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Categorizing Risks and Success Factors of Water Industry in Malaysia

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Abstract

This study investigated categories of risks and success factors associated with water industry in Malaysia. Seven risk categories were proposed, which are technology, organization, economy, government, nature, crime and public. The proposed categories of success factors were regulatory agencies, water operators, financial, assets, human resource, contract and public. Categories of risks and success factors were developed based on the integration of theory of perceived risk (Bauer, 1960), risk items of Ameyaw (2015), stakeholder theory and legitimacy theory. To validate the proposed categories of risks and success factors, 100 questionnaires were distributed by post to the management personnel of water operators and 32 questionnaires were returned. Descriptive analysis and relative importance index were

used to analyze the data. The results indicated highest agreement towards the occurrence of risk factors in term of technology, economy and public. However, there was a big gap between risks' probability of occurrence and risk allocation and also between severity of risk factors and risk allocation amongst water operators in Malaysia. This highlights low awareness amongst water operators in Malaysia on water risk management. Additionally, the respondents considered all items of success factors as important. Implicit in these findings is that there is a need for the regulatory agencies to play an active role in promoting risk management awareness amongst water operators through campaign, workshop and training programs.

Keywords: risk categories, success factor categories, water industry

1. Introduction

1.1 Introduce the Problem

Dry season in Malaysia always leads to water supply disruption in several states. The worst water crisis was in Selangor in year 2014 where the state implemented six-month water rationing policy. Recent equinox phenomenon also gave severe water supply problem to Johor and Negeri Sembilan whereby they also implemented water rationing policy. Disruption in water supply gives huge problem to peoples' life. This is because water is one of the critical needs in human life. Thus water supply disruption cannot be tolerated at any time. The disruption also affects business operation badly. This in turn could reduce Malaysian economic growth and tarnish image due to failure in providing good water supply through effective infrastructures. The bad image could reduce foreign direct investment to the country. Additionally, improper understanding on operational risks could create bad contractual relationship between public and private sectors which could increase litigation risk in the future. Bad relationship between public and private sectors could also create unconducive environment for healthy economic growth. This gave huge impact on peoples' daily life and economic activities especially factory operation.

As the disruption of water supply in Malaysia is always linked to dry season, global warming, water pollution and water assets breakdown, which are considered as unpredictable, water operators must have proper risk management in their operation. Cassidy (2005) and Deloach (2000) defined risk as uncertain and unpredictable situations that disrupt the process of achieving corporate objectives and creating shareholders' values. Gupta (2011) and Shimpi (2005) stated that risk is highly uncertain and could negatively affect a company's operations, including but not limited to, strategy operations, human capital, reputational exposure and the legal framework in an unpredictable business cycle. In other words, risk management is a value-added tool for business improvement by identifying and analysing potential risks or hazards inside and/or outside the company, and in turn, determining suitable actions to mitigate (Smith et al., 1997). In short, every water operator has to effectively manage operational risks so that water supply and business growth could be ensured.

To assist Malaysian water operators in understanding water risks, this study intends to identify categories of risks and success factors in Malaysian water industry. Thus the objectives of this

study was to determine categories of risks and success factors in Malaysian water industry. Categories of risks and success factors were developed based on the integration of theory of perceived risk (Bauer, 1960), risk items of Ameyaw (2015), stakeholder theory (Freeman, 1984) and legitimacy theory (Meyer & Rowan, 1977). To validate the proposed categories of risks and success factors, survey research was conducted whereby management personnel of water operators were asked to give feedback on the proposed categories of risks and success factors listed on the pre-specified questionnaire. It is hoped that the findings would assist Malaysian water operators to undertake proper prevention measures to reduce operational risks in the water industry especially water supply disruption risk. In addition, the government could use the factors to develop policy for managing water supply operators and to prepare proper contract with private water supply operators. In short, this research is critical for protecting public and economic interests.

The paper is organized as follows. Next section presents a theoretical justification for every risk factor and critical success factor. Section 3 discusses research approach adopted to validate the proposed factors. Finally, a conclusion is presented in the concluding section.

1.2 Water Players in Malaysia

As stipulated under federal constitution, water sources are under the jurisdiction of states. This includes the distribution of treated water to the customers. There are 13 states in Malaysia and in turn 13 water operators in Malaysia. 10 water operators are majority owned by the states (government linked companies) and another three water operators are state government agencies. The three biggest water operators are Air Selangor Berhad, Syarikat Air Johor Berhad and Perbadanan Bekalan Air Pulau Pinang Berhad. Implicit in this scenario is that state government can influence the decision made by the water operators from time to time when necessary. On the other hand, water sources such as river, lake and underground water are under the jurisdiction of the state government. All states have specific agencies to monitor water sources in the state such as Lembaga Urus Air Selangor, Lembaga Urus Air Kedah and Badan Kawal Selia Air Negeri Johor. When water operators have intention to develop water infrastructure to process raw water they must get approval from the state water agencies. Only state water agencies can declare water rationing policy when necessary.

As the financial position of state government are limited, federal government through Kementerian Tenaga, Teknologi Hijau dan Air (KETTHA) or Ministry of Energy, Green Technology and Water established two agencies to monitor water operators, namely, Suruhanjaya Perkhidmatan Air Negara (SPAN) or National Water Services Commission and Perbadanan Aset Air Berhad (PAAB) or Water Asset Corporation Limited. SPAN is a technical and economic regulatory body for the water supply and sewerage services in Malaysia. It regulates all entities in the water supply and sewerage services industry including public water supply and sewerage services operators, private water supply and sewerage services operators, water supply and sewerage contractors, permit holders and suppliers of water and sewerage products. The water services industry is regulated in accordance Water Services Industry Act 2006 (Act 655) which was enforced on 1 January 2008. However, the focus of this study is on water supply industry because it is the most critical aspect in water services. Three main

functions of SPAN are licencing, approving water tariff and monitoring through compliance and performance audit. On the other hand, PAAB is established to implement liability free model in Malaysia. Under this model, water assets such as dam, treatment facility and pipeline are owned by PAAB which in turn lease the assets to water operators. This model enables water operators to control operational costs and utilize resources to fulfil customers' needs.

1.3 Developing Categories of Risks in Malaysian Water Industry

Critical risk factors are defined as uncertain and unpredictable situations that disrupt the process of achieving water operators' objectives and creating shareholders' values (Ameyaw & Chan, 2016; Ameyaw, 2015; Gupta, 2011; Shimpi, 2005). Based on the theory of perceived risk (Bauer, 1960), risk items of Ameyaw (2015), stakeholder theory (Freeman, 1984) and legitimacy theory (Meyer & Rowan, 1977), seven categories of risks in water industry were developed, which are technology, organization, economy, government, nature, crime and public (Selamat et al., 2022; Tamam, 2022).

The first risk category is technology. It is defined as the condition of water asset, the technology that is used to deliver specified outputs or deliverables, supporting utilities such as electricity that are required for the operation or construction of water system, pipeline system, the constructed or designed water facilities, remaining value of water asset and water meter (Selamat et al., 2022; Ameyaw et al., 2017; Ameyaw & Chan, 2016; Ameyaw, 2015). Theory of perceived risk considers technology (physical risk) as a critical risk and therefore must be included in the risk planning (Bauer, 1960).

The second risk category is organization. It is defined as water operators' capability to achieve targets of water services, estimate demand for treated water, purchase land for development on time, develop well-defined contract, resolve disagreement between shareholders, utilize effective procurement system, monitor period of construction and manage cost of construction cost (Selamat et al., 2022; Ameyaw & Chan, 2016; Ameyaw, 2015). From this definition it can be seen that organization is closely linked to water operators' capability to deliver economical, effective and efficient services to the consumers. The inclusion of organization is supported by the legitimacy theory. Legitimacy theory is usually used to understand organizational forms and structures in the expense of relevant assumption that business enterprise has to continue its survival (Meyer & Rowan, 1977).

The third risk category is economy. It is related to the issues of economic development such as agriculture, manufacturing, property, national gross domestic product (economic growth) and financial-related issues such as operational costs and water tariff that influence the performance of water supply industry (Selamat et al., 2022; Ameyaw & Chan, 2016; Ameyaw, 2015). All these issues affect the capability of water operators in fulfilling water demand. Usually water operators are unable to supply adequate treated water if water demand is higher than the production of treated water. This risk category is supported by theory of perceived risk. This theory considers economy (financial risk) as a critical risk and therefore must be included in the risk planning (Bauer, 1960).

The fourth risk category is government. It refers to the actions taken by the authority or

regulatory bodies with the objective of reducing political instability in the country, disagreement between state and federal governments, the incident of political interference, discontent and violence, the case of early termination of contract, unsystematic and overcrowded regulatory framework, the absence of legal and policy frameworks, contractual risk and sovereign risk (Selamat et al., 2022; Ameyaw & Chan, 2016; Ameyaw, 2015). In other words, the government must establish appropriate legal and policy frameworks to achieve sustainable development in the water supply industry. This risk category is justified by the stakeholder theory. Government is the most critical stakeholder in any areas including water supply industry and therefore must be included in the risk planning (Freeman, 1984).

The fifth risk category is nature. It is related to natural forces that disrupt the sources of raw water such as global warming, change of climate, dry season, scarcity of water sources and uncontrollable phenomenon such fire, flood, storm and disease pandemic (Selamat et al., 2022; Ameyaw & Chan, 2016; Ameyaw, 2015). The inclusion of nature as one of the risk categories is supported by the stakeholder theory. This is because nature or environment is one of the elements that need to be protected by any business organizations including water operators and therefore must be included in the risk planning (Freeman, 1984).

The sixth risk category is crime. It refers to criminal activities that are undertaken by people that badly affect water operators' effectiveness and efficiency in delivering water services to the consumers (Selamat et al., 2022; Ameyaw & Chan, 2016; Ameyaw, 2015). The examples of water-related criminal activities are river pollution, corruption in bidding process and water theft. To justify the inclusion of crime as one of the risk categories, theory of perceived risk was adopted. This is because theory of perceived risk considers crime (social risk) as a critical risk and therefore must be included in the risk planning (Bauer, 1960).

The final risk category is public. It is defined as the support given by people to reduce the delay in the process of approving water project, the incident of variation in water contract, the abandonment of water infrastructure project and others (Selamat et al., 2022; Ameyaw & Chan, 2016; Ameyaw, 2015). To justify the inclusion of public as one of the risk categories, stakeholder theory was adopted. This is because public is the most critical stakeholder in any areas including water supply industry and thus must be included in the risk planning (Freeman, 1984). The summary of the critical risk factors is illustrated in Table 1.

Table 1. Risk Categories

Factors	Items Used
Government	Conflict between federal and state governments
	Change in government and political opposition
	Government instability and political violence
	Political discontent and early termination

	Expropriation/nationalization
	Political interference
	Regulatory risk (weak regulation)
	Overcrowded regulatory framework
	Absence of policy and legal frameworks
	Unclear authority or function
	Sovereign and contractual risk
Economy	Pricing and tariff review uncertainty
	Financial and refinancing risk
	High operational costs
	Inflation rate
	Fall in demand
	Foreign exchange rate
	Non-payment of bills
	Unfavorable local or global economy
	Interest rate
	Housing development
	Commercial development
	Agriculture development
	Quasi-commercial risk
Organization	Insufficient water operator performance during operation
	Faulty demand forecasting
	Land acquisition risk
	Poor contract design

	Conflict between partners
	Procurement risk
	Construction time and cost overrun
Technology	Water asset condition uncertainty
	Technology risk
	Supporting utilities risk
	Pipeline failures during distribution
	Residual value risk
	Design and construction deficiencies
	Revenue loss due to old meter
Nature	Dry season
	Climate change
	Raw water scarcity
	Force majeure
Criminal	Low quality of raw water
	Pollution
	Water theft
	Corruption
Public	Public resistance to water project

1.4 Developing Categories of Success Factors in Malaysian Water Industry

Critical success factors are the conditions or tests that could contribute to the success of the project (Babu & Sudhakar, 2015; Abu Bakar et al., 2009). Ihuah et al. (2014) stated that critical success factors are a process of creating key areas critical to the success of the administration. Seven categories of success factors were proposed, which are regulatory agencies, water operators, water assets, financial, human resource, water contract and public. These categories of success factors were developed based on the integration of risk types of theory of perceived risk (Bauer, 1960) and risk items listed by Ameyaw (2015), stakeholder

theory (Freeman, 1984) and legitimacy theory (Meyer & Rowan, 1977).

The first success factor category is regulatory agencies. It refers to the federal and state government agencies that have authority to regulate all entities in the water supply industry including public water supply operators, private water supply operators, water supply contractors, permit holders and suppliers of water products. This includes KETTHA, SPAN, PAAB and state water regulatory agencies. The inclusion of regulatory agencies is supported by the stakeholder theory. Government agencies are the most critical stakeholder in any areas including water supply industry and therefore must be considered as one of the critical success factors by water operators (Freeman, 1984).

The second success factor category is water operators themselves. It refers to the commitment of water operators, the strength and competence level of water operators and the commitment of project partners (Ameyaw & Chan, 2016; Ameyaw, 2015). The inclusion of water operators is supported by the legitimacy theory. Legitimacy theory is usually used to understand organizational forms and structures in the expense of relevant assumption that business enterprise has to continue its survival (Meyer & Rowan, 1977). In other words, corporate legitimacy theory is related to how an organization coordinates its operation so that its business objectives can be achieved. In relation to water supply industry, it can be linked to the structures and procedures that are used by the water operators to ensure effective water service delivery to the consumers. This includes meet service targets, forecast demand, acquire land on time, design clear contract, solve dispute between shareholders, adopt effective procurement system, manage construction time and control construction cost (Ameyaw et al., 2017; Ameyaw & Chan, 2016; Ameyaw, 2015). In short it can be said that water operators must be considered as one of the success factor category in water supply industry.

The third success factor category is water assets. It refers to the level of quality of water assets, the technology that is used to deliver specified outputs or deliverables, supporting utilities such as electricity that are required for the operation or construction of water system, pipeline system, the constructed or designed water facilities, remaining value of water asset and water meter (Ameyaw et al., 2017; Ameyaw & Chan, 2016; Ameyaw, 2015). This success factor category is justified by the theory of perceived risk. Theory of perceived risk considers technology (physical risk) as a critical risk and therefore must be included in the risk management to ensure the success of organizational operation (Bauer, 1960). Thus the capability to manage water assets is considered as one of benchmarks to measure the success of water operators.

The fourth success factor category is financial. It refers to the ability of water operators to obtain adequate financing and the level of profit that can be gained by water operators (Ameyaw & Chan, 2016; Ameyaw, 2015). This relates to the issues of operational costs and water tariff that influence the performance of water supply industry. This success factor category is justified by the theory of perceived risk. This theory considers economy (financial risk) as a critical risk and therefore must be included in the risk management to ensure the success of an organization (Bauer, 1960). Thus the ability to manage financial-related issues

is considered as one of the benchmarks to measure the success of water operators.

The fifth success factor category is human resource. It refers to the quality of water workforce and local capacity building for utility staffs (Ameyaw & Chan, 2016; Ameyaw, 2015). This relates to the ability of staff members to deliver effective and efficient water services to the consumers. The inclusion of human resource is justified by the stakeholder theory. Employee is one of the critical internal stakeholders of any organizations (Freeman, 1984). It is the responsibility of the organizations to ensure the readiness and competency of their employees when delivering services to the consumers. Thus establishing effective human resource management is considered as one of the benchmarks to measure the success of water operators.

The sixth success factor category is water contract. It refers to flexible contracts with fair risk allocations and competitive tendering (Ameyaw & Chan, 2016; Ameyaw, 2015). This relates to the ability of water operators to strike a fair contract with the government agencies especially state governments. Without a fair contract it is hard for the water operators to deliver water services effectively and efficiently. The inclusion of water contract is supported by the legitimacy theory. Legitimacy theory is usually used to understand organizational forms and structures in the expense of relevant assumption that business enterprise has to continue its survival (Meyer & Rowan, 1977). Water contract will influence how water operators coordinate their operations so that their business objectives can be achieved. Water operators will ensure that the adopted structures and procedures can deliver effective water services to the consumers. Thus understanding water contract is considered as one of the benchmarks to measure the success of water operators.

The final success factor category is public. It is defined as the acceptance and support given by people to reduce the delay in the process of approving and developing water project (Ameyaw & Chan, 2016; Ameyaw, 2015). The inclusion of public is supported by the stakeholder theory. This is because public is the most critical stakeholder in any areas including water supply industry and thus must be considered as one of the benchmarks to measure the success of water operators (Freeman, 1984). The summary of the success factor category is illustrated in Table 2.

Table 2. Success Factor Categories

Factors	Items Used
Regulatory Agencies	PAAB commitment
	SPAN commitment
	State water regulatory agencies commitment
	KETTHA commitment

	Internal coordination within government
	Effective regulatory and legal structures
Water Operators	Water operators commitment
	Strong and competent water operator
	Strong commitment from project partners (shareholders)
Water Assets / Technology	Quality of water assets
Financial	Adequate financing
	Profitable water supply projects
Human Resource	Quality water workforce
	Local capacity building for utility staff
Water Contract	Flexible contracts with fair risk allocations
	Competitive tendering
Public	Public acceptance/support
	Strong public partner

2. Method

As stated above, the categories of risks and success factors that are relevant to Malaysian water industry were identified from a comprehensive literature study (Chan et al., 2010). Eventually, the categories of risks and success factors listed in questionnaire were itemized. Respondents were asked to rate the factors based on their significance on a 7-point scale ranging from 1 (very low importance) to 7 (very high importance). The questionnaire survey was distributed to management personnel in water operators in Malaysia through post, email and personal interview (nearby water operator). 32 valid responses were received from the data collection. The data was analyzed using reliability test, descriptive analysis and ranked using relative important index (RII).

3. Results

3.1 Reliability Analysis

After the collection of data, reliability test was conducted using Cronbach's Alpha. Table 3 shows the results of reliability analysis of categories of risks and success factors. As indicated in Table 3, the Cronbach's Alpha value for each dimension were greater than 0.65, indicating the acceptable and reliable data (Hair et al., 2013).

Table 3. Reliability Analysis of the Variables

	N of Items	Cronbach's Alpha
Risk Categories		
Government	11	0.72
Economy	13	0.85
Organization	7	0.70
Technology	7	0.72
Nature	4	0.79
Criminal	4	0.71
Public	1	-
Success Factor Categories		
Regulatory Agencies	6	0.72
Water Operators	3	0.80
Water Assets	1	-
Financial	2	0.71
Human Resource	2	0.75
Water Contract	2	0.78
Public	2	0.70

3.2 Descriptive Analysis

Descriptive analysis was conducted to examine the respondents' view on risk categories and success factor categories. Figure 1 indicates the response for the risk factors' occurrence, severity and risk allocation. Respondents perceived the highest agreement towards the occurrence of risk factors in term of economy (mean = 5.61), followed by technology (water asset) (mean =5.59) and public (mean = 5.58). For severity of risk factors, respondents agreed the public factors of were highest (mean = 6.03) followed by nature (mean = 5.65) and criminal (mean = 5.53). Respondents also perceived that the risk factors should be allocated to water asset (mean = 2.71), government (mean = 2.59) and organizational (mean = 2.39). Respondents also perceived that public should be allocated less risk factors (mean = 1.90).

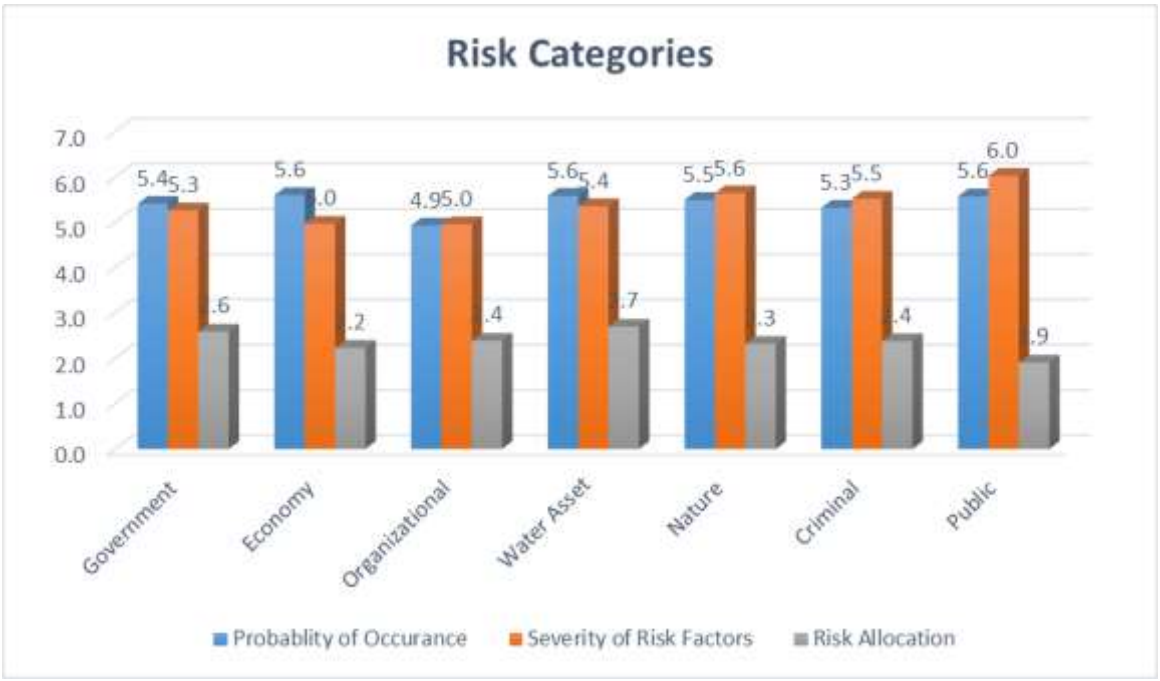

Figure 1. Risk Categories

From Figure 1 it can be seen that there is a big gap between risks' probability of occurrence and risk allocation and also between severity of risk factors and risk allocation amongst water operators in Malaysia. This highlights low awareness amongst water operators in Malaysia on water risk management. Thus regulatory agencies such as SPAN and state water agencies must play an active role in promoting risk management awareness amongst water operators through campaign, workshop and training programs.

As in Table 4, respondents indicated that the most important of success factor categories were strong and competence water operator (mean = 6.19, sd = 0.82). It was followed by PAAB commitment (mean = 6.16, sd = 0.57) and adequate financing (mean = 6.06, sd = 0.67). Competitive tendering (mean = 4.22, sd = 1.72), SPAN commitment (mean = 4.31, sd = 1.26) and quality water asset and workforce (mean = 4.47, sd = 1.44) were less importance.

Table 4. Descriptive Analysis of Success Factor Categories

RANK		Percentage (%)							Mean	SD
		1	2	3	4	5	6	7		
1	Strong and competent water operator	-	-	-	3.1	15.6	40.6	40.6	6.19	0.82
2	PAAB commitment	-	-	-	-	9.4	65.6	25.0	6.16	0.57
3	Adequate financing	-	-	-	-	18.8	56.3	25.0	6.06	0.67

4	Local capacity building for utility staff	-	-	-	-	21.9	65.6	12.5	5.91	0.59
5	State water regulatory agencies commitment	-	-	-	3.1	21.9	59.4	15.6	5.88	0.71
6	KETTHA commitment	-	-	-	3.1	21.9	62.5	12.5	5.84	0.68
5	Strong public partner	-	-	-	3.1	31.3	43.8	21.9	5.84	0.81
8	Effective regulatory and legal structures	-	-	-	-	31.3	59.4	9.4	5.78	0.61
8	Flexible contracts with fair risk allocations	-	-	6.3	-	21.9	53.1	18.8	5.78	0.97
10	Strong commitment from project partners (shareholders)	-	-	3.1	-	40.6	34.4	21.9	5.72	0.92
11	Internal coordination within government	-	-	-	-	43.8	50.0	6.3	5.63	0.61
12	Public acceptance/support	-	3.1	6.3	6.3	28.1	34.4	21.9	5.50	1.27
13	Water operators commitment	-		12.5	3.1	31.3	37.5	15.6	5.41	1.19
14	Profitable water supply projects	-	-	9.4	3.1	37.5	40.6	9.4	5.38	1.04
15	Quality water asset and workforce	-	12.5	15.6	15.6	28.1	25.0	3.1	4.47	1.44
16	SPAN commitment	-	3.1	34.4	12.5	28.1	21.9	-	4.31	1.26
17	Competitive tendering	6.3	12.5	15.6	18.8	21.9	15.6	9.4	4.22	1.72

Figure 2 illustrates the ranking of success factor categories in the form of histogram graph. From the graph it can be seen that the respondents considered all items of success factor categories as important. The lowest success factor category was competitive tendering (mean = 4.22 and sd = 1.72). Thus all these factors must be taken seriously by the Malaysian water

operators to ensure the effectiveness and efficiency of the water project.

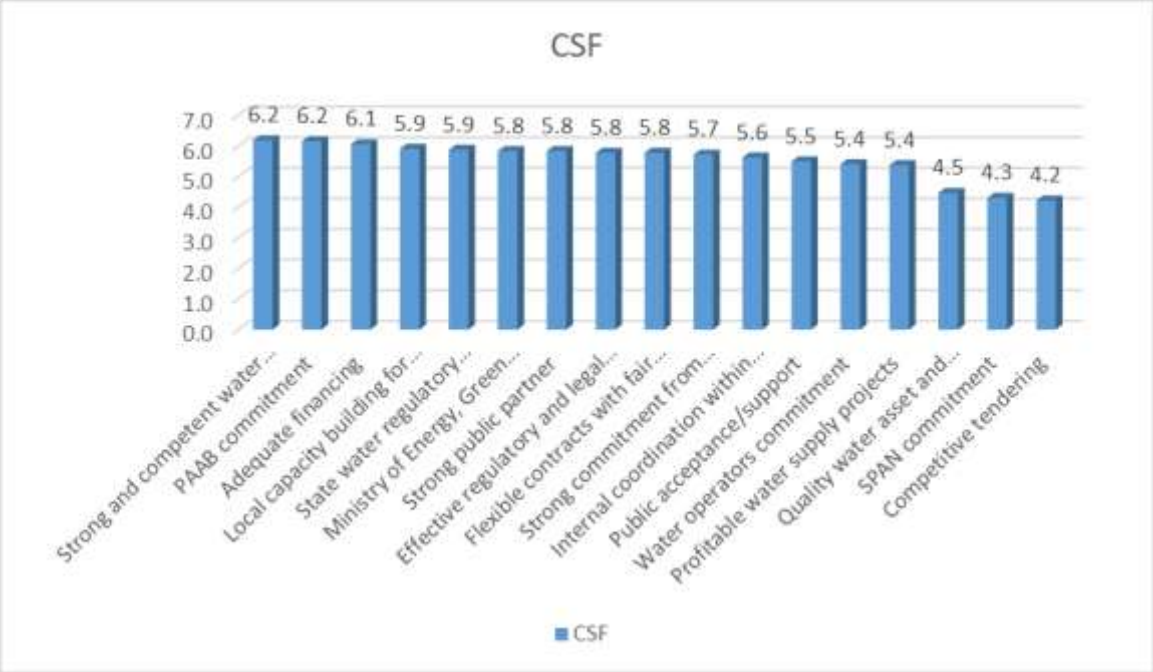

Figure 2. Success Factor Categories

3.3 Relative Importance Index

The final analysis was RII. The RII value had a range of 0 to 1 and the higher RII shows more important the factor is. All factors are nominally considered serious, but because some must be more important than others, the factors should be evaluated. A relatively large index method was used to determine the weight of each factor and based on this value the key success factor categories were identified (Pandit & Yadav, 2015; Bing et al., 2005). This is a statistical method for determining the relative classification of each category. The classification has been converted into an index of importance based on the following equation:

Relative Importance Index = $[\sum w] / [A \times N]$

Where;
w = weightage given to each factor by respondent,
A = highest weight,

N = total number of respondent

The results of the RII ranking are illustrated in Table 5. From Table 5 it can be seen that top success categories were strong and competence water operator, PAAB commitment, adequate financing and reliability and state water regulatory agencies commitment.

Table 3. Relative Importance Index of Success Factor Categories

	w	A	N	RII
1. PAAB commitment	197	7	32	0.88
2. SPAN commitment	138	6	32	0.72
3. State water regulatory agencies commitment	188	7	32	0.84
4. KETTHA commitment	187	7	32	0.83
5. Water operators commitment	173	7	32	0.77
6. Public acceptance/support	176	7	32	0.79
7. Adequate financing	194	7	32	0.87
8. Quality water asset and workforce	143	7	32	0.64
9. Effective regulatory and legal structures	185	7	32	0.83
10. Strong and competent water operator	198	7	32	0.88
11. Profitable water supply projects	172	7	32	0.78
12. Flexible contracts with fair risk allocations	185	7	32	0.83
13. Local capacity building for utility staff	189	7	32	0.84
14. Competitive tendering	135	7	32	0.60
15. Internal coordination within government	180	7	32	0.80

16. Strong commitment from project partners (shareholders)	183	7	32	0.82
17. Strong public partner	187	7	32	0.83

Strong and competent water operator was considered by the respondents as the most important part in effective project implementation. This shows that water operators must have proper operational system and competent workforce to ensure quality service delivery to the customers. Second most important factor was PAAB commitment. PAAB role is becoming critical because water industry in Malaysia is moving towards liability free model whereby water operators lease water assets from PAAB. Thus PAAB must ensure all assets are ready and properly maintained to avoid disruption in water treatment processes. Third most important factor was adequate financing. Without adequate financing it is difficult to undertake proper maintenance works and infrastructure development. In addition, water tariff must be increased to improve water operators' revenue and in turn financial strength. In short, these three success factor categories must be given priority by the water operators to ensure effective and efficient operation of the water project.

Success factor categories such as competitive tendering, quality water asset and workforce, SPAN commitment and water operators' commitment were measured relatively less significant than other factors. At personal interview stage these success factor categories were discovered as critical, but were not by the respondents as reflected by their weights. They are important but not the top priority. The listed success factor categories may be beneficial to the government body, organization or any private agencies to develop their own efficiency of operation and maintenance. They are critical to develop better perceptive about the water supply operation and maintenance, which is an initial step towards improvement.

4. Conclusion

This study identified 47 items for risk categories and 17 items for success factor categories from the literature review and expert interview. Water risks were grouped under 7 categories, namely, government, economy, organizational, technology, nature, criminal and public. From 17 items of success factors, 7 categories were developed, namely, regulatory agencies, water operators, water assets, financial, human resource, water contract and public. The questionnaires were then distributed to all water operators in Malaysia and the respondents were management personnel.

From the findings it can be concluded that there were big gaps between risks' probability of occurrence and risk allocation and also between severity of risk factors and risk allocation amongst water operators in Malaysia. This highlights low awareness amongst water operators in Malaysia on water risk management. Thus regulatory agencies such as SPAN and state water agencies must play an active role in promoting risk management awareness amongst

water operators through campaign, workshop and training programs. In relation to success factor categories, the most important categories discovered were the competence of water operator and PAAB commitment with a relatively large index of 0.88 and the least significant factor discovered was competitive tendering with a relatively large index of 0.60. The top five success factor categories were strong and competent water operator, PAAB commitment, adequate financing, state water regulatory agency commitment and local capacity building for utility staff. Government agencies and water operators can use these categories to develop effective and efficient operation and maintenance processes.

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