydrodynamic actions, three related to velocity (lateral pressure imparted by water flowing around a residence, localized changes in the velocity and



*Figure 5 example of water contaminants damage (2014)*



*Figure 6 water contaminant damage ((n.d.))*

turbulences) and two related to waves (non-breaking waves and waves breaking in) (Kelman & Spence, 2004)

## **2.3 Tsunami**

Although a lot of tsunamis are an outcome of earthquakes, it is not just earthquakes that cause them (e.g.: volcano, underwater landslide, etc.). In fact, importance to ensure that there is consistency and balance between tsunami-resistant construction and structural requirements of natural force such as earthquakes -that cause them most of the time-, which sometimes run counter to these principles (Grunder, Shimatsu, Koo et al., 2006).

When a tsunami hits coastline cities, it devastates them in a large scale. The “lucky” buildings, are of heavy construction according to (Grunder et al., 2006). Figure7, shows which buildings were more resistant, the ones with heavy timber and ferro-concrete structures had the best chance of surviving the impact of waves (Grunder et al., 2006). But in more recent research, there were many concrete buildings and coastal protective structures (seawalls, coastal dykes and the like) that failed in the 2011 Tsunami (Yeh, Barbosa, Ko, & G. Cawley, 2014).

Tsunami disasters cause physical damage, due to waves hitting buildings and what they end up carrying on the way (e.g.: cars and other building’s elements), slipping around some objects like



Figure 8 Some buildings can be more resistant to Tsunamis (2016)



Figure 7 Tsunami Japan 11 March 2011 (Kingston, 2011)

round columns, while slamming full force when a large wall is in its way. It also gathers debris - dirt, cars, trees - as it flows (K. Changmarch, 2011). Tsunamis can also cause fires, if it ruptures fuel facilities, wrecked ships or damaged cables (Sui Pheng, Kwan Kit, & Raphael, 2006).

The hit of the tsunami is where most its destruction resides, but it also has chemical actions on buildings as it is salty waves from the sea in addition to the dirt it transports. The chemical side is almost the same as in floods but since it is very salty water and does break sewerage pipes and carries it, the damage done to structural and nonstructural elements of the buildings, chemically, is greater. Figures 7 and 8 show how destructive a tsunami can be.

## 2.4 Hurricane

One of the tsunami generators is the hurricane, even if it is not the only thing a hurricane can cause neither does it cause it all the time. Hurricanes are very strong winds that go over the “highway speed”. In their performance, hurricanes bear practically anything in their way; from dust to buildings and are accompanied with heavy rains. If earthquakes generate from an hypocenter and travels to shake the foundation, the hurricanes pluck buildings or parts of them from the upper structure, it can breach the building envelope frequently and leads it to a cascading series of other

internal damages in an impacted building leaving the interior vulnerable to damage from heavy rains that accompany hurricanes (Diaz de Leon, Rossell, Dolhon et al., 2015).

So, in total, the damages done by the hurricanes are in somewhat similar to flood when it comes to water contamination, to tsunamis when it comes to carrying debris at high speed. Also, the wind being strong by itself, destroys building through facades and plucks trees and other objects causing them to hit the constructions.



*Figure 9 Hurricane Sandy (2012)*

Hurricane Sandy in the united states for example, figure 9, was the most destructive in 2012 causing \$70.2 billion worth of damage (Peer, 2018).



*Figure 10 Aftermath, Hurricane Michael (Bachman/Reuters, 2018)*

Hurricane Michael, figure 10, was the strongest to hit the USA in terms of wind storm; storm-force wind speeds stretched for more than 320 miles (B. Miller, 2018) and caused primarily billions of dollars as estimated by the National Weather Service to over \$30 billion (Perryman, 2018).

### **3. Disaster insurances for natural disasters' damage to buildings**

Natural disasters are not very frequent (more probability in highly exposed regions), but the damage they cause is immense; a few, extremely catastrophic events will consume a rather high proportion of the total damage caused by a large number of events in a time interval of some length (Munkhammar & Themptander, 1984). The construction companies, for instance civil engineers, incorporate the knowledge about those disasters as minimum requirements in technical codes and regulations and update them when necessary and according to the new data. In construction, a building that relies on minimum requirements does not necessarily withstand natural disasters.

When aware of the danger and losses, business has to know about the option of transferring those risks it can face and how they should approach them; the risks can be transferred from exposed entities through insurance, contingency funds, catastrophe bonds and other financial mechanisms (Syed, 2008). When a prevention method from collapse and damage to buildings fail, (apart from government help), insurances are the monetary resource to rebuilding and restoring constructions; the risk transfers to them.

Businesses sign with insurance companies for contracts that include, or not, catastrophe insurance due to the rarity of the events and ignoring -when they don't have the appropriate insurance- how huge is the aftermath. The distance in the past from a catastrophe is inversely proportional to the consciousness about the catastrophe left among the population (Munkhammar & Themptander, 1984). Businesses also tend to undermine the actions of the disasters as they find examples where the minimum rate in the earthquake tariff in force is about 1.4-1.5 per mile for example, but where the actual average rate charged to the insureds is only 0.9 per mile (Munkhammar & Themptander, 1984). What they fail to do is risk having larger insurances for such disasters or underestimate to what extent they should go for the coverage from an insurer.

Details of the connection of the business to the insurance companies will be superficially mentioned in this thesis, rather a general mentioning of what insurances cover when the damage is caused by a natural disaster will be discussed.

When it comes to risk, the ways to treat negative consequences of outcomes are:

“(1) take all the consequences when an accidental event occurs,  
(2) reduce the probability and/or the consequences of an accidental event by safety measures or  
(3) transfer the consequences of the occurrence to parties better able to carry them (i.e. buying insurance).” (Abrahamsen & Asche, 2010).

In the case of natural disasters, we can either refer to number (1) or (3) as the solution number (2) in this kind of events can help reduce the damage but most likely cannot prevent them from causing the devastating damage as they come as disasters and not “normal” accidents. The costs of repairing and rebuilding and the business interruption require a lot of money from a business to resume, so by transferring them, or at least part of the costs to another party as the insurance industry, a business is more likely to recover.

### **3.1 What do insurances consider when evaluating the natural disaster costs?**

First of all, it is important to mention that, in case of a natural catastrophe, it is not just the insurance company that covers the costs of the damage and not only does it vary from a country to another and from one company to a different one but also, from one insurance client to another. It is not possible for insurance companies to challenge the whole damage of such devastating catastrophes since they can wipe out entire cities. In fact, insurance schemes are widely used to increase the resilience of individuals, companies and public entities to external shocks reducing their future expenditures when a disaster strikes (UNDP). The government -the insurer of last resort in the event of natural disasters-can also rely on the private sector for insurance schemes or establish public social security schemes on its own or in partnership with other governments (UNDP).

Obviously, past experiences are the data that can be used to estimate the costs. It also plays a role for the insurance companies to decide the percentage of the damage they are willing to cover. Nevertheless, this measure is poor according to Friedman due to the random occurrence (or non-occurrence) of a severe geophysical event during the short sampling period of years that is usually available for study (Friedman, 1972). In addition, the changes through time occur according to:

- “1. type of construction;
2. susceptibility of structure to damage;
3. building codes;
4. kind and amount of insurance;
5. size and type of deductible;
6. cost of repair.” (Friedman, 1972).

The same article also states that insurance companies have to do future estimates according to the value of properties in the present and illustrates it with the example of estimating future earthquake risk in California, not upon what the 1906 San Francisco earthquake cost, but what it would cost if a comparable earthquake occurred today and affected the present type, distribution, and value of properties (Friedman, 1972). There are requirements for the private insurers to function properly:

- a supporting regulatory framework,
- the existence of service providers,
- access to regional or international reinsurer markets, and
- the availability of reliable data on risks and vulnerability (UNDP).

Without data, risk evaluation would be too vague, according to Friedman, the information available is the following:

- (1) past damage experience; (*should be based upon retrospective or prospective measure*)
- (2) data on the damage susceptibility of structures to be insured and the cost of repair; and
- (3) knowledge of physical characteristics of the natural hazards from the natural sciences. (Friedman, 1972)

These are the three basic points the insurance industry looks at to evaluate the costs of natural disasters. This being, in other words, the risk analysis’ main information resources that precedes the risk evaluation necessary for a risk assessment as “Risk analysis + Risk evaluation = Risk assessment” (Aven & Wiley, 2015).

The insurance companies employ in general actuaries to determine risk levels and premium prices for their policies (Kagan). Those actuaries evaluate the risks possible in the area where the business is located and how exposed this business is to those risks and so on.

At some point, the insurance company would set a limit to how much they are willing to cover in their policies with a limit of the amount that will be paid over a given timeframe, although policyholders can seek to purchase policies that provide for reinstatement of those limits in some cases (Gadaire & Szczucki, 2016).

### **3.2 How important is disaster risk insurance for a business restoration?**

As seen before, it is of great help to have an entity that pays a percentage of the costs due to the devastating damage caused by natural disasters. The client -here any business- chooses which risks they are taking and which they want to transfer to the insurance industry. The coverage then depends on the contract. At a basic level, insurance commits an individual or entity to pay a fixed amount at regular intervals (premium) into a common fund (the scheme), from which money is retrieved (pay-out) to compensate for losses arising from a predefined event (coverage) (UNDP). This is the basic insurance, and so, to actually cover major risks as in natural disasters, there are various options to choose from. The choice reflects the will of the company to pay the insurance according to how confident they are about the happening of the unwanted events that cause the business to rupture. Catastrophe insurance is different from other types of insurance since estimating the total potential cost of an insured loss, and a catastrophic event results in an extremely large number of claims being filed at the same (Kagan). Money-wise, the percentage of help they can get for the restoration costs varies according to the coverage they paid for.

According to UNDP, resilience of governmental balance sheets and the affected by the disaster's catastrophe is improved through disaster risk insurances. It is primordial, especially in natural disasters' risk zones, to be insured.

Natural catastrophes are rare but if they hit, they are destructive, which makes the choice of taking a certain insurance on them, or not, a hard decision to take for a business that doesn't want to be paying for a low probability event. If it has been a very long time since the happening of a natural catastrophe in the area where the business is, the company tends to feel "safe" with a tendency to

avoid extra costs for the short run and end up taking the risk instead of transferring it to the insurance company.

### **3.3 Types of disaster-oriented schemes in insurances for natural disasters**

“Insurance schemes can be private or public, mandatory or voluntary, direct or indirect.” (UNDP). But they also differ in term of percentages of coverage from one scheme to another and from one insurance company, of the same category, to another.

The insurances can also be either national or international; since the calamities cause too much damage and may require hundreds of billions of dollars.

To adequately choose what kind of insurance or insurance scheme to contract, the business must consider the area where it is located: some areas are more prone to some catastrophes than others, the coverage to sign up for should be about what this area can possibly face.

Note also that some insurances have schemes with replacement value or actual cash value and the difference is that replacement-value coverage helps replace your property at today's prices, whereas actual-cash-value coverage takes depreciation into account (Insureon, 2015).

#### **3.3.1 What does an earthquake insurance generally cover?**

Generally, an earthquake insurance for a business covers the following:

- Structural damage due to seismic activity.
- Damage to property such as inventory, equipment, and machinery.
- Lost business income as the business interruption stemming from an earthquake (in some policies) (Schwartz).

Still, an insurance company usually checks the building for existing damage or non-conformities in the construction first before issuing a contract. The cost of these insurances will then depend on different factors:

- the age of the building,
- the construction materials,
- the replacement cost,

- the distance to a fault,
- the foundation (underground parking, stilts, and basements),
- the soil conditions, and
- many other factors (Schumacher Insurance).

### **3.3.2 What does a flood insurance generally cover?**

Flood insurance covers for the building and its contents due to flooding or flooding generated by a hurricane, but the property and the equipment outside the building or vehicles are not covered by a commercial flood insurance neither do they cover, in general, the damage caused by earth movement even when caused by a flood (e.g.: sinkholes or mudflow) (Schumacher Insurance).

For insurances to be able to predict how much coverage they should cover for, there was for example a Black and Evans (1999) characterization of the flood by its depth, duration, velocity, contaminating substances, salinity, and season (summer or winter) and the results of their exercise were presented as tables of losses in monetary terms, with the total sum insured in monetary terms as a variable (Kelman & Spence, 2004). Through the years there have been many other ways for the prediction of coverage that are taken into consideration when the insurance industry sets how the damage coverage will cost.

It is also important to know what definition the insurance company is giving to flood, the understanding of how a policy defines flood is critical and it leads to important considerations (Gadaire & Szczucki, 2016). Another thing considered when it comes to flood insurance is that some damage has effect over time and it is suggested to check that as, depending on the policy language, damage sustained over a period of days may be deemed multiple occurrences under the policy (Gadaire & Szczucki, 2016).

### **3.3.3 What does a tsunami insurance generally cover?**

There is no specific insurance related solely to tsunamis: To be insured about tsunamis, one should be insured about flood, as most tsunamis cause it, and earthquake insurances as most tsunamis are a consequence of earthquakes.

### 3.3.4 What does a hurricane insurance generally cover?

Property insurance does not for sure include the hurricane insurance as some businesses think (Synergy Insurance). Unlike tsunamis, hurricanes insurances are different than the flood insurance even though a hurricane can cause flood and make some of the same damage.

Some property coverages include hurricane insurance, and as any other insurance, a business choses what to insure (from all to very restricted (specific)), it can be:

- All peril,
- named peril,
- wind and hail (McKinley, 2016).

### 3.3.5 A Summary table:

Table 1 Summary of the presented natural disasters insurances

<i>Natural disaster</i>	<b>Insurance</b>	<b>Coverage</b>	<b>Comments</b>
<i>Earthquake</i>	Earthquake insurance	<ul style="list-style-type: none"> <li>· Structural damage</li> <li>· Damage to property such as inventory, equipment, and machinery.</li> </ul>	In some policies it also covers lost business income as the business interruption stemming from an earthquake
<i>Flood</i>	Flood insurance	<ul style="list-style-type: none"> <li>· The building</li> <li>· The building contents</li> </ul>	Will depend on the definition given to “flood”. Does not cover: <ul style="list-style-type: none"> <li>· the damage caused by earth movement even when caused by a flood</li> <li>· the equipment outside the building or vehicles</li> </ul>
<i>Tsunami</i>	Flood and earthquake insurance	A combination of the two insurances coverage	There are no insurances specific to tsunamis

<i>Hurricane</i>	Hurricane insurance	<ul style="list-style-type: none"> <li>· All peril</li> <li>· Named peril</li> <li>· Wind and hail</li> </ul>	<ul style="list-style-type: none"> <li>· Property insurance does not for sure include the hurricane insurance</li> <li>· Different from flood insurance</li> </ul>
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### 3.4 Business interruption due to natural disasters, insurance

Damage caused to buildings where the business was ongoing is not the only damage a business goes through when hit by a natural catastrophe: a business interruption can take long periods of time during which a business risks a total shutdown as it is not able to have income and has to deal with extra-expenses. This calls for a must of a risk transfer: business interruption insurance.

Contentious and protracted negotiations with the insurer should be prepared by businesses that file BI loss claims. Being prepared for the negotiations can result in settling the claim at a substantial “discount” and a skilled public adjustor should be hired to handle those claims. The adjustor will need to rely on an experienced management accountant with knowledge about the business’ operations and familiar with the nature of the claims (McCallum & Knapp, 2016).

- **Business interruption insurance coverage (or business income (BI) insurance)**

Another type of insurance, that a business in view of a future natural disaster crisis would need to contract (not specific to just natural disasters), is the business interruption insurance. Restoration after a natural disaster is a long process, and businesses can lose so much income in as short as a day period. A business interruption insurance can help greatly in that part of the struggle as since it compensates for income lost while a business is being rebuilt (von Peter, von Dahlen, & C Saxena, 2012).

If there are costs to restoration, it should not be forgotten that the business itself is suffering from the interruption which frequently reaches 25% or more of the total losses (McCallum & Knapp, 2016). This kind of insurance is not sold separately, but is added to a property insurance policy or

included in a package policy (e.g.: business owner's policy (BOP) ("WHEN DISASTER STRIKES", 2005).

When it comes to business interruption, we must have in mind that different businesses are subjects to different kinds of risk (Heintz et al, 2009), and so, different insurance contracts or details in the insurance contract to analyze. This sort of insurance is mostly ambiguous since the reimbursement is for the profit that a business failed to earn during the time its operations were disrupted (McCallum & Knapp, 2016).

For an accurate coverage, the business should understand the language of the insurer and what do their specifications mean in their schemes; the slightest nuance in the policy can lead to a coverage of losses -due to the same business interruption source- or not cover anything at all.

According to the CPA journal (2016), there are two types of BI losses that are used in most insurance companies: “net-plus” and “gross-less” (see appendix A) and businesses can purchase an “extra expenses” that can account for only a nominal percentage of a BI insurance claim (McCallum & Knapp, 2016). The BI insurance covers for the business loss until it is restored, but it cannot fund with no time limits; Such “restoration period” -usually limited to a maximum of 12 months- is defined by the policy as the period of time required for the affected business to resume normal operations (McCallum & Knapp, 2016).

It is in addition very important that what is implied in each word is understood by the insured the same way the insurer defines it. For instance, the same journal states: “Although BI policies may indicate that insured parties will be compensated for a loss of net income, the actual BI loss computed under the net-plus definition, for practical purposes, is equivalent to the “operating income” that an insured sacrifices as a result of a loss event.” (McCallum & Knapp, 2016).

When what is wanted to be contracted in the policy does not apply exactly according to the insurer’s language, the business can either change the insurer or change the insurer’s language to fit what they want to be covered in the case of a natural disaster. For the second option, it is important to recheck the overall contract in case there are any clauses in case an insurer agrees to provide the language the business prefers, it should confirm that the language actually makes into the policy, and that other language does not contradict or nullify that preference (Heintz et al, 2009). To make informed decisions regarding the policy, the business needs to be familiar with

the language and to make informed decisions to avoid surprises when it comes to making a claim for coverage (Heintz et al, 2009).

Note that this insurance is connected to the restoration itself of a constructed building, as the reconstruction and repair of these can imply a long business interruption resulting in the business interruption insurance not covering a sum related to delays or has a time limit (e.g.: 12 months) and then when the restoration ends up taking longer to be done it can still cause it to shut its doors.

Attention should be paid to the type of business interruption insurance. Schumann classified business interruption into three types:

Type 1: Business interruption insurance: intended to compensate the insured for direct losses and for the income lost during the period of restoration or the time necessary to repair or restore the physical damage to the covered property.

Type 2: Extended business interruption insurance: provides coverage, typically for a limited duration, for the income lost after the property is repaired, but before the income returns to its pre-loss level.

Type 3: Contingent business interruption insurance: provides coverage for the insured's loss of income resulting from physical damage, not to its property, but to the property of providers, suppliers, or consumers of its product or services (Salty Schumann, 2013).

The insured has to substantiate its losses to the insurer. The business interruption claims are difficult to quantify since they rely on projections about future income streams and expenses. This type of insurance is based on the indemnity principle with the insurance restoring the insured to the same position as prior to the loss; not more and not less (Salty Schumann, 2013). When the reporting system and classification is lacking a description to the building's exposure, it is likely to stifle progress by the insurance industry (Kurth, Keenan, Sasani, & Linkov, 2019).

## 4. Disaster preparedness

To be well prepared is to know what type of building we are running our business in and to know what catastrophes can hit and how much damage this may cause and how much it could cost, in other words; to have a good disaster risk management in place.

Natural catastrophes are rare (black swans) and are subject to uncertainties (See Appendix A), but can cause huge destruction; that means that especially in a place that is prone to a certain natural disaster or another, it is primordial to have a disaster preparedness plan. As we have seen in the previous chapters, rebuilding and repairing is time and money consuming; the more time is spent in the restoration, the more money it costs to the business and can end up costing it its doors to never reopen.

### 4.1 Disaster preparedness, emergency and Risk management

To be prepared for a disaster is to have a risk management and a resilience strategy and plan in place. Disaster risk management is not specific to construction, it is also about other materials and a focuses on loss of life, but here, the focus will be on the built properties since the other aspects are not part of the scope of this thesis. Also, it is to say that, in the private sector when it comes to emergency management, they refer to it as business continuity management (Syed, 2008).

A disaster management, construction oriented, is in the process of construction by building better designed structural and non-structural parts that can withstand better certain disasters and help control the damage inflicted. It is also about being able to resume the business as soon as possible using insurance to transfer the costs of reconstruction. A business should be ready before the event happens about both what should be done before and after a natural catastrophe strikes:

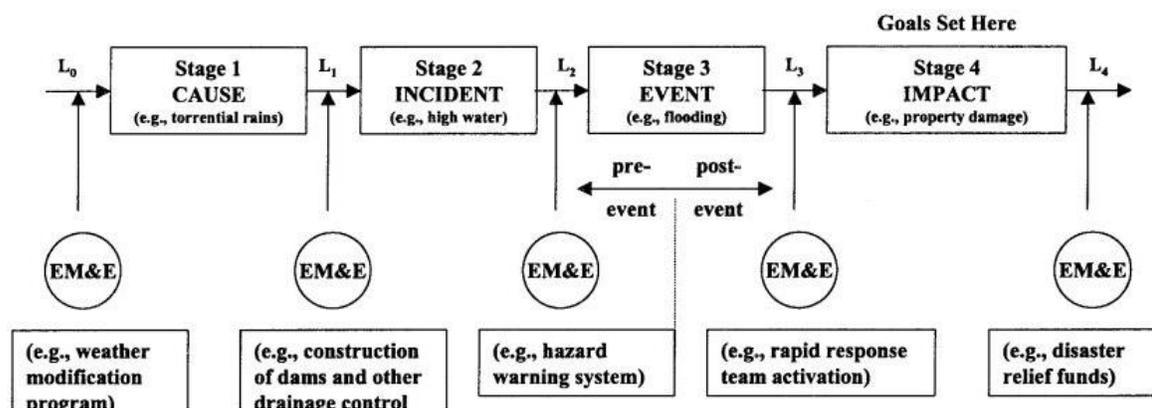


Figure 11 Impacts of emergency management and engineering (Tufekci & Wallace, 1998)

“pre-event and post-event response” (Tufekci & Wallace, 1998). Figure 11 shows the impacts of being prepared for a disaster in the different stages of the catastrophic event.

There are four pragmatic phases: mitigation, preparedness, response, and recovery in the United States’ comprehensive emergency management description (Altay & Green, 2006). The following table collects the multiple components of these operations (non-exclusive to rebuilding).

*Table 2: Typical activities of disaster operations management (Altay & Green, 2006)*

<b>Mitigation</b>	<b>Response</b>
<ul style="list-style-type: none"> <li>• Zoning and land use controls to prevent occupation of high hazard areas</li> <li>• Barrier construction to deflect disaster forces</li> <li>• Active preventive measures to control developing situations</li> <li>• Building codes to improve disaster resistance of structures</li> <li>• Tax incentives or disincentives</li> <li>• Controls on rebuilding after events</li> <li>• Risk analysis to measure the potential for extreme hazards</li> <li>• Insurance to reduce the financial impact of disasters</li> </ul>	<ul style="list-style-type: none"> <li>• Activating the emergency operations plan</li> <li>• Activating the emergency operations center</li> <li>• Evacuation of threatened populations</li> <li>• Opening of shelters and provision of mass care</li> <li>• Emergency rescue and medical care</li> <li>• Fire fighting</li> <li>• Urban search and rescue</li> <li>• Emergency infrastructure protection and recovery of lifeline services</li> <li>• Fatality management</li> </ul>
<b>Preparedness</b>	<b>Recovery</b>
<ul style="list-style-type: none"> <li>• Recruiting personnel for the emergency services and for community volunteer groups</li> <li>• Emergency planning</li> <li>• Development of mutual aid agreements and memorandums of understanding</li> <li>• Training for both response personnel and concerned citizens</li> <li>• Threat based public education</li> <li>• Budgeting for and acquiring vehicles and equipment</li> <li>• Maintaining emergency supplies</li> <li>• Construction of an emergency operations center</li> <li>• Development of communications systems</li> <li>• Conducting disaster exercises to train personnel and test capabilities</li> </ul>	<ul style="list-style-type: none"> <li>• Disaster debris cleanup</li> <li>• Financial assistance to individuals and governments</li> <li>• Rebuilding of roads and bridges and key facilities</li> <li>• Sustained mass care for displaced human and animal populations</li> <li>• Reburial of displaced human remains</li> <li>• Full restoration of lifeline services</li> <li>• Mental health and pastoral care</li> </ul>

In this table we can see that *mitigation* is the part concerning the building restoration risk management after a natural disaster: infrastructure, the building itself, the economy part, risk management and insurance (risk transfer). The rest; *preparedness* (training, equipment, etc.), *response* (mostly centered on life loss) and *recovery* (financial assistance and restoration of services) focus more on life saving measures. In other literatures, response doesn't refer exclusively to loss of life and is deemed as insufficient: it yields only temporary results at a very high cost (Coppola, 2006).

The recovery step in this thesis is represented by “restoration” which is discussed in the next chapter, while the mitigation is covered by the present and previous chapters.

When dealing with this kind of risk, natural disasters, we must know that it cannot be eliminated completely, but it can be assessed and managed in order to mitigate the impact of disasters (Smith and Petley 2009). We have seen that for example in the United States they categorized it in four steps which the wheel in figure summarizes it to what should be managed *ex-ante* and *ex-post*. This disaster management cycle resembles the idea of the bowtie of risk assessment in fig.13 which extends to more than natural disasters.

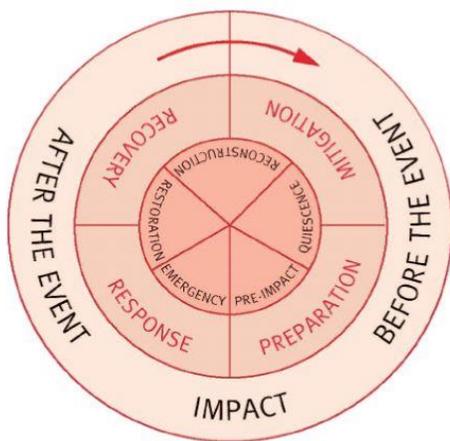


Figure 13 The Disaster Management Cycle (Alexander, 2002)

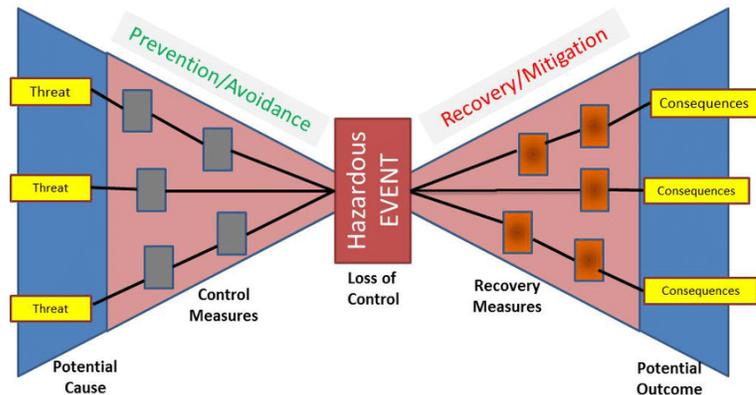


Figure 12 Bowtie Diagram (Parkinson & Bamford, 2016)

The main objective risk management aims to is minimizing the spending while maximizing the reduction of the negative effects of risks (Syed, 2008). One way to achieve that is to use a model approach (e.g.: fig.14).

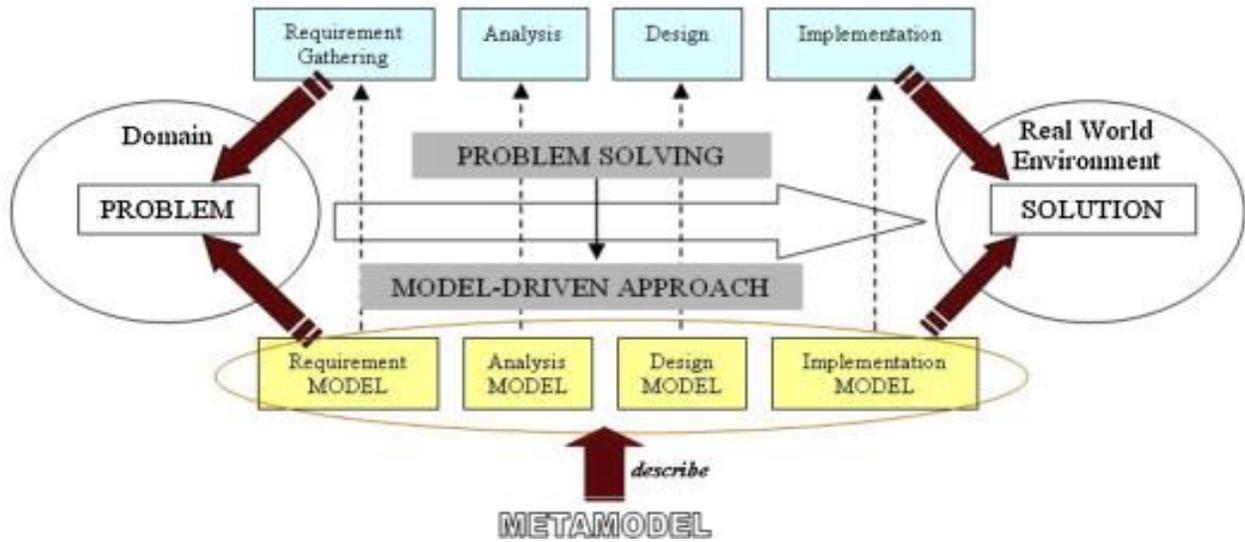


Figure 14 Problem solving through a model-driven approach (Othman & Beydoun, 2013)

Although prevention and avoidance would be ideal, they are not any easy tasks and most of the times not realistically achievable for a natural disaster. The main part in dealing with natural catastrophes focuses on how to recover fast and resume a business in the shortest period possible. We have seen in the previous chapters how important it is to contract an insurance company to transfer the risks. The two main risk management purposes are to ensure that adequate measures are taken to protect people, the environment and assets from undesirable consequences of the activities being undertaken, while balancing different concerns, for example safety and costs (T. Aven, 2011); In this thesis context, risk management would be a balance between the cost of insurance and barriers cost, and the benefits of those in the case of a natural disaster occurrence.

Risk transfer reduces volatility -the higher the volatility, the riskier the security (kuepper, 2019)- of performance at the cost of potentially higher overall performance (Freeman & Ch. Pflug, 2003), even though, when in practice, businesses are focusing more on the rarity of such events rather than their devastating outcomes. The damage and the cost of restoration tend to be huge if a tsunami or a strong earthquake hits for example, the risk transfer incurs cost in that period, and allows to use the other funds available for other matters (Freeman & Ch. Pflug, 2003) which gives sense to investing in a risk transfer to help recover the business.

### **4.1.1 Black swans**

A black swan concept refers to surprising events and outcomes. It comprises three types of surprising events (type 1 is included in 2 and 3):

“1. A surprising extreme event relative to the expected occurrence rate (extreme event in the sense that the consequences are large/severe, this understanding also applies to the interpretations 2 and 3 below).

2. An extreme event with a very low probability.

3. A surprising, extreme event in situations with large uncertainties (*see Appendix A*).

4. An unknown unknown.” (Terje Aven, 2013)

This thesis’ concern is about events of type 2, mostly: natural catastrophes happen, we know about them, but they are rare, so they tend to be neglected.

Especially for areas prone to being faced with natural disasters, this kind of events should not be considered lightly. The data may be scarce and the information on disaster losses plays a crucial role in disaster and risk management (Syed, 2008) but a business owner should be awakened about the importance of disaster risk management.

A highlight on this kind of black swans raises awareness that even if those events are rare, they exist, and they should definitely be taken into consideration when assessing risk and not be ignored by the decision maker.

### **4.1.2 Decision-making (and strength of knowledge)**

Risk management is a support to decision making, in fact, risk information supports decisions related to setting risk reduction priorities and measures, the design of risk transfer schemes, and disaster preparedness (Syed, 2008). Information is needed to know about risk with the objective of making the “right” decision clearer to the decision maker rather than keep it blurry. Syed mentioned risk reduction, risk transfer and disaster preparedness; the latter is achieved by the two previous ones among other parts of risk management steps. Mascali also underlined the role of risk management and wrote that to be effective, a response in a risk management solution must assist clients when and where they need it most. In-depth knowledge of mitigation procedures and the

insurance claims process becomes an extension of an insured's risk management department (Mascali, 2007).

As mentioned in the previous section, black swans, natural disasters are known, we do not have beforehand the exact magnitude an earthquake can hit or when or how many times it will hit an area in a business' lifetime. What we do know is that in an area close to a tectonic plate boundary, an earthquake will happen at some point no matter how far in the past this event last occurred. Information/ knowledge may not be about circumstances or their detail, rather, the knowledge is in most cases about the possibility for this type of events to happen and its general characteristics, i.e. if an extreme event is to happen and cause huge damage, the decision-making should be oriented towards the long-term as any major mishap can cause the business to permanently close. The details about the natural disaster itself cannot be gathered from the few data available and it may give information that is not close to what would happen in the future in terms of earthquake magnitude for example.

## **4.2 Business premises' Risk and Resilience**

The building codes are a key manifestation of risk-based planning in the building industry being the principal policy mechanism regulating the design and construction of buildings. They define the minimum level of threat that a building must be able to tolerate (probability-based ultimate strength design) (American Society of Civil Engineers (ASCE), 2017). A minimum level of "tolerance" of a building is not the optimal especially when it comes to a surprising strong disaster and the building is not designed to stand it. Also, the areas that have not experienced disasters before are increasingly likely to be exposed to new threats due to climate change (Syed, 2008) and so, they need to assess this risk while in the construction process.

It is important to know the building codes and regulations of the country in question and know how the building was constructed and if there were more things introduced that are related to its resilience that don't figure in the regulations; knowing the building helps know where to start and how to start its reconstruction.

The importance of risk management is in it being a systematic approach to setting the best course of action by identifying and acting on risk issues (Syed, 2008).

Risk management is a set of actions before, while and after a negative (or positive) outcome is probable. In the figure bellow we have the 8Rs and 4Ts of hazard risk management by Paul Hopkin as a summary:

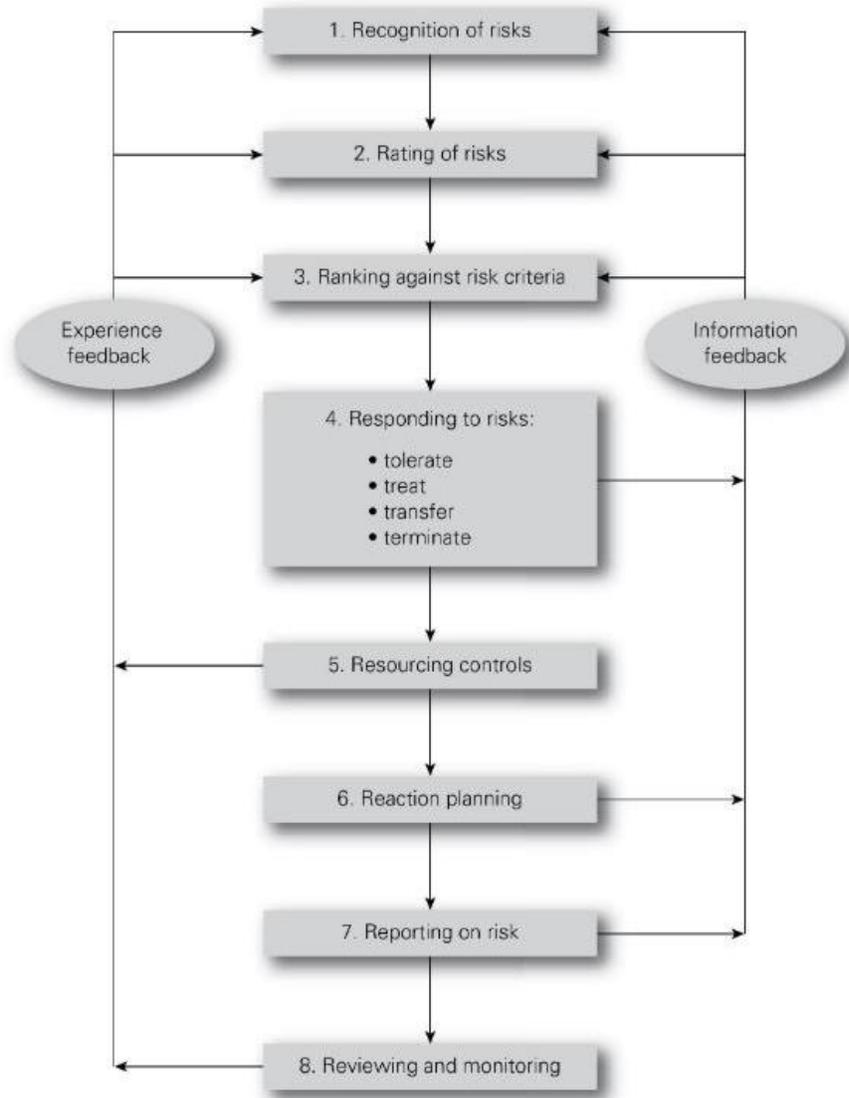


Figure 15 the 8Rs and 4Ts of (hazard) risk management (Hopkin, 2012)

Few major shortcomings are observed in the risk assessment and related risk management in their current implementation despite obvious successes (Sikula, Mancillas, Linkov, & McDonagh, 2015) and this is due to:

- (i) limited ability to account for emerging threat scenarios due to lack of past data on performance,

- (ii) focus on preventing failure of individual components through engineered solutions without consideration of the larger system due to the tendency to limit the scope to the quantifiable aspects of the system, and
- (iii) acceptance of a residual risk without preparation for their eventual occurrence (Bostick et al. 2018).

One way to complement those limitations faced in risk management is to consider the theme of resilience since it is closely tied to risk considerations and highly complementary; holistically reducing losses from stress requires both risk management and resilience (Kurth et al., 2019). Resilience helps meet the need to improve building functionality and timely recovery against multiple hazards (known and unknown risks) (Kurth et al., 2019).

The capacity of a business to face disasters, to be restored and resume its activities is its resilience. In this thesis, the focus is on the reconstruction of the business premises after a natural disaster occurs. The following definition of resilience by the NRC is going to be used: “[Resilience is] the ability to plan and prepare for, absorb, recover from, and more successfully adapt to disruptive events.” (National Research Council (NRC), 2012).

Three main objectives of resilience are described by Cimerallo as the 3Rs:

- Reduced failure probabilities;
- Reduced consequences from failures – in terms of injuries, lives lost, damage and negative economic and social impacts; and
- Reduced time to recovery – the time required to restore a specific system or set of systems to normal or pre-disaster level of functionality (Cimerallo, 2016).

Cimerallo also uses a performance indicator functionality of the system in function of time to express where risk analysis and resilience analysis' results are important when an unwanted event happens (see following figure).

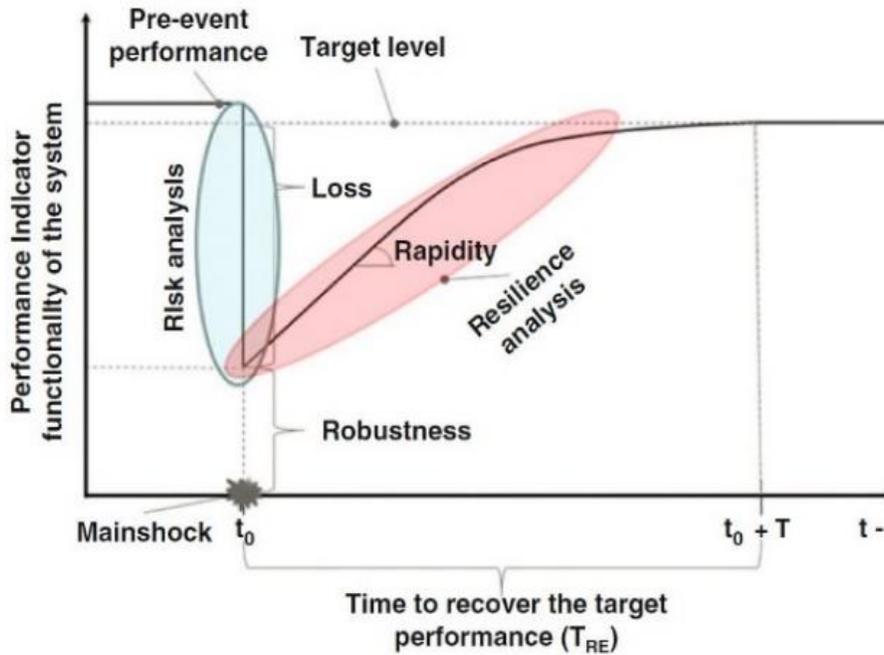


Figure 16 Risk analysis vs. Resilience analysis (Cimerallo, 2016)

Buildings are characterized by complex systems and have a unique set of performance and life cycle considerations, which require a unique resilience analysis to identify, justify and implement enhancements (Kurth et al., 2019). The curve below shows the different states of resilience of a building when an adverse event happens with a view of its performance before and after that event occurred. It puts the stress on the importance of all aspects and stages of resilience and that resilience should be thought of for the long term: no stage of resilience should be neglected as it affects the performance of the building post-event. (A full description of the curves is included in Appendix B).

Improving the resilience of a building resides in provisions within building codes that allow flexibility in design, facilitating innovative methods to increase their performance capability

(Kurth et al., 2019). This flexibility exists since there are no regulations ensuring the buildings will recover their usage after a disaster (Mieler et al., 2015).

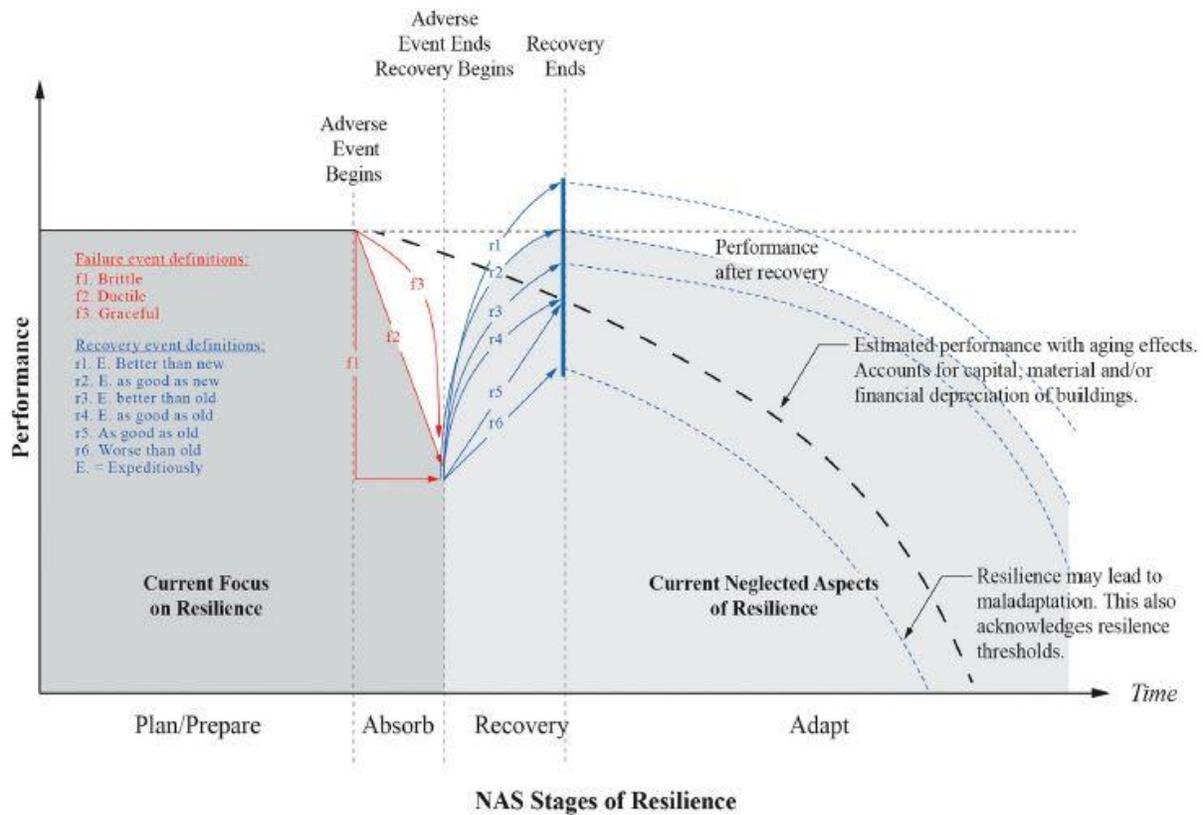


Figure 17 Resilience curve adapted from Ayyub 2014, Linkov et al., 2014b, NRC 2012. (Kurth et al., 2019)

Insurances, for instance, offer methodologies in form of certifications to mitigate some kinds of risks in new construction (e.g. hurricane) like the “FORTIFIED certification” by the Insurance Institutes for Business and Home Safety (IBHS) (IBHS, 2017; Malik, Brown, & York, 2013).

There is, of course, an economical challenge for the industry to set performance standards that account for the uncertainty based on a translation of a precautionary principle to a fixed quantification of social welfare and optimal resource allocation (Kurth et al., 2019). Quantifying what is subjective and uncountable can create misunderstanding and disagreement between the different parts of a contract but also between the risk manager and the decision maker.

## 5. Restoration/recovery

A structure is like a body; it sends warnings. The difference is that it does not heal itself nor are the warnings always obvious: it needs checking and restoration when it gets damaged by a natural disaster. There should be accurate revisits of how good the construction is after a disaster; it can reveal that a restoration could mean to tear the building down and build up a new one.

Restoration of a building is costly, and so it should be done in a way that the business is recovering the most important parts of the building first. Knowing which part of the business building is a priority, by the business itself and the construction restoration party, is essential. The construction company, if they are acquainted with the business and its functions, are able of wasting less time in figuring it out after a disaster strikes.

As we have seen in previous chapters, for example, a business interruption insurance has a time limit, so if the restoration is done in a concise manner, chances are the business is going to recover faster.

Usually, before an insurance company accepts to insure a building, it runs a check. This check is to know first if they will accept to sign the coverage in case anything happens, but also to check how much they will charge for an insurance or another. The vulnerability of the constructed items will depend on many factors. The table below specifies vulnerabilities resulting from different features of the buildings.

*Table 3 Features of Constructed Items and their Contribution to the Vulnerability of these Items (Ofori, 2002)*

<i>Features of Constructed Items</i>	<i>Resulting Vulnerability</i>
Location specific and immobile	Items are exposed to disasters which occur where they are located; they cannot be moved as a precaution.
Highly expensive	Impossible to test the completed item by exposing it to the full force of a possible disaster. Thus, simulations and limited tests applied which may not fully reflect the real situation.
Long development process	Planning, design and construction involve multiplicity of operations, with dispersed control.
Durable	Durability both a requirement and a feature. Item is exposed to elements and wear and tear which may weaken it.
Usage	Items are occupied and utilised for various purposes. Thus, disasters affecting them can lead to loss of lives.

This step done by an insurance, does not mean that the business has done its part in knowing the state of the building where it is held. Insurance does not mean all will go perfect, restoration is a combined work from the business, the restoration company -here the construction company- and the insurance. The contribution of three different entities requires communication and understanding as an important asset to achieve the expected goals.

The following subchapters will be about the restoration process of the building(s) where a business is run and the requirements for it. The restoration of the urban infrastructure and the supply chain are primordial, but this is not the subject of this thesis.

## **5.1 Restoration and recovery's important considerations**

*First*, it is to mention that after a natural disaster, the destruction can be either partial or result in total demolition (examples in chapter 2), so the restoration required could be structural and/or finish work depending on the damage inflicted. In occasions, there are no obvious damages, but the building will still need to be checked in case there are any vulnerabilities caused to the structure. *Second*, it is not uncommon to have a building where different businesses are held which can complicate the restoration as, of course, all businesses would want to resume as fast and have their own business as a priority or some may fail and cause others to waste time and money. *Third*, within the same business building, there can be a variety of functions, e.g. industrial and sales. The time required to recover varies by the amount of damage suffered, but also varies by the nature of the company's operations ("Salty" Schumann, 2013). *Fourth*, a restoration with the insurance help is meant to help rebuild the building to its former condition and not improve it; turning failures into strength would be on the company's costs. If only accounting in an insurance (replacement cost value) for building or renovating to original state only, owners and managers can get into trouble. The ordinance or law endorsement covers the expense of updating the property to any building, zoning or land use laws, since restoring a building to its previous condition is disallowed if it is not up to code (Hunt, 2010). *Fifth*, when contracting a restoration company, one must check if they are certified to do a restoration work related to the type of the natural disaster. For example, the flood damage to buildings can be classified into two main categories:

- damage due to direct contact: If the material used for the foundation is not water-tight or if the foundation is on or under the ground level, or if there are no barriers built in front of the door, the water can easily come into contact with the building. In this case, if the

building is not sufficiently water-tight, the water can infiltrate inside the building. This is going to lead to material deterioration and erosion, non-sanitary living conditions, and risk of drowning.

- structural failure: due to hydrostatic pressure, hydrodynamic pressure, debris impact, and a combination of these actions (Kelman & Spence, 2004).

The recovery of a business' load of work also varies according to the amount of efforts spent on the type of response the company has: reactive and/or anticipatory. According to McKnight & Linnenluecke (2017) through a research they did in the USA, business continuity management involves identifying two things: the exposure to threats and the resources and the capabilities a firm needs to mitigate the risks. McKnight & Linnenluecke (2017) in their article, constructed three propositions for each of the reactive responses only (a) or both reactive and anticipatory responses (b) of a firm to disasters comparing regions for erratic impact dispersion, uncertain reoccurrence intervals, and low warning. The ones that implement reactive responses only would likely be:

Proposition 1a: In regions associated with disasters possessing more erratic impact dispersion.

Proposition 2a: In regions where disasters have lower expected recurrence rates.

Proposition 3a: In regions associated with disasters providing less warning (McKnight & Linnenluecke, 2017).

The ones that implement reactive and anticipatory responses tend to be:

Proposition 1b: In regions associated with disasters possessing more even impact dispersion.

Proposition 2b: In regions where disasters have higher expected recurrence rates.

Proposition 3b: In regions associated with disasters providing more warning (McKnight & Linnenluecke, 2017).

The geography, then, has a strong impact on the business's risk aversion and how they consider risks and how they manage them and decide about the investments towards solving natural disasters' issues.

In risk transfer (insurance wise), it is important to understand the terms used in the policies and contracts. Every business is different according to its nature but also to the building where it is held, those specifications, if known by the reconstruction companies beforehand can help reduce the delays considerably, as any single day is important when it comes to resuming a business: The communication should be triangulated business owner(s)-insurance-construction company even before any natural disaster happen.

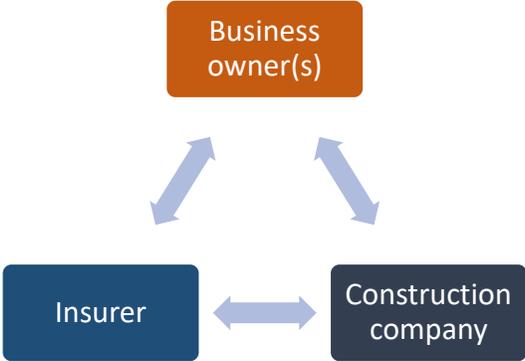


Figure 18 Triangular communication Business-insurer-construction company

When it comes to the restoration, it should be considered whether the carrier has a catastrophe unit that will come on site in the event of a disaster. The carrier’s history should also be checked to know if it weathered the storm after the last disaster or if it exited the market and whether it will be around when the business needs a claim paid (Hunt, 2010).

It is only after a disaster occurs that it becomes crystal clear the extent to which latent risk factors were present. Unfortunately, by then it is too late to prevent losses (Syed, 2008). So, before an incident occurs, there should be an identification and establishment of a relationship with an emergency restoration company to assist with clean-up efforts (Gadaire & Szczucki, 2016).

The building’s present condition, the risk appetite of the firm (how much risk is the business owner(s) willing to take? how much are they transferring? and when transferring, what are the details in the insurance scheme, what is actually insured? Knowing what help the government is possibly giving to the business.), the resilience of the constructed building, and finally, the construction/restoration company’s ability are the main factors/actors the business is supposed to know about, act on, control and manage tightly. These elements are important for a better and faster restoration getting the business back on track, ignoring them can very easily cause it to close its doors. Obviously, there are many other different factors most of which depend on the

government in question as when a natural disaster strikes the whole community is affected: employers and employees included.

In the chart that follows, Castillo (2005) is insisting on the importance of the relationship of a business with its customers. The figure is a set of questions the business owner(s) need to know before hand to be able to partially continue their business without losing their clients. If paid attention to the questions and how the business is prepared to answer them or not, the risk manager can detect what risk measure could be adopted in each situation.

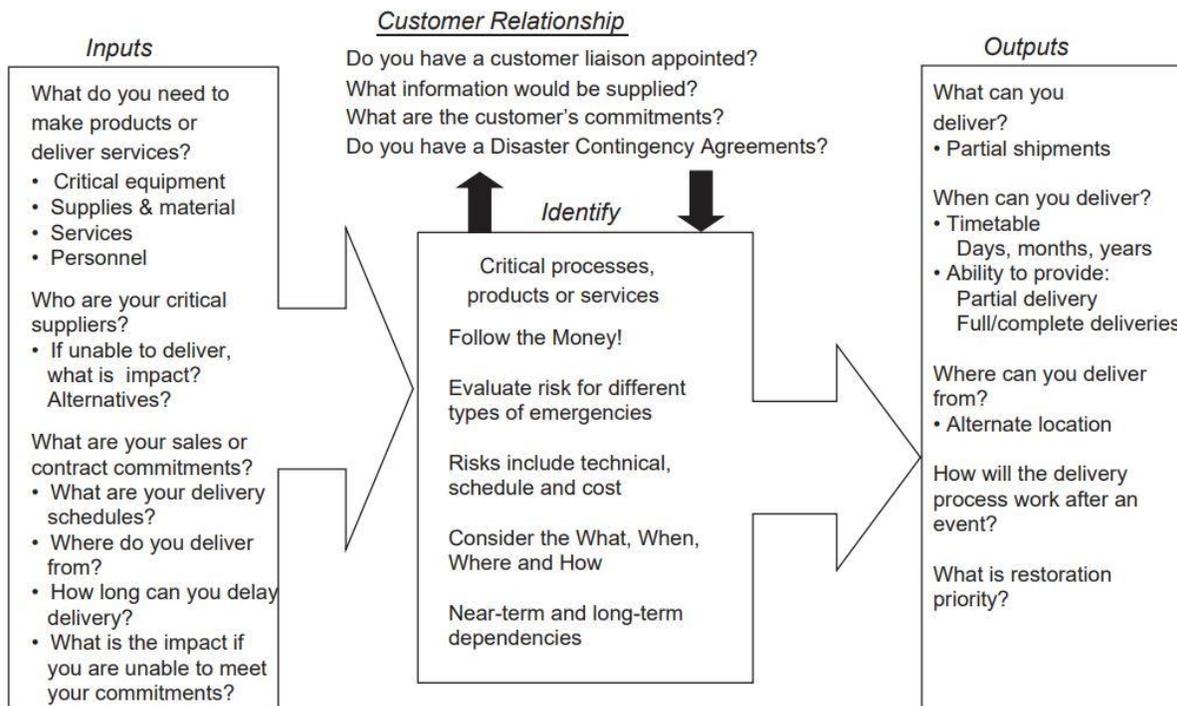


Figure 19 identifying critical assets/processes (Castillo, 2005)

Answering this questionnaire can in addition help the business continuity in ways that it can buy them some extra time meanwhile restoring the physical assets lost in the disaster e.g. the construction of the building.

Over and above that, the business constructed property takes place in a geographical area with its proper characteristics, and some areas are more prone to one disaster than another and this should be taken into consideration as well. As a matter of fact, the geographical properties contribute in the decisions of the design of the building, the natural disaster the area could be exposed to and the access to the location of the building before and after the catastrophes. Companies that take

local geography into account demonstrate stronger identification with their local environment which is an important component in developing a sense of place (Shrivastava & Kennelly, 2013; Whiteman & Cooper, 2000). This sense of place strengthens the awareness about the kind of catastrophes possible in a specific area.

Construction companies are also able to advise what kind of insurance the business might need or preferably use since they supposedly know more about the geography, the construction and what kind of natural disaster is more plausible along with its possible outcomes. Membership in particular industries such as construction that perform better following disasters is important (Webb, Tierney, & Dahlhamer, 2000). A construction company then serves as expert knowledge input in the risk management and resilience management within a company. Moreover, the outcomes of risk assessment enable prioritized decisions (Zio, 2018).

A business that proves to recover fast and keep its clients, inspire more trust and client fidelity; firms that respond effectively stand a better chance of preserving competitive advantage (Herbane, Elliott, & Swartz, 2004). The quicker the physical constructed locale is restored, the shorter the business interruption and so increasing chances of keeping the clients or even enhancing the competition with businesses of the same type for proving better resilience.

## **5.2 Restoration and recovery process**

To be able to establish a restoration process related to reconstruction and restoration of a business premises, an organized to-do list can have a huge impact on property loss and the amount of time a business spends out of commission (Hunt, 2010). A restoration process should be personalized to the type of business and the kind of natural disaster, but in general terms, a process in case of a natural disaster has some clear but also some unobvious steps to follow for a better recovery.

So far, along this thesis, we have already seen different ways to shorten and help with the recovery.

What a business should do after the disaster is summarized in five general reaction steps:

1. Communicate with employees, customers and stakeholders.
2. Contact your insurance company.
3. Use your online presence to help the community.

4. Check your backed-up data.
5. Evaluate your business model (Post, 2017).

In this thesis, it is to stress the importance of having established, beforehand, a relationship with a construction company that is supposed to restore the building after a natural disaster. A second step of communication after communicating with employees, customers and stakeholders then, should be to contact the construction firm in order to be ready to further clarify any claims related to the insurance and to have an estimate related to the claim and the rest of the extra expenses that the business is not insured against.

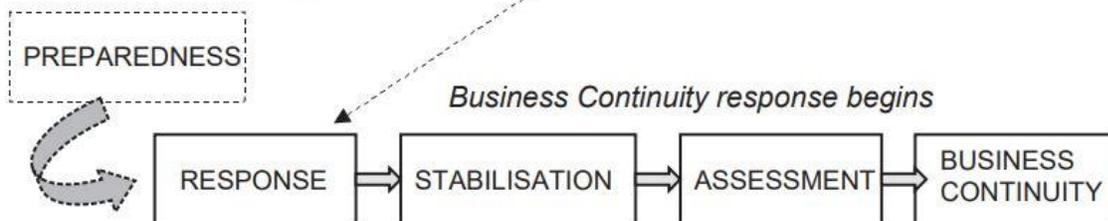
Business resumption activities cost a lot more than business continuity activities (Castillo, 2005). Business continuity management is defined by ISO as the capability of the organization to continue delivery of products or services at acceptable levels following a disruptive incident ISO (2012), while the business resumption requires the cost of rebuilding the whole locale for example, while Resumption equates with the recovery of processes(Castillo, 2005).

#### Disaster Preparedness Model



*Once the event stabilizes*

#### Business Continuity Model



*Business Continuity response begins*

Figure 20 integrating disaster preparedness and business continuity models (Boeing).(Castillo, 2005)

Steps for this business continuity model were represented by (Castillo, 2005) in the following figure about what roles should generally be in each step of it.

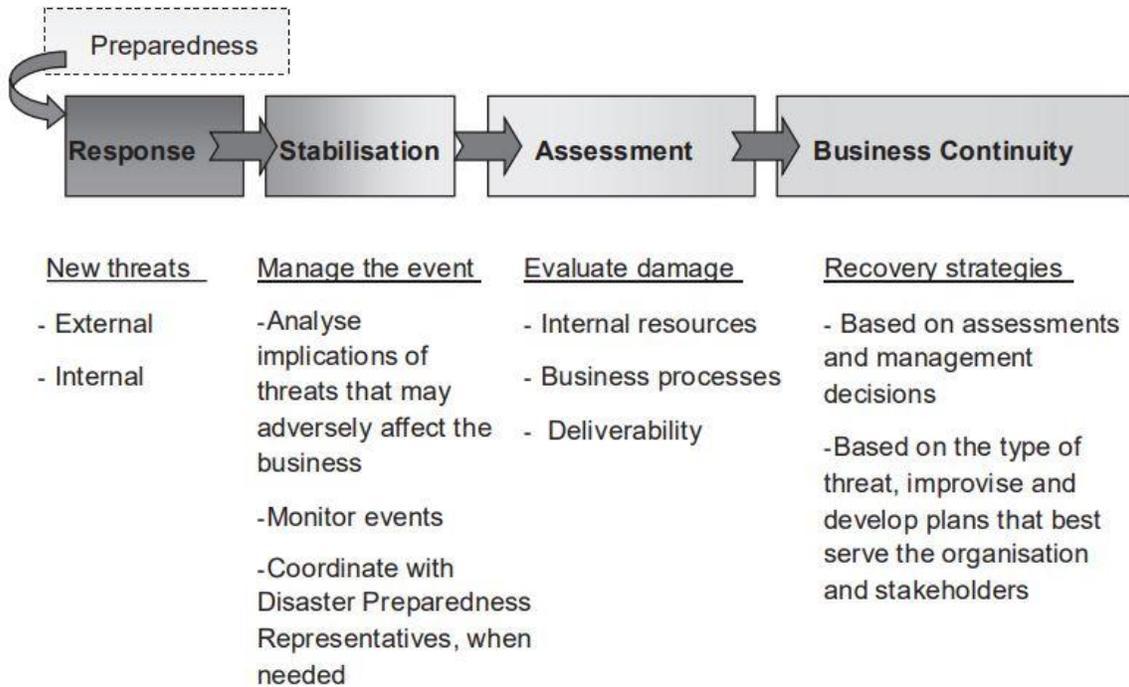


Figure 21 Business continuity representative role (Castillo, 2005)

These steps can be anticipatedly planned using scenario analysis and checklists, which will be discussed in the following chapter.

## **6. A suggested framework to improve risk management for natural disasters**

Since minimizing costs and speeding business resumption are the objective, companies must act confidently and quickly after a catastrophe, though many are not fully equipped to confront major catastrophes head-on (Mascali, 2007). This is a call for a better preparedness to an improved response, and what is better preparedness than having an idea of the scenario of the restoration process in mind in order to know the steps to follow instead of starting to think about them after the disaster occurs.

One part of the framework suggested in this thesis is to have a checklist -detailed as much as possible at the moment of risk assessment- of the steps necessary to follow, in case of each possible natural disaster the area has a probability to be exposed to, including the construction company and the insurer's part in it and which step they are intervening. This list should express what risks the business is taking and which is transferred; which means, it should be done with the help of a construction company who knows the business and the insurer.

To be able to build these checklists, a scenario analysis will be part of the framework in order to have more accurate checklist(s) that fit different scenarios about the outcomes of the catastrophes.

The two parts of the suggested framework will rely on good networking and partnership so that the engagement of experts in construction would make it possible to spot the different vulnerabilities concerning the building. This established relationship between the business owners and the construction company will help in the making of a more accurate checklist and scenario analysis.

The scenario analysis and the checklists, involving experts, can be of additional time and cost, which, depending on the size and nature of the business add extra expenses to the business risk reduction in terms of faster response to natural disasters.

### **6.1 The framework starters**

To initiate the framework, meetings should be held between the business owners, stakeholders and other employees to first discuss the areas possible natural disaster according to its geography and disasters history. This type of information can be gathered through experts in the domain (e.g.:

geologists) and available information websites. When collecting this information, it is not the probability of the natural catastrophes happening that are discussed, rather, their possible occurrence.

An awareness of the risks should rise to better understand the need for the upcoming steps and the importance of all actors in its development.

Afterwards, the business actors should collect a list of the different restoration companies they will contact in order to choose commonly which one is most reliable and experienced in the reconstruction after such disasters happen. The discussion includes contacting the chosen companies and asking for their references. Six requirements in choosing a contractor according to the president and CEO of Interstate Restoration in the USA, Stacy Mazur, are:

1. Asking about the safety program.
2. Checking the provider's ISNetworld rating (ISN is an internationally recognized third-party consultant that many Fortune 1000 companies use to validate contractors to ensure they are meeting the highest safety standard possible.)
3. Asking the contractors for references.
4. Thinking about the big picture: consider the provider's expertise, processes and the depth of resources it will have during a hectic time when every passing day can impact the health of the business.
5. Being careful about price-shopping.
6. Planning together: Practicing before an event allows the restoration contractor and any other parties involved to launch into action the moment disaster strikes (Mazur, 2018).

Once this step completed, a list of pros and cons should be facilitated to have a better view of the difference options to choose from.

Through these meetings, the business is ready to establish a relationship with a restoration partner of their choosing. The role of this partnership is part of the following subchapter.

## **6.2 Roles of establishing a partnership with a restoration company**

As seen in the previous chapter, establishing a work relationship with a construction company helps improve the business resumption. It is then interesting to have it as part of the suggested

framework not only as a complementary step but also as the main element for acting on both previously presented parts of this framework.

This partnership will also speed up the start of the restoration work as time of looking for a contractor at the last minute will be saved.

Companies hold different risk perceptions regarding their ability to prepare for different types of disasters, which might ultimately contribute to their level of disaster preparedness and response (McKnight & Linnenluecke, 2017) and so, establishing a partnership with a restoration company would help in the acknowledgement of such a risk. Knowing what kind of impact to expect leads to better decision making by changing the perception of a low probability and high impact risk such as a natural disaster. Hence, the quality of relationships with others influences how they deal with uncertainty (Richard Eiser, Bostrom, Burton et al., 2012).

How to establish this partnership will be dependent on its risk perception, the size of the business, its ability to choose an experienced in natural disasters contractor and its ability to maintain a work relationship they might not see as important.

When work material is clear, the work flows with less disruptions. So, when the whereabouts of the business are introduced to the restoration company, and when the importance of the different areas of the business premises and their priorities are set, the restoration company will have a better-defined approach to the remodeling.

To take advantage of this partnership, the business can use their expertise to know the insurance specifics and needs that the building requires for the case of the possible natural catastrophes previously discussed in the meetings.

### **6.3 Insurance**

Before using this framework, the business might already have an insurance, related or not to the natural disasters. They should look through the terms of their present insurer and look according to the outcome of the previous suggested framework's steps what else still needs coverage or if they need to find a way to change their contract with their insurer.

If they have not yet contracted any insurance, the input of their restoration partner will help contact the appropriate insurance and coverages.

From chapter 3, the importance of having an insurance for this type of risks is seen as essential to covering the costs of restoration, the business interruption caused by it and resuming the business.

In the process of contracting an insurance company, no detail should be overlooked and everything in the contract should be understood according to the insurer's language. This will diminish misunderstanding and time wasted in the process of getting the needed coverage from the insurance.

#### **6.4 Scenario analysis, identification of risks**

To have part of the restoration prepared in advance, in the sake of saving time, a “what if” analysis that deals with limited scenarios can be a helpful way to proceed to scenario creation. The formulation of scenarios by the analyst is enabled, in practice, by the building of a hypothetical world allowing them to query and navigate (Rizzi, 2009). A what-if analysis is a simulation tool with the goal of inspecting the behavior of a complex system under hypotheses called as a predictive system (Rizzi, 2009).

For this framework, it is suggested to use the “what-if” analysis in a way to prepare scenarios of the possible damage to be affecting the building (Low-high) and what can be done to restore and rebuild faster. The scenarios of impacts allow the building of scenarios for recommendations and steps to follow for different possibilities.

Knowing in advance what is going to be part of the risk transfer and what is accepted - when it comes to the costs- can improve the risk preparedness for possible natural disasters. This is not a what-if analysis in the broad term, meaning; it will not be running in Excel for the sake of looking for the outcomes to modifying different inputs, instead, it is meant for the creation of a scenarios in order to be acquainted with different consequences and be a basis for knowing how to deal with them.

The scenarios should be created in accordance with the magnitude of the disaster happening and the damage it might cause to the building (it is impossible to have all the scenarios, but to approach different levels of impact to the building is requested), to have a view of what the restoration would be. That should include:

- Possible natural disasters (e.g.: depending on the closeness to the sea, to the tectonic plate boundaries, history, etc.)
- A range of magnitudes for each natural disaster
- The business premises' different functions
- The parts of the premises to be prioritized in the rebuilding process
- The possible damage/impact
- A set of possible reactions/responses
- The portion of the cost that goes to insurance
- The cost of recovery taken by the business
- Possibilities to have extra barriers to prevent or reduce the damage
- (Other specifications varying due to the business nature, size and complexity)

Note that the business owner should have the building plans and all the important files updated and safe, so they don't get damaged or lost because of the disaster. This will make it easy to navigate the building and check recovery plans.

The scenario analysis itself will be performed by the business actors with a great part of it facilitated by the restoration company as a great deal of it is related to construction damage.

## **6.5 Checklist, risk response**

From the outcome of the scenario analysis, a checklist is a simple and handy tool to extract and use results to speed up the business resumption following a natural catastrophe.

A business can make a checklist, according to which, in case of a natural disaster, it will be easier to go through the response and restoration steps. This checklist will use the outcomes of the scenarios analyses and go through the response steps for those scenarios to how and who the responsibilities go to, internally and externally.

Making the checklists require meetings and communicating with both the restoration company and the insurer.

The general points the checklist should include are (not restricted to):

1. Parties to contact in order of relevance
2. The financing parties
3. External resources, estimation of how much of the cost would be transferred to the insurer
4. Estimation of the cost taken by the business
5. Internal resources to meet the cost and capabilities to do so
6. Allocation of responsibilities
7. Vital components of the business
8. Scheduling a crisis plan of response
9. If applies, know who to contact in case of hazardous material spills or discharges

This checklist should be understood by all the actors taking part in its creation and its execution.

## **6.6 Further meetings**

Other meetings should be scheduled later as business functions and employees may change. The business might also be renovated and remodeled. In this case, not only employees and stakeholders should be present in the meetings, but also the restoration company, and eventually the insurer. All parties should be updated and discuss any implications of the change.

Meetings should also be held internally as part of the overall risk management of the business to insist on the importance of the disaster preparedness and the roles of each responsible (internal and external) in the execution of the checklist steps and prioritization.

## **6.7 Summary of the framework**

The suggested framework has three main components that go by the hand:

- An established partnership with a restoration company
- Scenario analysis
- Checklists

Significant benefits are achieved by preparing beforehand what cannot be avoided when the impact is high, even when it has a low probability of happening.

How to proceed:

1. Meetings between the business owners, stakeholders and other employees to discuss the probable natural disasters to the area where the business is held
2. Discuss which restoration company to contract
3. Establish a partnership with the chosen company
4. Introduce the contracted company to the whereabouts of the business
5. With the restoring company discuss the importance of the different business premises' areas
6. Also, the business should discuss with the restoration company the impacts on the building to set reconstruction priorities
7. Discuss the insurances to contract and the different coverages with the help of the restoration company's insight
8. When choosing an insurance, carefully study the contract specifics and the insurance language implications
9. Scenario creation
10. Perform scenario analyses
11. Make simple and specific checklists according to the outcomes of the scenario analysis for each responsible party and range of damage
12. consider further meetings:
  - to insist on the importance of the disaster preparedness and the roles of each responsible (internal and external) in the execution of the checklist steps and
  - on the events of making relevant changes to the building and the business stakeholders and the responsibilities for the execution of the checklists.

The insurance is understood and assumed here proven to be essential, as discussed in previous chapters. The main improvement this framework gives is preparing and planning the steps to follow in a clear and simplifying manner so to prevent time wasting after a disaster strikes.

## **7. An example of the application of the suggested framework**

For this example, a fictional café with a bakery business, called “ZenCup (ZC)” in a low-lying coastal area X (5km from sea shore) is taken. This area is prone to earthquakes and tsunamis according to its closeness to the tectonic plates and to the shore in addition to its history.

The development of the framework’s implementation is given in section 7.1 through the steps presented in the framework summary in section 6.7. The benefits of having it implemented in the unfortunate event of an earthquake is presented in section 7.2.

### **7.1 Implementation of the framework by ZenCup business**

Zencup business owners decided, after watching the news about a Tsunami that hit Indonesia on December 23<sup>rd</sup>, 2018, to prepare for natural disasters that can hit their region. They agreed to follow the steps on the suggested framework in this thesis (section 6.7).

- **Framework starters**

ZenCup business owners gathered with their employees and stakeholders to check and discuss the possible natural disasters their area is prone to. After contacting the regional municipality for some insight and their search on the internet about the history of natural disasters, they have decided that:

- the area is prone to earthquakes (close to tectonic boundaries) and,
- the area is possibly prone to Tsunamis (close to tectonic boundaries and the sea) (1).

The meeting ended by the business owners and stakeholders tasked to look for potential restoration companies and ask about their references. This task is a preparation for the next scheduled meeting to decide on which company to partner with.

The meeting was held, and they decided on an (fictive) experimented restoration company called “Back&Restored (BR)” (2).

- **Roles of establishing a relationship with a restoration company**

The business owners of ZC contacted the restoration company and partnered with them on the basis of attending any needed meetings to prepare for disasters and, being ready to come on site with skilled workers and restore their building with no delays (3).

ZC business owners met with BR to get them to know how their business and its premises function. BR representatives had a tour on site with presentation of relevant information (4) and then they gathered to discuss the priorities on the reconstruction if needed. ZC created a priority list for their business where the Café side has more priority and presented it to BR (5).

BR requested having the plans of the building and specifications so they can study the vulnerabilities of the premises and the possible impacts of both Earthquakes (intervals of magnitude) and Tsunamis (height and speed) and give advice for any modifications if they see needed (6).

- **Insurance**

After BR studied the building and its specifics, ZC suggested a meeting to use their expertise to find the most suitable insurance coverages to their needs and capabilities of payment. Since the area is prone to earthquakes and is close to the shore, and from the restoration company's expertise and knowledge of insurances, insurance on earthquakes, flood and business interruption were highly recommended. ZC took advices from BR on the insurer to contract and the specifics of their coverages. ZC ends up considering a (fictive) insurance company called "WeInsure (WI)" (7).

ZC, before signing the contract with WI, reads through the contracts offered and tries to get clarifications on the ambiguous terms in it. They used the insight of the restoration company to help sign what they really need for their business (8).

- **Scenario analysis, identification of risks**

The scenario creation is mostly prepared by the restoration company as the scenarios include expertise in the building sector. In the case of an earthquake, the damage to the building varies depending on the magnitude of the earthquake and the closeness to the epicenter but also on the resistance of the building itself. BR choose to work on three intervals of magnitude for the scenarios (Magnitudes on Richter scale fig.22).

# Earthquake Magnitude Scale

Magnitude	Earthquake Effects	Estimated Number Each Year
2.5 or less	Usually not felt, but can be recorded by seismograph.	900,000
2.5 to 5.4	Often felt, but only causes minor damage.	30,000
5.5 to 6.0	Slight damage to buildings and other structures.	500
6.1 to 6.9	May cause a lot of damage in very populated areas.	100
7.0 to 7.9	Major earthquake. Serious damage.	20
8.0 or greater	Great earthquake. Can totally destroy communities near the epicenter.	One every 5 to 10 years

Figure 22 Earthquake magnitude scale and classes (UPSeis)

The interval from 2.5 to 5.4 is ignored since BR sees that the building can withstand this earthquake levels with no problem. They study, then, the impact on the building for the following intervals with the different directions of the seismic movement:

[5.5,6.0], [6.1,6.9], [7.0 or greater].

For the tsunami scenarios, the building is considered too close to the shore and at low altitude, also, the restoration company valued the building as not able to fully withstand a tsunami wave which will lead to (the tsunami waves depend on too many factors. For the example simplification, the cases will be distinguished depending on the amount of damage):

- partial destruction (windows, separation walls) with its subcases
- total destruction (the whole structure fails) (9).

From the scenario creation, the scenario analysis start by BR evaluating the possible damage on the building for each interval and the vulnerability of the different facades and their exposure. From this analysis, an estimation of the costs of the damage categories is made (10).

- **Checklists, risk response**

After the restoration company's work on the scenarios, a meeting between ZC, BR and WI is set to discuss the steps that will be part of the different checklists and for the different responsibilities. The checklist are then made according to the different scenarios and responsibilities. A Simplified

example of the checklist is illustrated by the main action list for the business owner responsible for the follow-up on the restoration progress (11):

Earthquake checklist.				
Case: Main action list				
Responsible: Business owner of ZenCup				
Step Number	Step	checked	In progress	Comments
1	Call the restoration company BR to check the building damage and start the restoration <ul style="list-style-type: none"> <li>• which area has been damaged?</li> <li>• Structural damage?</li> <li>• Area priority?</li> </ul>			
2	Get a reconstruction cost estimation <ul style="list-style-type: none"> <li>• Overall cost</li> <li>• Finishing works cost</li> </ul>			
3	Contact the insurer, WI, and get a coverage estimate			
4	From the transferred cost and the whole cost, check the part of the cost that will be paid by the business ZC			
5	Meeting with BR and WI for updates on work progress and financial situation			
6	Others			

Figure 23 a checklist example

○ **Further meetings**

The checklists may need to be modified if the building conditions or the responsables of the checklists have changed which will require update meetings with the concerned parties (12).

## 7.2 Benefits of the framework in the event of an earthquake

The area X was shaken by an earthquake of 6.2 Richter causing considerable damage to the building.

ZC in this case will have to check the checklists that match the earthquake interval [6.1,6.9] and make sure that all parties are on site and ready to operate whenever the surrounding infrastructure allows it.

ZC will not have to look for a restoration company at last minute since they are partnered with BR. They know the insurance specifics and have an idea of the coverage for the present disaster situation. The responsibilities are already split beforehand, and the business priorities are set.

The business owner, the employees, the restoration company all should be having their checklists to follow as an agreed plan of action. Change orders from the construction company will be reduced as they have been acquainted by the business nature and the business premises. The ex-ante preparation will then allow a quicker start of the restoration work and less money spent on it to recover the business in shorter period than if this framework was not implemented. With the proper planning, a good restoration contractor should be able to reduce a business's cost of getting back on its feet by 20% to 50% and reduce downtime by as much as 50% (Mazur, 2018), which makes a huge difference for the business resumption.

### ➤ Output of the Framework

The benefits of the present framework on the preparedness's output for the business is summarized in the table below according to the utilization of each step and their combination as a framework.

*Note that:*

- Since the example and the area the building is are fictive, the comparison is made based on the utilization or not of the different components of the framework instead of a direct comparison with other frameworks. Natural disasters are happening all over the globe and each country and business uses different framework.
- For the same reason, any governmental and/or international help is not mentioned in this example.
- The levels are described relatively to the business being considered small in this example.

- The importance of the components of the framework is based on what is explained and discussed in the present and previous chapters.
- The saved time after the natural catastrophe implies saving money; the cost is mentioned when it is direct cost saving.
- Any day delay in the restoration process is a considerable/significant delay as any single day matters for the business interruption and losses.

Table 4 The output of the different framework stages, singled and combined into the framework

Preparedness improvement (steps in section 6.7)	Expected cost: Low, Medium, High	The added value in the ex-post	If the element is not used, expected time of delay is: Significant, Insignificant	If the element is not used, expected cost of delay is: Low, Medium, High	Comments
1	Low	Time	Significant	High	The identification of risks is <b>key</b> to all disaster preparedness
2	Low	Time, Quality	Significant	Medium	Having a work relationship with the right restoration company, saves time and costs and dismisses misunderstandings and reworks
3	Medium	Time, Cost	Significant	Medium	
4	Low	Time	Significant	Low	
5	Low	Time	Significant	Low	
6	Low	Time	Significant	Medium	
7	Low	Time, Cost, Quality	Significant	High	
8 (part 1: specifics and implications of the coverages)	Low	Time, Cost	Significant	High	

8 (part 2: contracting insurance)	High	Cost	Significant	High	
9	Medium	Time	Insignificant	Medium	
10	Medium	Time, Cost	Significant	Medium	Scenario analyses reveals vulnerabilities to different levels of impacts and their possible outcomes
11	Medium-Low	Time	Significant	High	Checklists help speed the process of restoration by having clear steps to follow
12 (part 1: no changes made in the building or responsible parties)	Low	Quality	Significant	Low	Meetings to update the changes made in any relevant component of the checklists are mandatory for the preparedness as some changes can make the former checklists obsolete.
12 (part 2: changes made in the building or responsible parties)	Low	Time, Cost, Quality	Significant	Medium-High	
<b>Combination (1-12) of the framework as a whole.</b>	Medium-high	Time, Cost, Quality	Significant	High	The suggested framework improves how fast the business resumption is on different levels as the combination of steps provides a fast-reliable start and functioning of the restoration; Apart, these elements are less successful.

According to this table, the suggested framework has an impact on the improvement of the preparedness to set in motion a quick and more reliable restoration process. This framework also increases the level of knowledge strength as the restoration company knows more about the business premises and the business has more knowledge of the risks and the insurance policies (See classification in appendix A).

## **8. Discussion**

Natural disasters are known to be a high impact risk with low probabilities of happening, this probability changes from one area to another for different kinds of catastrophes. They can cause serious damage to the construction or even its total collapse.

The prediction time of these risks coming up doesn't allow to prepare and plan for the recovery, and even then, one cannot know the exact outcome.

A tsunami for example has two different effects: one being chemical, flood-like, and the other is physical as it comes at high speed and carries with the sea water: debris, trees and vehicles. These two damage forms to the construction come in all magnitudes. Damage will depend on the closeness to the shore for example, and how high is the tsunami wave, how resilient is the structure, etc.

In the following, the role and appropriateness of the suggested framework for business resumption in the aftermath of a natural catastrophe will be discussed.

### **8.1 The role of the suggested framework**

The risk perception of a business changes its priorities. Normally, businesses aim for more benefits and low cost. The implementation of risk reducing measures and time for planning recovery are taken lightly when it comes to natural disasters, one issue being the non-contracting of proper insurance because it is expensive, and the probability of such events is low and/or they just didn't live the event in the business lifetime.

The other issue is, when the unwanted event happens, a lot of time is wasted looking for a restoration company while the demand is high due to the extent of the disaster in addition to trying to manage the restoration and its costs.

Scenario analysis of the different possible damage to construction, according to the different possible natural disasters, clarifies the expectations to be considered in the planning of a recovery. In this part, the restoration company has a big role in identifying the building's structural and nonstructural properties and their reactions. The partnership between the business and the constructor also introduces the latter to the business needs, premises-wise, to understand better how to approach the restoration when needed.

The scenario analysis also includes the insurance specification to each set of damage and the catastrophe causing it with an estimation of the covered costs. The insurance specifics and language must be well understood to be able to approach the scenarios.

This part done, checklists should be made according to those scenarios for different responsibilities, be them internal or external. Every checklist is chronologically ordered to serve the purpose of timesaving. Priorities should be easy to spot in all checklists.

Checklists are made to save the time of solution-thinking and to lower the management's stress after a disaster. They are also helpful to avoid making preventable mistakes when trying to solve the different problems faced.

Of course, to make a checklist that is priority oriented, a good understanding of what should be done and how much time it might take to perform every step in the way, relies on having a partnership with the restoration company present in the making. The restoration company has the adequate expert knowledge input in these regards and will be the responsible for performing the reconstruction, which makes them accountable for their estimations.

Also, in this part of the suggested framework, the position of the insurance's contribution in the process is clearer and would be understood as to what extent the costs will be covered and what situations it will apply to, reducing so, an extra waste of time regarding any upcoming disagreements on the insurance language.

Overall, the role of this framework is not to avoid the occurrence of a surprising event, but to prepare for its occurrence reducing the risk of long business interruptions due to reconstruction and the costs that it implies. This framework improves the resilience of the business to the adverse events by simplifying the steps to take and to check in the aftermath of a natural disaster beforehand.

## **8.2 The appropriateness of the framework for business resumption**

The present suggested framework is an attempt to simplify the tasks for the business to perform after a natural catastrophe strikes. Simplifying tasks are two faces of the same coin. On the one hand, tasks are easier and clearer to perform, on the other, simplifications can result in

misunderstandings and scarcity of information. To avoid this issue as much as possible, meetings should be held, with all involved parties (including the insurer), for clarifications and adjustments.

Providing any type of input from a restoration company can result in extra payments that the business might outlook as unnecessary and avoid establishing a partnership. Same for insurance, there are expenses to prevent the business doors to permanently close so, a closer look by the business owners should be given to the aftermath and its outcomes.

The application of the framework relies on the use of the insurance, expensive for natural disasters but is a rescue craft when needed. Contracting an insurance is the primordial solution to bringing back the business and is deemed essential for this type of events, will they unfortunately happen.

The application of the framework also relies on the restoration company's partnership with the restoring company. The business owners should do a good checking of construction market before going on a partnership with a restoration company that may have poor expertise. If not, it can result in a vain partnership and the framework will be bound to fail in completing its objective even if all the ingredients are present: the strongest the knowledge the lesser the surprise.

Thus, the framework starts with the assumption that the three main actors are in and are reliable in doing their part of the job. It is also assumed that these three communicate when needed for the better understanding and clarifications.

The scenario analysis in the present framework cannot be expected to be complete or precise as it is not possible to detail every situation or cover all the possible scenarios and all their aspects. The point here is to have a close idea of the impacts on the building and studying scenarios that are meaningful in the study of cases. The scenarios should allow the creation of appropriate, clear, structured and flexible -according to small variations in amount of damage in the same category- checklists.

Since the scenarios are not thorough and cannot go into the last detail of an outcome, the checklists need to entertain an admissible flexibility. The availability of the responsibility carriers and their ability to perform the checking and the following of checklists can be questionable, either for their competences or for the human life-threatening nature of the disastrous event; life loss and injuries. The implication of the unavailability of either internal or external people able to use the checklists

will have negative consequences on the performance of the framework. There should be backup actors for this situation that are present in any meeting the business carries.

Apart from human resources, checklists must be kept safe from any damage and have backup copies.

Assumptions about the framework, its execution and the availability of the concerned parties play important roles in its success or failure.

## 9. Conclusion

The main objective of this thesis is to provide a suggestion of a framework to improve the rapidity of business resumption, while insisting on the importance of having the adequate insurance for that.

Natural disasters are not frequent, but they can result in massive destruction. A preparedness for this type of risks is recovery oriented. On this basis, the knowledge of what to expect from a natural disaster, having a proper insurance, establishing an adequate partnership with a restoration company to have a plan of action ready is likely to save the business from a permanent closure.

To spot the possible improvements and suggest a framework, the following steps have been taken:

- First, there is a need to know what the characteristics of the possible natural disasters are,
- Second, after being aware of the risks, the intuitive reaction is to transfer the risk to an insurer. The problem in this case is that insurances are expensive and diverse, and the natural disasters in one area are rare.
- Third, after understanding that an insurance can save the business from ruin, it is important to plan and be prepared so to save time, which implies saving money and saving the business
- Fourth, to be prepared knowing how damaging a natural catastrophe can be, it is also important to think about the restoration and recovery processes as to what considerations to take.

These points helped shape the following suggested framework for improving the business restoration:

- Establishment of a partnership with a restoration company
- Creating a scenario analysis and gathering the different outcomes
- Making checklists for the different involved responsables on the different scenarios.

Simple and clear checklists decrease misunderstanding and increase time saving where time is literally money.

Given all the restrictions after a natural disaster, planning for a hard time on times of ease, can greatly speed the business resumption, and so, prevent a business shutdown.

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## **Appendix**

**Appendix A: Word definition**

**Appendix B: NAS Stages of resilience**

## Appendix A: Word definition

1. **BI loss:** “BI loss computed under the net-plus definition, for practical purposes, is equivalent to the “operating income” that an insured sacrifices as a result of a loss event. Notice that the “plus” in the net-plus policy language refers to any continuing or unavoidable expenses that the insured incurs during the period its business operations are suspended. Such “restoration period” is defined by the policy as the period of time required for the affected business to resume normal operations, usually limited to a maximum of 12 months.” (McCallum & Knapp, 2016)
2. **Disaster Risk Insurance:** “Disaster risk insurance covers hazards arising from geological, meteorological, hydrological, climatological, oceanic, biological, and technological/man-made events, or a combination of them. Natural hazards include earthquakes, floods, storms, tsunamis, droughts and freezes. Man-made hazards can also be insured against, including air/water/soil pollution, nuclear radiation, toxic waste, dam failures, transport accidents, factory explosions, fires, and chemical spills.” (UNDP)
3. **“Gross-less”:** “The second definition of a BI loss, called “gross-less,” is incorporated in many BI insurance policies in effect since 2002 or earlier. It defines a BI loss as the gross earnings—that is, gross profit—sacrificed by the insured as a result of the loss event during the restoration period, less any “saved expenses.” This term refers to costs that the insured party avoided as a result of the loss event.” (McCallum & Knapp, 2016)
4. **“Net plus”:** “Net income (net profit or loss before income taxes) that would have been earned or incurred, and continuing normal operating expenses.” Accountants might quarrel with the parenthetical interpretation of the phrase “net income,” (McCallum & Knapp, 2016)
5. **Precautionary principle:** “When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm. Morally unacceptable harm refers to harm to humans or the environment that is
  - threatening to human life or health, or
  - serious and effectively irreversible, or
  - inequitable to present or future generations, or
  - imposed without adequate consideration of the human rights of those affected.

The judgement of plausibility should be grounded in scientific analysis. Analysis should be ongoing so that chosen actions are subject to review. Uncertainty may apply to, but need not be limited to, causality or the bounds of the possible harm.

Actions are interventions that are undertaken before harm occurs that seek to avoid or diminish the harm. Actions should be chosen that are proportional to the seriousness of the potential harm, with consideration of their positive and negative consequences, and with an assessment of the moral implications of both action and inaction. The choice of action should be the result of a participatory process.” (COMEST, 2005)

## 6. RISK MANAGEMENT PROCESS:

- **Establish the Context:** Establishing the context involves:
  1. Identification of risk in a selected domain of interest.
  2. Planning the remainder of the process.
  3. Mapping out the following: the social scope of risk management, the identity and objectives of stakeholders, and the basis upon which risks will be evaluated, constraints.
  4. Defining a framework for the activity and an agenda for identification.
  5. Developing an analysis of risks involved in the process.
  6. Mitigation of risks using available technological, human and organizational resources (Syed, 2008).
- **Mitigation:** Involves reducing or eliminating the likelihood or the consequences of a hazard, or both. Mitigation seeks to “treat” the hazard such that it impacts society to a lesser degree. (...) (Coppola, 2006)
- **Preparedness:** Involves equipping people who may be impacted by a disaster or who may be able to help those impacted with the tools to increase their chance of survival and to minimize their financial and other losses. (...) (Coppola, 2006).
- **Response:** Involves taking action to reduce or eliminate the impact of disasters that have occurred or are currently occurring, in order to prevent further suffering, financial loss, or a combination of both. Relief, a term commonly used in international disaster management, is one component of response. (...) (Coppola, 2006)

- **Recovery:** Involves returning victims' lives back to a normal state following the impact of disaster consequences. The recovery phase generally begins after the immediate response has ended, and can persist for months or years thereafter. (...) (Coppola, 2006).

## 7. Strength of Knowledge (SoK): Classification table:

Table 5 "Proposed criteria for classifying the strength of knowledge (SoK) in a security risk assessment" (Askeland, Flage, & Aven, 2017)

SoK label	Criteria for SoK label
<b>Strong</b>	<p>All of the following conditions are fulfilled (whenever relevant):</p> <ol style="list-style-type: none"> <li>1. <b>The phenomena involved are considered well understood:</b> <ol style="list-style-type: none"> <li>a. All risk sources (actors) are known</li> <li>b. Both the capacity and the intention of the risk sources are considered well understood</li> <li>c. Both models used to reflect and predict risk source (actor) knowledge and behaviour (including knowledge of and response to measures) and models used to predict consequences, are known to give predictions with the required accuracy</li> </ol> </li> <li>2. <b>Much reliable data are available:</b> <ol style="list-style-type: none"> <li>a. <b>High-frequency events: Both common-cause variation and special-cause variation are well characterised</b></li> <li>b. <b>Rare events: Knowledge component data not relevant</b></li> </ol> </li> <li>3. <b>There is broad agreement among experts</b></li> <li>4. <b>All assumptions have been identified, documented and are seen as very reasonable:</b> <ol style="list-style-type: none"> <li>a. All explicit assumptions are documented</li> <li>b. A process for identifying tacit assumptions has been carried out</li> <li>c. All explicit assumptions are seen as highly reasonable, and the effect of potential further tacit assumptions is considered negligible</li> </ol> </li> <li>5. <b>The knowledge K has been thoroughly scrutinised</b></li> </ol>

<b>Moderate</b>	Conditions between strong and weak
<b>Weak</b>	At least one of the following conditions are fulfilled: <ol style="list-style-type: none"> <li>1. <b>The phenomena involved are not considered well-understood:</b> <ol style="list-style-type: none"> <li>a. <b>No risk sources (actors) are known</b></li> <li>b. <b>Both the capacity and the intention of the risk sources are considered poorly understood</b></li> <li>c. <b>Both models used to reflect and predict risk source (actor) knowledge and behaviour (including knowledge of and response to measures), and models used to predict consequences, are non-existent or known to give poor predictions</b></li> </ol> </li> <li>2. <b>Data are not available, or are unreliable:</b> <ol style="list-style-type: none"> <li>a. <b>High-frequency events: Both common-cause variation and special-cause variation are poorly characterised</b></li> <li>b. <b>Rare events: Knowledge component data not relevant</b></li> </ol> </li> <li>3. <b>There is considerable disagreement among experts</b></li> <li>4. <b>Assumptions have not been identified and documented, or represent strong simplifications:</b> <ol style="list-style-type: none"> <li>a. <b>Explicit assumptions have not been documented</b></li> <li>b. <b>A process for identifying tacit assumptions has not been carried out</b></li> <li>c. <b>Most explicit assumptions (if any) are seen as representing strong simplifications, and the effect of tacit assumptions is considered non-negligible</b></li> </ol> </li> <li>5. <b>The knowledge K has not been scrutinised</b></li> </ol>

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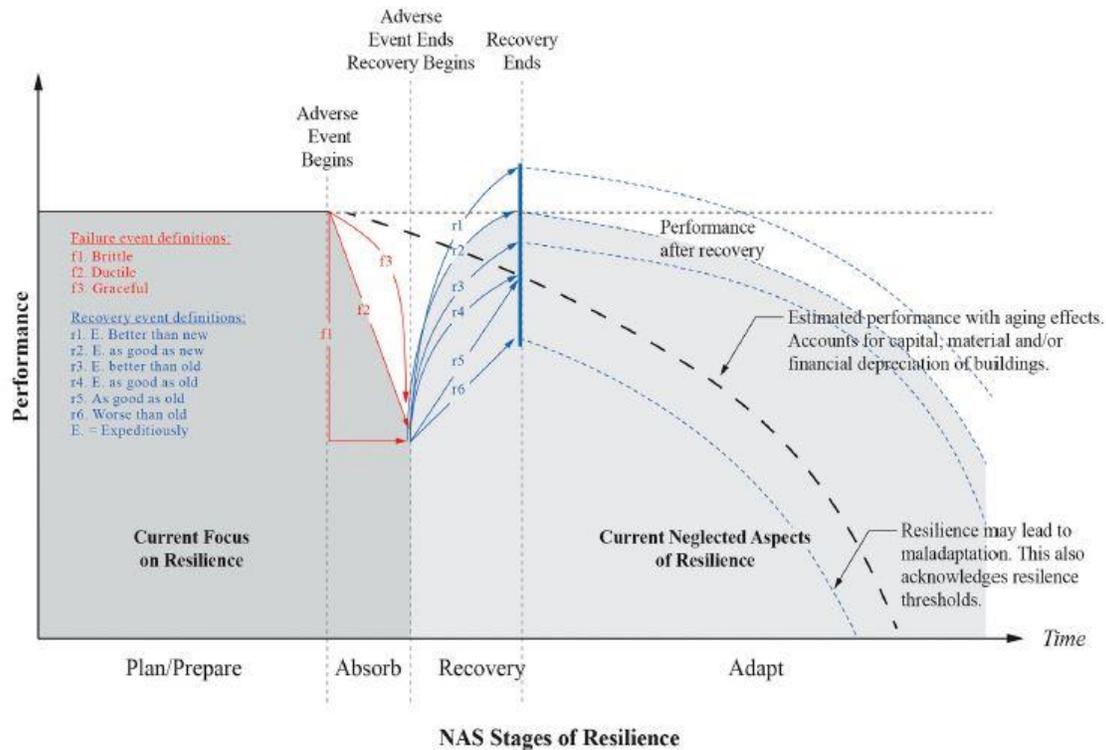
**8. Uncertainty:** “In ISO 9000:2015, within the definition of risk a note expands on the term uncertainty. In summary it suggest when faced with missing or imperfect information about an event, probability, or outcome, we are uncertain. Basically, when unsure, there is risk of the results being different than our expectations. Synonyms for uncertainty include: unpredictable, unreliability, riskiness, doubt, indecision, unsureness, misgiving, apprehension, tentativeness, and doubtfulness. In the context of risk, we often can examine the uncertainty to gauge the magnitude and potential actual outcomes. The degree of risk to some extent is measurable. A hard part here is quantifying the impact of information we do not know we don’t know.” (Schenkelberg, 2017)

Table 6 "Criteria for classifying the level of uncertainty related to the background knowledge *K* of a risk assessment" (Flage & Aven, 2017)

Level of uncertainty label	Criteria for level of uncertainty label
<b>Low</b>	<p>All of the following conditions are fulfilled:</p> <ul style="list-style-type: none"> <li>• <b>The phenomena involved are well understood; the models used are known to give predictions with the required accuracy</b></li> <li>• <b>Much reliable data are available</b></li> <li>• <b>The assumptions made are seen as very reasonable</b></li> <li>• <b>There is broad agreement among experts</b></li> </ul>
<b>Medium</b>	<p>Conditions between low and high, e.g.:</p> <ul style="list-style-type: none"> <li>• <b>The phenomena involved are well understood, but the models used are considered simple/crude</b></li> <li>• <b>Some reliable data are available</b></li> </ul>
<b>High</b>	<p>At least one of the following conditions is fulfilled:</p> <ul style="list-style-type: none"> <li>• <b>The phenomena involved are not well understood; models are non-existent or known/believed to give poor predictions</b></li> <li>• <b>Data are not available, or are unreliable</b></li> <li>• <b>The assumptions made represent strong simplifications</b></li> <li>• <b>There is lack of agreement/consensus among experts</b></li> </ul>

## Appendix B: NAS Stages of resilience

(Explanation of figure 17 in this thesis.)



The curve, (Figure 1 in the citations is figure 17 in this thesis) “illustrates an adaptation of the National Academy of Science (Taleb) definition of resilience (Ayyub, 2014; Linkov et al., 2014b; NRC, 2012) as the change in a system’s performative function and quality over the course of either or both an extreme event or a gradual accumulation of internal or external stress (Lounis & McAllister, 2016). [...] also adapts conceptual developments that have acknowledged a variety of types of failures and elastic responses that speak to the intersection of resilience and adaptation (Ayyub, 2014). ‘Plan and prepare’ refers to the time before and in expectancy of an adverse event or stress. ‘Absorb’ describes a system’s ability or inability to resist the impacts of the event or stress and avoid complete failure, beyond which recovery is not possible. ‘Recovery’ describes the system’s ability to rebound from the impacts of an event and return to its pre-event state or functioning. ‘Adaptation’ describes the evolution of the system to become less susceptible to and more capable of recovering from a future event. The resilience curve depicts the ability of a system to deliver a critical function (e.g. lawfully habitable space, productive workplace or others

depending on the interests of various parties) either specific to the building or part of a cluster of programmes and services in the built environment (National Institute of Standards and Technology(NIST), 2015).” (Kurth, Keenan, Sasani, & Linkov, 2019).

Also,“The stylized trajectories of Figure 1 explore the life cycle stages of built infrastructure in the context of resilience. Resilience has largely been understood to reference known risks that are conceptualized as shocks (Miller et al., 2010), whereas adaptation (or adaptive capacity) offers the ability to accommodate unknown phenomena that are both shocks and stressors (Wise et al., 2014). Therefore, adaptive capacity may lead to either engineered resilience by virtue of design and/or operations or it may advance transformative adaptation wherein building systems and materials may transform but the overall identify (i.e. function and performance) is relatively static. Arrows R1 and R3 in Figure 1 represent alternative scenarios wherein the process of rebounding previously lost function intersects with adaptation. This intersection is understood as a threshold by which engineering resilience is inherently limited beyond its capacity for a single stable state, as represented in arrows R2, R4 and R5. A declining performance based on ageing effects of a building is represented in the dark dashed lined in Figure 1. It can be argued that R4 and R5 represented a more realistic function of resilience, as R2 fails to account for relative asset or system depreciation that would have occurred with or without a specific event or stress. In this sense, building resilience cannot address all shocks and stresses as would be implied from R2.” (Kurth, Keenan, Sasani, & Linkov, 2019).

And the “types of failure include brittle (F1), ductile (F2) and graceful (F3). Ductile failure in a building may include the maintenance for as long as possible of critical mechanical, electrical and circulation systems. For instance, structural ductility in a seismic event may allow for evacuation. Graceful failure may include passive elements of design (e.g. passive ventilation, light, power, egress, and potable water) that allow for a gradual depopulation of a building in a manner that minimizes economic loss and material damage.” (Kurth, Keenan, Sasani, & Linkov, 2019)

## Appendix References

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