

Emerging financial risks from climate changes on building assets in the UK

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Abstract

Purpose – The different scenarios of climate change, such as floods, temperature change and storms, are considered the main drivers influencing the building sector. Understanding how and when the emergence of these climatic risks, specifically financial risks, is pivotal in dealing with these risks and applying the adaptation and mitigation strategies so as to minimise the effects and damages. Thus, the aim of this paper is to discover the financial risks emerging from climate change impact on the building sector, and to determine the timescale of occurrence for such risks.

Design/methodology/approach –The research methodology formulated in this study is founded on a systematic literature review and statistical analysis. Built on this, the potential financial risks emerging from Climate Change Scenarios (CCS) were identified and designed as a questionnaire to collect data from UK expert professionals. Statistical methods were used to rank and compare the outcomes of the survey.

Findings – The research observed that around 40% of the participants in this study indicated that one-third of the total identified financial risks (23 factors) would emerge within 5–10 years. The most important factors are increased insurance excess and additional expense in insuring buildings in flood risk zones, whilst the least important financial risks are inability to repay debts and un-insurability due to climate change.

Research limitations/implications – This study is limited to the UK, and regional implications are not covered. However, it is a starting point.

Originality/value –The main contribution of this research project is establishing and developing clusters of the potential risks emerging from CCS, which can assist professionals in the building sector in the management and development of strategies to cope with these emerging risks.

Keywords: Climate change, financial risks, emerging risks, risk management, building, assets.

Introduction

The theories behind the emergence of climate change are mainly attributed to the increase of human activities on the earth, especially during the beginning and continuation of the industrial era, which is responsible for the production of huge amounts of greenhouse gas emissions (McMullen and Jabbour, 2009; Woodward, 2008; Hertin et al., 2003; Changnon, 1995). These drivers have significantly contributed to the different ways in increasing the frequency of climate change scenarios during recent decades (De Wilde and Coley, 2012; Steenbergen et al., 2012; Garvin et al., 1998; Pretlove and Oreszczyn, 1998). Increases in severity and the frequency of extreme events of climate change scenarios is also owing to the changes in the temperature of the sea's surface (Solomon et al., 2007). Climate change has become a global phenomenon, and its threats have a huge variety of risks and impacts across all aspects of life, including the building sector. There is evidence to suggest that climate change will influence several sectors economically due to changes in temperature, which will increase the possibility and severity of flood, and the extreme events of climate change, resulting in different levels of economic consequences (Midgley et al., 2005 and Berz 1997). London Climate Change Partnership (LCCP, 2013), stressed that the changes of temperature and extreme climate events, including flooding, is considered the key threat to the economy and business activities. The report went on to point out that, most economic and social losses in the building sector come as consequences of various changes in the frequency and severity of the several climate change scenarios, such as temperature changes and flooding, along with extreme climate change events (Steenbergen *et al.*, 2012). Climate change will exacerbate economic losses, such as a high rate of population migrating to stay away from the affected areas, which increases living standard costs, and a large concentration of population in urban areas, which increases the pressure on services and resources (Roaf et al., 2009). Dailey et al., (2005) argued that the level of financial risks is based on both factor location and the condition of the markets of the building sector. These factors affect administrative and operational expenses along with associated taxes. The construction process might also be affected through delay in the supply of materials or in construction work, which will ultimately increase financial losses, including overheads and financing (Szyman and McNamara, 2008). Buildings are recognised as a safety valve in the value of real estate investment. Extreme events of climate change scenarios result in structural damage to buildings and cause extensive risks (Steenbergen

et al., 2012). The influence of climate change may reduce the level of their attraction in terms of rents and value generation (Szyman and McNamara, 2008). In the building sector, the return/profit is recognised as a cornerstone of investment in this sector. For example, buildings utilising energy-saving methods are more attractive to stakeholders than normal buildings (Huovila et al., 2007). Other economic tools and incentives cannot be neglected, as these impact buildings economically, such as through tax rates and increased rates of profit from investment return (Huovila et al., 2007). According to LCCP (2002), it is highly projected that the risks of climate change will alter occupants' attitudes (Grossman, 2012). For instance, according to Bigano et al. (2008), the tourism industry is an important income source for most countries in the world, and climatic conditions play a very influential role in the industry. Hence, understanding and establishing the separate and collective risks emerging from climate change patterns, and the impacts they have on buildings, are essential for the design and optimal timing of policies, systems, and procedures strategies, all of which help assets to deal with and manage such emerging risks and to avoid their impacts and threats.

Thus, the aim of this paper is to expand the existing literature, discover the financial risks emerging from climate change impact on the building sector, and to determine the timescale of occurrence for such risks. The rest of the paper is structured as follows; section two describes the theoretical background from the related work already done. Section three describe the design and implementation of the research. Section four presents and discusses the results from the survey. Finally, section five presents conclusion and further research recommendations.

Theoretical background

Risks emerging from climate change patterns have become a global problem, and their impacts are reported widely (Woodward, 2008). According to Twigger-ross and Orr (2012), in the building sector, the term risk is used to refer to 'the likelihood an event will occur with the magnitude of its outcome'. The author went on to suggest climate change risks lead to damage in buildings and real estate, which result in financial losses; these can be measured from an economic perspective by evaluating the costs of the damages. The International Research Institute for Climate and Society describes Climate Risk Management (CRM) as a subject which includes multiple disciplines "early- response systems, strategic diversification, dynamic resource-allocation rules, financial

instruments, infrastructure design and capacity building”. The World Bank (2006) defined the CRM concept as a method of assessing the threats that may appear due to the climate change scenarios of the future. The United Nations Framework Convention on Climate Change (2011) used risk management processes to define CRM as a topic that requires the following activities:

- Risk assessments to make informed decisions;
- Reducing risk through proper planning and better preparation;
- Sharing, transferring and pooling risk through the use of adaptation.

We define CRM in this paper as a systematic way of identifying, analysing and then responding to the risks, which are emerging due to climate change and affecting the efficiency of the real estate stock. From a buildings perspective, climate risk can be defined as all threats occurring on buildings and their elements. In this research, the emerging financial risks refer to all economic risks impacting the real estate sectors, resulting in economic losses. These include direct and indirect emerging risks, such as a reduction of the value of property and insurance problems, respectively. The risk of climate change is quite important in real estate management, as it describes the conditions that can adversely affect the efficiency of a building and disturb the comfort level of the occupants. It is essential though, to improve risk detection and management with the changing climate conditions, in order to select better operation strategies and adapt according to the environment. The next part of the paper groups emerging financial risks according to the source that trigger their occurrence.

Emerging financial risks from change in temperature

The impacts of heat waves is considered to influence the level of profitability, productivity, and increase the consumption of energy resulting in additional operational expenses (CCRA, 2012). The evidence of this can be seen in the example of July 2006, when organisations operating within the UK lost almost £840 million per week because of inadequate productivity amongst staff owing to the effects of increased temperature during that period (Roberts, 2008). Capon and Oakley (2012) explained that the thermal comfort affects productivity leading to financial loss. The author went on to explain that productivity declines by approximately 8% when the temperature is 26°C; the losses in this situation amount to approximately £35 million, whereas increases in this percentage

may reach 29% at a temperature estimated to be around 32°C; this will lead to losses of approximately £126 million. Employees lose more than half of their production at 38°C, which is estimated as resulting in approximately 62%; financial losses will be around £270 million. The report went on to suggest that by the year 2050—as a result of high temperatures—the use of energy, especially for air-cooling purposes, is expected to increase by around 10–16%, thus leading to increases in the economic pressure on financial resources (Glynn, 2005).

Increased temperature will lead to restricted access and road usage due to erosion, and increased landslip resulting in further disruptions (Tubb *et al.*, 2003). Furthermore, changes in the level of proportion of rainfall patterns will increase the frequency of drought and soil moisture, subsequently resulting in increases of soil heave and contraction, which induce structural damage in real estate, and increase of cost of repair. It is predicted that the changes in temperature level are likely to augment the problem of soil moisture (Vivian *et al.*, 2005; Graves and Phillipson, 2000). In particular, the land areas with clay soil will be vulnerable to heaving and shrinkage (Gill *et al.*, 2004). This will lead to greater financial losses and the limitation on available lands and areas suitable for building and construction projects resulting in disparity in the prices of land. According to Gill *et al.*, (2004) and Tubb *et al.*, (2003), the risks of climate change patterns would affect the attractiveness of the areas and residential complexes.

Emerging Financial Risks from Flooding and Extreme Events

Increased frequency of climate change patterns, including flooding, more intense precipitation and storms, are projected to negatively affect the economy across many sectors. Financially, this will result in increased pressure on businesses by increasing disruption (CCRA, 2012). It is pointed out that those extreme events can lead to the shutdown of approximately one-quarter of global supply chain matters (CCRA, 2012). For example, floods in Thailand and earthquakes in Japan have had a notable impact in terms of quarterly profit, which encourages international insurance companies to sound the alarm and accordingly to take immediate action regarding the economic risks of climate change scenarios (Wagner, 2012). According to Swiss (2013), 2013 was one of the most expensive years in terms of the amount of losses due to the risks of climate change patterns. In consequence, around £5 billion in insurance claims were issued just in the first half of the year due to flooding. Garvin *et al.*, (1998) argued that the impacts

of extreme weather have much potential in influencing the economy through the following risks:

- Delays and disruption to work due to climate hazards;
- Damage to materials' use, with greater difficulties in their use, owing to increased site wastage;
- Day loss due to the frequency of climate change and the number of unsuitable days for work, which affects site productivity;
- Increased problems across plants, such as through the disruption of the use of the plant and more damages.

These risk increases the scenarios of construction work disruption leading to reductions in the growth and profits; this will lead to more financial burden and greater losses. For example, Vivian et al., (2005) reported that in the USA, the impacts of climate change scenarios are recognised as the fourth reason for delays in the construction of highway. Moreover, sudden changes in climatic patterns result in an increased duration of projects, as well as further delays in delivery. This also leads to increases in associated costs (Graves and Phillipson, 2000).

The increased possibilities and expectations of damages will affect insurance availability and accordingly will lead to greater financial risks, such as losses, greater economic pressure and decreased profit (Berz, 1997; Tubb et al., 2003). Financial risks lead to increases in the pressure on insurance companies, and further push them to bear heavy losses or to increase prices significantly or otherwise to withdraw from the insurance market (Repetto, 2012). Furthermore, it was reported that the average annual insured losses increased from approximately £0.5 billion in the 1960s to around £6 billion in the 1990s, where the average increase is approximately half a billion each year (Roaf et al., 2009). For example, in the UK, average losses are approximately £700 million per year; this amount could rise up to £2 billion in a bad year, such as that which occurred in 1990 (Garvin et al., 1998). In addition, the financial risks emerging from climate change patterns are increasing dramatically with the expected amount of losses during 2010–2060 (Repetto, 2012). Berz (1997), LCCP (2002), Wilby (2007) and Twigger-ross and Orr (2012) pointed out the following emerging financial risks will influence real estate:

- New extreme values in certain regions;

- Increased exposure to more insurance claims for insurance companies;
- Increased cost and difficulty of obtaining flood insurance cover in both level household and business;
- Insurance claims and reduced the value of the mortgage, especially in the affected areas;
- Greater claims potential;
- Lagging premium adjustment;
- Rising demand for insurance cover of natural hazards.

Moreover, increasing threats of flooding risk on real estate means stakeholders are less able to renew their property insurance, resulting in further losses and increases in the probability of invalidating their mortgage (LCCP, 2002). For instance, in the UK, insurance companies have the option of opting out from insuring any property when are located under the threats of climate change patterns (Graves and Phillipson, 2000). Berz and Loster (2001), as cited in Gill (2004), note that, in the affected areas, the rate of risk might be too high reflecting negatively on insurance companies and policyholders. Risks that may emerge from such consequences are:

- Companies lose the affordability to insurance coverage in the affected areas, leading to loss competition in the market;
- Higher insurance rates and premiums;
- Buildings and real estate become uninsurable due to the damages of climate change scenarios or increase the proportion of exposure to such risks in the future.

From a business perspective, the impacts of climate change will limit economic growth due to dwindling investment opportunities and weaknesses in profit ratios due to different climatic hazards on real estate. This will lead to further financial risks, (LCCP, 2002) such as:

- An increase in internal and administrative expenses especially in insurance process;
- Reduction of employment opportunities in the affected sectors;

- Weakness of the incomes from investment leading to an increase the failure to achieve equity growth;
- Increased insurance premiums;
- Withdraw insurance or reduce the limits of insurance cover.

The report prepared by Land Use Consultants in association with other organisations (2006) suggested the following emerging financial risks:

- Failure to meet consumer expectation;
- Disruption to supply chains and productivity;
- Financial and operational problems selling or letting and higher management costs;
- Insurance cover problems due to increased risk of subsidence in areas with clay soils;
- Higher costs and potential problems of insurance due to flood damages to buildings and real estate.

These emerging financial risks—specifically those on buildings and real estate—will affect the value of property. It is expected that the value and prices of property will be adversely affect the stakeholders' equity in mortgages (Hallett, 2013). Accordingly, the probability of mortgage rejection might be increased due to the rise of vulnerability to the impacts of various climate change scenarios on such buildings and real estate (Graves and Phillipson, 2000). Furthermore, this will result in decreases in the ability to secure funding for refurbishment due to the negative valuation of the property or non-acceptance in the mortgage.

The sources that trigger the occurrence of risks are directly related to the consequences of climate change scenarios as reported in literature, that is, temperature, flood, and extreme events (precipitation and wind). Thus, we classified the risks as one cluster of risks emerging from three sources of climate change scenarios. Our focus here is to build our research construct from the financial risks that might emerge from the climate changes scenarios. Table 1 presents the summary of the financial risks emerging from climate change patterns on real estates. This study is aiming to gauge the opinion of professionals on the likelihood of risks occurring, and if so, what is their timescale of occurrence. Therefore, the hypotheses are posited as follows:

There is no significant difference between respondents in rating the likelihood of the occurrence of risks emerging from climate change.

There is no significant difference between respondents in rating the occurrence timeframe of risks emerging from climate change.

Insert Table 1 here

Methodology

This study is designed to investigate the emerging financial risks in the real estate sector due to climate change. This research uses questionnaire to assess the likelihood climate change risks appearing in the industry. The selected financial risks were extracted from the literature review, where 23 financial risks were identified. The scope of the research is centred on investigating and identifying the various potential emerging financial risks and their timeframe of occurrence as a result of climate change scenarios on real estate. This is achieved by considering several steps: firstly, investigating the causes of climate change and establishing the possible scenarios that might affect the building sector; secondly, identifying the potential risks emerging from CCS that could have a direct impact and might induce damage on real estate; thirdly, clustering the identified emerging risks in a systematic and practical way.

The initial part of the questionnaire was designed to obtain general information about the respondents. The second part of the questionnaire assessed the chances for a climate risk to occur. The respondents completed an online survey, which asked them to rate a number of risks that may negatively affect the performance of the real estate assets.. The third part of the questionnaire aimed to assess the timescale about the occurrence of these risks. Respondents could select from four options (1-4), which corresponded to never, within 5 years, from 5 to 10 years, and over 10 years for the risks. The survey population consisted of people who belonged to the building management industry or other real estate supporting sectors. These participants included architects, consultants, constructors, engineers, project managers, and risk managers who were currently working in various hospitals, housing associations, and universities. The researchers sent over 300 questionnaires to potential participants and were able to receive 78 completed surveys, which converted to a rate of response of 26 percent, which was sufficient for this

particular study. Couper (2000) stated that a rate of response between 20 and 30 percent is the typical average, when using a web survey design. Addendum (2012) also supports that this particular range of responses lies well within the acceptable survey response rates.

The questions used to measure the effect of emerging risks were based on a 5-point Likert item from “Very Unlikely” to “Very likely”. In order to verify whether the risk statements in the questionnaire reliably measure the financial risks construct, a Cronbach's alpha test was performed on the data set. The test showed Cronbach's alpha is 0.850, which indicates a high level of internal consistency for the adopted scale to measure the likelihood of financial risks. Furthermore, Kendall coefficient of concordance was also used to examine whether the respondents used the same standard in the ranking of emerging risks. The P-value was ≤ 0.05 , this indicates that the respondents' agreement on rating the risk influence and time of occurrence is not due to chance. Thus, the respondents' applied essentially the same standard when completing the questionnaire.

This research study employed descriptive statistics for analysing the questionnaire results. This method determined the lowest and the highest risks for the future. The use of mean value also helped in the ranking of the different risks, as well as identifying the more significant risks. SPSS was used in order to compare the different risks and rank them according to the experience and professional positions of the survey respondents. Furthermore, one-way ANOVA test was used to test whether the respondents concurred on the influence and timescale of risk occurrence.

Results and analysis

Profile of the respondents

The respondents are profiled according to the organisation in which they are working, as well as their particular professional position within it. Most respondents work in the public sector (64%). 15 respondents belonged to the private sector (21.8%), while only five of them working in charity organisations (6.4%). The remaining seven respondents (7.7%) belonged to other sectors, such as the academics. Around 47.44% respondents selected their professional position as environmental, sustainable or energy manager. 22 participants (28.21%) selected facility manager as their professional role,

while there were 11.51% participants as risk managements. The real estate managers make up 7.7% of the participants. 3 respondents (3.85%) identified themselves as academics while there was a single participant identified as an owner of building assets.

63 participants (81%) responded that they were in charge of handing over 20 buildings. 4 respondents (5%) were handling 11 to 20 buildings, 4 participants (5%) were handling 6 to 10 buildings, while 7 participants (9%) were in charge of handling less than 5 buildings.

Results from ANOVA tests confirmed that the respondents (amongst all three professional roles in organisations) were in agreement on the possible emerging effect of financial risks as the $p\text{-value} > .05$. However, there were significant differences between public and private sector on one financial risk ‘additional expense in insuring buildings in flood risk zones’. Further tests, using the Tukey, confirmed there was a difference between the private and public sector in the mean rating at the 0.05 significance level. These results are expected in the sense the private sector is more sensitive to any additional costs that may influence their balance sheet. In addition, there were significant differences between the public and other types of sectors on financial risk namely ‘Increase costs to purchase’ based on its occurrence time frame. Further details on why this is the case is shown in Table 2.

Insert Table 2 here

Rating and ranking of likelihood occurrence of financial risks

Figure 1 shows the rank the financial risk factors based on the overall frequency percentage. The ranking is also presented based on the type of organisation of the respondents. The results of the rating of the likelihood of the identified risk occurring is shown in Figures 1 and 2.

Insert figure 1 here

The results suggest that risk F17 ‘Increased insurance excess’ is the most likely risk factor to arise across buildings and real estate due to threats of Climate change Patterns (CCP) according to 52.6% of the respondents, with the impact becoming very likely to occur according to 35.9%. 39.7% of the respondents thought ‘Additional expense in insuring buildings in flood risk zones’ is very likely to have impacts on

the building sector; the impact is likely to occur according to 38.5%. The risk ‘Increase costs to purchase’ was found to lead to a negative impact on buildings and real estate according to 47.4% of the respondents, with the impact noted as being very likely to emerge for 30.8%.

Insert figure 2 here

Generally, there are fundamental consequence effects from this financial risk factor, such as increase in the capital and operational expenditure costs leading to unaffordability issues. The influence of F4 ‘Increase in administrative expenses’ on the building sector is likely to occur according to almost half of the respondents, while 14.1% of them believe that such risk are very likely to appear, and 25.6% of them show neutrality. The risk ‘Affordability of property rent/development’ also results in increased financial impacts, where 43.6% of the respondents find the effect due to this risk factor being likely to arise, whilst 12.8% of them think it is very likely to occur. On the other hand, however, 30.8% of the respondents show neutrality. The statement concerned with ‘Additional expense in insuring buildings prone to the urban heat island effect’ is found to likely have an influence on the building sector, according to approximately 41% of the respondents, whilst 16.7% of them consider the impact to be very likely to emerge. The neutrality is observed for 20.5% of the respondents. It is likely for risk F20 ‘Increases in areas prone to soil heave/shrinkage’ to have an influence on the building assets, as shown by 42.3% of respondents, whilst the impact becomes more likely to occur (very likely) according to 10.3% of them. The percentage of people showing neutrality is 30.8%, whilst 12.1% of the respondents think that it is unlikely to induce an impact in terms of this financial emerging risk. According to 35.9% of the respondents, risk ‘Fall in value of mal-adapted properties’ is likely to have an effect on building assets, whilst only 15.4% of them consider that the effect due to this financial risk factor is very likely to emerge on property. Moreover, approximately one-quarter of the respondents—equating to 26.9%—show neutrality in terms of this emerging risk factor. The risk ‘Lower profit margins’ is likely to emerge according to 41% of the respondents, whilst only the impact is noted to be very likely according to 9% of them, whereas more than one-quarter of the respondents, equating to 30.8%, show neutrality. More than one-quarter of the respondents believed that the financial risk factor that is F22 ‘Affordability of property insurance’ will likely to emerge, as shown by 37.2% of

them; and the impact will be more likely (very likely) to occur according to 14.1% of the respondents.

The neutrality is observed for the remaining financial risks factors from the influences of CCS. Moreover, the lowest likelihood occurrence financial risk is 'Unable to repay debts' as around 65.4% of the respondents it is unlikely and are neutral. The next two less important financial risk factors are 'Un-insurability due to climate change' and 'Business become less competitive'.

Timeframe of financial risks likelihood occurrence

There is a clear difference amongst the respondents in estimating the occurrence/influence timescale of financial risk on real estate. Figure 3 shows the likelihood of risks Timeframe influencing buildings.

Insert figure 3 here

Some respondents indicated that the occurrence timeframe in terms of risk 'Increased insurance excess' is from 5–10 years. The majority of respondents from charity and public organisations indicated that the impact might occur between 0–5 years. For the private sector respondents thought its influence might appear in 0–5 years or 5–10 years. In terms of risk 'Additional expense in insuring buildings in flood risk zones', the effect could occur over ten years for the charity and other organisations, whilst the majority of respondents from private organisation thought the effect could be arise between 5–10 years. The risk 'Increase costs to purchase' is expected to be observed between 0–5 years by the charity organisation, as well as in the overall view. On the other hand, the impact occurrence timescale is varied from one year and more than ten years for the remaining organisations. For risk 'Increase in administrative expenses' the effect could be after ten years for the other organisation, whilst it could be happen in 5–10 years for the charity and in 0–5 years for the private sector. Risk 'Changing patterns of consumer demand' is possible to occur between 5 and 10 years, and more than ten years for the private and public organisations, whilst this may occur between 0 and 5 years, and in the longer term (5–10 years) for other organisations.

Insert figure 4 here

Figure 4. shows that the risk 'Increased insurance excess' could arise in real estates at a timescale of between 0 and 5 years, based on academics and other professional

respondents. According to risk managers and real estate portfolio management, the impact might emerge between 0 and 5 years or between 5 and 10 years. Risk 'Additional expense in insuring buildings in flood risk zones' might influence real estates in 5–10 years, as viewed by the academics, whilst its influence might be observed after ten years as indicated by facility managers, risk managers and those in the 'other' role. This was followed by nearly the same respondents as real estate portfolio managers reported that the impacts happen in the timeframe of 0–5 years and 5–10 years. The risk 'Increase costs to purchase' could occur between 0–5 years, according to the risk managers and other professionals. However, it could arise between 5 and 10 years, based on real estate portfolio managers. The facility managers consider that the influence might emerge between 0 and 10 years. Risk 'Increase in administrative expenses' is mainly observed between 0 and 5 years for academics and for more than ten years for real estate portfolio managers. Risk 'Changing patterns of consumer demand' was expected to happen between 5 and 10 years, as based on the views of academics, whilst it was more than ten years for risk managers. Furthermore, it was more than 5 years for real estate portfolio managers.

Discussion

Climate change and its potential impacts are becoming global issues, as this can impact many sectors and levels of society across the world (Midgley et al., 2005; Brown et al., 2011; De Wilde and Coley, 2012). However, fundamentally, the impacts and effects from climate change scenarios on real estate are crucial and more serious (Capon and Oakley, 2012; De Wilde and Coley, 2012; Steenbergen et al., 2012). Financial risks are the emerging risks related to the cost of other emerging risks on buildings and real estate, such as physical, operation and reputational risks. The literature review in this study claims that the financial risks emerging from climate change will have both direct and indirect emerging risks, impacting buildings and real estate. The direct risks include costs of the repair of damage or the replacement of key components (Graves and Phillipson, 2000; Gill et al., 2004; ABI, 2005). Indirect emerging financial risks, on the other hand, are those related to occupant and employee productivity (Capon and Oakley, 2012), and insurance problems (Graves and Phillipson, 2000; Tubb et al., 2003; CCRA, 2012; Repetto, 2012). The absence of the determinants of such risks and forecasts of the future climate change scenarios would ultimately exacerbate the problem in the building sector. This study had endeavoured to discover the emerging financial risks related to

real estates. This study observed, the financial emerging risks are highly likely to have an influence on the building sector, where around 40% of the participants in this study indicated that around one-third of the total identified financial risks (23 factors) would emerge within 5–10 years, where the most two important factors are increased insurance excess and additional expense in insuring buildings in flood risk zones, whilst the least two important financial risks are inability to repay debts and un-insurability due to climate change. The level of financial emerging risks is based on several drivers, such as severity and magnitude of the climate change scenarios' impacts on property and the level of vulnerability of buildings to such impacts and risks. Furthermore, across all groups of respondents, the emerging financial risks were given a significant degree of significance—especially in private organisations and for facility and risk managers. The implications of financial emerging risks on assets will have significant impacts—especially on owners and investors, as well as occupiers. This view is supported by Szyman and McNamara (2008), who point out that real estate that is suffering from financial emerging risks will become less attractive to occupants, owners and investors due to their energy consumption, increased costs for resources, and the materials required for maintenance or repairs. In addition, one strategy that may reduce the vulnerability of assets to emerging financial risks from CCS is to periodically maintain property, as well as assess each other's risk factors arising in terms of their costs. The challenge facing this strategy is that the owners and investors are looking to achieve higher level of profit from their buildings—even with low quality solutions for such risks, which will exacerbate the financial problems; the managers responsible for providing practical and effective solutions, as well as improving buildings' adaptability to emerging risks, help to minimise the impacts of financial risks

Conclusion

This paper aim was to discover the impact of the emerging risks due to climate change on building assets. It identifies that there are several emerging risks, which have the ability to impact the finances of building assets in an incremental manner. The study observed that 'Increased insurance excess' is the most likely risk factor to arise across buildings and real estate due to threats of CCP, which is likely to occur 5-10 years timeframe. Ranked second 'Additional expense in insuring buildings in flood risk zones' the effect could arise between 5–10 years. Third was 'Increase costs to purchase', which is expected to impact negatively on buildings and real estate within 0-5 for the majority

of sampled organizations. Fourth was ‘Increase in administrative expenses’ on the building sector, which is likely to occur in 0-5 years according to charity organizations, and varied for the rest. Taking into account these emerging risks during the operation phase of property assists in avoiding disruption and decreasing necessary maintenance, which could result in reduced financial losses. Asset owners must incorporate into their asset management strategy and decision-making processes, climate change consequences to create business models that are robust. This will ensure that the asset management strategies are resilient to climate change and founded on sound business strategies for pursuing new opportunities from climate change consequences while minimizing the impact of emerging risks.. This research provides a starting point for wider research that is required to endeavour further investigation on both the risks emerging from CCS and the timescale of their emergence—especially across different types of building and real estate—demonstrating them in parallel with potential conditions of climate change on the building sector in different areas and regions. There is still a lack of research on Climate Change Risk Management (CCRM) approaches and strategies, which might be considered a road map for facing and dealing with these different risks emerging from climate change patterns.

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Table 1: List of identified emerging financial risks

Emerging Risks identified		Reference
F1	Lower profit margins	CCRA (2012); Glynn (2005)
F2	Inability to repay debts	Tubb <i>et al.</i> , (2003)
F3	Equity growth not realised	Gill <i>et al</i> (2004); LCCP
F4	Increase in administrative expenses	ABI (2005); Gill <i>et al.</i> , (2004)
F5	Reduced ability to secure funding for refurbishment due to negative property valuation	Graves & Phillipson (2008)
F6	Reduced ability to secure funding for adaptation due to negative property valuation	Graves & Phillipson (2008)
F7	Fall in value of mal-adapted properties	Hallett (2013)
F8	Loss of income from properties	Szyman & McNamara (2008); Huovila <i>et al.</i>
F9	Businesses become less competitive	Gill <i>et al</i> (2004)
F10	Properties may not be saleable because of climate change compliance	Szyman & McNamara (2008); Huovila <i>et al.</i>
F11	Negative property valuation due to structural damage or compliance with climate change	Hallett (2013); Szyman &
F12	Negative property valuation due to services damage or compliance with climate change	Hallett (2013); Szyman &
F13	Loss of revenue due to customer behaviour	Bigano <i>et al.</i> , (2008); LCCP (2002);
F14	Changing patterns of consumer demand	Grossman (2012); LCCP
F15	Affordability of property rent/development	Szyman & McNamara (2008)
F16	Increase costs to purchase	Tubb <i>et al.</i> , (2003)
F17	Increased insurance excess	Repetto (2012)
F18	Additional expense in insuring buildings prone to the urban heat island effect	Gill <i>et al.</i> , (2004); Tubb <i>et al.</i> ,
F19	Additional expense in insuring buildings in flood risk zones	Repetto (2012); CCRA (2012)
F20	Increases in areas prone to soil heave/shrinkage	Vivian <i>et al.</i> , (2005); Gill <i>et al.</i> , (2004);
F21	Un-insurability due to climate change	LCCP (2002); Graves &
F22	Affordability of property insurance	Gill <i>et al.</i> , (2004); LCCP
F23	Availability of property insurance	CCRA (2012); Tubb <i>et al.</i> ,

Table 2: Hypotheses testing result

	Likelihood impacts	Timeframe occurrence
Research Question	Are there differences between the ranking of the likelihood occurrence of emerging risks based on professional role and type of their organisation?	Are there differences between the respondents in rating the timescale of occurrence emerging risks based on their professional role and type of their organisation?
Hypothesis	<i>Ha₀ ($p \leq 0.05$): there is no significant difference between respondents in rating the likelihood of the occurrence of risks emerging from climate change.</i>	<i>Hb₀ ($p \leq 0.05$): there is no significant difference between the respondents in rating the occurrence timeframe of risks emerging from climate change.</i>
Results	The result from one-way ANOVA test indicated that there were significant differences between public and private sector on one financial risk 'Additional expense in insuring buildings in flood risk zones'.	There were significant differences between public and other type of sectors on financial risk 'Increase costs to purchase'.
Researchers' Observation	• The damages occur from flooding and its frequency in certain areas lead to increase in insurance in vulnerable areas. • Public organisations and other institutions put this risk in their top 5 emerging risks. The difference might be due to their experience with such risk event, as well as that floods considered in the most dangerous climatic patterns.	• Respondents from other institutions indicated this risk is highly expected to occur in a very early timescale (0-5 years). • Public and private organisations did not agree with this expectation. This could be attributed to the fact that they already have strategies for mitigating the impact of this risk through long-term contracts to secure sources.
Conclusion	The null hypotheses <i>Ha₀</i> was rejected for 'Additional expense in insuring buildings in flood risk zones'.	The null hypotheses <i>Hb₀</i> was rejected for 'Increase costs to purchase'.

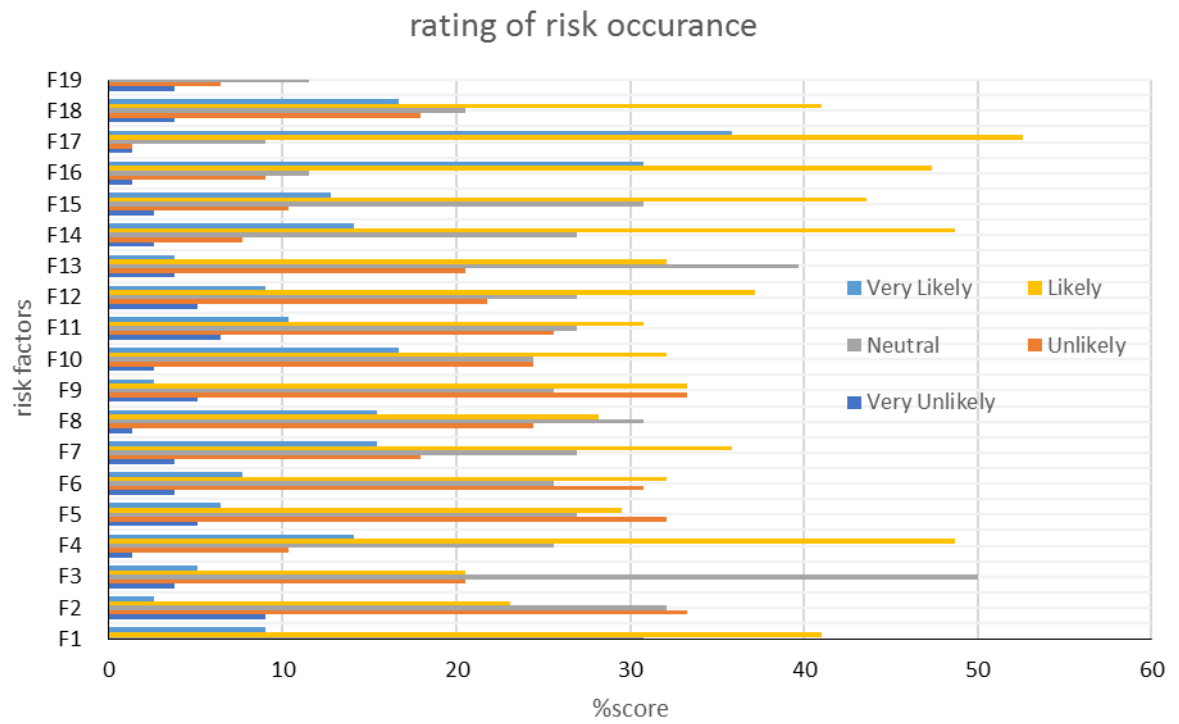


Figure 1: Rating of financial emerging risk factors

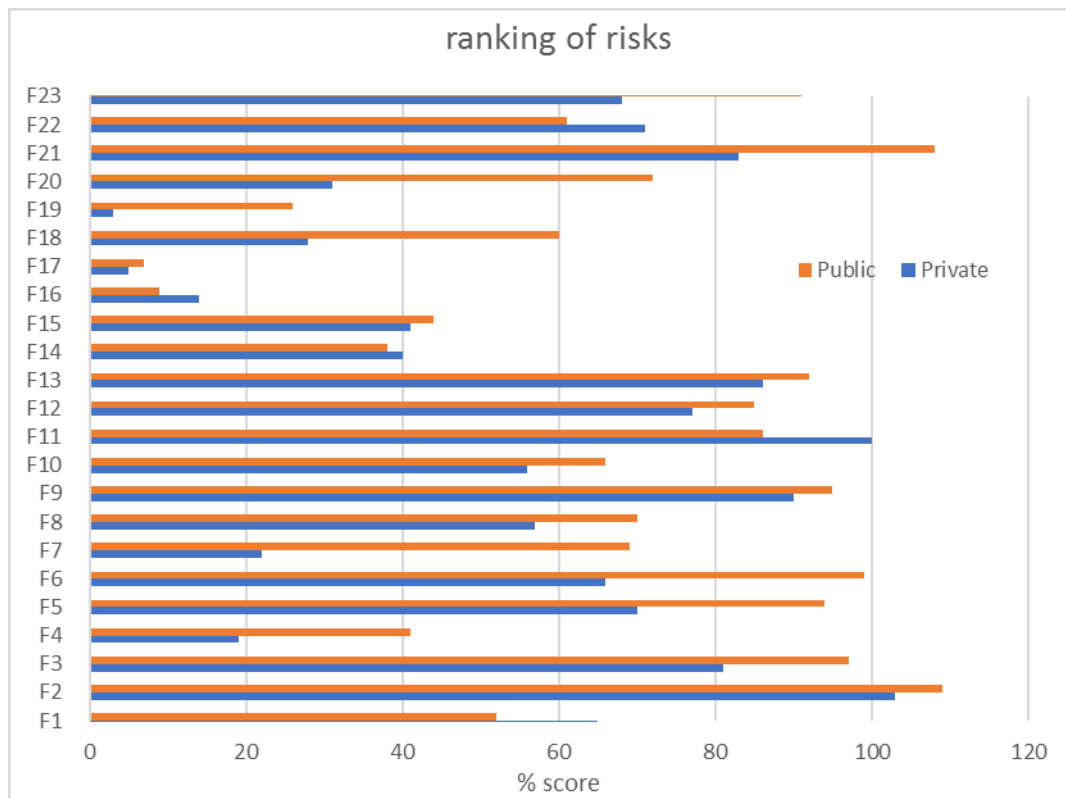


Figure 2: Institutional ranking of financial emerging risk factors

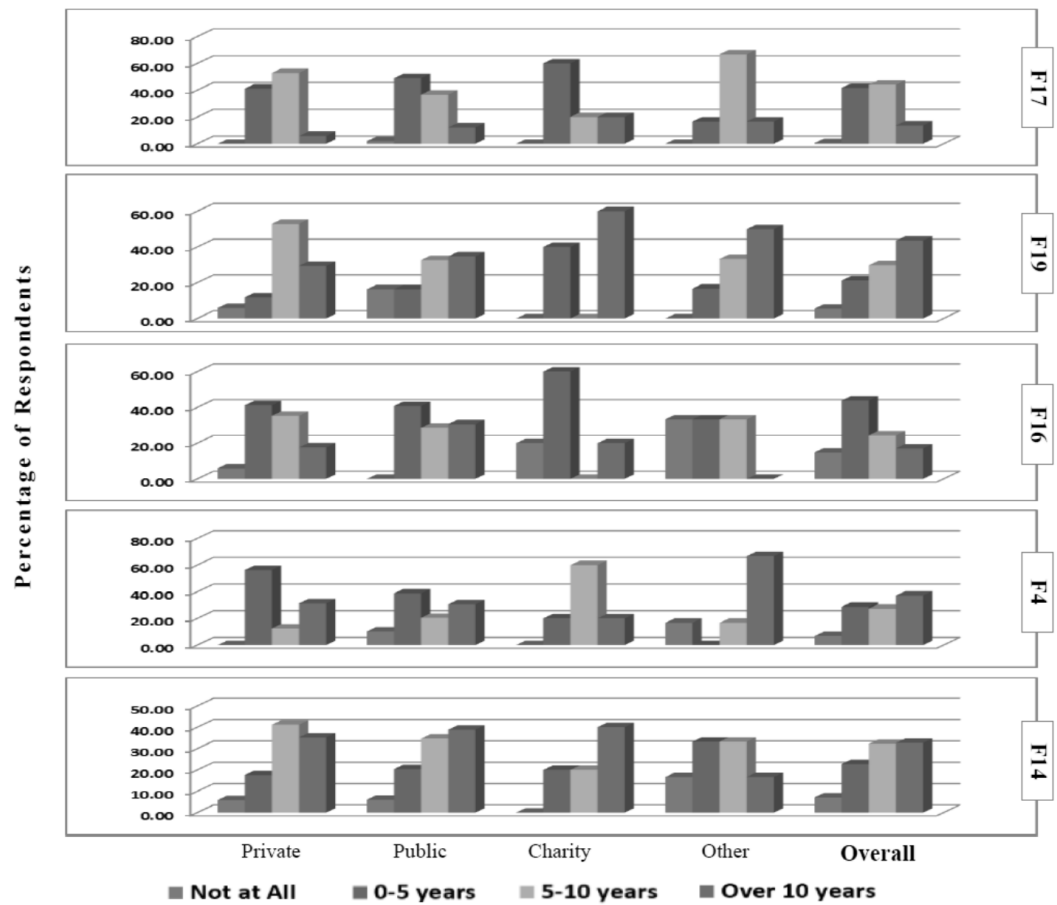


Figure 3 Timeframe for Financial Risks Based on Type of Organisation

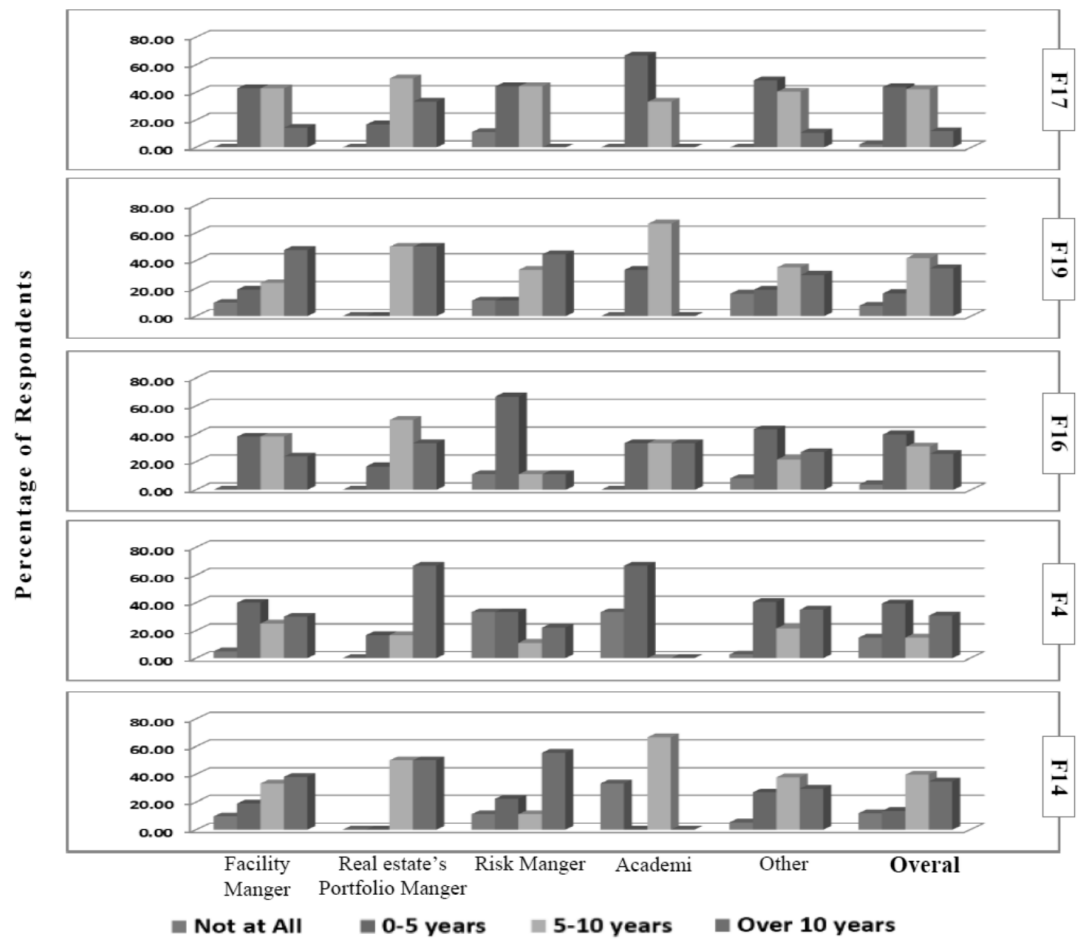


Figure 4 Timeframe for Financial Risks Based on Professionals Role