BLACK SWAN EFFECTS ON THE REAL ESTATE ENVIRONMENT: A CONCEPTUAL FRAMEWORK

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ABSTRACT

Unpredictable events can have a major impact on real estate, yet they are often overlooked in many property decisions. This research looks at linking property market analysis to Black Swan (BS) Event theory, a term made famous by Taleb (2008) as those unpredictable disastrous events which have three key characteristics: rarity, extreme impact and retrospective predictability. The research takes the form of a narrative synthesis applying a literature review approach to define an extensive range of BS events into a conceptual framework so as to measure the impact on property markets with reference to risk and uncertainties.

For property asset managers, this is important as BS events can be related to the impact on Place/location and Space/operation. To improve the resilience and reduce vulnerability towards these events, property strategies can embrace new disaster management research and so lower the impact of Place risk, although improved connectivity makes global organisations more vulnerable to space risk failure after a major BS Event. In this paper, BS management models are funnelled to the antifragility concept, as a positive sensitivity to increases in volatility. Finally, the study offers a conceptual framework of illustrating the relationship between BS effects and its respective fragile and antifragile strategies.

Keywords: *Antifragility; Black Swan Effects; Black Swan Management; Randomness; Real Estate Environment.*

1. INTRODUCTION

In the past, key underlying macroeconomic indicators have been the driving forces behind the trend in real estate performance. This has implications of modelling property market performance using macroeconomic variables as systematic risk factors. Further, property market modelling is based on standard assumptions of mainstream economics: stable preferences are acting on a perfect market, accessible information, and homogenous products that derived from historic data. Thus, they can fail when stable assumptions cease to hold and extreme volatility occurs, as featured by the recent severe price swings associated with Global Financial Crisis (GFC). Hence, most investors accept the fact that their future performance predictions are imperfect and their investment activities will, inevitably, involve risks (Hargitay and Yu, 1993; Higgins, 2014b; Mandelbrot and Hudson, 2004; Ohman *et al.*, 2013).

These major downside risks are often outside the regular expectations and commonly referred as statistical outliers (outside ± 2 standard deviations) and also termed as risk associated with the lower tail in the normal distribution (Granger, 2010; Higgins, 2014b). Taleb (2008) coined ‘Black Swan’ to describe these unexpected random events that form part of our lives. Similarly, Brooks and Tsolacos (2010) identified such unpredictable, short lived events as ‘noise in the market’. Further, these shocks extended into a broader depth that cover natural, man-made and hybrid disasters. Hence, this research paper aims at conceptualising BS theory in a property environment by bringing forth different authors’ interpretations to a single platform.

The structure of this paper begins with a background of defining the BS concept. Section Three identifies different types of BS events along with the respective categorisation in the model/data dichotomy and natural and non-natural disaster classification. Section Four elaborates the phenomena of rare and extreme

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events aligning with two types of randomness. Then the literature review extended into analysing the impact of BS events linking into the possible management strategies on real estate environment. The last section provides the conceptual framework with concluding remarks.

2. THE BLACK SWAN: THE IMPACT OF THE HIGHLY IMPROBABLE

Unpredictable events are labelled as a concrete and precise category of knowledge named ‘unknown’, ‘improbable’ or ‘uncertain’, but according to Taleb (2008), it is simply the lack of knowledge. For instance, before the discovery of Australia, elsewhere in the world convinced that all swans are white. The sighting of the first BS illustrates the fragility of knowledge. Taleb (2008) coined the term “Black Swan” to describe these random events which have the following three key characteristics:

> First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact. Third, in spite of its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable (p. xvii).

These three characteristics of BS events can be summarised as rarity, extreme impact and retrospective predictability. The exposure to BS effect is having a membership in the extended disorder family: (i) uncertainty, (ii) variability, (iii) imperfect, incomplete knowledge, (iv) chance, (v) chaos, (vi) volatility, (vii) disorder, (viii) entropy, (ix) time, (x) the unknown, (xi) randomness, (xii) turmoil, (xiii) stressor, (xiv) error, (xv) dispersion of outcomes and (xvi) unknowledge (Taleb, 2012).

Similarly, Aven (2013) defines BS as a surprisingly extreme event relative to one’s belief/knowledge. This surprising aspect must always be understood in relation to by whom and when. The following Figure 1 illustrates this. Let C denotes the consequences of the activity in relation to the values such as life, health, environmental, assets and the like. Risk assessment of the activity is conducted at present and as the time goes by C may be realised. If the consequence deviates from the risk assessment then it has become a surprise as illustrated in the Figure 1. Such surprising accident is a BS event which the risk analyst had not predicted before.

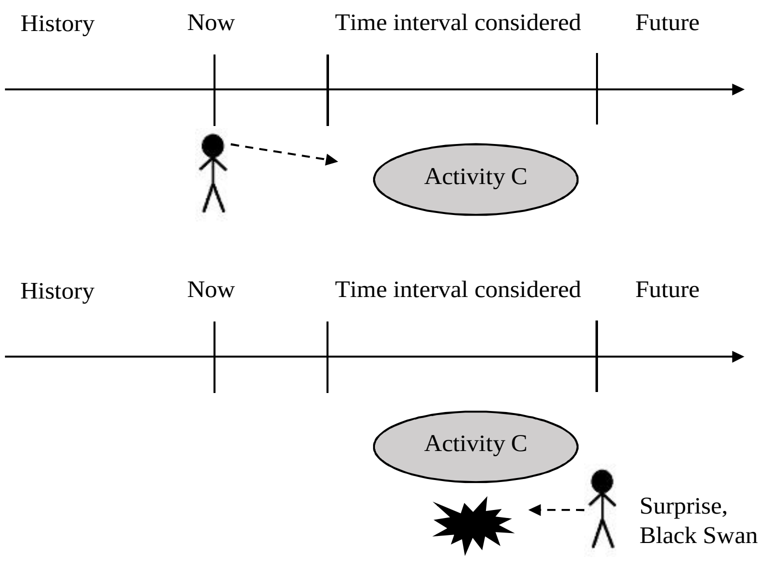

Figure 1: The Black Swans’ Surprising Aspect: Micro Perspective
Source: Aven (2015)

In a macro perspective, looking at a large number of such activities, for example, a risk assessment is conducted and it is concluded probable consequences. Subsequently, one cannot say that it is a BS if such an event which included in the list of probable consequences, actually occurs. Therefore, one must be carefully interpret the perspective when discussing whether an event is a BS event.

Earlier, these rare and extreme consequences associated with BS events are included in the definition of disaster. The Oxford dictionary (2011) defines disaster as: “A sudden accident or a natural catastrophe that causes great damage or loss of life, an event or fact that leading to ruin or failure” (p. 407). Similarly, Asian Disaster Reduction Center (2003): “A serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of affected society to cope using only its own resources”.

3. TYPES OF BLACK SWAN EVENTS

The term BS is used to express any of these types of events, tacitly assuming that it carries an extreme impact (Aven, 2015). There are a number of different approaches, strategies and measures that can be used to confront such events. Aven and Krohn (2014) identified three main types of BS events along with the definition by Aven (2013) as:

i. Events completely unknown to the scientific environment,

ii. Events not on the list of known events from the perspective of those who carried out a risk analysis but known to others, and

iii. Events on the list of known events in the risk analysis but judged to have negligible probability of occurrence and therefore not believed to occur.

These three types of BS events can be grouped into the three existing forms of knowledge and non-knowledge associated with risk which made famous by U.S. Defence Secretary Donald Rumsfeld. Higgins (2013) formed a framework of uncertainty surrounding BS events together with examples of such events as illustrated in Figure 2. The framework separates BS events into known knowns, known unknowns and unknown unknowns based on the availability of model and data.

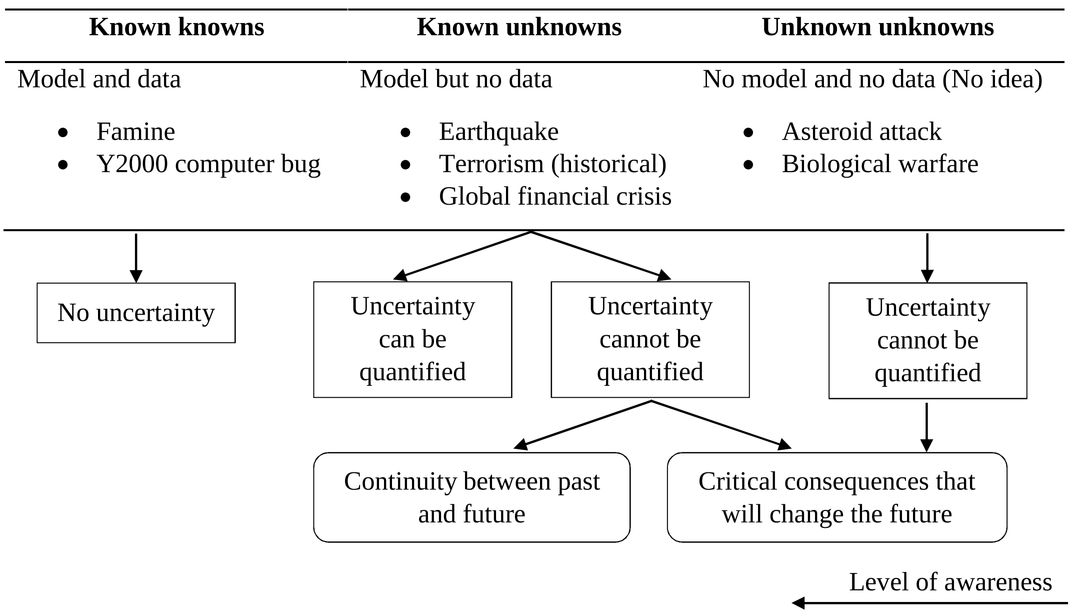

Figure 2: Distinguishing the Knowns and Unknowns: Black Swan Event Framework
Source: Higgins (2013)

The known known is where it is exactly known what could happen and when, for example year 2000 millennium bug can be measured and the disruption can be forecasted. Known unknown events can be quantifiable for example structures can be designed to withstand strong earthquakes (e.g. Structural design of the Taipei 101 tower) but when it will occur is unknown. The unknown unknown events are difficult, if not impossible to model. For instance, there was no quantifiable information prior to the terrorist attack to the World Trade Centre on September 11, 2011. Consequently, the level of awareness is increased and such events are included in the known unknown category. As a provision, new building design features can limit the impact of airborne terrorism (Aven, 2015; Higgins, 2013; Taleb, 2008). These known and unknown BS events can be again categorised into three types: natural, man-made and hybrid disasters according to the definition of disaster (Shaluf, 2007).

4. WILD VS. MILD RANDOMNESS OF BLACK SWANS

This low predictability and large impact has made the BS event a huge puzzle. However, what is more surprising is not the magnitude of the forecast errors of the impact, but the absence of awareness of such events. There are two possible ways to study the phenomena of rare and extreme events with the use of two mutually exclusive types of randomness. The first is to rule out the extraordinary events aside as outliers and focus on the normal which is the mild or Gaussian approach. The second approach is to consider the extremes, particularly if they carry an extraordinary cumulative effect which is the wild, fractal or scalable power law approach (Mandelbrot and Taleb, 2010; Taleb, 2008).

4.1. MILD RANDOMNESS AND REJECTION OF NORMALITY

In a population that follows a mild randomness; one single observation with large deviation from the normality may seems impressive by itself but will not disproportionately impact the aggregate due to averaging. The bell curve has thin tails where large events are too rare to be consequential. Having a closer look at the tails of the bell curve, the probability of exceeding multiples of σ (sigma, standard deviation) are obtained by a complex mathematical formula and the following values in Table 1.

Table 1: Probability of Exceeding Multiples of Sigma

0 σ	1 in 2 times	**6 σ**	1 in $10*10^{8}$ times
1 σ	1 in 1.63 times	**7 σ**	1 in $78*10^{10}$ times
2 σ	1 in 44 times	**8 σ**	1 in $16*10^{14}$ times
3 σ	1 in 740 times	**9 σ**	1 in $89*10^{17}$ times
4 σ	1 in $32*10^{3}$ times	**10 σ**	1 in $13*10^{22}$ times
5 σ	1 in $35*10^{5}$ times	**20 σ**	1 in $36*10^{87}$ times

Source: Mandelbrot and Taleb (2010)

With a mild type of randomness such as height and weight, this type of probability is reasonable. It should be emphasised that the ratio varies with respect to a scale in the Gaussian model where the frequencies drop rapidly in an accelerating way. Thus, Gaussian model is termed as non-scalable. On the contrary to orthodoxy, the possibilities of unpredictable large deviations are simply marginalised in the definition of normal distribution and are considered as statistical outliers. Taleb (2008) devised this normality assumption as the Great Intellectual Fraud. A concern is the frequent misuse of Gaussian distributions as it misses many risk characteristics including asymmetries in downside distributions and fat tails of loss distributions representing low-probability, high-consequence outcomes. In simple words, using the Gaussian model is like focussing on the grass while missing out the gigantic trees (Mandelbrot and Taleb, 2010). In the real terms, price changes are very far from following the bell curve where the far edges flare too high with too many big changes. Thus, the normal bell curve tails do not become imperceptible but follow a Power Law with a fat tailed distribution that can cover higher probabilities of extreme values (Casti, 2011; Higgins, 2014b; Mandelbrot and Hudson, 2004; Pate-Cornell, 2012).

4.2. REAL WORLD WILD RANDOMNESS OF BLACK SWANS

Whereas, wild randomness is an environment in which a single observation or a particular number can impact the total disproportionately. Those that are susceptible to wild randomness can only be expressed accurately using a fractal scale. Technically, fractal distribution defined in equation 1 where $P_{>x}$ the probability of exceeding a variable x is and α is the asymptotic power law exponent. Mandelbrot and Taleb (2010) demonstrates the fractal distribution of wealth in Europe as an example given in Table 2.

$$\mathbf{P_{>x} = Kx^{-\alpha}} \qquad \text{(Eq: 01 The Fractal Distribution)}$$

Table 2: A Fractal Law with a Tail Exponent (α) of 2

Richer than 1 million	1 in 62.5	$P_{>1} = 1/62.5 \times 1^{-2}$
Richer than 2 million	1 in 250	$P_{>2} = 1/62.5 \times 2^{-2}$
Richer than 4 million	1 in 1,000	$P_{>4} = 1/62.5 \times 4^{-2}$
Richer than 8 million	1 in 4,000	$P_{>8} = 1/62.5 \times 8^{-2}$
Richer than 16 million	1 in 16,000	$P_{>16} = 1/62.5 \times 16^{-2}$
Richer than 32 million	1 in 64,000	$P_{>32} = 1/62.5 \times 32^{-2}$
Richer than 320 million	1 in 6,400,000	$P_{>320} = 1/62.5 \times 320^{-2}$

Source: Mandelbrot and Taleb (2010)

The α can be changed to generate additional scenarios: lowering the α means increasing the probabilities of large deviations and increasing will reduce the chance of occurrence. For example, if the α is one, the probability of exceeding a variable will be decline by half in the above scenario. Since scalable laws do not yet yield precise forecasts, an alternative methodology should be modelled where large deviations and stressful events dominate the analysis instead of relaxing on bell curve (Mandelbrot and Taleb, 2010).

4.3. *WILD DOMINANCY OF BLACK SWANS AROUND THE GLOBE*

BS events are increasingly dominating the environment. In the first half of 2015, there were 510 natural catastrophes according to July 2015 presentation by Munich Re and the Insurance Information Institute. The five largest natural catastrophes in the first half of 2015 are earthquake in Nepal (25.04.2015), winter storm in US (16-25.02.2015), flash flood in Chile (23-26.03.2015), winter storm in Europe (30.03-01.04.2015) and sever storm in US (07-10.04.2015). Table 3 compares the natural catastrophes against the average and the top year. Amount of losses in 2015 is lower than the average but there is an increasing number of events. The highest amount of losses is marked in 2011 caused by the earthquake in Japan whereas the earthquake in Haiti in 2010 resulted in the highest number of fatalities.

Table 3: The Comparison of World Natural Catastrophes

	2015 Jan-June	**Average of the Last 10 Years 2005-2014**	**Average of the Last 30 Years 1985-2014**	**Top Year 1985-2014**
Number of all the events	510	440	330	620 (2012)
Overall losses (USD m)	35,000	95,000	64,000	302,000 (2011)
Insured losses (USD m)	12,000	27,000	15,000	82,000 (2011)
Fatalities	16,200	46,000	27,000	230,000 (2010)

Source: Munich Re (2015)

5. BLACK SWAN EXPOSURE ON REAL ESTATE

The pricing of property is based on conventional property valuation techniques as risks are commonly pooled to provide a measurement of value. Thus, property valuation techniques fail to notice the aforesaid outliers. Therefore, property decision should incorporate sufficient understanding of possible occurrence of known BS events to make a viable corporate property decision. For property asset managers, the impact of BS events can be related to the impact on place/location and space/operation. Firstly, place risks can damage the physical buildings. Secondly, the space risk associated with the economic loss for the space occupier that may spread across several unrelated locations (Higgins, 2015). The known unknown BS events relating to place and space risks are shown in Table 4.

Table 4: Place and Space Risks of Black Swan Events

	Form	Place Risk	Space Risk	Comments of Vulnerability
Natural Disasters	Seismic activity	√		Location with factors of urban growth and limited planning and building policies
	Weather related	√		Highly localised impact, coastal areas (hurricanes) and low lying areas (floods)
	Infectious virus	√	√	Variations in relation to disease, environmental condition and treatment capability
Man-made Disasters	Investment strategies		√	Insecurity of scientific approaches within unpredictable markets
	Armed conflicts	√		Interwoven with religion, social instability and economic poverty
	Violence (Terrorism)	√		Normally, specifically focussed relating to perceived compensation and rewards
	Technical (Infrastructure)	√	√	Failures in design, operation and management
	Cyber attacks		√	Critical internet infrastructure can be attacked providing failure of systems

Source: Higgins (2014a)

However, the increasing complexity of the world made up of a tangled web of relationships and other interdependent factors. This complexity not only increases the incidence of BS events but also makes forecasting even ordinary events impossible (Taleb *et al.*, 2009). Due to the connectivity, risks can reach systemic dimensions which in the worst case result in a domino effect. The modern world may be increasing in technological knowledge; in return, it is making things a lot more unpredictable. Subsequently, the role of BS is increasing due to the increase of artificial which moves away from ancestral and natural models and the loss in robustness and resulted in complications. Further, these advances making secondary space impact significantly more after a major BS event (Buhl, 2012; Higgins, 2015; Higgins, 2014a; Taleb, 2012).

6. PROPERTY STRATEGIES FOR BLACK SWAN EXPOSURE

6.1. BLACK SWAN MANAGEMENT TOWARDS ANTIFRAGILITY

Accurate predictions can be conducted in a situation where there is a strong knowledge base with a fewer uncertainties and statistical methods can be employed for standard risk analysis. However, in the real scenario, surprises and BSs may occur and therefore it is obviously not straightforward to assess and manage the BS type of risks. Hence, different approaches are recommended (Aven, 2015).

Traditionally, the most common referred approach is to use of precursors of serious events through a mix of alertness, quick detection and early response. The underlying assumption of precursors is that the reliable predictor of the future backed up by past information. However, this assumption works well only when the change is slow where there are a less presence of BSs and the elements of the system are not tightly connected. Further, it raised a question that judgements about the errors could be derived from false negatives (i.e. no indication of risk situation when one is actually present) and false positives (i.e. erroneous signals indicating some risk situation when it is actually not) (Aven, 2015; Walker *et al.*, 2010).

The limitations of the traditional approaches for dealing with the uncertainty recommended new approaches under the conditions of deep uncertainty. The literature offers three overlapping (not mutually exclusive) approaches of dealing with deep uncertainty (Leusink *et al.* 2009 cited in Walker *et al.*, 2010):

i. Adaptation: change the policy in response to the change in conditions,
ii. Resistance: plan for the most pessimistic future scenario, and
iii. Resilience: make the assurance of quick recovery after a future occurrence.

In another perspective, Snowden (2003) mapped four different new approaches in the Cynefin framework to decision making in complex social environments: simple, complicated, complex and chaotic. The proposed decision making strategies are summarised below.

i. Simple/Known >> Sense, Categorize and Respond>> Best Practice
ii. Complicated/ Knowable >> Sense, Analyse and Respond>> Good Practice
iii. Complex >>Probe, Sense, Respond>> Emergent Practice
iv. Chaotic >>Act, Sense, Respond>> Novel Practice

However, a mechanism is required by which the system regenerates itself continuously rather than suffering from random events, unpredictable shocks and volatility. The focus on improvements leads to the concept of Antifragility. According to Taleb (2012), Antifragility is beyond robustness or resilience. The resilient resists BSs and remains the same but the Antifragile gets better and better as a convex response to a stressor, leading to a positive sensitivity to increase in volatility as opposed to fragility which suffers from the variability of its environment beyond a certain pre-set threshold. Figure 3 illustrates the nonlinearity of the fragility and the Antifragility. Nonlinearity comes in two kinds: concave (curves inward) and convex (curves outward). Smile is a better way to understand these two differences as expressed by Taleb (2012) where the happy face is the Antifragility with the positive convexty effect and the sad face is the fragility with the negative convexty effect (concavity).

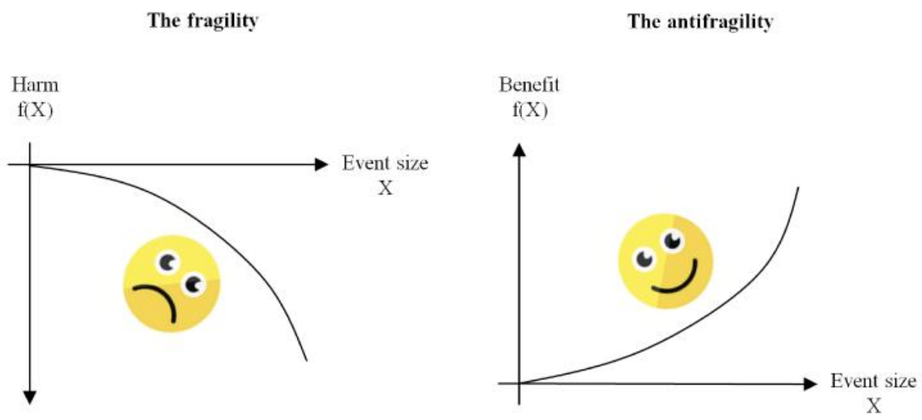

Figure 3: Nonlinearity of the Fragility and the Antifragility
Source: Taleb (2012)

This property is behind every major shift with the time such as evolution, culture, revolutions, political changes, technological innovation and likewise. The Antifragile is seen as a blueprint for living in a BS world, the key being to love randomness, variation and uncertainty to some degree, and thus also errors. Antifragility has a singular property of building a systematic and broad guide to non-predictive decision making under uncertainty where the unknown preponderates, any situation in which there is randomness, unpredictability, opacity, or incomplete understanding. For instance, the process of discovery or technological progress depends on Antifragile tinkering, aggressive risk bearing rather than formal education. Thus, Antifragility is not mere antidote to the BS; understanding Antifragility makes us less intellectually fearful in accepting the role of these events (Taleb, 2012).

6.2. PROPERTY STRATEGIES FOR BLACK SWAN EVENTS

Research on Information Technology (IT) project planning has identified the devastating impact of BSs and the requirement for more precise analysis of the outliers. Flyvbjerg and Budzier (2011) found that one of six IT projects outruns the budget by about 200% which highlights the true pitfall of IT initiatives. In order to mitigate the BS effect, stress testing that covers statistical outliers and extreme values is recommended. Even if the company successfully passed through the stress test, smart mangers take additional steps to avoid BSs. They split big projects into ones of limited size, complexity, and duration; implement contingency plans to deal with unknowns; and reward themselves of the best possible forecasting techniques. For example, 'reference class forecasting' a method based on the Nobel Prize winning work of Daniel Kahneman and Amos Tversky. These techniques, which take into account the outcomes of similar projects conducted in other organisations (Buhl, 2012; Flyvbjerg and Budzier, 2011).

For the BS Management in real estate environment, reference class forecasting can be undertaken to provide prediction-based disaster indices based on the information on similar occurrences (Higgins, 2015). In mapping place risks, the World Health Organisation (WHO) Collaborating Centre for Research on the Epidemiology of Disasters has maintained an Emergency Events Database (EM-DAT) assess various types of natural catastrophes and man-made disasters (primarily those relating to industrial and transport accidents and avoids armed conflicts and acts of terrorism) above an estimated US$100,000 since 1988. Based on the EM-DAT data, Hollnagel *et al.*, (2007) designed a prediction based Disaster Risk Index (DRI). That demonstrates the statistical evidence of the vulnerability of countries locations in which six of the top ten countries are in Africa while remainder is located in Asia.

However, according to Taleb *et al.* (2009), instead of trying to anticipate these BS events, the most appropriate response is to reduce the vulnerability to them. Risk management should be about lessening the impact of these events instead of developing sophisticated techniques that perpetuate illusions of the environment. Further, research on IT project planning can assist as to identify requirements for more precise analysis of the outliers, and suggested establishing risk management tools to reduce the complexity and decrease the variability of performance. Higgins and Perera (2016) demonstrated this by the following real estate examples within the Antifragile outlook.

i. Designing for flexibility: Rearrangement of global organisations structure and efficiency brings the workplace flexibility through through modularity, agile planning approaches and limiting the project financing multiplier. If a BS event occurs in one location, the system can be maintained in the alternative location to maintain the continued existence.

ii. Implementing safety barriers: Simple approaches to standardise language and reporting, offers a framework to avoid place risk. This one framework toolset and single vocabulary can improve knowledge sharing across multinational organisations. Another strategy is the recognition of leading cities resilience to adverse events. This forms part of Grosvenor (2014) report on resilient cities. The resilience derives from the interplay between vulnerability and adaptive capacity. Taleb (2012) coined this new disease as 'neomania' that makes us build BS-vulnerable systems.

iii. Corporate real estate partnership: As technical innovations create lower fixed costs, and advances in digital networks improve communications, corporate real estate strategies are changing to offer a consistent integrated service delivery with sophisticated property management IT for global coverage. The creation of operational teams that transcend geographic and temporal boundaries can offer lower costs and turnaround times. The shared information is also advantageous with improved management knowledge.

7. CONCLUSIONS AND RECOMMENDATIONS

BS events have the characteristics of rarity, extreme impact and retrospective predictability across different classes of risk categories from known to unknown. The risk management and decision making drive exclusively on known knowns. However, a large fraction of real-world risk management challenges fall in the domain of known unknowns and unknown unknowns. Due to the growing significance of these risks, BS events cannot be ruled out as outliers in the Gaussian distribution as per the mild randomness. The normal bell curve tails do not become imperceptible but follow a Power Law with a fat tailed distribution that can cover higher probabilities of extreme values. Hence, it can be emphasised that real world BS challenges are fall into the wild randomness following fractal or scalable power law approach.

The impact of BS events in real estate environment can be related to the impact on place/location and space/operation. As the strategies for these downside risk in the real estate environment, reference class forecasting can be undertaken to provide prediction-based disaster indices based on the information on similar occurrences. As per the Antifragile outlook, the rearrangement of global organisations structure and efficiency through the designing for workplace flexibility, implementing safety barriers and corporate real estate partnership can be implemented. The concept Antifragility is also made famous by Taleb (2012) which has a positive convexity effect between the size of event and the benefit from the event rather than suffering from random volatility. The aforementioned key literature finding are summarised into a conceptual framework as illustrated in Figure 4. It illustrates the relationship between BS effects with its respective strategies in the distinctiveness between fragility and Antifragility.

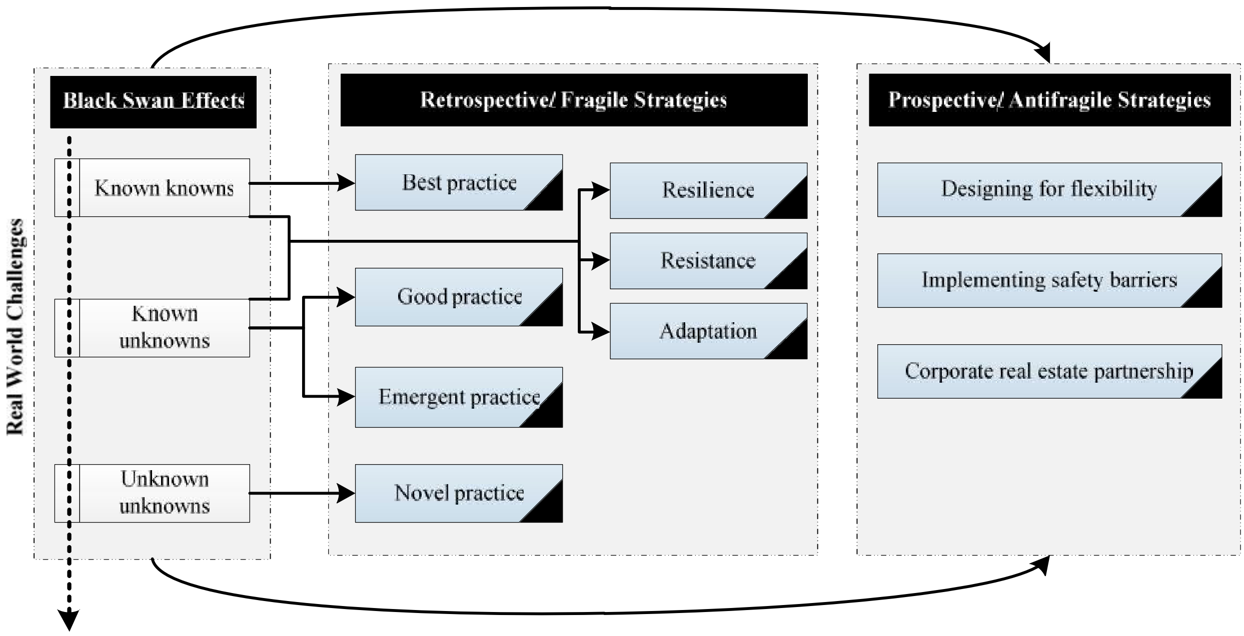

Figure 4: The Summary of Key Literature Findings

For corporate real estate decision makers, BS research embraces to identify the favourable and adverse effects on real estate decision making. BS management research agenda should be more focused on lessening the vulnerability beyond the quantitative forecasting judgements to anticipate low-probability and high-impact events.

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