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QUANTITATIVE RISK ANALYSIS: DETERMINING UNIVERSITY RISK MITIGATION AND CONTROL MECHANISMS

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Abstract

The paper seeks to examine adequacy of risk mitigation mechanisms by using methodologies derived from quantitative risk analysis in a University context. A questionnaire and an interview schedule were administered. The researchers used 'risk modal' responses model for the evaluation of the adequacy of risk mitigation. Furthermore, the researchers incorporated expert judgements, binomial distribution model and one way-repeated measure ANOVA into the risk mitigation analysis. The first category of findings revealed that (1) the University has no adequate control mechanisms to mitigate risk (2) the University does not take adequate account of key risks identified by key stakeholders and thirdly (3) the University's overall approach to risk management, as assessed for one-academic year is not adequate for its strategic objectives. The second category from general perspective suggested there was a significant relationship between individual key risks been assigned to appropriate managers and risk mitigation. Moreover, there was good reason to suggest a relationship between various committees taking adequate account of key risks identified by key stakeholders and risk mitigation. Lastly the results revealed that there was enough evidence supporting a relationship between institution's overall approach to risk management, and its strategic objectives on risk mitigation.

Key Words: Risk, Mitigation, Quantitative Risk Analysis, Social Setting, Institutional Risks.

1. CONTEXT OF STUDY

Two distinct approaches have been proposed to explain risk mitigation (Chavez-Demoulin & Embrechts, 2006; Faisal, Banwet & Shankar, 2006; McNeil, Frey & Embrechts, 2005; Szegö, 2005; Butler, 2002; Morgan, Fischhoff & Bostrom, 2002; Holzmann, 2001; Sjöberg, 2000). One (quantitative risk analysis) is predominantly developed and used by quantitative risk analyst as literature (Embrechts, 2008; Degen, Embrechts & Lambrigger, 2007; Mikosch, 2006; McNeil et. al., 2005; Giesecke, Schmidt & Weber, 2005) suggests and the other (qualitative analysis) being used by social scientist as studies (Vose, 2008; Van der Sluijs, Craye & Funtowicz, 2005; Bedford & Cooke, 2001; Kindinger & Darby, 2000; Haimes, Kaplan & Lambert, 2002) indicate. Until recently, these two perspectives have been promoted largely within disciplinary boundaries (financial mathematics), but rather in isolation from each other in social aspect of risk mitigation, though researchers such as Vose (2008) and Van der Sluijs, et al. (2005) have seriously addressed the scope for more integration, especially in social settings such as Universities.

Quantitative writers, Kaplan & Garrick (1981) showed, as early as 1980s, that lay people and experts in risk mitigation do not use the same approaches of 'risk mitigation' when assessing risks.

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Arguably, most quantitative experts (quants) focused on quantitative assessments of likelihood and consequences, whereas the general public and most qualitative analyst use a number of qualitative dimensions such as 'experience,' or 'lack of knowledge to those exposed' and 'catastrophic potential' subjectively (Van der Sluijs, et. al., 2005; Kindinger & Darby, 2000; Haimes et. al., 2002). The qualitative analysis has been very influential, and has become well known in risk mitigation at the expense of quantitative (often termed as quants) in social setting. However, the most used quantitative analysis as review of literature (Embrechts, 2008; Vose, 2008; Embrechts & Lambrigger, 2007; Saunders, Cornett, McGraw & Anne, 2006; McNeil et. al., 2005; Bedford & Cooke, 2001) shows is in the financial institutions, but not in social settings such as institutions of higher education (IHE). Although, the quants have made an important contribution to the understanding of risk mitigation, but have been subjected to two main criticisms due to the social characteristics of risks.

The first objection was that quants do not treat qualitative risk characteristics as both inherent attributes of the hazards themselves and as constructs of the respondents. In this respect, a number of authors (Haimes et. al., 2002; Kindinger & Darby, 2000) have argued that whether one feels in control of the consequences of a risky event, whether one feels that exposure to a risk is voluntary, or whether one believes that knowledge is available to those exposed to risks are all, at least in part, related to social, cultural, and institutional processes. But, this argument is relatively, unfortunate, skewed and distorted. What is often not recognised is that even the simple act of categorising (unquantifiable variable) could be viewed as a quantitative as well. Thus, using likert scale to quantify an unquantifiable variable. Besides, numbers in and of themselves can not be interpreted without understanding the assumptions which underline them. The bottom line here is that quantitative and quanlitative data are, at some level, virtually inseparable. Neither exists in a vacuum nor can be considered totally devoid of the other. To ask which is better or more valid ignores the intimate connection between them. To do good risk mitigation therefore, analyst need both.

The second criticism leveled at the quantitative experts was that it did not, at first, distinguish between different groups of respondents other than experts[1] (in quantitative methods) and laypersons (general view and subjective). The classic numerate approaches[2] generated by quantitative studies (Embrechts, 2008; Vose, 2008; Embrechts & Lambrigger, 2007; Saunderset al., 2006; McNeil et al., 2005; Morgan 1993) (re)present or are based on aggregate and predominantly objective data. This view sharply contrasts with the qualitative and predominantly individual analysis in risk mitigation. Additionally, a number of studies (Morgan 1993; Standard & Poor, 2005; Nicholas & Steyn, 2008) have now shown that individual respondents (risk analyst) could differ in their ratings of the same risk-issue on the same qualitative risk characteristic during risk mitigation analysis. Such studies have stimulated an important debate about the relative value and significance of qualitative as opposed to quantitative risk mitigation analysis. Some studies (Vose, 2008; Faisal et al., 2006; Holzmann, 2001; Sjöberg, 2000) have suggested that although risk management processes (which include risk mitigation) are iterative, but are nearly impossible to separate one process from another. Proponents (Kindinger & Darby, 2000; Haimes et al., 2002) of the qualitative appear to have increasingly not accepted this point and some of their recent studies (Cox & Babayev, 2005; Fletcher, 2005; Yazarr, 2002; Bass & Robichaux, 2001; Kindinger & Darby, 2000) have not used rigourous[3] quantitative methods to explore social dimensions.

One other problem with qualitative approach to risk mitigation is that there appear to be (at least) two different versions of the analysis due to level of subjective and experience in a social setting. The first version maintains that individuals (qualitative risk analyst) would choose to attach themselves to institutions' risks with the same type of social organisation in different spheres of their lives and would therefore adhere consistently to the same risk whatever the institutional context. This version also

[1] In this study, experts are quantitative analyst who on a daily basis will coordinate a Model Control Process, where Analytical Modeling, Model Risk Group, Risk Management and IT and provide sign off on new models and recertification of existing models. This person is involved with the analysing and performing review of newly developed models. They provide technical expertise within the Risk Valuation, by assigning them with the design and of mark review and valuation methodologies. Strong Mathematics background is a plus. Strong C++, C#, ModelRisk, Analytical skills necessary.

[2] Reducing socially constructed phenomenon to single digit

[3] This paper cannot cover all the aspects of the vast and growing field of quantitative risk management. For further readings, I refer readers to books of McNeil et al. (2005) (for quantitative risk management in general) and references provided.

implies that individuals would conform to the same risks of the institution over time and therefore tends to treat risks as innate attributes of institution. Proponents of the qualitative version of risk mitigation rather argue that questionnaire surveys cannot tap into the relevant dimensions of social relations and promote the use of qualitative methods set in specific social settings. On the other hand, proponents of the quant version, however, think it is legitimate to use questionnaire items to elicit risk mitigation without recourse to qualitative approach.

Following the above point and in recent years, a number of writers (Vose, 2008, Nicholas, 2004; Stirling, 2003; Sjöberg, 2000) have looked at institutional dimensions and versions (such as control mechanisms, sources of key risks identification, approaches and perceptions of risks) which underlie risk mitigation. They point out that institutions reframe their interpretations of the context of risk mitigation according to institutional mitigation procedures, in which their understanding are also involved. It is learnt from this that risk mitigation analyses are amplified or attenuated according to a variety of social stimuli and experiences. This has a number of ramifications and ambiguity. This ambiguity in risk mitigation has serious implications for developing methodologies to test risk mitigation empirically, because it is unclear whether the unit of analysis should be individuals or situations. Hence, the researchers interest here in using a dominant quantitative, but supported by qualitative framing of risk mitigation analysis to investigate adequacy of control mechanism to mitigate risk. The researchers felt that it might be possible to extend this bridging of the qualitative with a more quantitative approach by investigating the possible contribution of statistical methods. The researchers did so, because, statistical analysis would focus specifically on specific patterns of risk relationships that generates risk mitigation.

The study reported here essentially uses a statistical method even though the researchers are aware of the criticism that questionnaires composed of general and context-free questions fail to incorporate any analysis of social relations and cannot, therefore, truly tap into risk mitigation. If questionnaires are to be used at all, respondents should be chosen according to their adherence to particular institutions with distinctive group characteristics. In this respect, the study incorporated a sample of respondents selected in this way (cf. methodology). In addition, the questionnaire reported here was followed up with interviews schedule. The objective of the study therefore was to use methodologies derived from both the quantitative (dominant approach) and qualitative analysis of risk mitigation in order to investigate the adequacy of control mechanisms to mitigate risk in a South African University. The quantitative is dominant approach in order to cater for the criticism leveled against it in the usage of risk mitigation. Consequently, the below research question(s) have emerged.

1.1 Research Questions

Main Question

1. To what degree has the institution adequate control mechanism to mitigate risk?

Sub Questions

a) Is the responsibility for the oversight of individual key risks been assigned to appropriate managers?
b) Has the institution taken adequate account of key risks identified by key stakeholders?
c) To what degree is the institution's overall approach to risk management, as assessed for one-academic year adequate for its strategic objectives?

2. METHOD

A questionnaire was administered. The research participants were individuals working in a historically black South African University who are tasked to undertake risk management activities for the institution. The researchers used the University's General Prospectus (2009: 34-43) to identify the

target population. In the data collection process these population included three different types of committees operating in the University. These were; (1) committees of senate (2) joint council and senate committees and (3) management committees. These three categories either had members who belonged to the executive committee of senate or non-executive committee of senate (cf. University General Prospectus, 2009:34-43). The reasons for this selection[4] were in three folds. Firstly, the purpose of the research, notes that the functionality of institution lies in a risk analyst's ability to predict and model quantifiable risk, based on appropriate polices and procedures. This, in this case is the responsibility of the various committees mentioned above. Secondly, the various committees assume a position of risk management in the institution and lastly to limit the study to respondents in management as well as decision making positions.

The researchers note here that they used a stratified random sampling for selecting risk analyst identified by different committees. A total of 90 respondents were selected: 20% of these refused to be interviewed, 8% were never at their offices. Thus, making it a total of 28% who did not take part. Meanwhile, neighborhood of 72% completed the questionnaire, giving a total of 64 respondents. Six respondents, with a 100% response rate were interviewed using a structured interview schedule. Given the length of the interview (the mean time; 57 minutes), The researchers regard both the questionnaire and the interview schedule as a reasonable response rate.

The questionnaire consisted of 8 main sections. The first section of the questionnaire apart from the background information measured risk awareness[5] of the institution. In the second and third parts (identification and prioritisation, risk mitigation), respondents were asked to rate specific situations of the institution with regard to risk mitigation. Other variables included risk planning and, risk quantification to mention but a few. Each item was scored on a 5-point scale from 1, 'disagree strongly' to 5, 'agree strongly'. Using this system to categorise individual's responses, the sample consisted of 14% junior workers, 1.6% a stratum of executive management committee. 10% directors and 23.4% associate professors. There were 35.6% managers in the sample. A neighborhood of 1.6% was made up of employees such as security personnel and secretaries.

Meanwhile, the five scales (likert) of all the variables also showed noticeably varying degrees of internal consistency. The risk mitigation scales had Cronbach's alpha coefficients of 0.63, which is a respectable value in socially setting (Cohen, Cohen, West, & Aiken, 2003; Stevens, 2002; Tabachnick & Fidell, 2001; Maxwell, 2000). Moreover, the instrument as a whole had a Cronbach's alpha of 0.72, whiles with standardised items, the value indicated 0.82. Thus high reliability was achieved. This fact together with a high Cronbach's alpha suggest that statistically, a risk analyst can distinctly reason that there is a high level of confidence associated with the various variables and the instrument as a whole. The below elaborates on the research results.

3. RESEARCH RESULTS

The variable that was investigated was risks mitigation mechanisms in the University based on research questions (cf. research questions). In this section though, the discussion began with disaggregating the variable to ascertain the level of response. This is then followed by mathematical treatment of risk mitigation: benchmarking. A composite response of risks mitigation in the University was also analysed. Lastly, the section addressed the question of specific patterns of risk relationships that generated risk mitigation. The section though starts with the sub-variables (disaggregated responses) associated with the University-wide risk mitigation.

3.1. Sub-variables associated with the University-wide risk mitigation-Disaggregated responses

[4] See Bayaga (2009b) for details of "Criteria for Selection of the Institution".
[5] See bayaga (2009b) for details of all the 8 variables.

This sub-section aims to address degree of risk mitigation and control mechanisms. (cf. main research question). In essence, it addresses the question of whether the institution has adequate control mechanisms to mitigate risk. Table 3.1 below revealed responses (using modal responses) of each sub-variable the University undertakes with regards to risk mitigation. While, respondents disagreed with the institution having adequate control mechanisms to mitigate risk. The same could be said of the issue of the institution taking adequate account of the key risks identified by key stakeholders. Thus in both cases, the respondents disagreed with the statements. One similar category of such sub-variable was the issue of the institution's overall approach to risk management. As assessed for one-academic year, this was not adequate for its institutional strategic objectives[6]. Similarly, respondents disagreed with the statement as evidenced in the modal response in table 3.1 below.

These categories of sub-variables apparently resonate with the previous variable, which dealt with risk identification (for details see Bayaga, 2009b). This, as evidenced in both cases (risk identification and mitigation) suggests that in a competitive industry such as HEIs environment, every University operates in a climate of risk. During the interview this was equally pointed as a respondent (Sala) argued that:

> *…It is never possible to remove all risk from a University, but it is important to assess and reduce risk to an acceptable and appreciable level where possible.*

In relation to HEIs, assessing and minimising risk has recently become very important, particularly due to both international and national requirements[7]. Therefore, it is vital that the University undertakes risk monitoring and control risk - especially as the University environment changes rapidly and new HEIs-related risks appear all the time. In this category of risk mitigation variable though, the two sub-variables with which respondents agreed with was the issue of responsibility for oversight of individual key risks been assigned to appropriate managers (cf. table 3.1 below). This sub-variable, commensurate with the University's capability of assigning and setting-up various committees which are mandated to undertake risk management. The other sub-variable with which respondents agreed with was the issues arising from audits being brought to the attention of the executive management team. Evidential documents[8] University of Fort Hare Final Strategic Risk Assessment, 2009; Student satisfaction index survey) of recent audit suggest that external auditors' reports are prepared and brought to the attention of the management of the University.

Table 3.1: Sub-variables associated with the University-wide risk mitigation

	The institution has adequate control mechanisms to mitigate risk	Responsibility for the oversight of individual key risks has been assigned to appropriate managers	The institution takes adequate account of the key risks identified by key stakeholders	The institution's overall approach to risk management, as assessed for one-academic year is adequate for its strategic objectives	The issues arising from audits are brought to the attention of the executive management
64		**64**	**64**	**64**	**64**
Mode	**2**	**4**	**2**	**2**	**4**
Percentile					
25	**2.00**	**2.00**	**4.00**	**4.00**	**3.00**
50	4.00	4.00	4.00	4.00	4.00
75	4.00	4.00	4.00	4.00	4.00

N* - sample size

Modal responses -** The responses were categorised using a five-point likert scale where: Strongly agree = 5; Agree = 4; Unsure = 3; Disagree = 2; Strongly disagree = 1

[6] For more on risk and strategic objective see Bayaga (2009b).
[7] See King report (2009) , HEQC, (2004) & HEFCE, (2006)
[8] These documents are not for external circulation, for further references, special permission needs to be sought.

To sum this subsection, it is important for the University to place much emphasis on the three sub-categories (i.e. 1st, 3rd and 4th) as presented in table 3.1 above. The reason being that the fact that the modal responses appeared to be disagreed for those three variables suggests that the University does not mitigate risk adequately. This as well compromises the mandate of the committees, in which case their mandate is not sufficiently met as evidenced by the distribution of their responses. In terms of this particular variable (risk mitigation), these results suggest that risk are innate attributes of institutions, which could be measured using a questionnaire items. Thus, unit of analysis be preferably situations. This is a response to the question of either the unit of analysis be individuals or situations (cf. context of the study).

3.2 Mathematical treatment of risk mitigation: Benchmarking Procedure

The essence of this section was to exemplify how to conduct risk mitigation analysis. The section in essence seeks to use the results obtained in section 3.1 to set out a benchmark that the University may follow. This as well seeks to explore the application of objective (quantitative) risk benchmarking as opposed to purely subjective one. Series of authors (Vose, 2008, Nicholas 2008, Standard & Poor, 2005) have argued that the benchmarking is very crucial as subjective and erroneous decisions could be catastrophic. To begin with, reference is made of table 3.1 above. Firstly, the table reveals various modal responses of the sub-variables at different percentiles[9]. Secondly, and for the purpose of this section, table 3.1 suggest that while across board the modal response-thus the response favoured by the respondents is 'disagreed' as 2 denotes disagreed, the response changes if subjected to variety of quartiles. Following the presentation in table 3.1 above, where as 25th percentile corresponds to three different responses, at both 50th and 75th percentiles, the response remains constant respectively. Thus, at 50th and 75th percentiles, in each of the sub-variables, it is evidenced by table 3.1 that they (respondents) all agreed to each of the sub-variables, which evidently may not be the case, if subjected to 25th percentile.

What do the above imply? Judging from the different levels of quintiles, it can be argued that at 25th percentile, the University does not do well in one or more of the sub-variables in risk mitigation. For instance, with the sub-variable "the institution takes adequate account of the key risks identified by key stakeholders"; at 25th percentile, there is the probability or chance of a respondents not responding to 3, which denotes unsure- for argument sake. And if probability moves up, it does not [10]order well for the University as the committee members supposedly are responsible for decision making in the University in terms of risk mitigation and management. The question therefore is, how does risk analyst objectively determine the probability of members responding to say 3, which denotes unsure (or fewer than 3)? To do this, the research uses binomial distribution[11]. Firstly, inferring from the five-point likert scale: The number of responses denoted as n = 5; And 3 which denotes unsure is known. An analyst is required to calculate the probability of responding to three (3) or fewer[12]

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[9]See the use of percentiles as risk measure in Bayaga (2009b) and authors such as Greenland (2001) (for Risk Analysis): Artzner, Delbaen, Eber (2002) (for Risk management: value at risk and beyond); Granger et. Al., (1989); McNeil & Frey (2000). Meanwhile, in descriptive statistics, using the percentile is a way of providing estimation of proportions of the data that should fall above and below a given value. The *p* th percentile is a value such that at most (100 *p)* % of the observations are less than this value and that at most 100(1 - *p)* % are greater. (p is a value between 0 and 1). Thus: (1) The 1st percentile cuts off lowest 1% of data (2) The 98th percentile cuts off lowest 98% of data. The 25th percentile is the first quartile; the 50th percentile is the median. One definition is that the pth percentile of n ordered values is obtained by first calculating the rank, rounded to the nearest integer and then taking the value that corresponds to that rank. One alternative method, used in many applications, is to use a linear interpolation between the two nearest ranks instead of rounding. Linked with the percentile function, there is also a weighted percentile, where the percentage in the total weight is counted instead of the total number. In most spreadsheet applications there is no standard function for a weighted percentile.

[10] In this research order denotes 'to speak well"

[11] For more on binomial distribution see Evans, Hastings, & Peacock (2001). Statistical distributions. Measurement Science and Technology: Hilbe (2007).Negative binomial regression: Feller (2008). An introduction to probability theory and its applications: Winkelmann (2008). Econometric analysis of count data

[12] Here fewer denotes 2, 1 and 0 as in the five point likert scale; where 0 is no respondent has an idea of what the University does. Thus question left blank.

ρ (3) ; ρ (2) ; ρ (1) ; ρ (0) ……*Equation (1)

*Note: I recommend readers to read ρ (3) and others as 'probability of choosing unsure (3).

Inferring from table 3.1 and working or benchmarking at 25th percentile as probability ρ = 25% = 0.25; then according to the equation (2) below, the probability of responding to three being unsure is given as:

$$\rho\ (x=3) = \binom{n}{x} p^x\ (1-\rho)^{n-x} = \frac{n!}{(n-x)!x!}\rho^x\ (1-\rho)^{n-x} \ldots\ldots\ldots\ldots\ldots\ldots$$

Equations 2

Substituting ρ =0.25 and x= 3 into Equations 2: we have

$$\rho\ (x=3) = \binom{n}{x} p^x\ (1-\rho)^{n-x} = \frac{5!}{(5-3)!3!}0.25^3\ (1-0.25)^{5-3}$$

$$= 10(\ 0.25^3\ (1-0.25)^{5-3})$$

$$=10(0.02)\ (0.75)^2$$

$$= 0.1125$$

The probability of exactly 3 out of 5 responses is 11.25 percent: This implies that with the current understanding and knowledge of risk mitigation process in the University, there is till 11.25% chance of a respondent being unsure of the situation in the University. Thus there is 11.25% chance of respondents being unsure (p=3) of the University's situation pertaining to the question "the institution takes adequate account of the key risks identified by key stakeholders" at 25th percentile.

The other probabilities need to be calculated.

$$\rho\ (2) = \rho\ (x=2) = \binom{n}{x} p^x\ (1-\rho)^{n-x} = \frac{5!}{(5-2)!2!}0.25^2\ (1-0.25)^{5-2}$$

$$= 10\ (\ 0.25^2\ (1-0.25)^{5-2})$$

$$=10(0.06)\ (0.75)^3$$

$$= 0.2531$$

Thus 25.31% will disagreed (p=2) with the University's situation pertaining to the question "the institution takes adequate account of the key risks identified by key stakeholders" at 25th percentile.

$$\rho\ (1) = \rho\ (x=1) = \binom{n}{x} p^x\ (1-\rho)^{n-x} = \frac{5!}{(5-1)!1!}0.25^1\ (1-0.25)^{5-1}$$

$$=5\ (\ 0.25^1\ (1-0.25)^{5-1})$$

$$=5(0.25)\ (0.75)^4$$

$$= 0.7910$$

Thus 79.101% will strongly disagreed (p=1) with the University's situation pertaining to the question "the institution takes adequate account of the key risks identified by key stakeholders" at 25th percentile.

$$\rho(0) = \rho(x=1) = \binom{n}{x} p^x (1-\rho)^{n-x} = \frac{5!}{(5-0)!0!} 0.25^0 (1-0.25)^{5-0}$$

$$=1\ (0.25^0 (1-0.25)^{5-0})$$

$$=1\ (0.75)^5$$

$$=0.2373$$

Thus there is 23.73% chance of risk not even identified by the committee members (p=0) with the University's situation pertaining to the question "the institution takes adequate account of the key risks identified by key stakeholders" at 25th percentile. Note that this category of members is different from the strongly disagreed. The category is assumed to have no idea of what is in the University.

What the indexes above imply is that with the current understanding and knowledge of risk identification in the University supposedly known by the members of the committees, there is enough evidence at these four different probabilities (p=3, p=2, p=1, p=0) to suggest that respondents would choose unsure or fewer than unsure (cf. table 3.1), if the University benchmarks at 25th percentile.

The above benchmarking model and variety of others as noted by Power (2004), can assist institutions to enhance their risk mitigation process which subsequently enhances their mitigation approaches. Power's argument is also supported by other authors (Hausken, 2002; Henkel, 2002; Barton et al., 2002**;** Clarke & Varma, 1999) who caution the ineffective use of risk mitigation process in an organisation due to lack of technical know how of mitigation procedures especially in socially settings. In conclusion to this section, it is imperative to note that the mathematical model developed in conjunction with the data in section 3.1 suggest that risk mitigation can be broken down into two components: (1) risk elimination and (2) risk reduction as revealed. The research argues that risk elimination process should be aggressive and proactive for top priority risks. This may follow model (s) as depicted in this section (Mathematical treatment of risk mitigation) above. Noting that identification and prioritised risks are essential to achieve the full benefits of University-wide risk mitigation. Thus, risk elimination (which is circumstantial) requires carrying out the necessary action(s) to completely remove the identified issue or risks from the University.

On the other hand, a reduction of the degree of occurrence, or lessening of the impact, can be attained by actions early in the University. Also, here it is argued that the application of the model may be helpful enough to mitigate risk through the benchmark model. In addition to the reduction process, even a prototype to confirm say a technology is an example of mitigating the identified risk that the technology is new to the University and may not be able to deliver the required functionality. This mitigation activity would reduce the likelihood of say the technological environment causing a problem to the University in service as it would have been previously tested or proven. However, researchers (Nicholas 2008, Vose, 2008, Embrechts & Lambrigger, 2007; Saunders et. al., 2006; McNeil et al., 2005; Standard & Poor, 2005; Sjöberg, 2000; Morgan 1996) caution that Universities need to beware of the 'risk' of 'risk mitigation', because sometimes it may not go far enough due to the subjective nature. In the example above though, the mitigation may concentrate resources to address the prototype and then assume that there would be no problems with the service implementation. This would reduce the likely occurrence, but not eliminate it completely. Noting that if, technology changes during the time period, this risk would have to be reinstated and revisited by reporting and continues monitoring. This is the reason for an additional model such as the above to reduce the level of subjectivity. The next sub-section addresses composite risk responses associated with the University-wide risk mitigation.

3.3 Composite Risk Associated with the University-wide Risk Mitigation

A composite risk mitigation response (cf. table 3.3) was conducted to respond to the aggregate response of the variable risk mitigation. In this analysis, while well over one-half (60.9%) were in agreement, just a little below one-fifth (17.5%) disagreed with the view that the institution has risk mitigating and control mechanisms. A comparatively negative response was indicated by 11.9% of the respondents who asserted that they were unsure of the mitigation and mechanisms the institution employs. Noting from the respondents who disagreed together with those who were unsure as a

composite 29.4% (i.e. 17.5 +11.9), it could be reasoned that even though to an appreciable level, the University undertakes risk mitigation, in its composite level, the 29.4% remains a matter of concern. This suggests that there is some reason to argue that the mitigation process of the University begs the question of the mandate of the risk analyst (committee members).

Table 3.3: University-wide risk mitigation

		Responses	
		N	Percent
Risk Mitigation and Mechanisms	Disagree	56	17.5%
	Unsure	38	11.9%
	Agree	195	60.9%
	Strongly agree	31	9.7%
Total		320	100.0%

Following the above, the current study argues that there are inevitably some risks to a University that risk analyst can neither eliminate nor reduce to an acceptable level. For this reason, risk analyst can only mitigate those risks by assessing what might happen as a result of the risk and reducing their impact should they occur. In many situations though, the greatest damage can occur because no one fully understands the nature of the risk and end up making it worse. This as noted by Standard & Poor (2005) occurs when risk is not disaggregated and models followed. More so, it occurs when specific patterns of risk relationships that generate risk mitigation are not pursued.

3.4 Specific patterns of risk relationships that generates distinctive ways of risk mitigation

The relationship between specific patterns of risk relationships and distinctive ways of risk mitigation was measured by comparing the results between variables that measure specific patterns[13] of risk relationships and risk mitigation. In essence, the patterns of risk relationships are various attributes in risk mitigation, which makes it possible to analyze the impact of different factors separately. This follows the objective of the research as stated in the context of the study. A specific pattern of risk relationships was determined based on the response of individual risk analyst in the University. Three hypotheses generated were tested using the one-way repeated measures analysis of variance (ANOVA). The researchers chose one-way repeated measures ANOVA to analyse the results, which was the correct statistical test. First, the choice was appropriate because the intent was to measure the variance in specific patterns of risk relationships that generates risk mitigation. Second, the test was correct choice because the dependent variable, specific patterns of risk relationships, is measured by their responses, and their score is measured as a continuous variable. In this regards, a number of assumption needed to be observed. A one-way repeated measure ANOVA requires the dependent variable follow a normal distribution. To demonstrate this assumption, a bell shaped histogram was used. Inspection of the shape of the histogram revealed a normally distributed curve. Thus the scores are reasonably normally distributed, with most scores occurring in the centre, tapering out towards the extremes. Also other preliminary analysis (linearity and homoscedasticity) performed ensured no violation of assumptions. Below is an elaboration of the hypotheses.

[13] Individual key risks been assigned to appropriate managers- account of the key risks identified by key stakeholders- institution's overall approach to risk management- and its strategic objectives identified- as specific patterns of risk relationships and risk mitigation.

Hypothesis 1

Ho: There is no significant relationship between individual key risks been assigned to appropriate managers (committees) and risk mitigation

Ha: There is a significant relationship between individual key risks been assigned to appropriate managers and risk mitigation

A one-way repeated measures ANOVA was used to test for assigning individual key risks to appropriate managers and risk mitigation. The result differed significance across two committees and risk mitigation, F (2, 27) = 5.77, p = 0.008. Tukey post-hoc comparisons of the two groups indicate that the second group (M = 5.41) gave significantly[14] higher preference ratings than the first group (M = 4.43), p =0.007. The significant relationship between individual key risks been assigned to appropriate managers, in this case committee members and risk mitigation suggests that the null hypothesis be rejected.

Hypothesis 2

Ho: There is no significant relationship between various committees taking adequate account of the key risks identified by key stakeholders and risk mitigation.

Ha: There is significant relationship between various committees taking adequate account of the key risks identified by key stakeholders and risk mitigation.

On the other hand though, another one-way repeated measure ANOVA was conducted to compare scores on the various committees taking adequate account of the key risks identified by key stakeholders and risk mitigation. The means and standard deviations are as presented below. There was a significant effect for risk mitigation (wilks' lamda = 0.25, F (2, 28) = 41.17, p<0.0005, multivariate partial eta squared = 0.75). Noting that this results suggests a large effect size. Suggesting that there is significant relationship between various committees taking adequate account of key risks identified by key stakeholders and risk mitigation.

Hypothesis 3

Ho: There is no significant relationship between institution's overall approach to risk management, and its strategic objectives on risk mitigation.

Ha: There is significant relationship between institution's overall approach to risk management, and its strategic objectives on risk mitigation.

A one-way within subjects (or repeated measures) ANOVA was conducted to compare the effect of institution's overall approach to risk management, its strategic objectives and risk mitigation. There was a significant effect of institution's overall approach to risk management, wilks' lambda = 0.10, F (2, 3) = 13.42, p = .032. Two paired samples t-tests were used to make post hoc comparisons between overall approach to risk management and its strategic objectives. A first paired samples t-test indicated that there was a significant difference in the scores for risk mitigation (M=5.4, SD=1.14) and strategic objectives (M=9.4, SD=1.14) conditions; t (4) =-5.66, p = .005. These results suggest that institution's overall approach to risk management and its strategic objectives really does have an effect on risk mitigation. Specifically, the results suggest that institutions with overall approach to risk management, significantly impact on risk mitigation.

4. DISCUSSION OF FINDINGS

The research in the first place noticed that among other things, the University lacked risk mitigation in various forms: (1) the University lacked mechanisms for the institution to have adequate control to mitigate risk: recommendation that follows is that further research be carried out to identify such mechanisms (2) lack of adequate account for key risks identified by the institution key stakeholders; recommendation that follows is that further research should be carried out to identify

[14] *Note*. Judgments were made on a 5-point scale (1 = strongly disagreed, 5 = strongly agreed). Means that do not share subscripts differ at $p < .05$ in the Tukey honestly significant difference comparison.

such key risks identified by the institution key stakeholders (3) lastly the University's overall approach to risk management, as assessed for one-academic year such that it is adequate enough to meet its strategic objectives is inadequate. To achieve the above though, the research suggests the creation of a coherent strategy for mitigating the risks in a cost effective manner. In view of this, Xolani (a respondent) argued that:

> *...any suggested mitigation activities must take into account cost, time to implement, likelihood of success, completeness, and impact over the entire institutional risks.*

This risk mitigation strategy must be constrained by the business context and should consider what the University could afford, integrate, and understand so to be sufficient and adequate. The strategy must also directly identify validation techniques that can be used to demonstrate that risks are properly mitigated. Typical of such strategies may include the benchmark developed to assess the degree of control mechanisms of the institution with regards to risk mitigation. Other authors (Nicholas & Steyn 2008, Yazarr, 2002; Bass & Robichaux, 2001; Kindinger & Darby, 2000) shared similar view. In fact, Standard & Poor (2005) explained that other metrics to consider may be financial in nature and include estimated cost takeout return on investment in relation to student pass rates as well as through put. Following this strategy, Bayaga (2009b) argued that risk identification and prioritisation are only beneficial if actions are defined and executed to mitigate the risk. In respect of this argument, Standard & Poor (2009) suggest that risk mitigation actions must be defined individually for each risk. The authors add that in some cases, immediate actions are necessary. Especially following the inferential analysis made. For other risks, future plans and considerations are more appropriate. In this study though, the question then is; what should be the University's risk mitigation strategy?

Following a series of interviews with the respondents[15], a respondent (Jalil) commented that:

> *… risk mitigation strategy should include actions that are proactive to prevent a risk from occurring and impacting an institution or reducing the impact of the risk.*

To make this point clearer, Jalil explains that if a risk analyst shows that an institution has unacceptably high levels of risks using models as exemplified in section[16] 3.2, then one needs to take some actions to counter them. In this respect, Nicholas & Steyn (2008) come in handy with the idea that: (1) reduce the probability of the risk affecting the institution (2) limit the impact of the risk if it does occur.

This approach follows Nicholas & Steyns' (2008) definition of risk. In this definition, the authors pointed out that risk is a function of the probability (likelihood) and the impact of an event[17] should the event occur. Thus mathematically, there is a direct relationship between risk, its likelihood and impact. Hence to control risk, it makes sense to control either its likelihood and or impact. A similar approach[18] in terms of determining the relationship was conducted in section 3.4. In this section specific pattern of risk relationships that generated risk mitigation was compared. The results revealed that there was a significant relationship between individual key risks been assigned to appropriate managers and risk mitigation. Moreover, there was significant relationship between various committees taking adequate account of the key risks identified by key stakeholders and risk mitigation. The final aspect revealed that there was significant relationship between institution's overall approach to risk management, and its strategic objectives on risk mitigation. Thus in theory, there is good reason to control either the likelihood or impact of the pattern of risk relationships that generated risk mitigation. In practice though, an analyst would often wish to do both, thus likelihood and impact. However, generally an analyst should try to reduce the probability of the risk affecting the institution in the first place. In this regard a respondent (Lille) noted that:

> *…one way of doing this is risk avoidance.*

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[15] All names are pseudonyms

[16] See section 3.2 Mathematical treatment of risk mitigation: Benhmarking Procedure

[17] In this research event defines risk factor.

[18] See section 3.4- Specific patterns of risk relationships that generates distinctive ways of risk mitigation

This strategy precisely resonates with Nicholas & Steyns' (2008) view of avoidance. In both Lille (respondent) and Nicholas & Steyn's (2008) views, avoiding is 'not doing' the things that could lead to a problem occurring, such as not entering into a line of business –say recruiting more students even though the University is ill-equipped, and or a particular deal or a new infrastructural project of the University, which has no sufficient significant basis. Reason being that it carries a risk and does not meet the strategic objective of the University. However, it is imperative for institutions to be cautioned that series of similar events may overwhelm the University and might mean that an analyst may end up not doing anything new, and hence not being able to benefit fully from business opportunities. A solution offered by a one of the respondents (Tasia) was:

> *….that an analyst could instead take a more positive approach by changing the way in which the institution carry's out an activity.*

This is quite appropriate to higher education institutions (HEIs)-related risk, as James continued:

> *….because of their relative autonomy and usually have the opportunity to adopt a best practice approach to acquiring or operating systems in terms of risk mitigation and planning.*

In this instance, it is important to differentiate risk mitigation from risk planning, because as some studies (Nicholas & Steyn, 2008; Power, 2008; Standard & Poor, 2005; HEFCE, 2001) cautioned, risk mitigation must not be confused with the planning component of University-wide risk management. Where as risk mitigation strategy is as stated above (cf. Nicholas & Steyn (2008) explain that risk planning is prepared for execution after a risk becomes a problem and starts to impact a University. Risk planning therefore, becomes a matter of urgency in incorporating the three hypotheses tested above. Noting that since all the three null hypotheses stated in the study were rejected, it suggests that there is a significant relationship of specific patterns of risk relationships and risk mitigation. Thus, the specific patterns of risk relationships aspire to influence risk mitigation. This is consistent with previous research (Nicholas & Steyn, 2008) that has suggested that specific patterns of risk relationships generate distinctive ways of risk mitigation. With reference to the results of the study, it is apparent from the data analysis that specific patterns of risk relationships have important and direct relationships with distinctive ways of risk mitigation.

However, the advantages of using quantitative models are also obvious: firstly, the use of expert judgements (by ranking responses) becomes consistent and transparent through the application of quantitative risk analysis models. But, this must be done to create a model that must define the concepts of social settings more exact, thus helping to interpret final results.

CONCLUSION AND RECOMMENDATIONS

Following the above, the key findings are (1) the University has no adequate[19] control mechanisms to mitigate risk (2) the University does not take adequate account of the key risks identified by key stakeholders and thirdly (3) the University's overall approach to risk management, as assessed for one-academic year is not adequate for its strategic objectives. Notwithstanding the concerns raised above two positive sides are (1) the responsibility for the oversight of individual key risks has been assigned to appropriate managers (2) the issues arising from audits are brought to the attention of the executive management team as appropriate. Following the context and methodology of the study , it is recommended that the research be conducted in white dominated University to compare and contrast the results, or be replicated in a country other than Southern African country for risk mitigation and analysis policy .

There were a number of other conclusions that could be made. The study showed that there was a significant relationship between individual key risks been assigned to appropriate managers and risk mitigation. Moreover, there was significant relationship between various committees taking adequate account of the key risks identified by key stakeholders and risk mitigation. Lastly the results revealed that there was significant relationship between institution's overall approach to risk

[19] Adequate in this research is being able to meet objects set for a particular time period

management, and its strategic objectives on risk mitigation. This was consistent with other research (Nicholas & Steyn, 2008) that had contented that specific pattern of risk relationships generate or influence risk mitigation. In addition, the finding showed that one to one relationship between specific patterns of risk and risk mitigation mainly characterise a 'situation' as unit of analysis.

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