Factors Affecting Maintenance in Hazardous Work Environments

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Abstract

The paper gives insights about carrying out maintenance activities in hazardous work environments by first identifying factors that affect the maintenance activities and then uses the Total Interpretive Structural Modelling (TISM) method to analyse the interrelationship between identified major factors that affect the mechanical maintenance activities in hazardous environment in process industries. The MICMAC analysis used to rank these factors. The identified key factors are effectiveness and robustness of safety department, tools and technology being used for the maintenance activities. This paper states that safety department plays an integral role in providing a safe environment for the working maintenance teams.

Keywords
Hazardous work environment; TISM; Human factor; safety department

1. Introduction
Maintenance as the word itself suggests relates to the activity of keeping the equipment and machinery at the workplace in their original state such that their condition does not depreciate over continuous usage and passage of time. Maintenance is one of the most underrated and neglected areas of a process-oriented organization owing to it being a cost center rather than a profit producing one. The umbrella of maintenance involves all activities from lubrication to overhauling of large machines. Carrying out maintenance is not always easy as the machines are required for carrying out the production process at the factories and stopping a machine for carrying out maintenance directly relates to downtime of the machine and hence subsequent loss in production.

Maintenance becomes even more difficult when the activity has to be carried out in hazardous environment which includes exposure of the working personnel to high temperature, toxic gases, poisonous vapors, excessive dust, etc. Many a times, it is observed that because an equipment is operating in hazardous environment, the damage to the equipment is much higher than anticipated. Also, the working personnel are scared to work in such environments and have adverse and irreversible health effects from prolonged working in such conditions. This paper identifies eight factors that affects carrying out the maintenance activities in the hazardous environment and then analyze interrelationship between these variables to help the managers understand which factor they should concentrate on to carryout maintenance activities more efficiently in such environments.

The main objectives of this paper are as follows:
• To identify and establish interdependence of the factors that affects the maintenance activities in hazardous work environment.
• To rank the factors based on driving power and dependence of each factor.

2. Literature Review
Utilizing failure and accident knowledge to attain the highest level of safety at the lowest possible cost is the major goal of the maintenance process. The goal of risk-based maintenance is to achieve tolerable risk standards by inspecting high-risk elements more frequently and thoroughly as well as maintaining them more frequently (Arunraj and Maiti 2007). By more precisely estimating event occurrence, maintenance and evaluation play a crucial role in risk reduction. If appropriate safety mechanisms are in place with little maintenance and inspection, the repercussions and danger to employees, the environment, and the equipment can be made tolerable or negligible where there is a probability of a high-risk catastrophic failure. A number of examples in which the authors have been involved and where failures would have been avoided if effective risk assessment protocols had been in place, or in which risk assessments were made to avert failure, are reviewed by Brown and Le May (2000). Over the past few decades, the focus of maintenance methods has shifted beyond minimizing downtime to more advanced techniques like "condition monitoring" and "reliability-centered preventive maintenance

(RCPM)". The process sector requires a thorough maintenance program since it frequently works with dangerous compounds under challenging operating circumstances. Thus, crucial preventive maintenance (PM) choices for integrated loss avoidance are now required of plant managers and engineers. " Preventive maintenance (PM") can decrease the chance of losses resulting from accident circumstances and unexpected process unit failure (Ghosh and Roy 2009).

Process industries, for example, are typically characterized by a high level of organizational and technological complexity, and as a result, they are fortified with layers of security. To increase the robustness and resilience of the process industries organization, Okoh and Haugen (2015) looked into the robustness and resilience properties that present in maintenance and how they may be improved in relation to maintenance contact with other areas like production and support. In order to prioritize the most important tasks and rate the maintenance organizations under consideration, Shanmugam and Robert (2015) offers criteria and a scientific technique for evaluating maintenance organizations by employing the "Analytical Hierarchy Process methodology". Maintenance does not differ from the general rule that management systems should be built to meet the nature of the job to be managed. " Maintenance management" has always evolved somewhat later than what is currently needed over time (Sherwin 2000). Using the failure rate reduction method, Yeh et al. (2009) suggests a maintenance plan for leased equipment and generates an ideal "preventive maintenance (PM) strategy" that reduces predicted total cost. Under the proposed maintenance plan, the lessor corrects flaws with few repairs during the lease period and may be penalized if the length of the repairs exceeds the time frame allowed by the lease agreement.

From literature review and experts' opinion the identified factors affecting maintenance in hazardous work environment is presented in Table 1.

Table 1. Identified factors affecting maintenance in hazardous work environment.

F. No.	Factors	Description of the factors	Reference /Expert Opinion
1	Human factor (F1)	The factor deals with the skill level of the workforce, and whether they are equipped with the correct knowledge about the process (production and maintenance) and which tool is to be used when and how. How often is the workforce educated and trained on the various aspects of maintenance for the environment in which they are working. This factor would also include the involvement of the employee in the process, and the psychological and physical state of mind the employee is performing certain activities. There have been incidences wherein employees under mental stress or under the influence of alcohol have committed blunders while working on a machinery.	Galar et al. (2011); Papic and Kovacevic (2016); Shanmugam and Robert (2015).
2	Effectiveness and robustness of safety department (F2)	Safety department is majorly related to providing a safe working environment for all the employees inside as well as outside the factory premises. Proper and regular usage of Personal Protective Equipment (PPE) is an essential factor, these are equipment that are meant for the safety of working personnel against any unforeseen accidents that may happen on the field. Some of the PPEs include, helmets, safety shoes, protective eye-wear, gloves, etc.	Okoh and Haugen (2015); Expert Opinion
3	Cost factor (F3)	The cost involves for preventive maintenance and safety cost for maintenance in hazardous work environment. There are various costs involved in a failure, the major one is the loss is the lost production, then there are other costs such as replacement costs of machinery, risk allowance paid to the workforce etc.	Jasiulewicz-Kaczmarek and Drozyner (2011); Tsang (2002); Ghosh and Roy (2009).
4	Time required for maintenance (F4)	Additional time required to perform maintenance activities in hazardous work environment due to safety and prevention of accidents. In process industries, one-to-one spare parts maintained for the critical equipment's, but also it takes significant time to replace the spare in hazardous work environment.	Wee and Widyadana (2012, 2013).

5	Failure rate/ history of failures (F5)	In hazardous environment, the equipment failure rates, and replacement of spare parts are high comparably with normal environment. This is usually determined from the past recorded data. It shows that how many times an equipment has undergone failure in a fixed period of time, (maybe 6 months or 1 year). It is important to note that, too frequent failures, directly relate to a wrong method of maintenance or usage of a wrong tool or wrong maintenance of certification. Another important point to be looked at here is the type of maintenance practices being followed in the process industry viz preventive or corrective. Generally, it is observed that, if an equipment is maintained under preventive maintenance, the rate of failure or sudden breakdown is reduced significantly.	Sherwin (2000); Yeh et al. (2009); Zheng and Fard (1991); Lie and Chun (1986)
6	Tools and technology being used for the maintenance activities (F6)	In hazardous work environment, usage of the right tool, and the training of the maintenance workforce is very important, otherwise it could lead to catastrophic results. The technology being used, is an important factor with respect to the time required for the maintenance activities in hazardous environment.	Arunraj and Maiti (2007); Expert Opinion
7	Lubrication schedules and type of oils being used (F7)	The lubrication schedules play a very major role in optimum running of equipment. If the lubrication schedule is not followed judiciously, it will lead to breakdowns. Also, the appropriate type of oils and grease should be used in hazardous operations.	Safronchuk (2019); Gresham (2008)
8	General environment in which the system is operating (F8)	If the general environment where the machine is running is corrosive in nature, it has to be ensured that proper maintenance in operational condition to be used for the construction of the of the machine and its parts and also the workforce has to be taken care of, otherwise they may suffer from illness	Brown and Le May (2000). Expert Opinion

3. Research Methodology

3.1 Data Collection

The study conducted semi-structure interview with a standard questionnaire. The Purposive sampling technique was used in this study. 26 responses were gathered from "general managers," "construction engineers," "maintenance managers," "maintenance service managers," "maintenance supervisors," and "plant engineers" employed in process-based companies from various parts of India.

3.2. TISM

The TISM methodology is used to comprehend how many elements affecting maintenance in risky work situations interact with one another. To examine the links between many aspects in the manufacturing and service industry, many researchers have adopted the TISM technique such as studies of "Patri and Suresh 2017;" "Patil and Suresh 2019;" "Menon and Suresh 2019;" "Menon and Suresh 2020a;" "Suresh and Arun Ram Nathan 2020;" "Lakshmi Priyadarsini and Suresh 2020".

The following steps are adopted from the article "Vaishnavi et al. 2019a;" "Vaishnavi et al. 2019b;" "Vaishnavi and Suresh 2020;" "Menon and Suresh 2020b;" "Lakshmi Priyadarsini et al. 2020" to successfully apply the TISM model:

The first step was to find the variables influencing maintenance tasks in dangerous work situations. This was discovered through examining the literature and consultation with subject-matter experts. Table 1 includes a list of the influencing elements. The factors are human factor (F1), effectiveness and robustness of safety department (F2), cost factor (F3), time required for maintenance (F4), failure rate/ history of failures (F5), tools and technology being used for the maintenance activities (F6), lubrication schedules and type of oils being used (F7), general environment in which the system is operating (F8).

It is necessary to build conceptual links between the components in order to arrive at the "initial reachability matrix (IRM)." In India, 26 responses were gathered from "general managers," "construction engineers," "maintenance managers," "maintenance service managers," "maintenance supervisors," and "plant engineers" employed in process-based companies. The IRM is shown in Table 2.

Table 2. IRM for factors affecting maintenance in hazardous work environment.

	F1	F2	F3	F4	F5	F6	F7	F8
F1	1	0	0	1	0	0	0	0
F2	0	1	0	0	0	0	0	1
F3	0	0	1	0	0	0	0	0
F4	0	0	1	1	0	0	0	0
F5	0	0	1	0	1	0	0	0
F6	0	0	0	1	1	1	0	0
F7	0	0	0	0	1	0	1	0
F8	0	0	0	0	1	0	0	1

"How factor-A influences Factor-B" is the third step where the relationship between the factor is interpreted (Sreenivasan and Suresh, 2021).
The FRM was created via the transitivity check and this is the fourth step of TISM (Sreenivasan and Suresh, 2022). Table 3 contains the FRM.

Table 3. FRM for factors affecting maintenance in hazardous work environment.

	F1	F2	F3	F4	F5	F6	F7	F8	Driving Power
F1	1	0	1*	1	0	0	0	0	3
F2	0	1	1**	0	1*	0	0	1	4
F3	0	0	1	0	0	0	0	0	1
F4	0	0	1	1	0	0	0	0	2
F5	0	0	1	0	1	0	0	0	2
F6	0	0	1*	1	1	1	0	0	4
F7	0	0	1*	0	1	0	1	0	3
F8	0	0	1*	0	1	0	0	1	3
Dependence	1	1	8	3	5	1	1	2	

*, ** represents transitive links
Step 5 is creating the levels from the FRM (Thomas et al., 2023).
Using professional judgements, the significance transitive linkages are determined (Thomas, and Suresh, 2022) and direct links are depicting in Table 4.

Table 4. Interaction matrix

	F1	F2	F3	F4	F5	F6	F7	F8
F1	1	0	0	1	0	0	0	0
F2	0	1	0	0	0	0	0	1
F3	0	0	1	0	0	0	0	0
F4	0	0	1	1	0	0	0	0
F5	0	0	1	0	1	0	0	0
F6	0	0	0	1	1	1	0	0
F7	0	0	1*	0	1	0	1	0
F8	0	0	0	0	1	0	0	1

* represents significant transitive links

Finally, interaction matrix and level partitions are used to produce the digraph (Suresh et al. 2021). The TISM model is shown in figure 1, and the reasons for the crucial and direct transitive links are covered in section 4.1.

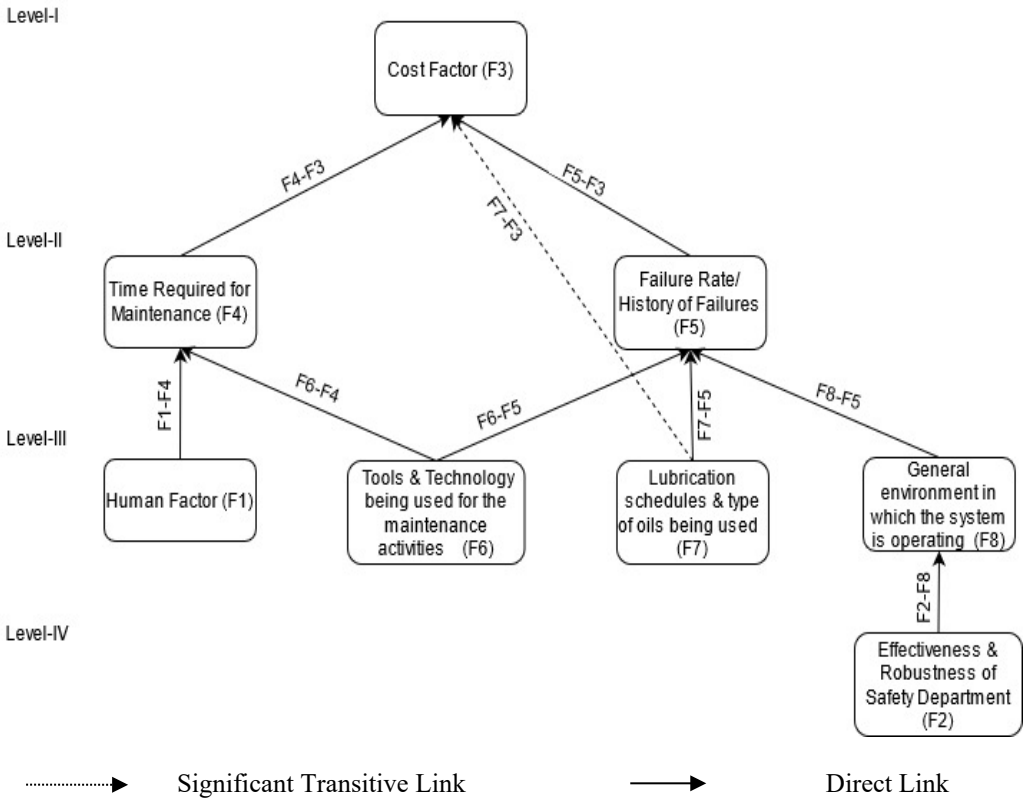

Figure 1. TISM model for factors affecting maintenance in hazardous work environment.

4. Results and Discussion

4.1 Interpretation of ISM Digraph

Figure 1 represents the graphical representation of TISM analysis of the factors having an affecting maintenance in hazardous work environment.

Level IV: Level four has one factor, which is factor 2.

Factor 2 affecting F8: The safety department of any organization works to maintain a healthy work environment for the working personnel. Through the observations made during this study, it was noted that, the higher the efficiency of the safety department, the safer the working environment in the industry. Safety department ensures the reduction, removal or replacement of job site hazards, thereby making the workplace safe to work. The safety department determines the standard of the workplace, tools, safety equipment, etc. at the site before giving clearance to the working team to commence the work.

Level III: Level three have four factors, which are factor 1, 6, 7 and 8.

Factor 1 affecting F4: The work force is the key element in any maintenance department. As per the observations from primary data, it can be devised that, a highly skilled and competent work force will be able to diagnose the problem and also suggest a tentative solution to overcome the problem. On the contrary, an incompetent work force will be dependent on superiors to diagnose the problem and provide a solution. Sometimes, the team for personal benefits may extend the work which will cause delay in work completion and significant losses.

Factor 6 affecting F5: Tools and technology being used for the maintenance activities play an important role while carrying out the maintenance activities. If the tools and technology being used, are as per the prescribed standards, then it is observed that the failure rate of equipment reduces drastically. Use of appropriate technology significantly reduces the failure rate in equipment.

Factor 6 affecting F4: In addition, all the tools which are regularly observed, calibrated and maintained in their original condition, are easier to use, and hence take lesser time to carry out the maintenance activity. Correct technology-based tools, help the maintenance team to work with higher efficiency and hence solve the problem in lesser time.

Factor 7 affecting F3: Lubrication is one of the most important but neglected part in the maintenance of equipment. Any equipment which is lubricated as per the instructions in the manual is unlikely to undergo a major breakdown. However, poor and inadequate lubricant is said to be a major cause for the equipment wear and tear leads failure. The costs of lubrication as compared to the cost of these breakdowns is negligible. Hence, to reduce the cost of maintenance, proper, adequate and timely lubrication of all the equipment is a must.
Factor 7 affecting F5: Poor lubrication is the key to equipment failure. Poor, untimely and inadequate lubrication leads to unplanned downtime of the equipment due to which the production process comes to a standstill. In order to eliminate lubricant starvation, any maintenance engineer should work on four components which include the equipment, type of lubricant, lubrication process and frequency.

Factor 8 affecting F5: Toxic gases, poisonous and chemical vapors, excessive dust, etc. are a common site in any process and chemical-based industry. The insides of the equipment generally have a protective layer which protects them from such gases and vapors, but over continuous usage, the layer depletes and the equipment starts to erode. In addition, when these gases settle on the surface of the equipment, they start to corrode the equipment from outside as well.

Level II: Level two have two factors, which are factor 4 and 5.

Factor 4 affecting F3: In any industry, the equipment's are procured for production of final products, which earn revenue for the company. If an equipment has suffered a failure, it will not be able to carry out the production activity and hence the company suffers loss. In addition, other costs such as salaries of machine operators will have to be paid, cost of overhauling the equipment including spares and manpower costs, becomes additional burden to the company. The higher the downtime, lower is the production and higher are the costs incurred.
Factor 5 affecting F3: Every time a failure occurs, many costs are incurred, and higher the failure rate, or higher the downtime, higher will be these costs. Some of the internal costs include, the cost of spares to overhaul the machine, the cost of overtime salaries that has to be paid to the employees, the cost relating to the handling of damaged parts, the cost of salaries that have to be paid to the operators despite not operating the machine, whereas external costs include, the cost of lost or delayed orders, the cost of losing the image of the company and so on.
Level I: Level one has one factor, which is factor 3.
All other factors influence first level factor 3.

4.2 MICMAC analysis

MICMAC involves categorization of the identified factors into four classes (Suresh et al. 2019a; Suresh et al. 2019b; Suresh and Abhishek 2021), and it's shown in Table 5.

Table 5. Factor's classification using MICMAC.

Class	Factor's classification	Driving power	Dependence	Factors
Class-I	Autonomous	Weak	Weak	• Human Factor • Lubrication schedules and type of oils being used. • General environment in which the system is operating. • Time required for maintenance
Class-II	Dependent	Weak	Strong	• Failure rate/ history of failures • Cost factor
Class-III	Linkage	Strong	Strong	• None
Class-IV	Driving	Strong	Weak	• Effectiveness and robustness of safety department • Tools and technology being used for the maintenance activities

As per the MICMAC analysis, the factors affecting maintenance in hazardous work environment are ranked (Suresh et al. 2021; Suresh and Krishnan 2021; Suresh et al 2021) in Table 6.

Table 6. MICMAC rank for factors affecting maintenance in hazardous work environment.

Factor	Driving power	Dependence	Driving power / Dependence	MICMAC rank
F1	3	1	3.000	2
F2	4	1	4.000	1
F3	1	8	0.125	6
F4	2	3	0.667	4
F5	2	5	0.400	5
F6	4	1	4.000	1
F7	3	1	3.000	2
F8	3	2	1.500	3

		Class -IV			Class -III				
Driving Power ➔	8								
	7								
	6								
	5								
	4	F2, F6							
	3	F1, F7	F8						
	2			F4		F5			
	1								F3
		1	2	3	4	5	6	7	8
		Class -I			Class -II				
		Dependence ➔							

Figure 2. MICMAC graph

Figure 2 depicts the MICMAC graph. Table 6 shows the ranking of the factors affecting maintenance in hazardous work environment. According to the ranking, effectiveness and robustness of safety department, tools and technology being used for the maintenance activities are the key factors. Cost factor is the factors are ranked sixth in the MICMAC analysis ranking.

5. Managerial/ Practical Implications

The study uses TISM approach to identify the interrelationship between factors affecting maintenance activities in hazardous work environments, and then uses MICMAC analysis to rank these factors. The models used in the study are easy to understand and interpret by any practitioner. In addition, mechanical maintenance teams can use this study to understand the interrelationship between the factors and how changing one factor can have ripple effect changes on other factors. As per the study conducted, effectiveness and robustness of safety department and tools and technology being used are the key driving factors and have maximum influence on the maintenance activities in hazardous environments. Also, failure rate and cost factors are dependent and are influenced by all the other factors taken in this study.

6. Conclusion

The study examines the interrelationship between factors affecting maintenance activities in hazardous environments in process industries. The results obtained through this research will help the maintenance teams in carrying out maintenance activities in the most optimum and safe manners. In addition, it was also noticed from the results of the study, that, effectiveness and robustness of safety department plays an integral role in creating a safe work environment for the maintenance teams. Tools and Technology used by for carrying out the maintenance activities in hazardous environment play an integral role and reduces the time required and cost factors significantly. On the contrary, cost factors and failure history contribute the least towards maintenance activities in hazardous environments. This research basically focuses on maintenance of production equipment's in process industries, the future researches can be carried out specific type of maintenance activities in various chemical

process plants.

References

Arunraj, N. S., & Maiti, J., Risk-based maintenance—Techniques and applications, Journal of hazardous materials, vol.142, no.3, pp.653-661, 2007.

Brown, S. J., & Le May, I., Risk-based hazardous release protection and prevention by inspection and maintenance, J. Pressure Vessel Technol., vol.122, no.3, pp.362-367, 2000.

Galar, D., Stenström, C., Parida, A., Kumar, R., & Berges, L., Human factor in maintenance performance measurement, In 2011 IEEE International Conference on Industrial Engineering and Engineering Management, IEEE, pp. 1569-1576, 2011.

Ghosh, D., & Roy, S., Maintenance optimization using probabilistic cost-benefit analysis, Journal of Loss Prevention in the Process Industries, vol.22, no.4, pp.403-407, 2009.

Gresham, R. M., Best lubrication practices save money, Tribology & lubrication technology, vol.64,no.6, pp.29-31, 2008.

Jasiulewicz-Kaczmarek, M., & Drozyner, P., Maintenance management initiatives towards achieving sustainable development, In Information Technologies in Environmental Engineering, Springer, Berlin, Heidelberg, pp. 707-721, 2011.

Lakshmi Priyadarsini, S., Suresh, M., & Huisingh, D., What can we learn from previous pandemics to reduce the frequency of emerging infectious diseases like COVID-19?, Global transitions, vol.2, pp.202-220, 2020.

Lakshmi Priyadarsini, S., & M. Suresh., Factors influencing the epidemiological characteristics of pandemic COVID 19: A TISM approach, International Journal of Healthcare Management, vol. 3, no.2, 89-98, 2020.

Lie, C. H., & Chun, Y. H., An algorithm for preventive maintenance policy, IEEE Transactions on Reliability, vol.35, no.1, pp.71-75, 1986.

Menon, S., & Suresh, M., Enablers of workforce agility in engineering educational institutions, Journal of Applied Research in Higher Education, vol.13, no.2, pp.504-539, 2020a.

Menon, S., & Suresh, M., Factors influencing organizational agility in higher education, Benchmarking: An International Journal, vol.28, no.1, pp.307-332, 2020b.

Menon, S., & Suresh, M., Total Interpretive Structural Modelling: Evolution and Applications, In International Conference on Innovative Data Communication Technologies and Application, Springer, Cham, pp. 257-265, 2019.

Okoh, P., & Haugen, S., Improving the robustness and resilience properties of maintenance, Process Safety and Environmental Protection, vol.94, pp.212-226, 2015.

Papic, L., & Kovacevic, S., Human factor in mining machines maintenance operations, In 2016 Second International Symposium on Stochastic Models in Reliability Engineering, Life Science and Operations Management (SMRLO), IEEE, pp. 456-465, 2016.

Patil, M., & Suresh, M., Modelling the enablers of workforce agility in IoT projects: A TISM approach, Global Journal of Flexible Systems Management, vol.20, no.2, pp.157-175, 2019.

Patri, R., & Suresh, M., Modelling the enablers of agile performance in healthcare organization: A TISM approach, Global Journal of Flexible Systems Management, vol.18, no.3, pp.251-272, 2017.

Safronchuk, K. A., Knyazkina, V. I., & Ivanov, S. L., Mobile lubrication and filling units to reduce mining machines and equipment downtime when providing maintenance, In IOP Conference Series: Materials Science and Engineering, vol. 560, no.1, p. 012088, IOP Publishing, 2019.

Shanmugam, A., & Robert, T. P., Ranking of aircraft maintenance organization based on human factor performance, Computers & Industrial Engineering, vol.88, pp.410-416, 2015.

Sherwin, D., A review of overall models for maintenance management, Journal of quality in maintenance engineering, vol.6, no.3, pp.138-164, 2000.

Sreenivasan, A., & Suresh, M. (2021). Modeling the enablers of sourcing risks faced by startups in COVID-19 era. Journal of Global Operations and Strategic Sourcing. 15(2), 151-171.

Sreenivasan, A., & Suresh, M. (2022). Modelling of factors influencing organizational readiness for change in start-ups during the COVID-19 emergency. Journal of Modelling in Management, https://doi.org/10.1108/JM2-02-2022-0040

Suresh, M., & Abhishek, R. D., Modelling the Factors of Store Environment on Impulse Buying Behavior Using TISM, In Advances in Materials Research, pp. 741-751, Springer, Singapore, 2021.

Suresh, M., & Arun Ram Nathan, R.B., Readiness for lean procurement in construction projects, Construction Innovation, vol.20, no.4, pp.587-608, 2020.

Suresh, M., & Krishnan, S. V., Modelling the Factors of Environmental Sustainability in Healthcare Dispensaries, In Advances in Materials Research, pp. 753-761, Springer, Singapore, 2021.

Suresh, M., Ganesh, S., & Raman, R., Modelling the factors of agility of humanitarian operations, International Journal of Agile Systems and Management, vol.12, no.2, pp.108-123, 2019a.

Suresh, M., Mahadevan, G., &Abhishek, R., Modelling the factors influencing the service quality in supermarkets, International Journal of System Assurance Engineering and Management, vol.10, no.6, pp.1474-1486, 2019b.

Suresh, M., Roobaswathiny, A., & Lakshmi Priyadarsini, S., A study on the factors that influence the agility of COVID-19 hospitals, International Journal of Healthcare Management, vol.4, no.1, pp.290-299, 2021.

Suresh, M., Sangeetha, D., & Kumaraswamy, S., Modelling of Factors Influencing Saving Behaviour of Women in India: An Interpretive Structural Modelling, In Advances in Materials Research, pp. 809-818, Springer, Singapore, 2021.

Suresh, M., Srividya, R., & Kumaraswamy, S., Modelling the Factors of Job Stress in Audit Firms: A TISM Approach, In Advances in Materials Research, pp. 819-829, Springer, Singapore, 2021.

Thomas, A., & Suresh, M. (2022). Readiness for sustainable-resilience in healthcare organisations during Covid-19 era. International Journal of Organizational Analysis, https://doi.org/10.1108/IJOA-09-2021-2960

Thomas, A., Ma, S., Ur Rehman, A., & Usmani, Y. S. (2023, January). Green Operation Strategies in Healthcare for Enhanced Quality of Life. In Healthcare (Vol. 11, No. 1, p. 37). Multidisciplinary Digital Publishing Institute.

Tsang, A. H., Strategic dimensions of maintenance management, Journal of Quality in maintenance Engineering, Vol.8, no.1, pp.7-39, 2002.

Vaishnavi, V., & Suresh, M., Modelling of readiness factors for the implementation of Lean Six Sigma in healthcare organizations, International Journal of Lean Six Sigma, vol.11, no.4, pp.597-633, 2020.

Vaishnavi, V., Suresh, M., & Dutta, P., A study on the influence of factors associated with organizational readiness for change in healthcare organizations using TISM, Benchmarking: An International Journal, vol.26, no.4, pp.1290-1313, 2019a.

Vaishnavi, V., Suresh, M., & Dutta, P., Modelling the readiness factors for agility in healthcare organization: a TISM approach, Benchmarking: An International Journal, vol.26, no.7, pp.2372-2400, 2019b.

Wee, H. M., & Widyadana, G. A., A production model for deteriorating items with stochastic preventive maintenance time and rework process with FIFO rule, Omega, vol.41,no.6, pp.941-954, 2013.

Wee, H. M., & Widyadana, G. A.,Economic production quantity models for deteriorating items with rework and stochastic preventive maintenance time, International Journal of Production Research, vol.50, no.11, pp.2940-2952, 2012.

Yeh, R. H., Kao, K. C., & Chang, W. L., Optimal preventive maintenance policy for leased equipment using failure rate reduction, Computers & Industrial Engineering, vol.57, no.1, pp.304-309, 2009.

Zheng, X., & Fard, N., A maintenance policy for repairable systems based on opportunistic failure-rate tolerance, IEEE Transactions on Reliability, vol.40, no.2, pp.237-244, 1991.

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