The House of Risk with Multi-Actor Approach Aligned with ISO 31000:2018 for Effective Risk Management in Business with Risky Environment

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Abstract. Effective risk management requires a thorough comprehension of risks and the involvement of multiple actors in the process. In conjunction with the internationally recognized ISO 31000 standard, the House of Risk (HOR) framework provides a robust approach to risk management. This article examines the HOR concept and its alignment with ISO 31000:2018. It highlighted the advantages of utilizing a multi-actor approach and applied it to a rafting business, a recreational activity business involving customers as participants. As a result of risk identification, there are twenty-three Risk Events caused by twenty Risk Agent (RA). In HOR Multi-Actor phase 1, eleven RAs were selected based on their CARPs' values and the Pareto principle, and twenty Preventive Actions (PAs) were identified from discussion with related company's stakeholder. HOR Multi-Actor phase 2 generated eight PAs based on the implementation difficulty and the correlation between PAs and the RAs. Based on these eight PAs, further sifting was performed using pairwise comparison, and finally, three highest-ranked PAs were selected to be implemented.

Keywords: House of Risk, Multi Actor, ISO 31000:2018

1 Introduction

Business with risky environment, business that operate in challenging and potentially risky environments, such as rafting, the paintball or shooting game industry, and other recreational activities involving customers as participants, must provide consumers with a safe and enjoyable experience. Creating a safe and responsible environment is essential for gaining customers' confidence and reducing the risks associated with these activities. Companies must have proper risk management to protect their assets and business continuity, meet compliance requirements, manage reputation, and build customer confidence. Risk management has become a crucial component for this kind of business. Risk is determined by the degree of uncertainty and the magnitude of an

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occurrence. Sinha et al. suggest identifying, assessing, developing, implementing solutions, and conducting FMEA analysis to reduce risk and seek continuous improvement [1].

Risk management entails perceiving an organization's future uncertainties and addressing them now [2]. Effective and proactive risk management is necessary for organizations to navigate uncertainty and mitigate potential losses; the House of Risk (HOR) is a comprehensive framework that provides a multidimensional proactive risk management approach that allows companies to consider risks from multiple perspectives, ensures a complete understanding of risks, and a risk-aware culture [3].

HOR initially had a single actor with many different perspectives. The multiple perspectives on HOR framework should involve multiple actors from various stakeholders, companies, government, and customers working together to identify, assess, and mitigate risks [4] as each actor has different expertise, knowledge, background, and individual values [5]. Risk perception is the subjective evaluation of a person's concern about the probability of a goods related accident, as well as how concerned they are about the consequences or impacts of the incident [6].

Moreover, the need to integrate risk management into the overall processes and decisions of the organization. ISO 31000 is an international standard that provides risk management principles, framework, and guidance that emphasizes a systematic and proactive approach to identifying, assessing, treating, and monitoring risks within organizations, including the involvement of stakeholders, the consideration of internal and external factors, and tailored to the context of the organization [7].

This article analyzes the HOR Multi-Actor concept and its alignment with ISO 31000:2018. The HOR Multi-Actor is a multi-actor representation of collaborative risk management efforts that involve different actors. As specified in ISO 31000:2018, organizations are encouraged to establish risk management frameworks that involve stakeholders within and outside the organization, including employees, customers, suppliers, and regulatory bodies in risk identification, assessment, mitigation, and decision-making processes.

Concept integration between the HOR Multi-Actor and ISO 31000:2018 was applied in a rafting business, in Bali Indonesia, which did not have structured risk management, so it was unable to identify and reduce risk sources that have the potential to occur in the company's business processes. The company's business process and the actors involved are depicted in Fig. 1. The local people were responsible for keeping the path clean, while the operations staffs were responsible for clearing the path and monitoring the river's flow and level. In addition, procurement personnel were responsible for procuring materials for business continuity. The operators were required to master all aspects of rafting, and the customers, as actors, will enjoy the results that have been prepared by other actors in the execution of the rafting game.

In the tourism sector, an individual's views of a potential activity that can explain a hazard and affect travel decisions are referred to as risk perceptions [8]. ISO 31000:2018 was used to encourage the company to include employees, customers and regulatory in the risk management framework, whereas HOR Multi-Actor were used to identify, assess, and mitigate risk and with multi-perspective multi-actor in 2 phases.

The remainder of this paper is organized as follows. Following the theoretical background section is a description of the research methodology, followed by the study's results. Finally, several conclusions are presented.

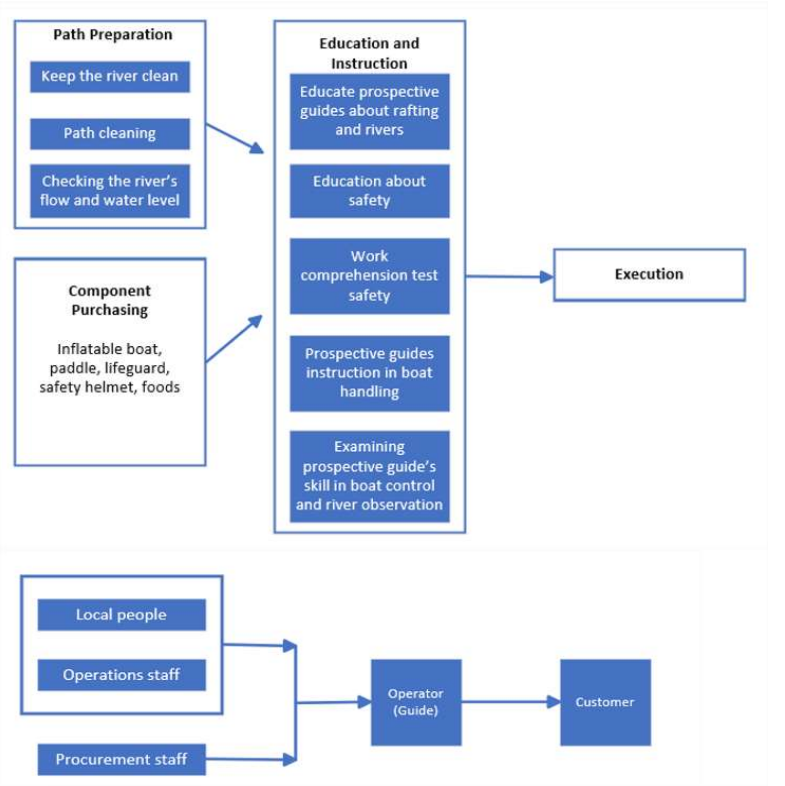

Fig. 1. The Business Processes and Actors Involved

2 Theoretical Background

2.1 House of Risk Multi-Actor Model.

HOR Multi-Actor is a modified form of the original form of HOR method [2]. The original HOR model was modified to accommodate the multi-actor factor since one risk event can arise from several actors.

HOR Multi-Actor Phase 1

In phase 1 of HOR Multi-Actor, we need to integrate the Aggregate Risk Potential (ARP) from the Risk Agent as in equation (1)

$$ARP_{jx} = O_j \sum_i SV_{ix} R_{ij} \qquad \forall j \text{ and } x \qquad \textbf{(1)}$$

Assuming that each Risk Agent has a different ARP value associated with each actor, the ARP rating needs to combine the ARP value of each actor. The formula is as follows:

$$CARP_j = O_j \sum_x \sum_i SV_{ix} \qquad \forall j \qquad \textbf{(2)}$$

Where:

ARP_{jx} : Aggregate Risk Potential of Risk Agent-j to Actor-x
O_j : Occurrence of Risk Agent-j
SV_{ix} : Severity to Actor-x's objective if Risk Event-i occurs
R_{ij} : Relationship between Risk Event-I and Risk Agent-j
$CARP_j$: Combination value of ARP for each Risk Agent-j

Several Risk Agents with significant ARPs that need to be prioritized are chosen using HOR Multi-Actor phase 2.

Table 1. HOR Multi-Actor Phase 1

Risk Event (E_i)	Risk Agents (A_j)				Severity Event-i to objectives actor-x (SV_{ix})		
	PA_1	PA_2	PA_3	PA_j	SV_{i1}	SV_{i2}	SV_{ix}
E_1	R_{11}	R_{12}	R_{13}	R_{1j}	SV_{i1}	SV_{i12}	SV_{1x}
E_2	R_{21}	R_{22}	R_{23}	R_{2j}	SV_{i11}	SV_{i22}	SV_{2x}
E_3	R_{31}	R_{32}	R_{33}	R_{3j}			
E_4	R_{41}	R_{42}	R_{43}	R_{4j}	SV_{i41}	SV_{i42}	SV_{4x}
…				…			
E_i	R_{i1}	R_{i2}	R_{i3}	R_{ij}	SV_{i1}	SV_{i2}	SV_{ix}
Total effectiveness of action k	O_1	O_2	O_3	O_4			
Degree of difficulty performing action k	A_1	A_2	A_3	A_4			
Effectiveness to difficulty ratio	ARP_{1X}	ARP_{2X}	ARP_{3X}	ARP_{JX}			
Rank of priority	$CARP_1$	$CARP_2$	$CARP_3$	$CARP_4$			

HOR Multi-Actor Phase 2

After several high-values risk agents were selected and identified from phase 1, HOR Multi-Actor phase 2 was used to prioritize the proposed Preventive Actions as depicted in Table 2. Then calculate the total effectiveness of each preventive action as in equation (3).

$$TE_k = \sum_j \sum_x ARP_{jx}\ E_{jk} \quad (3)$$

Where:
A_j : Risk Agent-j selected to be treated
PA_k : Preventive Action-k to be implemented
E_{kj} : Correlation between Preventive Action-k and Risk Agent-j
ARP_{jx} : Aggregate Risk Potential-j for Actor-x
TE_{kx} : Total Effectiveness of each Preventive Action for Actor-x
D_{kx} : Difficulty level in implementing the Preventive Action-k for Actor-x
ETD_{kx} : Ratio of Total Effectiveness to Difficulty level of Preventive Action-k for Actor-x

2.2. ISO 31000:2018

ISO 31000 is an international standard that provides principles, frameworks, and guidelines for effective risk management [9] and the ISO 31000:2018 process is depicted in Fig. 2 and ISO 31000:2018 systematic approach are as follows:

1. Establish scope, context and criteria.
2. Risk Assessment, including risk identification, risk analysis and risk evaluation.
3. Risk Treatment within organizations whether by avoiding, transferring, mitigating, or accepting it.
4. Monitoring dan reviewing the related actions in treating risks while maintaining internal communication within the organization and recording and reporting activities.

The standard encourages companies to have a proactive risk management culture that lets them take advantage of opportunities while minimizing potential negative impacts.

Table 2. HOR Multi-Actor Phase 2

	Preventive Action (PA_k)				Aggregate Risk Potential -j in actor x (ARP_{jx})			
To be treated risk agent (A_j)	PA_1	PA_2	…	PA_k	ARP_{i1}	ARP_{i2}	…	ARP_{jx}
A_1	E_{11}	E_{12}		E_{1k}	ARP_{i1}	ARP_{12}		ARP_{1x}
A_1	E_{12}			E_{2k}				ARP_{2x}
…								
A_j	E_{j1}	E_{j2}	…	E_{jx}	ARP_{i1}	ARP_{j2}		ARP_{jx}
Total effectiveness of action (TEk1)	TE_{11}	TE_{12}	…	TE_{k1}				
Total effectiveness of action (TEk1)	TE_{21}	TE_{22}	…	TE_{k2}				
…	…	…	…	…				
TE_{kx}	TE_{1x}	TE_{2x}	…	TE_{kx}				
Degree of difficulty performing action (Dk1)	D_{11}	D_{12}		D_{k1}				
Degree of difficulty performing action (Dk2)	D_{21}	D_{22}		D_{k2}				
…	…	…	…	…				
D_{kx}	D_{1x}	D_{2x}	…	D_{kx}				
Effectiveness to difficulty ratio (ETD_{k1})	ETD_{11}	ETD_{12}	…	ETD_{k1}				
Effectiveness to difficulty ratio (ETD_{k2})	ETD_{21}	ETD_{22}	…	ETD_{k2}				
…			…	…				
ETD_{kx}	ETD_{1x}	ETD_{2x}	…	ETD_{kx}				

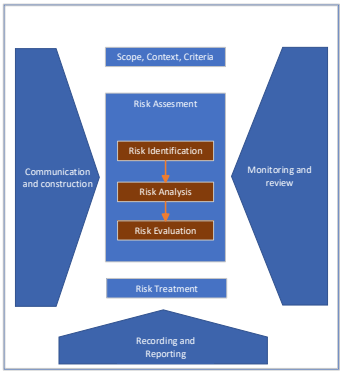

Fig. 2. ISO 31000:2018 Process [9]

3. Research Methodology

The research was conducted utilizing the international standard framework ISO 31000:2018, beginning with determining the context, Risk Assessment, and Risk Treatment by related actors: customers, CEO, and employees. The steps used to build the multi-actor HOR model combined with international standard ISO 31000:2018 are shown in Fig. 3 and described below:

I. **Risk Assessment** in ISO 31000:2018 and **HOR Multi-Actor Phase 1**

1. **Risk Identification**: identification of Risk Event (RE) by related actors as in Table 3 and Risk Agent (RA).
2. **Risk Analysis**: assess the Risk Occurrence from each RA and the Risk Severity to customer as well as company.
3. **Risk Evaluation**: Calculate the CARP value for each RA, which is the sum of the customer ARP and the company ARP. The Pareto principle filters RAs based on the highest CARP value, then rank the Risk Agents

II. **Risk Treatment** and **HOR Multi-Actor Phase 2**

Identification of Preventive Actions (PAs) from discussion with related company's stakeholder, assess the PAs based on the implementation difficulty of PAs and the correlation between PAs and Risk Agents, and we obtain PAs rank.

III. The selected PAs are re-evaluated using pairwise comparison to select the finest applicable PAs.

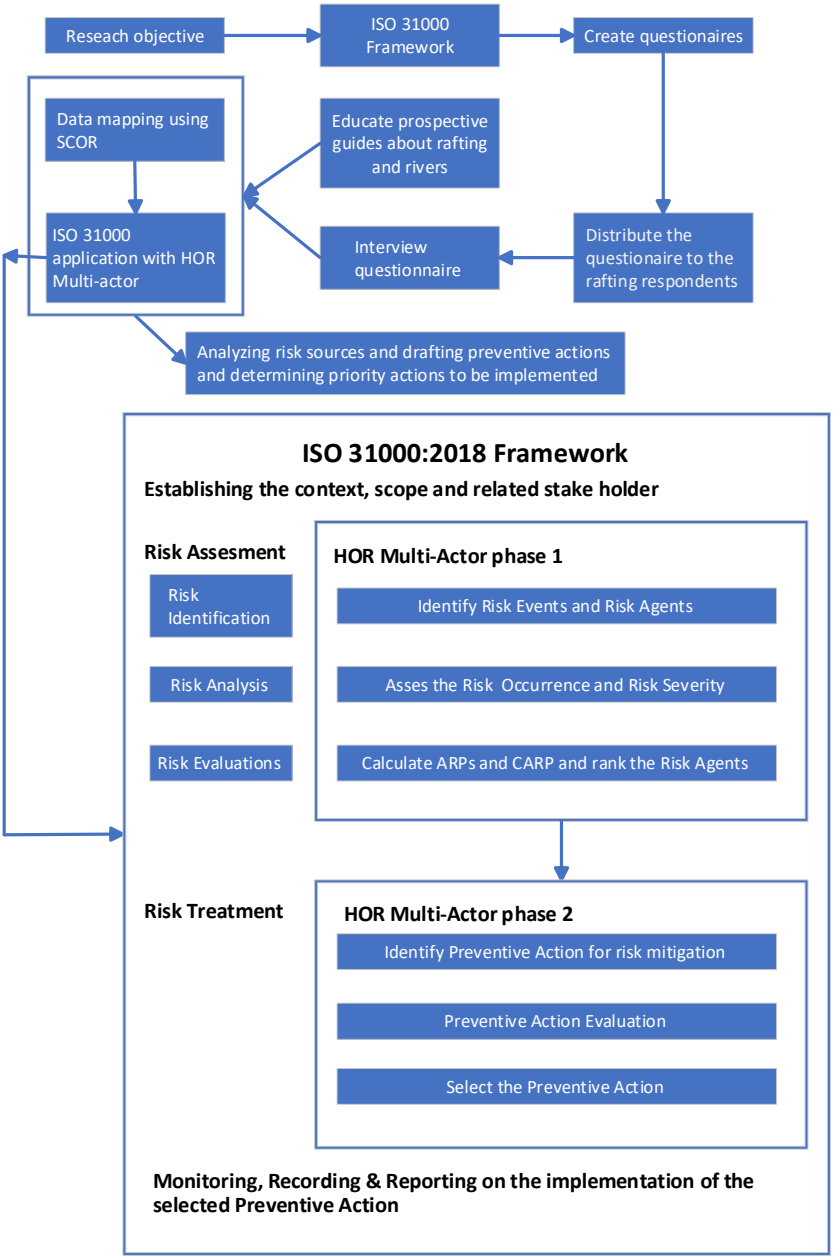

Fig. 3. HOR Multi-Actor in risk management process - ISO 31000:2018

4. Result and Discussion

The risk assessment can be started following the risk management process stated by ISO 31000:2018, which are risk identification, risk analysis, and risk evaluation.

4.1 Risk Assessment in ISO 31000:2018 and HOR Multi-Actor Phase 1

Risk Identification

As the first step in evaluating risk, all the possible risks that might impact were identified. This typically takes place during the planning phase and it is advised to perform it in groups composed of the core team members and pertinent stakeholders since the judgments are more accurate [10]. Information can be gathered through interview or active discussion. The final objective is to identify potential problems before it actually happens by doing proactive approach to risks [11].

In this step, Risk Event and Risk Agent were identified. Risk Events were identified through deep interviews with related actors: company management and active customers (lead users). Table 3 reveals the result of Risk Event identification.

Table 3. Risk Event and Related Actor

Related Actor	Code	*Risk Event*
CEO	E3	High government retribution fee
	E5	Reschedule or cancelation because of weather
	E6	Delay bonus payment because of lower market price
	E7	Delay payment from travel agent partner
CEO, Operation Management, Customer	E23	River pollution
Purchasing Management	E1	Boat breakdown
	E2	Repairment of supporting facility, such as lobby and restaurant
	E8	Difficulty in finding high quality glue for boat
Operation Management	E4	Blocked path by wood, garbage, etc.
	E9	Absent employee
Customer	E10	Delay pick-up service
	E11	Game accident
	E12	Miss-leading information regarding services
	E13	Price discrepancy
	E14	Insufficient infrastructure & facility
	E15	Inaccurate price setting
	E16	Long queue
	E17	No cash money
	E18	Bad connection in reservation process
	E19	No change in payment
	E20	Avoid cancellation of service reservations
	E21	Employee fraud
	E22	Illiquid cashflow and discrepancy in financial agreement

From related actors, there were 20 Risk Agents to ease the data processing in the next step. Table 4 summarizes the Risk Agents that have been determined.

Table 4. Risk Agents

Code	*Risk Agent*
RA1	Unconducive boat path
RA2	Weather
RA3	Insufficient number of employees
RA4	Cleanliness & environmental sustainability
RA5	Pricing problem
RA6	Employee indiscipline
RA7	Glue problem
RA8	Operator fitness
RA9	Preparation & briefing
RA10	Player focus
RA11	Miss-leading information
RA12	Rafting equipment
RA13	Operator in-accuracy
RA14	Operator responsibility
RA15	Supporting facility
RA16	Payment problem
RA17	Communication problem
RA18	No agreement procedure
RA19	Unfamiliar official account
RA20	Traveling disruption

Risk Analysis

In risk analysis, the Severity and Occurrence of each Risk Event was classified by using score 1, 3, 5, 7, and 9, where 1 is the lowest frequency/impact and 9 is the biggest one. The severity and occurrence were identified by observing the historical data. Fig. 4. shows the Risk Event mapping based on Severity and Occurrence. Risk Event E14 became the worst Risk Event, with severity 7 and occurrence 7.

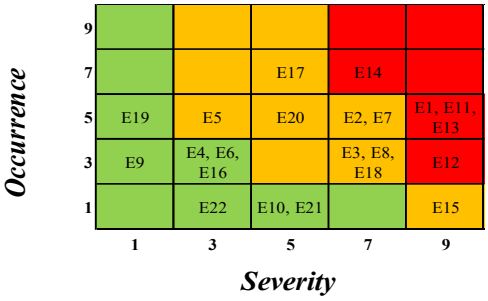

Fig. 4. Risk Event Mapping

Risk Evaluation

Risk evaluation could be started with a discussion of developing risk matrices to provide a semi-quantitative risk assessment methodology. This risk matrices development is also to help key stakeholder decisions [12].

The result in risk identification will become the input to the next process which is. creating Aggregate Risk Potential (ARP) for each actor. Each Risk Event is assessed based on Severity and likelihood of Occurrence of the Risk Agents. This risk evaluation is needed in generating the relationship matrix between Risk Event and Risk Agent. Then the result will be used to rank the Risk Agents (by calculating the CARP). As a result, HOR Multi-Actor phase 1 was developed (Table 5). Fig. 5 is a pareto chart that displays the rank of Risk Agents. Table 5 and Fig 5 shows that the three risk agents with highest CARP are RA2 (weather), RA6 (indiscipline employee) and RA1 (unconducive boat path).

Table 5. HOR Multi-Actor Phase 1

		Risk Agent (Aj)																			Severity	
		RA1	RA2	RA3	RA4	RA5	RA6	RA7	RA8	RA9	RA10	RA11	RA12	RA13	RA14	RA15	RA16	RA17	RA18	RA19	RA20	Company	Customer
Risk Event (Ei)	E1	9		3																		9	-
	E2		5																			7	-
	E4	7	5		5																	3	-
	E5																					3	-
	E6					9																3	-
	E7						5															7	-
	E8							9														7	-
	E9						7		9													1	-
	E10						7			5											7	-	5
	E11	9	7	5						3	5											-	9
	E12											9										-	9
	E13					9																-	9
	E14												9									-	7
	E15													9	5							-	9
	E16						5					7				1						-	3
	E17																9					-	5
	E18																	9				-	7
	E19																5					-	1
	E20						3					5	3		1		1		5			-	5
	E21											3			9					7		-	5
	E22														7				7			-	3
	E23				9																	3	7
Occurrence		5	7	3	7	3	9	4	9	7	7	5	5	5	5	5	5	5	5	3	3		
ARP	Company	510	539	81	294	81	378	252	81	0	0	0	0	0	0	0	0	0	0	0	0		
	Customer	405	441	135	441	243	585	0	0	364	315	710	390	405	580	15	275	315	230	105	105		
CARP		915	980	216	735	324	963	252	81	364	315	710	390	405	580	15	275	315	230	105	105		

Fig. 5. Pareto Diagram HOR Multi-Actor Phase 1

4.2. Risk Treatment and HOR Multi-Actor Phase 2

The next step after finding out and analyzing the risks, a mitigation plan needs to be developed, which is a plan to reduce the impact of undesired events. There are some ways to mitigate risk depending on the risk profile. In this step, several Preventive

Actions are determined to prevent the Risk Agents from happening in the future. Table 6 displays the identification of Preventive Action (PA).

Table 6. Identification of Preventive Action

Code	*Preventive Action*	Classification
PA1	Finding better track alternatives	*Avoidance*
PA2	Employee training in improving the employee skill	*Transferrence*
PA3	Routine maintenance for building	*Limitation*
PA4	Partnership with government for environment conservation to support tourism industry	*Transferrence*
PA5	Build garbage filtering in upstream line	*Acceptance*
PA6	Weather forecasting and confirmation to the customers	*Avoidance*
PA7	Developing work system & procedure	*Avoidance*
PA8	System procedure of payment agreement in mutual partnership	*Avoidance*
PA9	System & procedure of customer briefing	*Avoidance*
PA10	Customer arrival forecasting	*Acceptance*
PA11	Procurement of certified equipment	*Acceptance*
PA12	Thorough preparatory action and croscheck before opening	*Avoidance*
PA13	Setting fixed price as selling strategy	*Limitation*
PA14	Discussion with expert	*Transferrence*
PA15	Fulfilment of operator physical needs	*Avoidance*
PA16	Comfortable waiting room	*Acceptance*
PA17	Various way of payment (cash, debit/credit card or e-wallet)	*Transferrence*
PA18	Adding new devices for easier customer contact	*Limitation*
PA19	Provide reservation system	*Avoidance*
PA20	Create and improve official sosial media	*Avoidance*

After that, the relationship between each Preventive Action and Risk Agent needs to be determined. The total effect can be seen from the degree of difficulty and effectiveness ratio, so it is possible to rank the mitigation options. HOR Multi-Actor phase 2 is the output of this process. HOR phase 2 in Table 7 was applied to determine the priority of mitigation action considering the implementation difficulties (Dk). HOR 2 reveals the correlation between PA and RA. In HOR phase 2, the Total Effectiveness of each action (TE_k) and ratio of Effectiveness to Difficulties (ETD_k). Risk mitigation, which is an action to reduce negative impact that follows risk, will be selected by making Pareto chart. Pareto chart in Figure 6 shows the result of PA ranks.

Table 7. HOR Multi-Actor Phase 2

Risk Agent	*Preventive Action*													ARP P/K
	PA1	PA2	PA3	PA4	PA5	PA6	PA7	PA8	PA9	PA10	PA11	PA12	PA13	
RA1	9	3		9	9							9		510
RA2			9			9								539
RA4			9	9										441
RA5		9	9					3					9	243
RA6							9	3						585
RA9							3		9					364
RA 10									9					315
RA11							9							710
RA12						3				9	9	9	3	390
RA13														405
RA14														580
Dk	5	4	3	5	5	3	5	5	3	4	3	3	3	
TEo	4590	3717	11007	8559	4590	6021	12747	2484	6111	3510	3510	8100	3357	
ETDo	918	929,25	3669	1711,8	918	2007	2549,4	496,8	2037	877,5	1170	2700	1119	

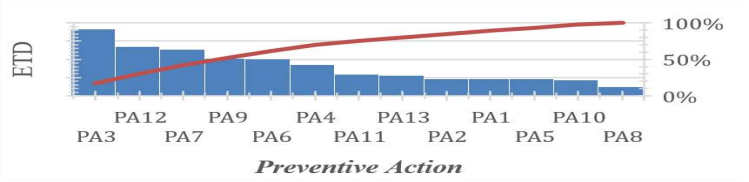

Fig. 6. Pareto Diagram HOR Multi-Actor Phase 2

4.3. Re-evaluated PAs using Pairwise Comparison

After obtaining the Preventive Action that passed the previous process, then check again to ensure which preventive measures are prioritized using pairwise comparison method. Table 8 summarizes the final weight of each PA, and PA with highest priority are PA7 (work system and procedure), PA9 (customer briefing procedure) and PA 12 (preparatory action and crosscheck before opening).

Table 8. Calculation of Weight Normalization

PA	PA3	PA4	PA6	PA7	PA9	PA11	PA12	PA13	Weight
PA7	0,293	0,255	0,31	0,293	0,37	0,255	0,18	0,265	0,278
PA9	0,293	0,181	0,31	0,147	0,185	0,228	0,361	0,132	0,23
PA12	0,093	0,09	0,077	0,169	0,053	0,161	0,104	0,162	0,114
PA13	0,065	0,09	0,077	0,104	0,185	0,066	0,06	0,094	0,093
PA6	0,093	0,128	0,077	0,073	0,046	0,093	0,104	0,094	0,089
PA3	0,065	0,128	0,055	0,066	0,041	0,066	0,074	0,094	0,073
PA11	0,065	0,064	0,055	0,076	0,053	0,066	0,043	0,094	0,064
PA4	0,033	0,064	0,039	0,073	0,065	0,066	0,074	0,066	0,06

This study inferred that risk assessment is also an important tool for evaluating risks in facing critical societal functions and services and provide a basis for taking actions to increase societal resilience [13].

5. Conclusion

The House of Risk Multi-Actor, in conjunction with ISO 31000:2018, provides a powerful model for effective risk management. This paper proposes a risk management methodology regarding the multi-actor in a business. As a means for risk assessment, this paper suggests the two phases House of Risk Multi-Actor. Differentiated from previous research which simply included only 1 actor, the suggested methodology employs an important role in risk management, with full consideration of all related actors.

The methodology was implemented in a rafting business with two actors (company and customer). Most of the Risk Events and Risk Agents are related to customers. From the House or Risk Multi-Actors, there were 23 Risk Events caused by 20 Risk Agents. In addition, 20 Preventive Actions could be identified in mitigating the risks. The most

important Preventive Actions are developing system and procedure, thorough preparatory action, and crosscheck.

This study is expected to help both the manufacturing firms and the service firms to plan the mitigation strategy in risk management. The future research should consider the other various actors and other industry sectors.

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