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GUIDELINES FOR WATER RESOURCE MANAGEMENT OF INDUSTRIAL BUSINESS SECTOR IN THE EASTERN ECONOMIC CORRIDOR (EEC) FOR SUSTAINABLE SUCCESS, USING DELPHI TECHNIQUE

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Abstract

This study is qualitative research aimed at water resources management guidelines to enhance sustainable success in industrial business sector in the EEC area using Delphi Technique to achieve the consistent consensus of 33 experts. In this research, the error reduction was determined by 0.44-0.43 and net change value was 0.01. Semi-structured interview was administered to collect data used to develop Likert's rating scales questionnaires. The 4 aspects of the guidelines for water resource management of industrial businesses to achieve sustainable success in the Eastern Economic Corridor (EEC) were data Insight, alliance centric, innovation and technology and resource management. The descriptive research statistics included percentage, mean, median, mode, and inter-quartile range. The data analysis was systematically conducted to achieve the objectives defined by the experts' consensus. The consideration was based on the congruence of the experts' opinions with the inter-quartile range less than or equal 1.5 according to the Delphi technique. The results showed that experts were consistent with water resources management guidelines to enhance sustainable success in industrial business sector in the EEC area is the highest in terms of data insights indicate on geospatial policy studies in the EEC. Government and related agencies. The aspect of alliance centric indicator was on coordinating with the community in the area to aware the importance and the need to manage water resources effectively. In terms of innovation and technology includes establishing a system to connect water sources with large pipelines and to link with water sources, on the resource management aspect indicator, it is important to promote and develop knowledge and competence of personnel for water resource management, respectively.

Keywords: Management, Water Resource, Industrial Business Sector, Eastern Economic Corridor (EEC), Delphi Technique

INTRODUCTION

Global water use has grown at more than twice the rate of population growth in the past century. According to the 2018 United Nations report, the world's people are reaching limits on their water consumption. By 2050, especially in regions where demographic growth and economically developed urban areas will be under pressure of limited renewable water

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resources which will inevitably affect the environment, ecosystem, climate, and bioenergy, all of which will affect water demand in a complex manner, exacerbated by the imbalance between "supply" and "demand" as well as deterioration in the quality of water resources. This will, therefore, affect economic growth, resulting in the enforcement of clear rules to limit pollution, conserve aquifers, and save water. The relationship between population and economic growth as well as demand for water resources must be emphasized in both the physical and administrative dimensions of the water supply agency's infrastructure (Boretti, A., Rosa, L.: 2019). Moreover, water scarcity also triggers every continent, especially in areas with a policy to promote investment development to become a leading economic zone. It can be seen that Thailand has promoted industry and investment as a leading economic zone in ASEAN. The constitution of the Kingdom of Thailand stipulates a “20-year national strategy” as a strategy for long-term development of the country. The objective is to raise the quality of the country in all sectors, and to develop Thailand into a high-income country as developed countries. The Thailand 4.0 policy enhances the competitiveness of the manufacturing and service sectors based on modern technology and innovation. The Eastern Special Development Zone or a so-called the Eastern Economic Corridor(EEC) project is an area development project with the main objective of expanding the development of the eastern seaboard area, which has been known for more than 30 years. The EEC project focuses on the development of 3 provinces in the eastern region, namely, Rayong, Chonburi, and Chachoengsao. EEC development plan recognizes the importance of area development both physically and socially to enhance the country's competitiveness. The number of industrial estates in the EEC consists of 4 industrial estates in Chachoengsao, 15 in Chonburi, and 15 in Rayong, making a total of 34, with a total area of 133,683 rai, 3,354 factories, the investment of 2.04 trillion baht, and the number of workers of 255,262.Water infrastructure is a key factor in driving all activities. When the EEC is developed according to the government's policy, water demand increases at a higher rate than in the absence of development. This will bring water demand up to 1 billion cubic meters by 2036, causing water demand to increase to 430 million cubic meters within the mentioned period.

To act to deal with the expected increase in water demand, there have been proposals to increase the capacity of both the reservoirs and water pipes within the area. To meet the demand, water from offshore sources as well as from neighboring countries have been proposed. It is estimated that the amount of water resource costs will continue to increase over the course of the operation. According to the estimation, if all alternative proposals are implemented, the water consumption in theEEC will reach 1,063 million cubic meters by 2027 and will be able to support the increased water demand throughout the projection period until 2036.

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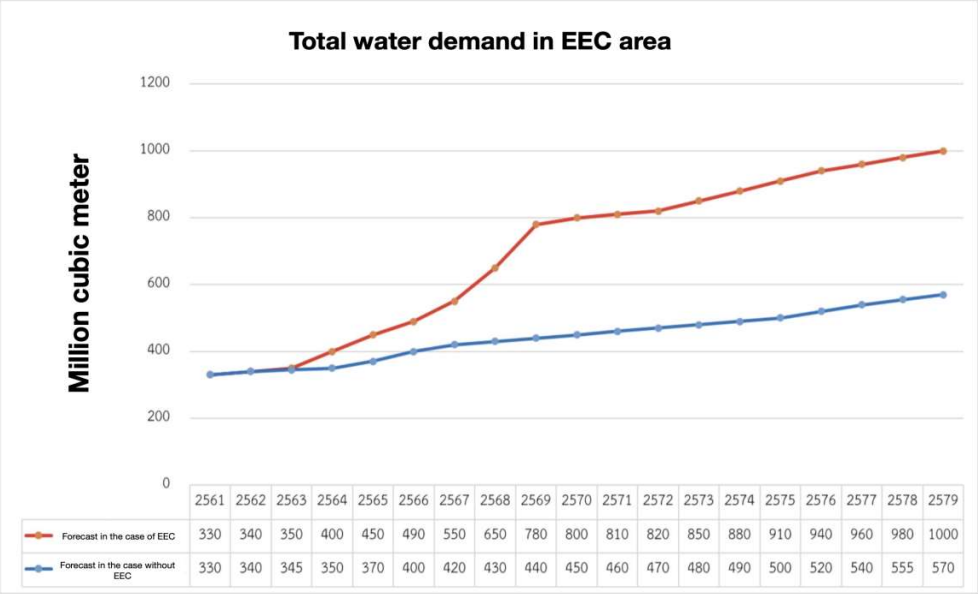

Figure 1:Water volume and forecast of total water demand within the Eastern Economic Corridor (The Royal Irrigation Department, 2020)

When comparing the peak water demand with the production capacity in the EEC, it is found that tap water capacity from the Provincial Waterworks Authority (PWA) and the Eastern Water Resources Development and Management Company started to have production capacity in shortage direction with the highest demand for water in 2019 (PWA District 1, 2019)

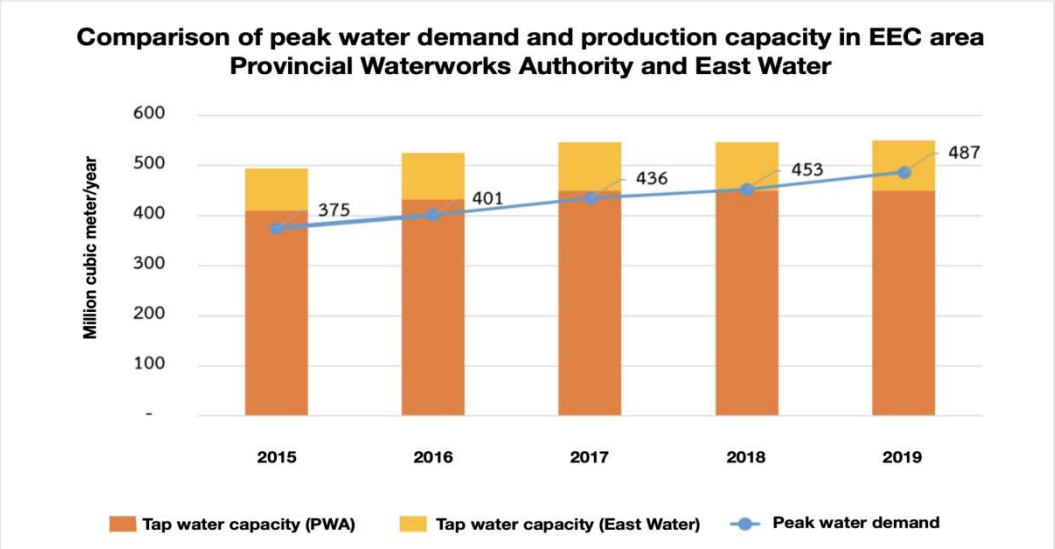

Figure 2:Comparison of peak water demand and production capacity in the EEC area (Provincial Waterworks Authority, 2020)

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From such issues, the water demand situation tends to increase continuously and there is a risk of a water shortage crisis in the EEC due to the expansion of the industrial sector. As the EEC will be a strategic area to drive the economy of Thailand, it is, therefore, imperative to prepare to avoid water shortages. A master plan for water resource development and water resource management in the eastern region must be formulated. The competitiveness of the industrial sector must be recognized and developed to lay a strong foundation to support the economic growth. Limited water resources and the environment must be managed effectively. Infrastructure must be developed to handle urban expansion considering the balance with the agricultural sector, ecosystem, social landscape, and public participation in order to make efficient use of water resources, and maximize sustainable benefits for current and future developments. In addition, flood mitigation and water quality management in watershed areas should be supervised and monitored. The supply of water sources should sufficiently be provided while the allocation of water in all activities should appropriately be made in balance with the growth in the area at present and in the future.

OBJECTIVES OF THE STUDY

To investigate guidelines for water resource management of the industrial sector for sustainable success in the EEC area

METHODOLOGY

This study is of a qualitative type, using Delphi Technique. Thirty-three experts were selected to participate in this study, considering their experiences and responsibilities related to water resource management. The error reduction was determined at 0.44–0.43 and the net change at 0.01. The experts were divided into 3 groups; 19 from government agencies responsible for water resource management, 7 from industrial businesses, and 7 academics related to water resource management, all of whom were recruited from the EEC area.Statistics used for data analysis included percentage, median, mean, mode, and interquartile ranges. The data analysis was made systematically based on the experts' consensus. The opinion congruence was determined with the interquartile range of less than or equal to 1.5, complying to the usage principle of Delphi technique in qualitative research. (Wantanakomol, S. and Silpcharu, T.: 2020). The steps of the tool creation for this study were as follows:

Round 1: Questions were prepared to construct a questionnaire with an open-ended for semi-structured interview. For areas were to be investigated; namely, data insights, resource management, innovation and technology, and alliance centric, all of which were to gain water resource management guidelines for industrial businesses to achieve sustainable success in the EEC area.

Round 2: The data obtained from the interview in Round 1 were processed and the content was categorized. The data with common characteristics or similar meanings were grouped together by means of content analysis. Then the groups of common data were named and a close-ended questionnaire with 5-point rating scale was developed according to the obtained

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data.The experts were to answer the questionnaire by weighing the importance of the matters asked.

Round 3: The responses from all experts in Round 2 were calculated to find the median and the interquartile range to review the opinions given in Round 2 and provide the feedback in terms of the answer consistency.If any inconsistency occurred the experts were required to provide additional reasons to confirm the clarity of the information. The information obtained would indicate the priority, percentage of the consistency and the inconsistency of the given opinions. This would bring about information valuable for diagnosis, and lead to accurate and reliable research conclusions.

FINDINGS

1. With respect to the data insights, the top 3 guideline items recognized the most for water resource management of industrial businesses to achieve sustainable success in the EEC were: 1) Geospatial policy studies in the EEC area of the government and related agencies must be focused on ($\bar{x}$= 4.85, S.D. = 0.442, Med = 5.00, Mode = 5 with the interquartile range of 0), 2) The data must be reliable for useful use ($\bar{x}$= 4.73, S.D. = 0.452, Med = 5.00, Mode = 5 with the interquartile range of 1), and 3) Data of water producers both public and private in the EEC area must be collected ($\bar{x}$= 4.73, S.D. = 0.517, Med = 5.00, Mode = 5 with the interquartile range of 0.5), respectively.

2. As for the resource management, the top 3 guidelines found were:1) Personnel's promotion and development of knowledge and competence for water resource management must be focused ($\bar{x}$= 4.64, S.D. = 0.549, Med = 5.00, Mode = 5 with the interquartile range of 1), 2)Water reserves must be stored both on the ground and underground for use in the dry season ($\bar{x}$= 4.64, S.D. = 0.603, Med = 5.00, Mode = 5 with a range between the quartiles of 1), and 3) Clear indicators for water resource management implementation goals must be defined ($\bar{x}$= 4.58, S.D. = 0.502, Med = 5.00, Mode = 5 with an interquartile range of 1), respectively.

3. In terms of innovation and technology, the top 3 guidelines found were: 1) A water resource linkage system or network must be provided with a large water pipe to connect the cost water sources ($\bar{x}$= 4.70, S.D. = 0.529, Med = 5.00, Mode = 5, withthe interquartile range of 1), 2) Technologyof 5G and Global Positioning System (GPS) that co-works with satellites must be used to forecast water conditions ($\bar{x}$= 4.58, S.D. = 0.561, Med = 5.00, Mode = 5, with the interquartile range of 1), and 3) The innovation and technology of 3R (Reduce, Reuse, Recycle) must be pursued to help support resource management ($\bar{x}$= 4.58, S.D. = 0.663, Med = 5.00, Mode = 5 with the interquartile range of 1), respectively.

4. Regarding alliance centric, the found top 3 guidelines for water resource management of the industrial business sector to achieve sustainable success in the EEC area were: 1) cooperating with local communities to see the importance and the need for effective water resource management ($\bar{x}$= 4.76, S.D. = 0.435, Med = 5.00, Mode = 5, with the interquartile range of 0.5), 2) Managing water so that all parties get the benefits (Win-Win) with the least

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damage and those affected get help thoroughly ($\bar{x}$= 4.73, S.D. = 0.452, Med = 5.00, Mode = 5, with the interquartile range of 1), and 3) Requesting for cooperation from the industrial sector to use water economically so that they can have sufficient water supply in the dry season ($\bar{x}$= 4.61 , S.D. = 0.556, Med = 5.00, Mode = 5, with the interquartile range of 1), respectively.

DISCUSSION

1. According to the content analysis, it was found that the experts, with respect to data insights in the Alliance Centric component, most agreed with the indicator related to cooperation with the local community to recognize the importance and the need to manage water resources as efficiently as possible. This is consistent with the study by Al-Tabbaa, O., Leach, D. and Khan, Z., (2019), which found that partner management potential, is a significant key mechanism for enhancing cross-sectoral collaboration efficiency to support and coordinate the management of each other's organizations by building a coordinating relationship, and supporting activities as well as communication measures for long-term sustainable collaboration. In addition, Enyinnah et al. (2020) study also shows that building partnerships is a key contributor to the development of innovation across the organization. Both conceptual and operational development can help them to work together in a long-term and sustainable way, reinforcing commitments and operation of organizations based on cooperation for resource management with a clear direction in the organization.

2. From the results of the study regarding data insights, the experts had a consistent and unified opinion, giving priority to the geospatial policy of the government and related agencies in the EEC, which accorded with the constructed area-based management tool for achieving wider sustainable development. According to Helen Fillmore and Loretta Singletary (2021), water management models need to focus on accessibility of both climate data and information used inwater resource management in order to allow data processing to drive decision-making for immediate and timely management. Gissi et al. (2022) mentioned, in addition to the United Nations Environment Program, in 2030, Marine Area-Based Management Tools (ABMTs) will be incorporated into the Sustainable Development Goals (SDGs) at large. In addition, Kansiri (2019) proposed that a master plan for flood management and city planning in Thailand should be formulated, coupling with budget provision for solving problems of local unpreparedness for sustainability in water management in the context of the country. This is in line with Pimpilai (2018) in that having a climate database system and community water demand data is the main factor for sustainably solving problems of management of water, natural resources, and environment in the modern era.

3. According to the results of a study regarding resource management, the experts had a consistent and unified opinion, giving priority to the indicators related to the promotion and development of personnel's competence in water management. This is in line with the study by Wattanakomol, S. and Silpcharu, T. (2022) who discusses how to empower personnel with upskill, re-skill to reduce risks and negative impacts during operations. They also propose

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guidelines for water management of industrial businesses to achieve sustainable success in the EEC area by allowing storing water both on the ground and underground for use in the dry season. They also suggested that clear indicators be set as a goal for water resource management operations.This is also in line with Chitradon (2019)'s study on Risk Management of Water Resources in Thailand in the Face of Climate Change, which stated that water resource risk management is similar to business risk management. This process includes an organized framework to deal with uncertainty or threats such as water source risks from rainfall as well as threats that we cannot control. It is necessary to find a solution through risk management planning and preventive measures for the security and sustainability of water resources. This is considered as a process of planning the use of resources and the allocation of work to meet expectations with the goal of maximizing work efficiency.

4. With respect to innovation and technology of the study, the experts had a consistent and unified opinion, giving priority to theindicators related to the use of innovation and technology to establish a system that connects cost water resources with large water pipelines. This is considered as a process innovation in application ofnew ideas, methods, or processes which will result in a continuous improvement in overall operational efficiency in terms of time, quality, cost and results. This finding accords with that ofAlaize Dall-Orsoletta (2022)'s who stated that the current of innovation and technology is both directly and indirectly playing a noticeably increasing role in the industry's cost structure. Innovations and technology can help reduce costs holistically in the long run throughout the supply chain and create value in terms of time, budget and manpower by introducing automated operating systems, robots, and artificial intelligence to both upstream and downstream processes to drive system-wide cost reductions. In addition, the finding is also consistent with that of Sanit ThipNangrong (2020)'s in that community water management innovations require planning by connecting water pipes to remote areas to allocate water equally. Technology such as satellite maps and coordinating equipment should be applied to explore the repair of water supply routes in the area. Modern innovative technologies should be used for maximum benefits in water resource management and sustainability. Beside this, innovation and technology 3R (Reduce, Reuse, Recycle) should be sought to help support resource management.This is considered a guideline for applying innovation and technology in accordance with the circular economy principle to improve water resource management and reduce water use in production, which is Iine withKirchherr, Reike, and Hekkert (2017)'s belief that circular economy is a combination of reduced consumption, reuse, and recycle that must be coordinated to create a link between the whole system to achieve sustainable effectiveness.Qinglan Liu et al (2022) additionally agreed that digital technology has brought about a change in methods and processes, resulting in more creation of new values to products and services by means of work system, production, design, and organization structure. Moreover, the introduction of SCADA system can help monitor the pressure and the amount of water in the pipe lines and control the operation of the system, resulting in reduction of water loss. What is best is that all information is displayed on the screen. This is considered as using innovation at the process change level. Thuan Than (2018) also

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supported that Thailand's water situation requires new tools and technologies in water management in order to properly and timely solve water problems that may arise in the future. Transparency in accessing information between each other in a timely manner will causecost-effectiveness in terms of time reduction in production processes and decision-making, and eventually cost reductions in the long run.

5. According to the results of a study in relation to innovation and technology, the experts had a consistent and unified opinion, giving priority to theindicators related tocooperation with local communities to recognize the importance and the need for effective water resource management, water management for all parties to benefit (Win-Win), the damage being minimal, the affected people receiving assistance thoroughly, asking for cooperation with the industrial sector to use water economically in order to have enough water to meet the needs of the dry season, building relationships with government agencies to facilitate the smooth operation of water resources management, and creating a process for relevant agencies to participate in effective water resource management in order to keep up with current situation. This is consistent with AnyanithaDistanont (2018)'s saying that water management will be successful if the organization has its stakeholders realize about its water management practices. Social networks must be built to collaborate with other organizations, the community, the public and the private sectors. This operation is known as "integrated water management," whereby all parties cooperate to make water management system efficient and sustainable. Thakorn (2018) found, in his study, that all sectors of the community play an important role in water management according to the Sufficiency Economy Philosophy. Good understanding of the process and the benefits from water management is encouraged among the community. Stakeholders are engaged in the planning process, emphasizing the value of water, effective use, and solutions for problems caused by disasters. This is also an answer to the Human Centric Smart Cities of McBride, Cingolani and Hammerschmid (2022), who said that elements of building a smart community include considering the happiness and well-being of the population, the integration of innovation across the ecosystem, inter-sectoral collaboration, preparation of government data, and administrative capacities. This is also consistent with the research by Baker, Fehrer and Brodie (2022) who said that the way to create awareness of the corporate reputation is to create products or innovations that have shared value throughout the service ecosystem, from stakeholders, consumers, and society. In addition, a research by Breiby et al. (2022) stated that sustainability management needs to focus on the surrounding areas both in the economic and social environment, starting with participating in joint planning with the goal of considering the impacts on stakeholders, organizing public hearing, and listening to perspectives from various target groups until it brings about the development of sustainable development guidelines, resulting inshared value.

Suggestions according to the findings

1. Policy-level agencies should have a risk assessment of water resources and information on problems and obstacles in water management, forecast the amount of water, adjust the organization for the appropriateness, provide a plan of the investment budget, and

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establish a special task force collecting information on the amount of water used in both the public and private sectors in the EEC area. The collected data must be accurate and can really be used. The development policy for the EEC should be clearly laid out. An investment plan, supportive access to funding sources, and efficient tools in water management to handle water problems should be provided. A major unit for water resource management policy should be established. Policies and work plans should be formulated in accordance with the EEC development plan. Knowledge on water resources are recommended to develop and include in the curriculum at all educational levels to cultivate and raise awareness of the value of water so that people use it appropriately.

2. Local authorities should develop the EEC to become a model area where economic development and modern technology can be applied to manage water resources for maximum efficiency. Related agencies should find more raw water sources in full capacity. Guidelines for formulating policies and measures related to flood risk should be proposed. A database system should always be up to date. The amount of water should be calculated in order to avoid problems of water contention among industrial plants, the private sector, and farmers. The integration of efficient water management should be accelerated from the creation of water resources to water retention and filling. Implementing a water grid system will help link the cost water from the irrigation reservoirs. Climate should be monitored, analyzed and reported to relevant authorities. Climate change must be alerted. All of these will lead to creation of a system for making full use of water, ensuring all sectors of adequate water.

3. Innovations and new technologies should be introduced to industrial business sector in the area to reduce water consumption in the production process, and the amount of wastewater. Significance and need of water resource management should be emphasized in the whole organizations. Short, medium, and long-term plans should be made to cope with the risk of water shortage. Water value should be learned, and added value be created. Personnel development in terms of up-skill and re-skill should be made to increase work efficiency while morale being built at the same time. Knowledge on solving problems of water resource risk management should be applied by building a factory or a model community as an example to transfer the knowledge of integrated water management. Social networks should be built to work with other organizations in the form of cooperation. All parties should behave as an information and knowledge source of water management for the efficiency and sustainability of the management system. Awareness should be encouraged in all sectors to recognize the importance of preserving the quality of water sources, and advocating for agencies and organizations to treat and eliminate toxins before releasing waste water into water sources.

Suggestions for further study

1. A research to confirm the model elements of industrial water management guidelines for sustainable success in the EEC area should be conducted.

2. A research on the structural equation model of water management guidelines for industrial businesses for sustainable success in the EEC area is suggested to undertake.

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3. New knowledge of water management guidelines for industrial businesses to achieve sustainable success in the EEC area should be investigated through quantitative research.

Reference

Alaize Dall-Orsoletta, Fernando Romero and Paula Ferreira. (2022). "Open and collaborative innovation for the energy transition" Journal of an exploratory study Technology in Society. 69 (2022): 101955 www.elsevier.com/locate/techsoc

Boretti, A., Rosa, L. Reassessing the projections of the World Water Development Report. npj Clean Water 2, 15 (2019). https://doi.org/10.1038/s41545-019-0039-9

Chitradon. (2562).[Online]. Risk Management of Water Resources in Thailand in the Face of Climate Change. [cited 15 June 2021]. Available from: http://tiwrm.hii.or.th/ web/index.php/knowledge/128-hydro-and-weather/295-riskmanagementclimate.html

Dean Elmuti and YunusKathawala. (2001).[Online].An overview of Strategic alliance. [cited 15 June 2021]. Available from: https://www.researchgate.net/publication/ 241223230

E. Gissi. (2022). "Data about marine area-based management tools to assess their contribution to the UN sustainable development goals" Journal of Data in Brief. 40 (2022): 107704

Enyinnah, N. U., Adefulu, A. D., Nwankwere, I. A.andOnyia, V. (2020). [Online]. Strategic Alliance and Innovativeness. [cited 17 June 2021]. Available from: https://www.researchgate.net/ publication/356192075

Helen Fillmore and Loretta Singletary. (2021).[Online]. Climate data and informationof needs indigenous communities on reservation lands: insights from stakeholders in the Southwestern United States Climatic Change. [cited 20 June 2021]. Available from: https://link.springer.com/article/10.1007/s10584-021-03285-9

Julian Kirchherr, Denise Reike, Marko and Hekkert. (2017). "Conceptualizing the circular Economy"Journal of Resources, Conservation & Recycling. 127 (2017): 221–232

Jonathan J. Baker. (2022). "Navigating the emergence of brand meaning in serviceEcosystems" Journal of Service Management. 10 (2022): 1108/JOSM-07-2021-0261

Keegan McBride. (2022). [Online]. Human Centric Smart Cities. [cited 15 June 2021]. Available from: https://www.researchgate.net/publication/358530415

Monica Adele Breiby. (2022). "Managing sustainable development in recreational and protected areas" Journal of Outdoor Recreation and Tourism. 37 (2022): 100461

Omar Al-Tabbaa. (2019). [Online]. Examining Alliance Management Capabilities in Cross-sector Collaborative. [cited 25 June 2021]. Available from:https://www.researchgate.net/publication/332380370

Qinglan Liu, Adriana Hofmann Trevisan, Miying Yang and JanainaMascarenhas. (2022).[Online]. A framework of digital technologies for the circular economy. [cited 12 July 2021]. Available from: https://doi.org/10.1002/bse.3015

Wattanakomol, S. and Silpcharu, T. (2022). Second-order confirmatory factor analysis of auto parts manufacturing industry management guidelines for sustainable success. Uncertain Supply Chain Management. Vol. 10 No 3. 905-912

Wantanakomol, S. and Silpcharu, T."Strategy for Preventing Corruptions in Industrial Business Organizations with Delphi Technique".Academy of Strategic Management Journal. Vol.20 No.3 (June 2020).