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Exploring Risk Management Activities for Solar PV: A Preliminary Investigation in Malaysia

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Abstract:

Solar photovoltaic (PV) is the most popular renewable energy for sustainable environment. Despite of the benefits, achieving the objectives of solar PV can be hampered by the potential risks. In Malaysia, solar PV is projected to be the main source of renewable energy by 2040;however the issue on risk is still underexplored. With limited information at hand, it would be relevant to first explore the relationships between risk management and solar PV prior to any in-depth investigation. Inspired by the Risk Management Principles and Guidelines ,this pilot study has prepared the research framework and hypothesis for the preliminary investigation. The questionnaire was sent to solar PV firms in Malaysia, where the analysis has found mixed results. In fact, only one relationship between risk context and solar PV was significantly positive, while the other five hypotheses, namely risk identification, risk analysis, risk evaluation, risk communication, and risk monitoring, although also positively correlated with solar PV have to be rejected for being statistically insignificant. Meanwhile, a relationship between risk treatment and solar PV was correlated in a negative way, but the result was rejected. Despite of that, all risk management activities are positively correlated to each other. This pilot study has gathered some basic information on risk management for solar PV in Malaysia. With the findings, this study has come up with four critical questions that deserve further attention before pursuing for any large- or full-scale empirical study.

.**Key words:** Green technology, MS ISO 31000: 2010, Photovoltaic, Pilot study, Renewable energy, & Technology assessment

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1. Introduction

Solar photovoltaic (PV) has many advantages, such as produces no noise and moving parts, no fuel or water usage, less maintenance (Zeman, 2003), reduces emissions of greenhouse gases (GHG), increases energy interdependence, and energy supply diversity (Solangi et al., 2011). It can be implemented to achieve various objectives, such as to meet the needs of society without compromising the environment (Bhardwaj and Neelam, 2015), reduce reliance on finite fossil fuels, reduce emissions, increase energy security, increase energy supply reliability (Grace et al., 2011), and fulfil future energy demand and preserve eco-systems (Devabhaktuni et al., 2013). In contrast, solar PV is also associated with some disadvantages, such as cannot operates without light, high initial cost, need large area for installation (Zeman, 2003), and generates little energy per unit of land (Baker et al., 2013).

In general, Malaysia is ideal for generating electricity with solar PV due to its location to the North of equatorial line between 1° and 7° with abundant of solar energy (Haw et al., 2006). In fact, previous study has found 89% of respondents believed in the reliability of solar energy whilst 72% preferred it as the main source of renewable energy in Malaysia (Gomesh et al., 2013). However, a recent study has found that Malaysia is relying heavily on the non-renewable resources and was suggested to develop its own renewable energy to sustain future energy supply (Chong et al., 2015). Prior to that, Malaysia was recommended to reduce its dependency on the non-renewable energy, which affect the environment and society (Shafie et al., 2011). Therefore, although solar PV is projected to be the main source of renewable energy in Malaysia by 2040 (Ismail et al., 2015), it is still at early stage of development where the installation was limited to the commercial and urban residential buildings (Ahmad and Byrd, 2013).

Besides that, a previous study has found discrepancy between planning and implementation of solar PV due to financial, administrative and political, and socio-cultural barriers in Malaysia (Yuosoff and Kardooni, 2012). Meanwhile, another study has found four barriers to implement solar energy, namely institutional barriers (e.g., lack of government policies), public acceptance (e.g., lack of public awareness), economic barriers (e.g., high cost of development), and technical barriers (e.g., low efficiency) (Azadian and Radzi, 2013). In a similar vein, a study has found barriers to implement green manufacturing practices to be organizational, environmental, societal, technology, regulation, financial, and suppliers (Ghazilla et al., 2015). These barriers can be associated to risk since any unintended consequences of risks will create barrier to success dissemination of solar PV (Tsoutsos et al., 2005). Although risk management has been the main topic in scientific, industrial, and public policy for a long time (Fischhoff et al., 1984), "studies of technology adoption that directly elicit risk preferences are scarce" (Ross et al., 2010, p.5).

Due to many firms either unaware or ignore the importance of risk management (Hetamsaria, 2005), this study has decided to explore the relationships between risk management activities and solar PV objectives in Malaysia according to the following objectives: (a) to identify the bivariate relationships between risk management activities, and (b) to investigate the relationships between risk management activities and solar PV objectives. To achieve the objectives, a risk management research framework for solar PV and hypotheses are built based on the activities highlighted in the MS ISO 31000: 2010 standard. Since the relationships are still underexplored, a pilot study was conducted to collect relevant data from solar PV firms in Malaysia. The data was then processed and analyzed with SPSS20.0.

2. Risk Management Activities

The Malaysian Standards (MS) of the International Organization for Standardization (ISO) 31000: 2010 has defined risk as an "effect of uncertainty on objectives" (p.1). The uncertainties may include events or process that may or may not happen and it may be caused by lacking of information or doubt. Risk may give positive or negative impact to business objectives. In relation to innovation risk, the standard further defines risk as the possibility of a given threat that will give a harmful impact to vulnerabilities of the business' asset. For the purpose of this study, risk shall be referred to any unintended outcomes with chances to affect the objectives of solar PV in a positive or negative way, while risk management shall be referred to as a process to identify, analyze, evaluate, control, and monitor the effects of risk on the objectives of solar PV. In general, the key concept of risk management is a process. The process enables organizations to identify, measure, plan and manage risks. There were originally three risk management activities when it was introduced in the 50s, which comprised of risk recognition, risk measurement, and risk handling (Close, 1974).

Throughout the time, five basic activities in risk management process has been established, comprising of risk identification, risk measurement, development and selection of risk management approach, implementation of risk management techniques, and monitoring of results (Darcy, 2001; Harrington and Niehaus, 2003; Rejda, 2011; Theil and Ferguson, 2003; Treischmann et al., 2005; Waring and Glendon, 1998).

Accordingly, risk management process was also identified with seven activities, namely establishing goal and context, risk identification, risk analysis, risk evaluation, risk treatment, risk monitoring and reviewing, and continuous communication (Berg, 2010). This suggests that risk management can be interpreted depending on the context, where it can be viewed either as a complete or specific process. Therefore, risk management can be applied to the entire organization, for specific functions, projects or activities, in many areas and levels, and at any time. It should be implemented and maintained in order to achieve the organizational objectives. This means, risk management can be tailored according to the context of different users. In Malaysia, the generic principle and guide line for risk management can be referred from the MS ISO 31000: 2010 standard. This standard defines risk management as "coordinated activities to direct and control an organization with regard to risk" (p.2). This generic risk management process consists of five main activities, namely establishing the context, risk assessment (i.e., identification, analysis, and evaluation), risk treatment, communication and consultation, and monitoring and review. Since the numbers of studies on risk management for solar PV are relatively small in Malaysia, this study will investigate the relationships between risk management and solar PV by referring to the activities addressed in the MS ISO 31000: 2010 standard. See Figure 1 for the generic process.

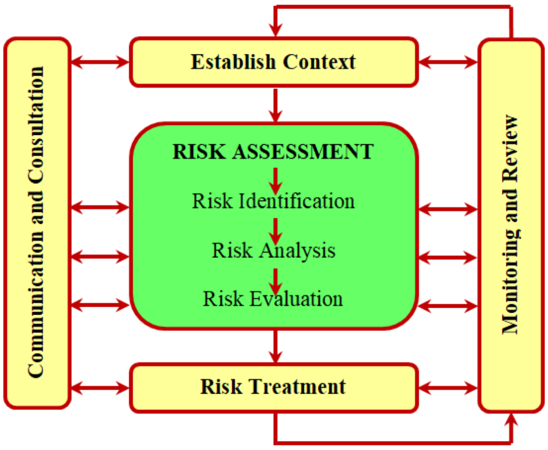

Figure 1: Activities in risk management process(MS ISO 31000: 2010).

3. Research Framework and Hypotheses

"Technology assessment may be viewed as a family of methods aimed at analyzing technological change and development with regard to specific technologies and technological systems, particularly their socioeconomic consequences and/or their meaning to people" (Hellstrom, 2003, p.329). It provides information and knowledge on the technical systems that should be assessed as early as possible (Ludwig, 1997). Two benefits of technology assessment are, (a) it identify and benchmarks the firm's technological capability strengths and weaknesses, and (b) it provides a useful tool for planning (diversification, divestment, merger, acquisition) and technology transfer (Panda and Ramanathan, 1996).With numerous concepts introduced to assess technological innovation (Gatignon et al., 2002), there are many generic assessment models/tools suggested in literature, such as technological capability gap assessment for automotive industry (Gerdsri et al., 2012), methodological tool for measurement and assessment of technological innovation (Velasquez et al., 2011), structural approach for innovation assessment (Gatignon et al., 2002), assessment indicators of technological capabilities for information technology sector (Jin et al., 2000), and technological capability assessment for electricity sector (Panda and Ramanathan, 1996).Meanwhile, there are also many types of assessment models/tools for specific application in literature, such as innovation strategy model for E-commerce (Fruhling and Siau, 2007), and technology capability assessment/audit tool for closing gap between technology management and governmental and non-governmental policy initiatives (Rush et al., 2007). However, all of these assessment models/tools are not specifically designed for addressing the risk of adopting green technological innovation.

Focusing on the risk of green technology is timely relevant since managing technological risks has been a main topic in the scientific, industrial, and public policy for a long time (Fischhoff et al., 1984). For instance, risks of structural change, and risks of protectionism are the possible risks relating to the transition towards green economy (Cosbey, n.a.). These risks need to be managed due to the impacts of transition that can be a win or a loss situation (ten Brink et al., 2012). Furthermore, the unintended consequences of the risks that create barrier for the success dissemination of green technology (Tsoutsos et al., 2005) will defeat its purpose to achieve sustainable environment.As the number of "studies of technology adoption that directly elicit risk preferences are scarce" (Ross et al., 2010, p.5), a risk management process specifically for green technology need to be explored in Malaysia. According to MS ISO 31000: 2010 standard, risk management process is a systematic application of management policies, procedures and practices. This means each of the activities in the process is equally importance to "increase the likelihood of achieving the objectives" of green technology (MS ISO 31000: 2010, p.vi). For this reason, the study will adopt all activities of risk management addressed in the MS ISO 31000: 2010 standard starting from the establishment of risk context, risk identification, risk analysis, risk evaluation, risk treatment, communication and consultation, and monitoring and review.

As a result, a research framework in Figure 2 is proposed in a way to enable the organization to identify and understand the activities to manage risk of solar PV, and allocate the relevant resources accordingly. Even though all activities are treated as equally important, this does not necessarily means the strength of relationships are also equal. This study expects the strength of relationships with solar PV will vary according to the risk management activities. This is crucial since knowing the strength of each relationship will enable the organization to identify the right activities under certain circumstances as to effectively manage the risk's event, consequence, and the likelihood of occurrence. Meanwhile, according to the generic risk management process, all activities interact with each other (as suggested by the arrows in Figure 1). As such, the research framework also enables different activities to be compared and contrasted between them. Hence, this study allows the correlations between activities to be investigated. For the purpose of this study, all generic activities are expected to be directly related to solar PV objectives. Due to the reason that the effects of each activity are expected to be varied on the objectives, by defaults, this study hypothesized that all risk management activities will positively increases the likelihood of achieving the solar PV objectives. In details:

H1: Risk context is positively correlated with solar PV objectives

H2: Risk identification is positively correlated with solar PV objectives

H3: Risk analysis is positively correlated with solar PV objectives

H4: Risk evaluation is positively correlated with solar PV objectives

H5: Risk treatment is positively correlated with solar PV objectives

H6: Risk communication is positively correlated with solar PV objectives

H7: Risk monitoring is positively correlated with solar PV objectives

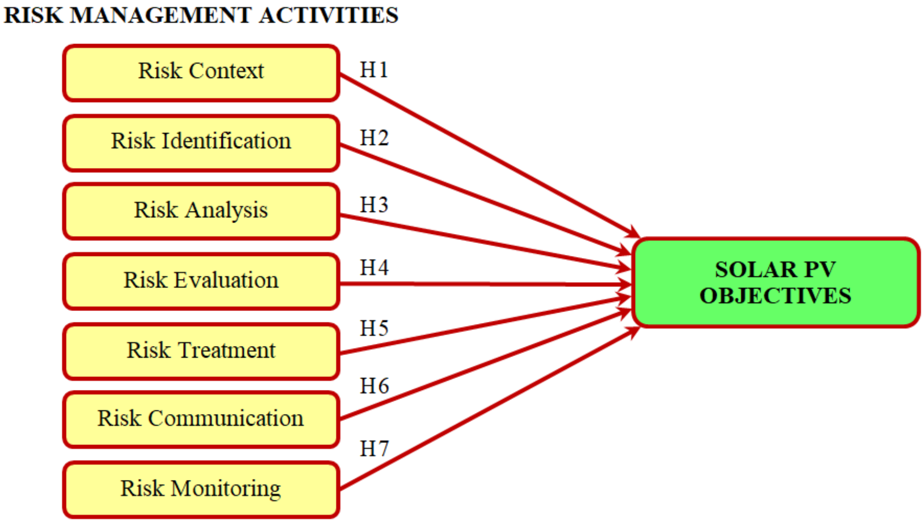

Figure 2: The relationships between risk management activities and solar PV objectives.

4. Analysis and Findings

The unit of analysis for this pilot study is solar PV firms in Malaysia. All firms were identified from the latest directory of Sustainable Energy Development Authority Malaysia (SEDA) and the membership list of Malaysian Photovoltaic Industry Association (MPIA) from the websites. In general, there were 23 firms registered with SEDA and 75 firms with MPIA. After cross-checking the lists for inspection of any overlapping names, addresses, branches, subsidiaries, etc., this study has identified a total of 86 valid firms. These firms were ranged from suppliers, manufacturers, distributors, consultants, and contractors of solar PV. The respondents were targeted from the management level and above with legitimacy to answer the questionnaire, such as manager, senior manager, general manager, and managing director. Due to very small size of sampling frame (N = 86), this study has decided to send the questionnaire to all firms in the industry.

A questionnaire was designed according to the principles and guidelines of MS ISO 31000: 2010 standard for risk management, and adapted to the context of solar PV industry in

Malaysia. A five-point Likert scale was applied from strongly disagree [1] to strongly agree[5]. In order to ease the respondents, the questionnaires were mailed with premium services (including return envelope) via Pos Malaysia Berhad. To further increase the response rate, a cover letter and data collection letter from Research and Innovation Management Centre (RIMC) of Universiti Utara Malaysia (UUM) were attached together with the questionnaire. Meanwhile, during the three months data collection periods, this pilot study has followed-up the respondents and encouraged them to fill-up and returns the questionnaire. SPSS20.0 was applied to process the data, and perform the respective analyses. All items were designed around the operational definitions shown in Table 1.

Table 1:Operational definitions.

Variables	Definitions	Source
Risk Context	The external and internal parameters to be taken into account when managing risk, and setting the scope and risk criteria for the risk management policy (p.3).	MS ISO 31000: 2010
Risk Identification	A process of finding, recognizing and describing risks (p.4).	
Risk Analysis	A process to comprehend the nature of risk and to determine the level of risk (p.5).	
Risk Evaluation	A process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable (p.6).	
Risk Treatment	A process to modify risk (p.6).	
Risk Communication	A continual and iterative process that an organization conducts to provide, share or obtain information and to engage in dialogue with stakeholders regarding the management of risk (p.3).	
Risk Monitoring	A continual checking, supervising, critically observing or determining the status in order to identify change from the performance level required or expected (p.7).	

4.1 Sample Size

Despite of all the efforts, this study only managed to receive 23 samples at the end of three months data collection periods, which represents 26.7% of response rate. This low response rate is consistent with the previous observation that the “incentives and reminders may not increase RR [response rate]” (Baruch and Holtom, 2008, p.1156). As a matter of fact, Figure 3 is showing the downward trend of survey response rates from over 70% in 1991 to less than 30% in 2007 (Bladon, 2009).

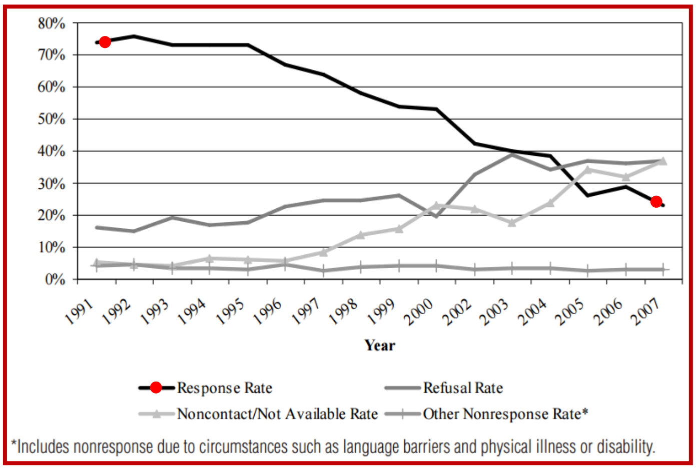

Figure 3: The downward trend of survey response rates (Bladon, 2009).

For comparison, a previous study on the enterprise-wide risk management practices was only responded by 55 respondents from service sector in Malaysia (Manab et al., 2010). Despite of that, this sample size is suitable for a preliminary study. In addition, although the sample size was small, the data still valid for analysis since "small sample sizes can have scientific merit even if they do not meet conventional requirements for statistical power, and valid sample size choices can be made for cost or feasibility reasons alone" (Bacchetti et al., 2011, p.1). Furthermore, the reviewers should "not focus on whether a proposed sample size is "adequate" or "valid." Criticism of sample size will rarely improve a study, unless the investigators have overlooked a method for efficiently increasing it" (Bacchetti et al., 2011, p.3). Prior to analysis, all missing values were treated with "multiple imputations" method, which is a better technique than "likewise deletion" method (Rubright et al., 2014).

4.2 Normality Test

This study has taken all necessary actions to remove outliers and several techniques to achieve normality, such as Square Root, Box-Cox, and Log transformations, however, the normality tests have repeatedly and consistently suggesting that the data were not normally distributed. Table 2 shows the best result of Shapiro-Wilk normality test after considering all suitable remedies for outliers and transformation techniques. Even so, not all variables managed to be normally distributed at $p > .05$. Despite of some argument on the necessity of the data being normal for parametric test (Williams et al., 2013), this study will not be analyzing the data with parametric test as this will affect the assumptions (Osborne and Waters, 2002). Furthermore, a previous study has shown that small sample size should be best analyzed with non-parametric test(Gibbons and Chakraborti, 2011).

Table 2:Normality test with Shapiro-Wilk.

Variables	Shapiro-Wilk		
	Statistic	df	Sig.
Solar PV Objectives	.948	23	.265
Risk Context Establishment	.869	23	.006
Risk Identification	.902	23	.028
Risk Analysis	.923	23	.077
Risk Evaluation	.935	23	.142
Risk Treatment	.906	23	.034
Risk Communication	.919	23	.064
Risk Monitoring	.891	23	.017

With limited statistical power and non-normal data, this study will perform the non-parametric test for non-response bias with the independent sample Mann-Whitney U test; the respondent's background and risk management activities with frequencies; and the correlation analysis with the Spearman's rank-order. In addition, this study will not perform exploratory factor analysis due to a previous study has found that "the number of misclassified items [in factor analysis] was also significantly affected by sample size" (Costello and Osborne, 2005, p.7). Meanwhile, previous study has also found that non-normal data distributions do create problem in estimating internal consistency reliability with coefficient alpha (Sheng and Sheng, 2012). As for these reasons, factor analysis and reliability test are irrelevant for this pilot study.

4.3 Non-response Bias

Response rate is just one indicator of sample quality. Others, such as non-response bias should be performed too (Baruch and Holtom, 2008). A non-response bias suggests that respondents who were not responded to the survey are indifferent from those responded. Since non-response resembles late response, the non-response bias was performed by comparing the early with late response groups. All samples returned within three weeks after delivery were treated as early responses. For non-parametric test, the independent sample Mann-Whitney U test was applied to compare the median distribution between two groups (Walgrave and Verhulst, 2011). Table 3 suggests that there was no different in distribution of median across early and late groups, where all *p*-values that ranged from .186 to .976 were greater than .05 ($p > .05$). Hence, the non-response bias is not existed in this study.

Table 3:Independent sample Mann-Whitney U test for non-response bias.

Null Hypothesis	Sig.	Decision
The distribution of *solar PV objectives* is the same across categories of non-response bias.	.284	Retain null hypothesis
The distribution of *risk context establishment* is the same across categories of non-response bias.	.257	
The distribution of *risk identification* is the same across categories of non-response bias.	.784	
The distribution of *risk analysis* is the same across categories of non-response bias.	.284	
The distribution of *risk evaluation* is the same across categories of non-response bias.	.186	
The distribution of *risk treatment* is the same across categories of non-response bias.	.605	
The distribution of *risk communication* is the same across categories of non-response bias.	.879	
The distribution of *risk monitoring* is the same across categories of non-response bias.	.976	

4.4 Respondents' Background

As shown in Table 4, this study was responded one third by the firms' directors (34.8%), followed by senior managers and managers (21.7% each), and executive officers (17.4%). With 56.5% of responses come from directors and senior managers, at least half of the data were contributed from higher management level of the firms. At a meantime, 57.2% of responses were dominated by respondents from planning/development (28.6%) and marketing/sales (28.6%), while at the bottom side, three respondents (13.0%) with quality background and two more (8.7%) from human resource have also contributed to this study. There were four (18.2%) respondents with more than 20 years of experience in the survey, in contrast to six (27.3%) respondents with experiences of less than 6 years. This implies that solar PV industry in Malaysia is still very young and growing due to only one third (31.8%) of respondents have at least 10 years of experiences in the business. Correspondingly, almost half of the respondents were solar PV contractors (45.5%), while the rests were solar energy providers (22.7%), solar PV manufacturers (18.2%), and consultants (13.6%). More contractors as respondents would signals the demand for solar PV installation in Malaysia is growing. Meanwhile, it appears that the number of business locations is more than the number of respondents. This happens due to some firms have branches in different regions of Malaysia. Although 14 businesses (27.5%) were located in Klang Valley, others were distributed almost in balance among Northern Malaysia (19.6%), East Course (19.6%), Eastern Malaysia (17.6%), and Southern Malaysia (15.7%). This suggests that solar PV industry is growing evenly in all regions of Malaysia.

Table 4: Respondents' background.

Respondent's Background	Frequency	Percent	Valid Percent	Cum. Percent
Respondent's Position				
Director	8	34.8	34.8	34.8
Senior Manager	5	21.7	21.7	56.5
Manager	5	21.7	21.7	78.3
Executive	4	17.4	17.4	95.7
Others (i.e., Engineer)	1	4.3	4.3	100.0
Total	23	100.0	100.0	
Respondent's Responsibility				
Planning/Development	6	26.1	28.6	28.6
Human Resource	2	8.7	9.5	38.1
Marketing/Sales	6	26.1	28.6	66.7
Operation/Production	4	17.4	19.0	85.7
Others (i.e., Quality)	3	13.0	14.3	100.0
Total	21	91.3	100.0	
Years of Experience in Business				
1 to 5 years	6	26.1	27.3	27.3
6 to 10 years	9	39.1	40.9	68.2
11 to 15 years	2	8.7	9.1	77.3
16 to 20 years	1	4.3	4.5	81.8
More than 20 years	4	17.4	18.2	100.0
Total	22	95.7	100.0	
Nature of Business				
Solar Energy Provider	5	21.7	22.7	22.7
Solar PV Manufacturer	4	17.4	18.2	40.9
Solar PV Contractor	10	43.5	45.5	86.4
Others (i.e., Consultation)	3	13.0	13.6	100.0
Total	22	95.7	100.0	
Business Location				
Northern Malaysia	10	19.6	19.6	19.6
Klang Valley	14	27.5	27.5	47.1
Southern Malaysia	8	15.7	15.7	62.8
East Course	10	19.6	19.6	82.4
Eastern Malaysia	9	17.6	17.6	100.0
Total	51	100.0	100.0	

4.5 Descriptive Analysis

With the mean score of 4.461, the statistical output in Table 5 has suggested that risk identification is the highest rated variable. This was followed by risk monitoring (4.245), risk context (4.207), solar PV objectives (4.142), risk analysis (4.141), risk evaluation (4.052), and risk treatment (4.033). Meanwhile, with the mean score of 3.955, risk communication is the only variable rated below scale 4. Hence, based on a five-point Likert scale with strongly disagree [1], disagree [2], neutral [3], agree [4], and strongly agree [5], it was found that the respondents were at least "agree" will all variables, except for risk communication.

Table 5: Means of variables.

Types	Variables	Means
Dependent	Solar PV Objectives	4.142
Independent	Risk Context Establishment	4.207
	Risk Identification	4.461
	Risk Analysis	4.141
	Risk Evaluation	4.052
	Risk Treatment	4.033
	Risk Communication	3.955
	Risk Monitoring	4.245

Even though risk communication has scored below scale 4, this does not necessarily indicate the variable is not agreed by the respondents. Furthermore, the mean score of 3.955 is very close to scale 4 and remarkably far away from scale 3. Therefore, it can be concluded that risk communication is leaned more towards "agree" than "neutral".

Correspondingly, Tables 6 to 13 are showing the frequencies (in percentages) and the mean scores of all statements that consolidated each variable. All statements with the mean scores less than the variables' means are highlighted in *italic*. "99" represents missing value, while numbers "1 to 5" are the five-point Likert scale.

As shown in Table 6, there were 10 statements that have made up solar PV objectives as dependent variable. All the statements were rearranged according to the mean scores from highest (4.70) to lowest (3.13) levels. When compared to the variable mean of solar PV objectives (see Table 5), it was found that three statements have the mean scores of less than 4.142. This implies that, in term of priority, solar PV may not be implemented mainly "to increase energy security" (3.74), "provide long-term lowest cost of electricity for consumers" (3.48), and "reduce price volatility" (3.13). In facts, solar PV industry in Malaysia was aimed mainly "to reduce emissions of GHG" (4.70), "reliance on finite fossil fuels" (4.61), "other air pollutants" (4.52) and "environmental impacts" (4.48).

Table 6: Responses on solar PV objectives.

Solar PV Objectives	**99**	**1**	**2**	**3**	**4**	**5**	**Mean**
To reduce emissions of GHG				4.3	21.7	73.9	4.70
To reduce reliance on finite fossil fuels					39.1	60.9	4.61
To reduce emissions of other air pollutants				4.3	39.1	56.5	4.52
To reduce environmental impacts				8.7	34.8	56.5	4.48
To compliance with future environmental regulations	8.6			17.4	69.6	4.3	4.30
To increase energy supply reliability	8.6			17.4	52.2	21.7	4.29
To increase fuel diversity				13.0	56.5	30.4	4.17
To increase energy security				*34.8*	*56.5*	*8.7*	*3.74*
To provide the long-term lowest cost of electricity for consumers			*13.0*	*34.8*	*43.5*	*8.7*	*3.48*
To reduce price volatility			*17.4*	*56.5*	*21.7*	*4.3*	*3.13*

Table 7 is showing only three statements with the mean scores higher than the average mean for risk context establishment (4.207). This suggests that when establishing the risk context for solar PV, the respondents will give priority on "the decisions to be made" (4.52), "responsibilities of the risk management process" (4.30), and "the activity, process, function, project, product, service or assets of risk management" (4.26). Although the other five statements have scored below the average mean, at least 50% of the responses were rated at scale 4. For instance, 73.9% of responses on "the scope of risk management activities to be carried out" are rated at scale 4. Nevertheless, the less important statement to be considered regarding risk context establishment is "the risk assessment methodologies to be used" (4.04).

Table 7:Responses on risk context establishment.

Risk Context Establishment	99	1	2	3	4	5	Mean
The decisions to be made in risk management					47.8	52.2	4.52
The responsibilities of risk management process					69.6	30.4	4.30
The activity, process, function, project, product, service or assets of risk management					73.9	26.1	4.26
The scope of risk management activities to be carried out				*4.3*	*73.9*	*21.7*	*4.17*
The relationship between project, process, or activity of the organization				*13.0*	*65.2*	*21.7*	*4.09*
The goals and objectives of risk management activities				*17.4*	*52.2*	*34.4*	*4.13*
The way performance and effectiveness is evaluated in the management of task				*17.4*	*52.2*	*30.4*	*4.13*
The risk assessment methodologies to be used				*26.1*	*43.5*	*30.4*	*4.04*

The responses on risk identification in Table 8 are suggesting that the "consequences" (4.65), "causes" (4.61), and "areas of impact of risk" (4.48) are the main criteria to be considered in risk identification activity. Meanwhile, although the "sources" (4.39) and "events of risk" (4.17) are still important as suggested by the mean scores, but when compared to the average mean of 4.461 (see Table 5), they have been given less priority by the respondents when identifying risk related to solar PV.

Table 8:Responses on risk identification.

Risk Identification	99	1	2	3	4	5	Mean
The consequences of risk					34.8	65.2	4.65
The causes of risk					39.1	60.9	4.61
The areas of impact of risk					52.2	47.8	4.48
The sources of risk					*60.9*	*39.1*	*4.39*
The events of risk				*4.3*	*73.9*	*21.7*	*4.17*

Meanwhile, Table 9 is suggesting "the availability of existing controls" (4.17) is the only item on risk analysis that has scored above the average mean of 4.141 (see Table 5). The other three, namely "the consequence of events", "likelihood of occurrences", and "level of risks" have the mean scores of 4.13 each. However, a detail look at Table 9 has indicated that "the levels of risks" with 21.7% of responses on "neutral", 43.5% on "agree", and 34.8% on "strongly agree" is the less important component of risk analysis for solar PV in Malaysia.

Table 9:Responses on risk analysis.

Risk Analysis	99	1	2	3	4	5	Mean
The availability of existing controls				17.4	47.8	34.8	4.17
The consequence of events				*4.3*	*78.3*	*17.4*	*4.13*
The likelihood of occurrences				*13.0*	*60.9*	*26.1*	*4.13*
The level of risks				*21.7*	*43.5*	*34.8*	*4.13*

As shown in Table 10, with the average mean of 4.052 (see Table 5), the critical elements of risk evaluation that should be performed are "the risk criteria" (4.26), "the level of risk" (4.09), and "the legal, regulatory, and other requirements" (4.09). In contrast, with the mean score of just 3.83, "considering the risk context" is the less critical factor when evaluating the risk of solar PV.

Table 10: Responses on risk evaluation.

Risk Evaluation	99	1	2	3	4	5	Mean
The establishment of the risk criteria					73.9	26.1	4.26
The level of risk found during the analysis				17.4	56.5	26.1	4.09
The legal, regulatory, and other requirements				21.7	47.8	30.4	4.09
The priority for risk treatment				*17.4*	*65.2*	*17.4*	*4.00*
The consideration of the risk context				*21.7*	*73.9*	*4.3*	*3.83*

With the average mean of 4.033, it was found that "the evaluation of treatment options" (4.22), "the implementation of agreed treatments" (4.13), "the design of a preferred treatment options" (4.04), "the documentation of risk treatment plan" (4.04), and "the necessity for a specific treatment" (4.04) are the most critical elements for risk treatment. However, risk treatment activity seems to be less emphasized on the need "to assess the level of residual risk" (4.00), "the desirable treatment for risk" (3.91), and "the identification of a preferred treatment option" (3.87). See Table 11 for details.

Table 11:Responses on risk treatment.

Risk Treatment	99	1	2	3	4	5	Mean
The evaluation of the treatment options					78.3	21.7	4.22
The implementation of the agreed treatments				8.7	69.6	21.7	4.13
The design of a preferred treatment option				13.0	69.6	17.4	4.04
The documentation of the risk treatment plan				17.4	60.9	21.7	4.04
The necessity of the risk for a specific treatment				21.7	52.2	26.1	4.04
The assessment of the level of residual risk				*13.0*	*73.9*	*13.0*	*4.00*
The desirable treatment for the risk				*17.4*	*73.9*	*8.7*	*3.91*
The identification of a preferred treatment option				*21.7*	*69.6*	*8.7*	*3.87*

As been highlighted before, risk communication is the less agreed variable by the respondents with the average mean of just 3.955 (refer Table 5). Despite of that, a detail looks at Table 12 has revealed risk can be effectively communicated through "the appropriate internal consultation plan" (4.20) where "the risk has been adequately identified" (4.17) from "the areas of expertise" (4.17). In addition, different point-of-views should be considered when "defining the risks criteria" (4.17) and "evaluating the risks" (4.17) within "the appropriate context of risk management process" (4.09). In contrast, the respondents seem to be less confident with "the appropriate external consultation plan" (3.57) for risk communication.

Table 12:Responses on risk communication.

Risk Communication	**99**	**1**	**2**	**3**	**4**	**5**	**Mean**
The development of an appropriate internal consultation plan	8.6		13.0	4.3	56.5	17.4	4.20
The adequacy of the risk identification					82.6	17.4	4.17
The areas of expertise to be brought together for analysing risks				4.3	73.9	21.7	4.17
The appropriate different in views to be considered when defining risks criteria				8.7	65.2	26.1	4.17
The appropriate different in views to be considered in evaluating the risks				13.0	56.5	30.4	4.17
The appropriate context of risk management process				13.0	65.2	21.7	4.09
The support of a treatment plan				*34.8*	*47.8*	*17.4*	*3.83*
The appropriate change management during the risk management process				*34.8*	*56.5*	*8.7*	*3.74*
The endorsement of a treatment plan			*8.7*	*30.4*	*43.5*	*17.4*	*3.70*
The interests of stakeholders			*4.3*	*39.1*	*39.1*	*17.4*	*3.70*
The development of an appropriate external consultation plan			*13.0*	*17.4*	*69.6*		*3.57*

Table 13 shows eight elements in risk monitoring activity. With the average mean of 4.245, it appears that the respondents have emphasized on monitoring "the identification process of emerging risks" (4.43), and "the operation of risk controls" (4.39). In contrast, "the detection of changes in external context" (4.13) is the last element to be considered when monitoring risk of solar PV in Malaysia. Despite of that, 87.0% of responses have agreed (at level 4) that this element is still a critical part of risk monitoring activity as a whole.

Table 13:Responses on risk monitoring.

Risk Monitoring	**99**	**1**	**2**	**3**	**4**	**5**	**Mean**
The identification of emerging risks				4.3	47.8	47.8	4.43
The operation of the risk controls					60.9	39.1	4.39
The information for improving the risk assessment					*78.3*	*21.7*	*4.22*
The learning of lessons from events, changes, trends, successes and failures				*13.0*	*52.2*	*34.8*	*4.22*
The analysis of lessons from events, changes, trends, successes and failures				*13.0*	*52.2*	*34.8*	*4.22*
The detection of changes in the internal context					*82.6*	*17.4*	*4.17*
The design of risk controls				*17.4*	*47.8*	*34.8*	*4.17*
The detection of changes in the external context					*87.0*	*13.0*	*4.13*

4.6 Correlation Analysis

A Spearman's rank-order correlation was performed to test the bivariate relationships from combination of eight variables at the significance level (*p*) of .05 (2-tailed). As a result, a total of 28 possible bivariate relationships were analyzed with the statistical outputs summarized in Table 14. As shown in the table, the correlation coefficients (*r*) for all 28 relationships were ranged from as low as *r* = .046 (i.e., between risk monitoring and solar PV objectives) to as high as *r* = .789 (i.e., between risk communication and risk evaluation). In term of the direction of relationships, it appears that all relationships (both significant and insignificant) were positive except for one relationship that is between risk treatment and solar PV objectives (*r* = -.197). This implies that any increases in risk treatment activity may be associated with the reduction (but not necessarily cause/affect) of the firm's ability to achieve solar PV objectives. Meanwhile, out of 28 relationships, 16 were found to be significant with nine relationships at *p*< .05, while seven others at *p*< .01. These significant relationships are representing 57.14% of all bivariate relationships. On the other hand, 12 relationships (equivalent to 42.86%) were found to be insignificant at *p*< .05.

Table 14:Summary of Spearman's rank-order correlation outputs.

Variables		Solar PV Objectives	Risk Context	Risk Identification	Risk Analysis	Risk Evaluation	Risk Treatment	Risk Communication
Risk Context	*r*	**.427***						
	r^2	**18.23%**						
	Sig.	.042						
Risk Identification	*r*	.155	**.487***					
	r^2	2.40%	**23.72%**					
	Sig.	.480	.018					
Risk Analysis	*r*	.075	.321	**.718****				
	r^2	.56%	10.30%	**51.55%**				
	Sig.	.734	.136	.000				
Risk Evaluation	*r*	.229	**.440***	**.677****	**.762****			
	r^2	5.24%	**19.36%**	**45.83%**	**58.06%**			
	Sig.	.294	.036	.000	.000			
Risk Treatment	*r*	-.197	.317	.150	**.444***	**.491***		
	r^2	3.88%	10.04%	2.25%	**19.71%**	**24.11%**		
	Sig.	.368	.141	.495	.034	.017		
Risk Communication	*r*	.308	**.442***	**.442***	**.445***	**.789****	**.645****	
	r^2	9.49%	**19.54%**	**19.54%**	**19.80%**	**62.25%**	**41.60%**	
	Sig.	.153	.035	.035	.033	.000	.001	
Risk Monitoring	*r*	.046	.174	**.467***	.247	**.573****	.384	**.770****
	r^2	.21%	3.03%	**21.81%**	6.10%	**32.83%**	14.75%	**59.29%**
	Sig.	.834	.428	.025	.256	.004	.070	.000

***. Correlation is significant at the 0.01 level (2-tailed).*
**. Correlation is significant at the 0.05 level (2-tailed).*

The strength of relationships can be interpreted as very weak (*r* = .00 to .19), weak (*r* = .20 to .39), moderate (*r* = .40 to .59), strong (*r* = .60 to .79), and very strong (*r* = .80 to 1.00) (Evans and Over, 1996). As a result, it was found that 10 significant relationships were moderately correlated from *r* = .427 (i.e., between risk context and solar PV objectives) to *r* = .573 (i.e., between risk evaluation and risk monitoring), while six significant relationships were strongly correlated from *r* = .645 (i.e., between risk treatment and risk communication) to *r* = .789 (i.e., between risk evaluation and risk communication). In addition, a further look at the coefficient of determination (r^2) to measure the percentage (%) of variance explained in variables has found four significant relationships with r^2 more than 50%. In details, there is 62.25% similarity in variances between risk communication and risk evaluation, 59.29% similarity in variances between risk monitoring and risk communication, 58.06% similarity in variances between risk evaluation and risk analysis, and 51.55% similarity in variances between risk analysis and risk identification. In contrast, there were six relationships with r^2 between 20% to 50%, and six others with $r^2 < 20\%$.

In regard to the first objective of this pilot study, which is to identify the bivariate relationships between risk management activities, the correlation analysis has shown that none of the bivariate relationships have zero correlation coefficient (or *r* = 0, for perfectly no association between two variables). This literally means all risk management activities were correlated to each other. However, the strengths of relationships varied from as low as very weak (i.e., between risk identification and risk treatment with *r* = .150) to as high as strong (i.e., risk evaluation and risk communication with *r* = .789). In addition, all of these relationships were positive that means any increases in one activity will probably increase the other activity, while decreases in one activity will also decrease the other activity (but this does not suggests a causal effect). Despite of that, some relationships, such as between risk identification and risk treatment (*p* = .495) did not statistically supported at $p < .05$ level. Therefore, out of 21 bivariate relationships between risk management activities, six of them were found to be insignificant. Thus, even though the six relationships were positively correlated; there was no confidence in the results as the strengths are too weak.

In regard to the second objective that is to investigate the relationships between risk management activities and solar PV objectives, the correlation analysis has suggested only the hypothesis between risk context and solar PV objectives (H1) was supported. This implies that the activity at establishing risk context may be positively correlated with the firm's ability to achieve solar PV objectives. In contrast, the other six hypotheses have to be rejected for being insignificant in relationship at $p < .05$. Despite of that, the results did support the proposed direction of relationship (positive) for five rejected hypotheses (namely H2, H3, H4, H6, and H7). Interestingly, the analysis is also suggesting a negative relationship for hypothesis H5, but the result was also statistically insignificant. This implies that performing the activity of risk treatment may possibly reduce the firm's ability to achieve solar PV objectives. Table 15 summarizes the results of hypothesis testing.

Table 15:Results of hypothesis testing.

	Hypothesis	Direction	Significance	Decision
H1:	Risk context is positively correlated with solar PV objectives.	Positive	Yes	Support
H2:	Risk identification is positively correlated with solar PV objectives.	Positive	No	Reject
H3:	Risk analysis is positively correlated with solar PV objectives.	Positive	No	Reject
H4:	Risk evaluation is positively correlated with solar PV objectives.	Positive	No	Reject
H5:	Risk treatment is positively correlated with solar PV objectives.	Negative	No	Reject
H6:	Risk communication is positively correlated with solar PV objectives.	Positive	No	Reject
H7:	Risk monitoring is positively correlated with solar PV objectives.	Positive	No	Reject

5. Discussion

Firstly, due to the size of less than 100 firms registered under both SEDA and MPIA, this pilot study has supported the previous claim that solar PV industry in Malaysia is still new and growing. In fact, two-third (68.2%) of the respondents has no more than 10 years of experiences in solar PV business, which means most of them are new in the industry. Furthermore, as compared to solar PV manufacturers (18.2%), and solar energy providers (22.7%), almost half of the respondents were contractors (45.5%), which is to support the growing demands of solar PV installation. Therefore, solar PV industry in Malaysia is indeed small and still underexplored.

Secondly, respondents were agreed that the main objectives of solar PV are to reduce the emissions of GHG and air pollutants, and also reduce the reliance on finite fossil fuels. On the other hand, respondents were less agreed that solar PV can increase energy security, provide lowest cost of electricity for consumers, and reduce price volatility (see Table 6). Judging by the pattern of responses, it appears that solar PV is introduced and promoted in

Malaysia mainly for environmental reasons rather than economics. This is consistent with the national policy on climate change and the status of solar PV in Malaysia as a green energy for environmental sustainability.

Thirdly, the statistic has found that solar PV firms in Malaysia put more emphasis on the internal development plan for risk management. This was shown by the development of appropriate internal consultation plan that scored the highest; while the external consultation plan was scored the lowest for risk communication activity (refer Table 12). There could be few explanations for this, such as the firm distrusts outsiders when communicating risk of solar PV, there is no necessity to have external consultation plan for risk, or because the firm treats risk of solar PV as not critical. Besides that, Table 13 has suggested that most firms were less sensitive with the potential events and changes from both internal and external contexts when monitoring the risks. This may suggests that risk monitoring activity is less critical to the firms.

Fourthly, out of seven risk management activities, risk evaluation and risk communication were found to be the most important activities. As shown in Table 14, risk evaluation was significantly and positively correlated with all risk management activities, namely, risk context (r = .440), risk identification (r = .677), risk analysis (r = .762), risk treatment (r = .491), risk communication (r = .789), and risk monitoring (r = .573). Similarly, risk communication was also significantly and positively correlated with risk context (r = .442), risk identification (r = .442), risk analysis (r = .445), risk evaluation (r = .789), risk treatment (r = .645), and risk monitoring (.770). In contrast, risk treatment and risk monitoring were found to be the less important risk management activities that only significantly and positively correlated with three activities. In details, risk treatment was only correlated with risk analysis (r = .444), risk evaluation (r = .491), and risk communication (r = .645). Similarly, risk monitoring was only correlated with risk identification (r = .467), risk evaluation (r = .573), and risk communication (r = .770). The imbalance focuses may influence the overall risk management activities for solar PV in Malaysia.

Fifthly, Figure 1 is showing that risk identification, risk analysis, and risk evaluation are the core activities for risk assessment that is located at the center of risk management process. Accordingly, the correlation analysis has found that risk identification was strongly related with risk analysis (r = .718), risk analysis was strongly related with risk evaluation (r = .762), and risk identification was also strongly related with risk evaluation (r = .677). All were found to be significant at $p < .01$ rather than $p < .05$, which is providing support to the MS ISO 31000: 2010 standard that suggests risk identification, risk analysis, and risk evaluation are the critical activities of risk assessment.

Sixthly, although solar PV objectives was significantly correlated with only one risk management activity, namely risk identification, this does not necessarily means the other activities were not correlated at all. As discussed early, other activities did correlated with solar PV objectives, but lacking of confidence level. In the other hand, even if the relationships were statistically supported, the strengths of these relationships are just too weak to be meaningful. Hence, it is relevant to question if the strengths of risk management activities with solar PV objectives be improved with the other activities or factors, such as incentives or policies? As a result, the roles of moderator or mediator between risk management activities and solar PV objectives should be investigated in future.

Lastly, the analysis has shown the correlation between risk treatment and solar PV objectives to be negative even though the strength of relationship was very weak (r = -.197) and rejected for being statistically insignificant (p = .368). Bear in mind the analysis was performed with the non-parametric test on non-normal data from small sample size that could have possibly affecting the power of analysis. However, rather than just simply accepting this as an excuse, the sign of negative correlation deserve alternative explanation. For instance, there are basically four options to treat risk, namely avoiding, reducing, transferring, and retaining (Berg, 2010). The negative relationship could be existed when the firms decided to avoid the risk by halting the operations, which will eventually increase the costs, waste the time, etc. The negative relationship may as well happen when the firms decided to reduce, transfer, or retain the risk of solar PV. The negative sign could also be suggesting that the firms are still not familiar with the risk treatment process. With the findings, this study has come up with at least four critical questions that should be addressed for future research agenda, namely:

i. Is it true that solar PV firms in Malaysia do not treat solar PV risks as being critical enough to be taken seriously? If yes, why?

ii. Is it true that solar PV firms in Malaysia are unfamiliar with (or not exposed to) the methods for dealing with solar PV risks?
iii. Is it true that Malaysia is lacking of policy on risk management for solar PV? and
iv. Is it true that the relationships between risk management activities and solar PV objectives can be improved with moderators or mediators?

6. Conclusions

This pilot study has explored the relationships between risk management activities and solar PV objectives in Malaysia. As for objective one, the correlation analysis has found that all risk management activities were positively correlated with each other. As a result, solar PV firms that plan to implement risk management process should concentrate on all activities at equal level. In relation to objective two, out of seven hypotheses, only one hypothesis between risk context and solar PV objectives was positively and significantly correlated. The other five hypotheses were also positively correlated, but not statistically significant. Meanwhile, one hypothesis between risk treatment and solar PV objectives was negatively correlated, although not being significant. There are some possible explanations for the mix in results, such as low statistical power of analysis has caused the insignificant results, and solar PV firms in Malaysia might have treated risks as not being critical enough to affect the objectives. Although the risk management activities were referred directly from the MS ISO 31000: 2010 standard, this study was not designed and interested in any way to investigate the standard itself. The findings have not just helped us to understand the nature of relationships between risk management activities and solar PV objectives in Malaysia, but also provided valuable information to be considered when undertaking future empirical study.

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