Scholar Publishing Group
Frontiers in Ocean Engineering
https://doi.org/10.38007/FOE.2021.020404
ISSN 2790-2706 Vol. 2, Issue 4: 25-34

Marine Engineering Development Project based on Risk Management

Mayank Bisen*

Adamson University, Philippines

**corresponding author*

Keywords: Risk Management, Offshore Engineering, Project Development, Management Research

Abstract: With China's attention to energy development, the offshore oil(OO) industry has also embarked on the road of rapid development, and the number of OO development projects is also increasing rapidly. This paper studies the development of offshore engineering(OE) projects based on risk management(RM). Taking the development of OO and gas field projects as the main research direction, this paper discusses the OO and gas field engineering projects and the division of engineering stages, analyzes the RM of OO and gas field projects, and takes a city as an example to carry out an empirical analysis through the oil risk assessment model and the comprehensive assessment of marine environmental risk, which verifies the feasibility and operability of the proposed marine environmental risk assessment management, It is of great significance to provide scientific basis for the marine authorities to make decisions on disaster prevention and mitigation, and to promote the healthy, coordinated and sustainable development of the marine economy.

1. Introduction

With the increasing frequency of marine development and utilization and the rapid improvement of coastal economic construction, marine ecological environment protection has attracted more and more attention. According to the monitoring and evaluation results for many years, the environmental pollution situation of the sea areas under our jurisdiction is still not optimistic. The environmental pollution situation of the coastal sea areas has not been significantly improved, which poses a serious threat to the marine environment, marine economy and public health and safety. This paper studies the risk, vulnerability and risk assessment and management of marine environmental risks, and strives to distinguish the distribution of "priority" of marine environmental risks in the assessment area by constructing the main types of marine environmental RM system and applying the scientific assessment model, which is conducive to the development of marine engineering projects.

Research on the development of OE projects based on RM, a large number of OO engineering practices at home and abroad show that effective project RM plays an indispensable role in the construction of engineering projects. Through effective project RM, the purpose of improving the construction quality, reducing the risk of major safety accidents, shortening the project duration and saving the project cost can be achieved [1]. Among them, project RM is one of the important objectives of project control. It not only directly affects the implementation cost of the project, but also relates to the success of the whole project. At home and abroad, risk assessment is divided into two dimensions: qualitative analysis and qualitative and quantitative analysis [2]. Risk assessment - qualitative analysis method. Western scholars regard the qualitative and quantitative analysis of risk as an integral part of risk assessment and resource allocation decision-making. According to different project uncertainty risk characteristics and the degree of information acquired during project preparation, appropriate methods should be selected [3].

At present, the research on RM related to the development of marine engineering projects only stays in the single type of risk assessment, and there is still a gap in the comprehensive assessment of marine environmental risk. On the basis of consulting a large number of domestic and foreign literatures and summarizing previous studies on risk assessment, this paper clarifies the research content and methods. According to the main types and characteristics of marine environmental risk, the basic concept and theoretical basis of marine environmental risk are summarized [4]. RM of OO and gas field development projects is to prevent and control the occurrence of risk accidents of OO and gas field development projects through RM plan, risk identification, risk assessment, risk control and other activities; In this paper, the project RM is combined with the RM of oil and gas field development projects, and the RM model of oil and gas field development projects is constructed [5].

2. Research on OE Project Development based on RM

2.1. Introduction to OO and Gas Field Project

Oil and gas processing system: exploitation and collection of oil and gas: oil and water extracted from the ground enters the manifold through the Christmas tree. In the oil field, there are two kinds of production manifold and test manifold. The test manifold is mainly used to measure the output of single well. The production manifold is the main manifold for oil-water treatment. After passing through the production manifold, oil-water is transported to the production process system, i.e. oil gas water treatment system [6-7].

Oil, gas and water treatment system: the separated crude oil generally needs secondary separation through an electric dehydrator, also known as a secondary separator. Most OO fields adopt the stage separation process, and the maximum number of stages is no more than three.

Water treatment system: the water separated from the process system is called production water, and the discharge of production water to the sea needs to meet certain discharge standards.

Public system: the public system mainly includes generators, water generators, air compressors, air conditioners, satellite communication equipment, cranes, seawater pumps and other equipment. It is mainly used to ensure the normal operation of production and life of OO and gas fields.

Safety system: the whole oil and gas field is in a potentially dangerous environment [8]. The platform is configured with different security systems according to different actual conditions. The safety system mainly includes combustible gas detection system, fire detection system, hydrogen sulfide detection system, etc. its main purpose is to detect various potential hazard sources containing explosion, fire and toxic gas, and reduce or avoid risk accidents such as casualties, environmental pollution and property loss that may occur in production engineering [9].

2.2. Engineering Stage Division of OO and Gas Field Development Project

Exploration and evaluation stage. This stage is the basis of oil and gas field development engineering and also the basis of oil and gas field development. At this stage, we mainly focus on finding out how much oil and gas reserves are underground and the reliability of oil and gas resources. At the same time, determine the appropriate recovery rate, and strive for the maximum reserve production degree on the premise of ensuring the maximum economic gas production of the oilfield project. So that the oil and gas field development project has good economic benefits [10-11].

Oil and gas reserves are fundamental to the survival of an oil company. The risk of reserves is mainly manifested in geological risk. The geological risk of reserves is caused by the uncertainty of underground reservoirs, which is directly related to geophysical prospecting technology, reservoir description accuracy and the number of wells drilled. This risk can be controlled by geologists and reservoir engineers [12].

Preliminary research stage. The main contents of this stage include the feasibility study of the project and the preparation of the ODP. The feasibility study of the project is one of the important contents of the preliminary study of the project, which is used for investment decision analysis.

Project construction stage. This stage is the focus of the oil and gas field project, which is related to the success or failure of the oil and gas field project. Therefore, at this stage, a lot of human, financial, material and other resources need to be invested [13]. At the same time, in this stage, we need to make full use of the project management knowledge to scientifically and effectively manage the major elements of the project. The final task of the project construction phase is to successfully deliver operational production and living facilities before the project deadline [14].

Development and production stage. Drilling and completion stage. Oil and gas resources are deeply buried in the ground. To extract underground oil and gas to the ground, we have to dig a channel, which is what we call a borehole. The so-called drilling is a series of processes to break through the stratum. The ultimate task of drilling is to discover and exploit oil and gas reservoirs. Well completion is also a very critical link. The main work of well completion includes: drilling through the oil layer, installing the oil layer casing, installing the electric production pump, Christmas tree and other equipment and devices. The quality of well completion process will directly affect the service life and development effect of a single well [15-16].

Production stage. The production stage is the process of obtaining stable oil and gas flow from the oil and gas reservoir. This stage is the longest stage of oil and gas field development projects, and also the stage of oilfield fund recovery. The management of this stage directly affects the economic benefits of the oilfield.

2.3. Research on RM of OO and Gas Field Engineering

The RM of OO and gas field development project is to take the engineering projects at various stages of OO and gas field development as the object, and adopt the methods and measures such as RM plan, risk identification, risk assessment, risk response plan and risk monitoring plan for the investment economic risk, progress risk, construction safety risk and quality risk existing in the oil and gas field development project, To prevent the occurrence of risk accidents or reduce the losses caused by risks, so as to reduce the risks of oil and gas field development and improve the investment benefits of gas field development.

2.3.1. Project Risk Assessment

Project risk assessment is a process of analyzing the risks in the project, obtaining the severity and occurrence probability of the losses of the risks to the project objectives, and grading and ranking them. Project risk assessment needs to comprehensively evaluate the influencing factors of the whole project, namely conditions, environment and mechanism. Project risk evaluation is based on risk planning and identification. By establishing project risk evaluation model and analyzing, the probability of occurrence of various risks and the loss caused can be obtained, and the key risks and overall risks of the project can be obtained, so as to provide a basis for the follow-up implementation of driving measures and risk reduction. In the process of risk assessment, decision-makers should consider whether different decision-making differences and their consequences can be accepted by decision-makers, which is also the decision-making process and result of decision-makers weighing the advantages and disadvantages among different decision-making schemes [18].

2.3.2. Contents of RM of Offshore Projects

RM plan: the RM plan is the first step of RM activities, and the guiding role of the plan runs through the whole process of RM activities. The level and operability of RM should be commensurate not only with the risk, but also with the impact of the risk on the organization. Because of this, it is very important to plan the RM process.

Risk identification: risk identification is the second step of RM, that is, to identify the possible risks in the whole project. In this process, we need to make full use of the collective wisdom and strength to form the risk identification table of the project. The technologies and tools for identifying risks include brainstorming, process and Delphi.

Risk assessment: after identifying the risks of the project, the risk assessment can be carried out. The purpose of risk assessment is to comprehensively assess and quantify the identified risk factors.

Risk response plan: after the above steps are completed, the risks existing in the project, the probability of their occurrence and the priority of these risks can be determined. After that, a risk response plan can be formulated. The risk response plan includes the following contents: risk description, risk probability, risk severity analysis, etc.

Risk monitoring: after the risk control measures are implemented, the risk will not disappear, but will change with the progress of the project. Therefore, it is necessary to dynamically track and analyze the identified risks and change the risk response plan accordingly. In fact, project RM is the process of risk analysis and management. Figure 1 gives an intuitive description of the process of project RM.

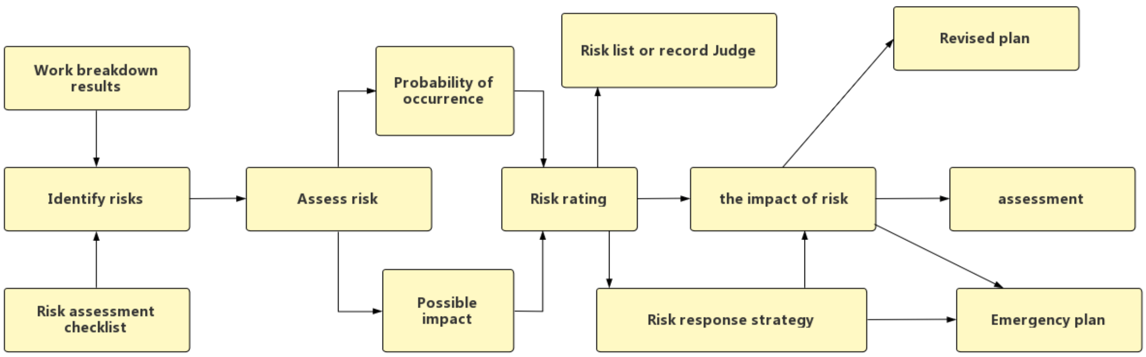

Figure 1. RM flow chart

3. RM Analysis of OE

3.1. Marine Environment Risk Assessment Index System

According to various elements of marine environmental impact, combined with the characteristics of marine environmental risk and the analysis of historical risk accidents, marine environmental risk mainly consists of red tide risk, oil spill risk and hazardous chemicals leakage risk. Since the three factors do not affect each other, but a variety of risks may occur in the same sea area at the same time, so when conducting marine environmental risk assessment, it is necessary to follow the thinking and method of analytic hierarchy process and gradually refine it. According to the theory that risk is composed of risk and vulnerability, this paper discusses the oil spill risk, and then constructs the marine environmental risk assessment index system.

3.2. Oil Spill Risk Assessment Model

(1) Oil spill risk assessment model

$$K_o = \sum_{i=1}^{x} ei \times Ki \tag{1}$$

In the formula, Ko is the oil spill risk, EI is the weight value of the ith index in the oil spill risk assessment, and its value is determined by the combination of analytic hierarchy process and Delphi method, and Ki is the scale value of the ith index in the oil spill risk assessment.

Vulnerability evaluation model

$$L_o = \sum_{i=1}^{x} sj \times Lj \tag{2}$$

Where, Lo refers to vulnerability, SJ refers to the weight value of the jth indicator in vulnerability assessment, and its value is determined by combining AHP and Delphi method, and LJ refers to the scale value of the jth indicator in vulnerability assessment.

Oil spill risk assessment model

$$W_o = K_o \times L_o \tag{3}$$

Where, wo is the oil spill risk index, Ko is the oil spill risk, and lo is the vulnerability.

3.3. Weight and Classification of Oil Spill Risk Indicators

According to the oil spill risk index evaluation system, the weight of each index is determined by combining analytic hierarchy process and Delphi method. On the basis of a large number of statistical data and previous experience, according to certain standards or referring to relevant classification standards of other industries, each single indicator is assigned a value of "1-3", which is used to indicate the level of oil spill risk of the evaluation unit. See Table 1 for specific weight and classification.

Table 1. Weight and classification of oil spill risk assessment index

Classification index	Level I indicator	Secondary indicators		Risk classification and value		
		Index	weight	Low risk, 1	Medium risk, 2	High risk, 3
Oil spill risk	Oil spill risk	Oil spill (T)	0.34	1~10	10~100	100⩽
		Oil spill frequency	0.35	⩽0.3	0.3~0.7	>0.7
		Ship tonnage(ton)	0.14	⩽1000	1000~50000	50000⩽
		Oil storage (10000 tons)	0.17	⩽50	50~200	⩾200
	vulnerability	Distance from risk source (m)	0.50	30~60	15~30	⩽15

According to the oil spill risk evaluation index system and evaluation model, the final oil spill risk evaluation value is calculated, and the corresponding evaluation conclusion is given according to the evaluation criteria.

3.4. Comprehensive Assessment of Marine Environmental Risk

Marine environmental risk assessment mainly includes two parts: one is risk assessment and the other is vulnerability assessment. The former is to evaluate the risk of the marine environment of a certain sea area, which is expressed by the degree of risk. The higher the result, the greater the intensity of the marine environment risk. The latter refers to the evaluation of the sensitivity of a certain sea area to marine environmental risks, expressed in terms of vulnerability. The higher the result, the more vulnerable the area is to risks.

(1) Marine environment risk assessment model

$$K = \sum_{i=1}^{x} ei \times Ki \tag{4}$$

Where k is the marine environment risk degree, EI is the weight value of the ith index in the marine environment risk assessment, and its value is determined by AHP and Delphi method, and Ki is the scale value of the ith index in the marine environment risk assessment.

Vulnerability evaluation model

$$L = \sum_{i=1}^{x} sj \times Lj \tag{5}$$

Where l is the vulnerability of the marine environment, Si is the weight value of the jth indicator in the vulnerability assessment, and its value is determined by AHP and Delphi method. Ki is the scale value of the jth indicator in the vulnerability assessment.

(3) Marine environment risk assessment model

$$W = K \times L \tag{6}$$

Where W is the risk degree of marine environment, K is the risk degree of marine environment, and l is the vulnerability.

However, in the process of comprehensive assessment of marine environmental risk, comprehensive assessment is often carried out for a region. At this time, the area needs to be divided into several evaluation units according to certain principles. Each assessment unit calculates the three risk assessment models of red tide, oil spill and hazardous chemicals to obtain the assessment results and determine the risk level. At the same time, each assessment unit may generate one or more marine environment risks.

4. Experimental Test Analysis

4.1. Evaluation and Analysis of Oil Spill RM in OE Oil and Gas Field Project Development

Taking city a as an example, according to the statistical results of 11 questionnaires on port oil terminals and coastal enterprises in city a and 14 tables on marine oil spill accidents of ships in city a, on the basis of oil spill risk evaluation index system and weight, the sea area of city a is divided into 270 evaluation units according to latitude and longitude grid, and the data is substituted into the model for calculation, and the results of each evaluation unit are obtained.

Evaluation results of oil spill risk index: according to the oil spill risk evaluation model, the risk index evaluation results of 117 evaluation units are at the low risk level, of which 35 evaluation units have an evaluation value of 0, indicating that oil spill has never occurred in these evaluation units, and the range of other evaluation values is 0.3019-0.9997; The risk index evaluation results of 149 evaluation units are in the middle risk level, and the evaluation value range is 1.0122 ~ 2.6504; The risk index evaluation results of 4 evaluation units are at high risk level, and the evaluation value range is 5.0747-6.3740. See Table 2 and Figure 2 for specific evaluation results.

Table 2. Oil spill risk assessment results of city a

	Quantity (PCs.)	Proportion (%)	Evaluation value range	Risk evaluation value
Low risk	117	43.33	0.3019~0.9997	1.006
Medium risk	149	55.19	1.0122~2.6504	
high-risk	4	1.48	5.0747~6.3740	

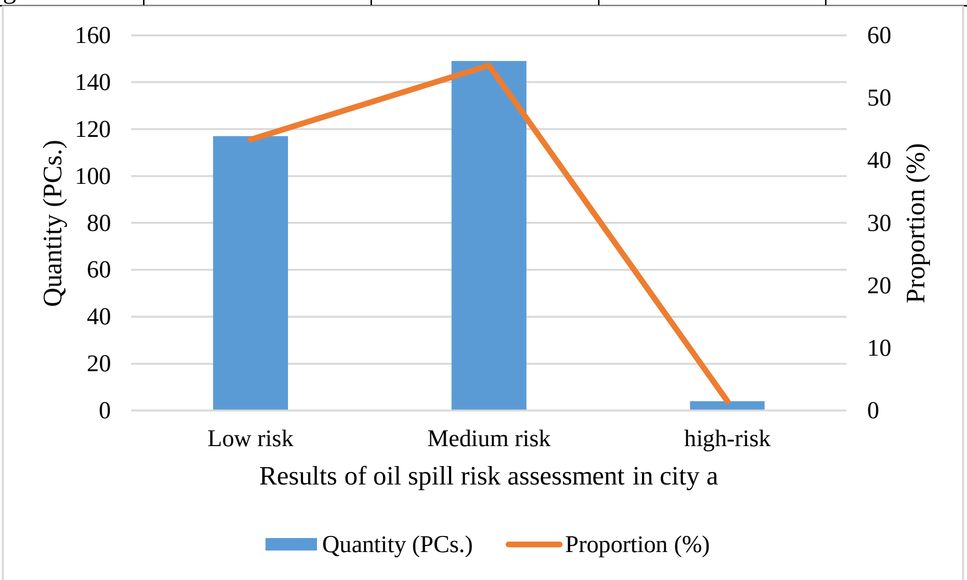

Figure 2. Results of oil spill risk assessment in city

According to the evaluation results, the risk of oil spill in city a is at the medium risk level, and the risk of oil spill at the oil storage terminal is the main risk source. The evaluation units with the oil spill risk index at the low risk level account for 43.33% of the total evaluation units, 55.19% at the medium risk level, and 1.48% at the high risk level. The oil spill risk evaluation value of city a is 1.1006, which is at the medium risk level. The main risk is concentrated in the ship oil spill accident.

4.2. Prevention and Control Measures of Oil Spillage in OO Field Project Development

Table 3 shows the risk assessment of various oil spill accidents.

Table 3. Risk assessment of various oil spill accidents

Accident type	Risk level	Accident probability	Risk value
blowout	5	2.5×10^{-4}	1.25×10^{-3}
Platform tank leakage	4	2.6×10^{-5}	1.04×10^{-4}
Fire and explosion	5	4×10^{-4}	2×10^{-3}
Submarine pipe rupture	5	6.79×10^{-4}	3.395×10^{-3}

The most effective way to prevent oil spills is to take effective measures from the aspects of engineering design, construction, installation and production management to eliminate potential accidents, stop the symptoms of accidents in time and prevent accidents. The measures to be taken include: design and selection of equipment in strict accordance with safety and environmental protection specifications and standards; Protective casing is set outside the riser of wellhead platform; Set safety valves in and above the oil and gas wells; An emergency shut-off valve is set on the riser below the deck; Provide safe and effective blowout prevention equipment, good kill materials and well control equipment; Make a detailed drilling plan before spud in; Strengthen the observation during drilling, find out the precursors in time, carry out effective control according to the correct shut in procedure, and organize the well killing operation in time; Consider environmental hazards in design and operation; In the design stage, the water injection volume, reinjection pressure, formation pressure, geological conditions, detection means, etc. shall be considered, the reinjection risk shall be analyzed, and corresponding emergency measures shall be put forward.

5. Conclusion

In this paper, the development of OE oil and gas field projects based on RM is studied, and the evaluation index system of marine RM is preliminarily established. Due to my limited ability and insufficient relevant data, this paper also has shortcomings: in terms of risk identification and risk assessment methods, I failed to adopt a variety of methods for comparative research. In terms of empirical research, I should collect data after the completion of the project to further verify the scientificity of the research conclusions. With the rapid development of OO industry, OO engineering development projects in the future will generate more complex and changeable risks. I believe that more diversified RM methods will be adopted in future research. In the study of risk identification and assessment, the use of mathematical simulation technology to analyze the project risk will also be the main content and development direction of the future OO and gas field project RM research.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] Moan T . Integrity Management of Offshore Structures With Emphasis on Design for Structural Damage Tolerance. Journal of offshore mechanics and arctic engineering, 2020, 142(3):031104.1-031104.15. https://doi.org/10.1115/1.4045373

[2] Glavind S T , Faber M H . A Framework for Offshore Load Environment Modeling. Journal of Offshore Mechanics and Arctic Engineering, 2019, 142(2):1-10. https://doi.org/10.1115/1.4045190

[3] Tukiman N , Ismail S , Sarip S . Present Knowledge and Future Direction for Risk Management in Offshore Oil and Gas Project. Test Engineering and Management, 2019, 59(6s):915-927.

[4] Mokhtari K , Amanee J . Risk analysis of offshore terminals in the Caspian Sea. Ocean Systems Engineering, 2019, 9(3):261-285.

[5] Tavares B G , Eduardo S D S C , De Souza A D . Practices to Improve Risk Management in Agile Projects. International Journal of Software Engineering and Knowledge Engineering, 2019, 29(03):381-399. https://doi.org/10.1142/S0218194019500165

[6] Pandey R , Shrivastava S , Rathore S , et al. Risk Management Framework for Educational Institutions in Tackling Veiled Relationship Violence among Students. The International Journal of Indian Psychology, 2021, 9(1):1915-1921.

[7] Astfalck L C , Cripps E J , Hodkiewicz M R , et al. A Bayesian approach to the quantification of extremal responses in simulated dynamic structures. Ocean Engineering, 2019, 182(JUN.15):594-607. https://doi.org/10.1016/j.oceaneng.2019.04.035

[8] M Urbański, Haque A U , Oino I . The moderating role of risk management in project planning and project success: Evidence from construction businesses of Pakistan and the UK. Engineering Management in Production and Services, 2019, 11(1):23-35. https://doi.org/10.2478/emj-2019-0002

[9] Sokolov M . Decision Making and Risk Management in Biopharmaceutical Engineering Opportunities in the Age of Covid-19 and Digitalization. Industrial And Engineering Chemistry Research, 2020, 59(40):17587-17592. https://doi.org/10.1021/acs.iecr.0c02994

[10] Smith L . Maintenance. Oceanographic Literature Review, 2019, 66(5):1168-1169.

[11] PopaDan Mihaidanmihai.popa@student.upt.roPolitehnica University of Timisoara. Engineering Risk of Series Production in Automotive Industry. Management Systems in Production Engineering, 2019, 27(1):5-11. https://doi.org/10.1515/mspe-2019-0001

[12] Sadeque M , Patel A . Global Journal Of Advanced Engineering Technologies And Sciences Risk Management And Sterilization Process In Medical Device Industry. International Journal of Advanced Scientific Technologies in Engineering and Management Sciences, 2021, 8(5):7-18.

[13] Pooworakulchai C . Applied Risk Management In Construction Industry: A Review. International Journal of Engineering Technologies and Management Research, 2020, 5(3):234-240. https://doi.org/10.29121/ijetmr.v5.i3.2018.196

[14] T. Kosova, Smerichevskyi S , A. Ivashchenko, et al. Theoretical Aspects Of Risk Management

Models In Economics, Marketing, Finance And Accounting. Financial and Credit Activity Problems of Theory and Practice, 2021, 3(38):409-418. https://doi.org/10.18371/fcaptp.v3i38.237474

[15] *Coates S , Tubel J , Lorch U . Practical risk management in early phase clinical trials. European Journal of Clinical Pharmacology, 2019, 75(4):483-496. https://doi.org/10.1007/s00228-018-02607-8*

[16] *Galli B J . Application of Systems Engineering to Risk Management – A Relational Review. International Journal of System Dynamics Applications, 2020, 9(2):1-23. https://doi.org/10.4018/IJSDA.2020040101*

[17] *Enol Z , Ko S . Kur Rsk Ve Kur Rsk Ynetmnn Frma Performansina Etks The Effect of Foreign Exchange Risk and Foreign Exchange Risk Management on Firm Performance. Ekonomi Politika & Finans Araştırmaları Dergisi, 2021, 6(2):534-564. https://doi.org/10.30784/epfad.896275*

[18] *Shepherd R F , Keogh L A , Werner-Lin A , et al. Benefits and burdens of risk management for young people with inherited cancer: A focus on Li-Fraumeni syndrome. Australian Journal of General Practice, 2021, 50(8):538-544. https://doi.org/10.31128/AJGP-04-21-5954*