Systematic Literature Review on the Effect of Human Error in Environmental Pollution

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Abstract- This report is a systematic literature review of the relationship between human error and pollution, to take account of unintentional contributions to environmental pollution. To examine this relation, a systematic literature review of articles, including the keywords "human error" and "pollution" was conducted. The keywords were searched in the Web of Science and Google Scholar (using Harzing's Publish or Perish) databases, then exporting the metadata into VOSviewer to create cluster diagrams or keywords and co-citation analyses. Next, a few articles were selected: four articles from various databases, including Google Scholar, SpringerLink, and ResearchGate, two chapters from the *Handbook of Human Factors and Ergonomics, Fourth Edition* by Salvendy, and three more articles derived from the co-citation analysis. The articles were compiled into Mendeley and then exported into MAXQDA to create a word cloud exhibiting some keywords within the nine articles. Next, the AuthorMapper program from Springer was used to find the current and most relevant contributions to the area of human error and pollution as well as the most relevant keywords for an extended lexical search within the chosen nine articles. Then MAXQDA was used to perform an extended lexical search to find the usage of the keywords and the key points within the articles. Overall, the main keywords of risk management, human factors in accident causation, accident causation, failure, automation, and regulation showed a high relevance within multiple of the chosen articles. Also, from the Springer AuthorMapper, the contributions were not highly concentrated from any specific author, country, or institution, but were varied with an increasing trend of articles being written in this topic area.

Keywords: human error, pollution, environmental pollution, regulation, risk management, human factors, systematic literature review

1 Introduction and Background

Since the increase in environmental pollutants as a result of industry, the concern for the effects of pollution has increased correspondingly. This mounting concern has resulted in the foundation of countless organizations such as the United States Environmental Protection Agency (EPA), World Wildlife Fund, and Greenpeace, all since 1970, just to name a few. Many studies since the 1970s have been focused on not only the effects but also what causes the release of environmental pollutants. However, others have been concerned with the mitigation of current pollutants in the environment and how to reduce the release of more in the future.

Though it is commonly perceived that the only possible causes of pollution stem from intentional actions taken without regard for their effects in the environment, like careless waste management practices, excessive carbon emissions from factories and transportation, and intentional littering. However, intuitively, that cannot be the case. Examples like the oil rig malfunctions of the Deepwater Horizon oil spill in 2010 are unintentional yet can prove just as dangerous and damaging if not more so than intentional pollution (Lehto & Cook, 2012; Sharit, 2012). In any case like this, there is likely the factor of human error as the outcome was the result of some mistake along the way from the design of a product to the operation of a facility, resulting in a failure which causes damaging outcomes.

2 Problem Statement

While many are researching the state of the intentional release of pollutants into the environment, it is also necessary to account for the unintentional causes of pollution that feed their way into the environment all the same. For this reason, it is essential to do an analysis of the state of research regarding human error and related pollution as a cause of it.

3 Procedure

Beginning with a key word search of "pollution" and "human error" in Google Scholar, SpringerLink, and ResearchGate, four articles that displayed a relevant abstract were chosen for more in-depth analysis. Next, the same search keywords were used to obtain metadata in Web of Science, including article title, author, abstract, keywords, and references, was exported to VOSviewer, where a cluster diagram of key terms and co-citations were formulated. Next, using Harzing Publish or Perish (through Google Scholar) metadata from 940 articles, including title, authors, and keywords, another cluster diagram of key terms was formulated.

From the cluster diagrams, the key terms with the greatest number of occurrences were chosen. Within nine chosen articles, using MAXQDA, a lexical search was conducted to find all of the places within the article where each term was mentioned in order to glean the essence of each section of the article where one of the key terms was used. Also, within MAXQDA, a word cloud was generated to search for the most frequently used words within the nine articles.

Some practitioners may consider issues related to pollution mitigation as overlapping with environmental management and sustainability, while human error may be considered to be overlapping with ergonomics. Additional information related to ergonomics and sustainability can be found in a systematic review of ergonomics and sustainability that was published in the journal *Ergonomics* (Radjiyev, Qiu & Xiong et al. 2015). Some methods for improving sustainability through usability were also reported during the *Int. Conference on Design, User Experience and Usability* (Duffy, 2014).

4 Results and Discussion

From the initial keyword search in Google Scholar, SpringerLink, and ResearchGate, four articles "Implementing a sea pollution and safety management system in the navigation companies" by Gasparotti, C. et al., "The impact of human errors on the estimation of uncertainty of measurements in water monitoring" by Kmiecik, E., "Temporal and spatial variation characteristics of air pollution and prevention and control measures: Evidence from Anhui Province, China" by Kuai, S. and Yin, C., and "Wind, waves, tides, and human error? – Influences on litter abundance and composition on German North Sea coastlines: An exploratory analysis" by Schöneich-Argent, R. I. et al. These four articles were uploaded to Mendeley to manage references.

Next, the search in Web of Science was conducted to formulate the cluster diagrams. Though it was initially thought that the Web of Science search would provide a more comprehensive and representative cluster diagram than, because the metadata would include more information, the minimum occurrence for the keywords even within both the abstracts and titles together had to be set to three in order to form any central point (see Fig. 1). This is likely because the total number of articles that could be found using the keywords "pollution" and "human error" was only 34, so despite the extra exported data, there were not enough articles to be picky about the number of times a word appeared.

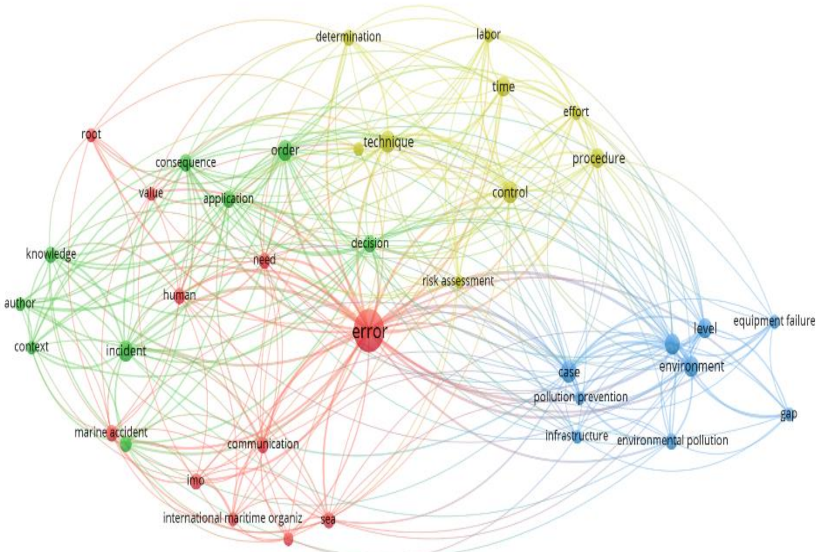

Fig. 1. Web of Science Cluster Diagram of title and abstracts data from 34 articles with a minimum of three occurrences per keyword shows a much more evenly spread diagram in comparison with the Harzing search cluster diagram; however, there is still an evident focus on human factors through the green and yellow strings (*Web of Science*, n.d.; *VOSviewer*, n.d.).

By comparison, the Harzing search was able to find 940 articles, from which it took only the authors, titles, and keywords. However, there were far more occurrences of each key term, so the minimum number of occurrences was set up to 18, which gave a far more interesting representation of the available literature through Google Scholar (see Fig. 2).

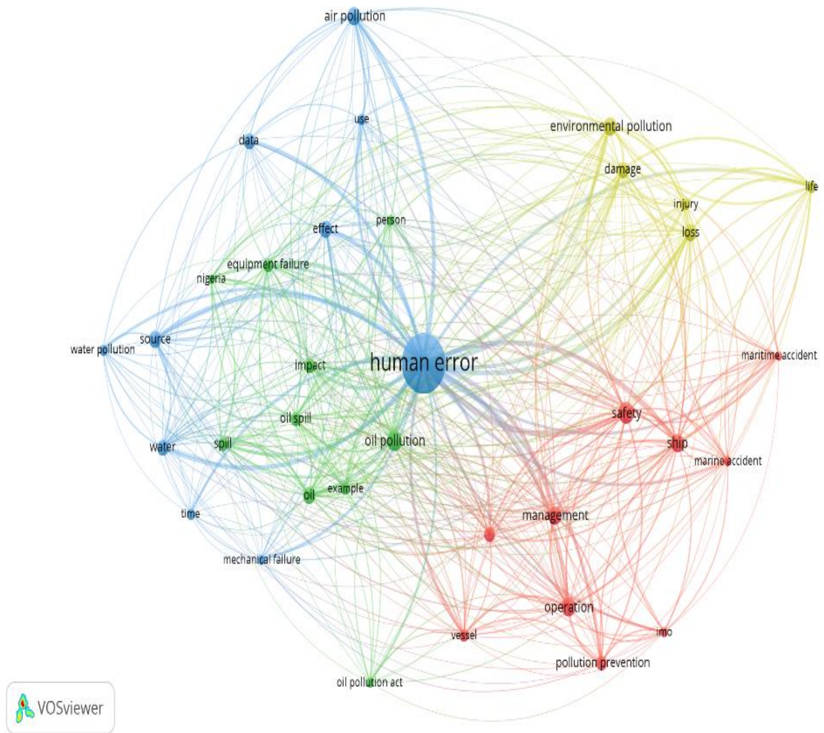

Fig. 2. VOSviewer Cluster Diagram of Harzing keyword search with a yield of 940 articles and a minimum number of key word occurrences of 18 demonstrates a central idea of human error surrounded by causes and effects like various types of pollution and equipment/mechanical failure (*Harzing's Publish or Perish*, n.d.; *VOSviewer*, n.d.).

Also, from the metadata exported from Web of Science, a co-citation analysis was run, which discovered the articles "Human and organisational factors in maritime accidents: Analysis of collisions at sea using the HFACS" by Chauvin, C. et al., "Safety in shipping: The human element" by Hetherington, C. et al., and *Human error* by Reason, J. Each of these articles was cited four times within the 34 articles found within Web of Science. Then through database searches, these three articles, except for the book *Human Error* by Reason (1990), were found and stored in Mendeley for reference management and later use.

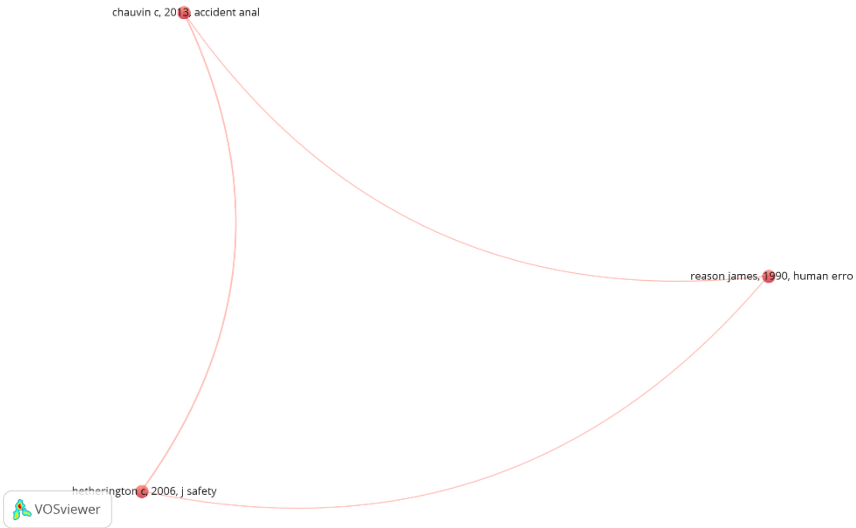

Fig. 3. Web of Science Co-citation Analysis reveals strong ties between three articles cited by 34 articles in Web of Science, which draws a strong relation back to fundamentals in human error and human factors (*Web of Science*, n.d.; *VOSviewer*, n.d.).

Next, two related chapters from the *Handbook of Human Factors and Ergonomics, Fourth Edition*, (Salvendy, 2012) "Occupational Health and Safety Management" (Lehto, 2012) and "Human Error and Reliability Analysis" (Sharit, 2012) were chosen as they related to human error and safety management and saved into Mendeley. Then, the four initially selected articles, the two chapters from *Handbook of Human Factors and Ergonomics*, *Fourth Edition*, and the three articles from the co-citation cluster analysis, except for Reason (1990), were transferred to MAXQDA to create a word cloud that emphasized the most frequently used words from all of the combined literature. In place of Reason (1990), an article reviewing *Human* Error by Gray (1993) was used to add to the word cloud instead. In order to meaningfully populate the figure, a stop list had to be created to cut out all prepositions and other elements within the word cloud that did not provide any insight into useful terminology for further lexical search.

Fig. 4. MAXQDA word cloud from nine articles displays a clear emphasis on human factors and secondary results relating to the environment and pollution. The overrepresentation of human factors terms likely is the result of the inclusion of two chapters of the *Handbook of Human Factors and Ergonomics, Fourth Edition* (Salvendy, 2012), which did not include much information or vocabulary related to pollution or the environment (*MAXQDA*, n.d.).

4.1 Leading Global Themes in Human Error and Pollution

Themes of Emphasis Among Leading Authors

Springer's AuthorMapper is reviewed under the search term "pollution" AND "human error." AuthorMapper shows that 1243 articles were published from the year 1979 to the present. However, 1988 is the first year that shows more than 10 related articles. The peak in 2018 and 2019 show 197 and 196, respectively.

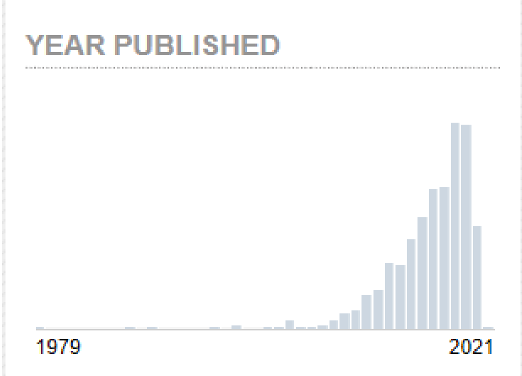

Fig. 5. Trend data from Springer's AuthorMapper shows an increase in the number of articles on the topic search "pollution" and "human error" that lead to a peak of 197 articles published in 2018.

Five 'leading publications' contains 101 out of 1243 listed articles. The articles are distributed among many publications. 1243 related articles are found within 841 different publications. Leading terms among the 1243 articles are shown in Table 1.

In order to further justify this systematic review of "pollution" AND "human error" within the digital human modeling thematic area within HCI International, it may be useful to consider the following. Though not initially apparent, leading terms in keywords among the 1243 articles overlap significantly with the subheading within the digital human modeling area. This theme is titled "Digital Human Modeling & Applications in Health, Safety, Ergonomics & Risk Management. "Safety," "Risk," and "Risk management" are three among the top seven leading terms. These three are listed within the title of our thematic area on Digital Human Modeling (DHM).

Table 1. Table shows leading terms among 1243 articles that contain 4115 authors publishing under 841 different publication titles. 1980 different institutions and 89 different countries are represented. Five of the first seven terms fit well within at least one chapter within the Handbook of Human Factors and Ergonomics. Three among the seven fit directly within the title of this DHM thematic area.

Rank of Leading Term Among Keywords	Leading Term Among Keywords in 1243 Articles
1	Safety
2	Risk Assessment
3	Sustainability
4	Uncertainty
5	Risk
6	Climate change
7	Risk management

The following tables show leading authors, institutions, and countries with years of publication and count. Keywords show emerging themes emphasized by countries, authors, and institutions within the AuthorMapper database for this search topic "pollution" AND "human error."

Table 2. Table shows leading authors among 4115 listed authors in Springer's AuthorMapper database. Leading keywords show emerging themes emphasized by these leading authors.

Author	Years	Leading Keywords	Count
Vinnem, Jan-Erik	2014-2020	Offshore risk assessment, Marine systems risk modeling	10
Atsuji, Shigeo	2016	Unsafety, Cumulative thermal effluent, Sustainability policy	6
Tzafestas, Spyros G.	2010	Human factors in automation, Modeling and simulation	6
Hauptmanns, Ulrich	2015	Process and plant safety, Risk, Engineered systems	5
King, David	2015-2018	Economic crisis, Europe income, Petroleum, Transportation	5

Themes of Emphasis Among Leading Countries

The leading contributions to the topics of human error and pollution, as demonstrated by Tables 3 and 4 as well as Figure 6, come from a variety of places. The largest number of contributions to this area have come from the United States, followed by the United Kingdom; however, the institutions with the most contributions come from an even more variable set of locations, including Norway and Sweden, which are known for their reasonably strict environmental regulations.

Table 3. A table of leading institutions from Author Mapper (Springer) shows leading institutions among 1980 different institutions that are represented within the 1243 articles. Count information is included. Leading keywords show institutional emphasis.

Institution	Country	Leading Keywords	Count
University of Stavanger	Norway	Offshore risk assessment, Lessons learned, Analysis techniques	11
World Maritime University	Sweden	Accident causation, Accidental pollution, Arctic navigation	11
Curtin University	Australia	Human error, Bayesian network, Biomass, Budyko equations	10
Chinese Academy of Sciences	China	Beijing PM2.5, AHP, Air pollution, Chemical constituents	9
University of Copenhagen	Denmark	AI, Anthropocentrism, Bioinformatics, Data Envelopment Analysis (DEA)	8

Table 4. A table of leading countries from Author Mapper (Springer) shows leading institutions among 89 different countries that are represented within the 1243 articles. Count information is included. Leading keywords show emphasis by country.

Country	Leading Keywords	Count
United States	Climate change, Petroleum, Automation	270
United Kingdom	Mediterranean Sea, Oil pollution, Regulation, Aerial surveillance	115
India	Emission, Smart city, Machine learning, Recycling, Remote sensing	109
China	Absorbent, Absorption, Aerogel, Cellulose, Hydrophobic, Oil	103
Germany	Bark scorch/Sunburn, Basal burls, Coat shake, Crack causes	75

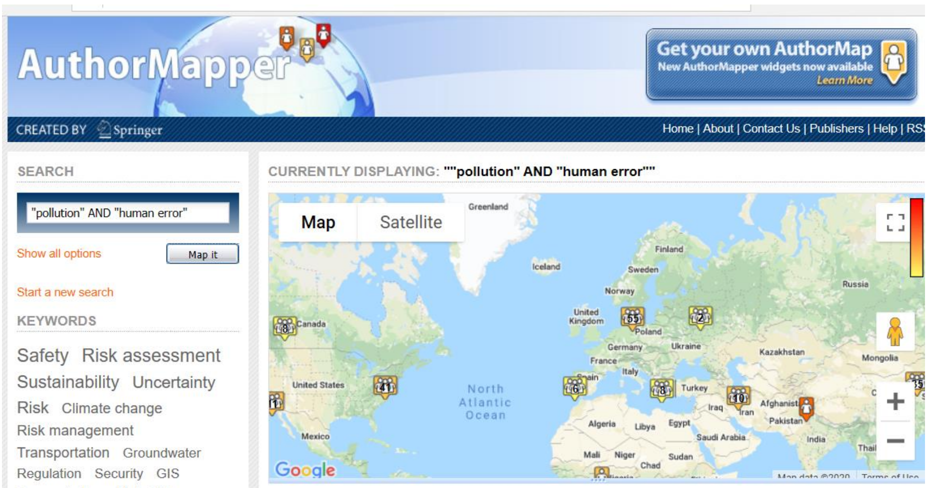

Fig. 6. Clusters within the map from Springer's AuthorMapper show the geographic representation as additional information beyond the table information that highlighted leading countries, including the United States, United Kingdom, India, China, and Germany. Even among a diverse set of publications, authors, and countries, the metadata shown in the list of leading countries helps to confirm is consistent with our intuition countries of what one would expect to be listed among leading countries associated with the "pollution" or environment-related topic.

Table 5. Leading articles over the last five years are shown based on relevance and are listed in table. These are identified from Springer's AuthorMapper and are listed in table with authors, country, and year of publication. It is interesting to note that the leading articles (by relevance) and leading authors are not from countries that are within the original list of leading countries. This further highlights the diversity of contributions and contributors to this research area.

Authors	Title and Publication Info	Country	Year
Ishak, Ismila Che, Wan Muhammad Hafiz Wan Ab Rani, Shaiful Bakri Ismail, and Norazimah Mazlan.	"A Study of Oil Spill at Marine Companies: Factors and Effects." In *Advancement in Emerging Technologies and Engineering Applications*, pp. 1-12. Springer, Singapore.	Malaysia	2020
Nakamura, Takahiro, Emiko Kanoshima, Tomofumi Koyama, Hiroshi Nishimura, and Mamoru Ozawa.	"Social Disasters and Damages." In *Science of Societal Safety*, pp. 73-86. Springer, Singapore.	Japan	2019
De Felice, Fabio, Antonella Petrillo, and Federico Zomparelli.	"Human Factors Challenges in Disaster Management Scenario." In *Human Factors and Reliability Engineering for Safety and Security in Critical Infrastructures*, pp. 171-187. Springer, Cham.	Italy	2018
Kazmi, Danish, Sadaf Qasim, I. S. H. Harahap, and Syed Baharom	"A probabilistic study for the analysis of the risks of slope failure by applying HEART technique." *Geotechnical and Geological Engineering* 35, no. 6 (2017): 2991-3003.	Pakistan, Malaysia	2017
Tavakoli, Mehdi, and Mehdi Nafar.	"The Improvement in Human Reliability in Power Grids by Identifying and Assessing the Risk of Failures Caused by Maintenance Operations." *Iranian Journal of Science and Technology, Transactions of Electrical Engineering*: 1-9.	Iran	2019

4.2 Content Analysis

Lexical Search Results

Key terms taken from the cluster analyses, word cloud, and leading global key terms were used to search within the nine chosen articles. For efficiency, the keywords "pollution" and "human error" were not used in the extended lexical search in MAXQDA, as they have many occurrences within the articles. Instead, the following terms were searched. Also, due to the inability to acquire a digital copy of *Human Error* by Reason, the lexical search was implemented through Google Books, through which samples of the literature were available.

Automation:
Reason's book on human error (Reason, 1990) is referred to within the co-citation analysis results. However, when considering the topic of automation, Reason refers to prior work of Bainbridge about the ironies of automation (Bainbridge, 1987) and Rasmussen et al. (1987) who co-edited a book about new technology and human error. This book may be of additional interest to the reader interested in the human-automation interaction aspects of pollution prevention. Baxter wrote more recently in 2012, emphasizing the cognitive aspects in an article titled "The Ironies of Automation: Still Going Strong at 30?". Along similar lines, Hetherington et al. (2006) and Sharit (2012) explain how the irony of automation occurs with increases in automation being attributed to increased burden of interaction with the technology. Further describing how it frequently results in increasing cognitive demands and corresponding with increases in human error, especially when the human can least afford the diversion of its attention.

Failure:
According to Sharit, performance failure is defined as the outcomes of actions that differ from what was intended or required. To elaborate, Reason states that failure can be considered at three levels of performance, including skill-based, rule-based, and knowledge-based. The interested reader could review Rasmussen's (1983) influential article for additional insight into skill, rule, and knowledge-based performance. Reason highlights potential skill-based failures, including inattention or omissions associated with interruptions. For failures at the rule-based level, Reason refers to a book by Holland et al. (1986) emphasizing processes of inference, learning, and discovery, and a conceptual framework. Reason refers to potential for misapplication of reasonable rules and application of bad rules and suggests redundancy to prevent related adverse outcomes.

Risk Management:
Lehto and Cook explain how improvements upon levels of risk must be decided by the management overseeing any kind of operation, based on the most cost-effective ways to implement new control measures. Sharit, however, points out how it is increasingly difficult it is to minimize risks further when reporting incidents is voluntary. This leads to underestimates of the number of incidents and eliminates the opportunity to improve

upon near misses where no serious accident has yet occurred, simply because the management is unaware of the issues.

Human Aspects of Risk Management:
Reason notes that decision aids can be designed to minimize failures at the plan formation stage. Whereas memory aids can improve performance at the storage and execution stage of a task. For additional insight, Reason also refers to Norman's article (1986) related to cognitive processes and information processing. On the topic of risk management, Reason (1990) refers to Fischhoff's outline of simple behavioral principles in complex system design. The presentation by Fischhoff was referred to by Reason and briefly noted in a book edited by Rasmussen and Batstone in 1989 based on presentations at the World Bank (Fischhoff, 1989; Rasmussen & Batstone, 1989). A more detailed version of related work may be seen in Fischhoff's co-authored book on behavioral decision theory (Slovic et al. 1987). Additionally, Reason refers to Fischhoff (1986) on decision making in complex environments that was originally presented as part of an edited book by Hollnagel, Mancini, and Woods (1986) on intelligent decision support in process environments.

Regulation:
In a proactive safety initiative, one would consider human capabilities and limitations as well as design first for reducing potential hazard. However, as a last resort regulation and, in some cases, litigation is effective at bringing about design modifications that reduce the potential hazards. Lehto and Cook (2012) and Sharit (2012) refer to examples where regulation helped to reduce potential hazard and risk. In similar mindsets, Kuai and Yin (2017), Gasparotti et al. (2008), and Chauvin et al. (2013) explain how increases in the number and comprehensiveness of regulations from international and government organizations will help to reduce accidents and pollution emissions. Furthermore, Hetherington et al. (2006) states that among the most common human factors is the failure to comply with regulations, resulting in error. In contrast, Reason (1990) highlights an example where not following the regulation reduced hazard and risk. Ultimately, one may consider that where human factors and design have not already been effective at minimizing hazard and risk, regulation may be needed.

Table 6. In reappraisal following review, it is recommended that the following be considered for effective hazard mitigation and human error reduction in the context of pollution.

Steps	Human error reduction	Strategy
1	Consider capabilities and limitations of people in the context of technical aspects	Fit the task to the human-based on human factors-related theory
2	Design out potential hazards	Proactive safety design – engineering and quality improvement
3	Regulate	Administrative and legislative

Accident Causation:
Among many potential causes, Lehto and Cook (2012) explain that unsafe acts and unsafe conditions cause most accidents. To support, Hetherington (2006) notes that reducing the number of technology failures helps to expose human error's effect on accident causation. Furthermore, Chauvin (2013) references Reason's "Swiss cheese" model on accident causation.

5 Conclusions and Future Work

This systematic review shows an increasing number of research contributions to hazard mitigation incorporating human error and pollution. The co-citation analysis and content analysis show that human factors theories are contributing to pollution-related research for the purposes of minimizing the potential for human error and adverse events. A summary of leading authors, leading countries, and leading publications show a diverse set of contributions, and some of the most relevant articles were found from authors that were not listed among leading authors and were not from leading countries. Articles with the highest relevance did not necessarily originate from leading countries or leading authors. The future looks bright internationally in this area for new projects applying human factors theories in mitigation of human error that could lead to pollution or adverse environmental events.

Additional examples of funded proposals can be found at the National Science Foundation website (www.nsf.gov) using search terms "human error" and "environment". A proposal awarded to Behzad Esmaili at George Mason University is titled "Measuring Attention, Working Memory and Visual Perception to Reduce Risk of Injuries in the Construction Industry". The proposal emphasized the idea that human error, including poor decisions or unsafe actions, are a main causal factor in up to 80% of workplace accidents across a wide variety of industries. The research recognizes our limited capacity for information processing as a major source of error and suggests that better understanding of cognitive processes will yield more effective methods for predicting and reducing the poor decisions that put workers and their environment at risk. A series of eye-tracking experiments is intended to provide an error-detection framework.

The proposal awarded in 2018 has led to a presentation at the Construction Research Congress related to a study of the association of risk perception and risk-taking behaviors (Dao and Hasanzadeh, 2018). A similar award was given as a continuing grant to Michael Dodd and Leen-Kiat Soh at University of Nebraska-Lincoln. The project, also emphasizing eye movements and eye-tracking methodologies is a proactive approach to occupational safety and health that has the potential for reducing occupational accidents and preventing injuries or adverse health-related events.

One additional project proposes to measure, predict and improve safety be improving hazards signal detection with augmented virtual environments. The award to

Matthew Hallowell and Leaf Van Boven at University of Colorado at Boulder also considers human error in construction. They suggest that skill deficiency could lead to difficulties at recognizing important hazard-related signals. The augmented reality technology, if successful at providing improved hazard signal recognition could lead to reduced human error applicable across various industries. Two recent publications produced as a result of this research emphasized emotional states and their impact on hazard identification skills and situation awareness (Bhandari et al. 2016; Bhandari et al. 2018). The article related to situation awareness emphasizes empirical relationships among hazard recognition, skill, risk perception and risk tolerance.

Projects emphasizing smart services can provide awareness and integration of systems design issues for considering capabilities and limitations of people in the context of human-automation interaction. ‘Smart’ approaches propose to take sensor data and engineering knowledge to transfer the data into useful services and interventions. One recent proposal "Smart Geoengineering Systems” was recognized among top 100 (Duffy et al. 2019). The proposal, listed alphabetically among top 100, considers whether modern geoengineering methods can be supplemented by systems and smart approaches to provide relief as humanitarian intervention for impact on an increasing number and severity of catastrophic events.

References

1. *AuthorMapper*. (n.d.). https://www.authormapper.com/, last accessed: 03/01/2020
2. Bainbridge, L. (1987). Ironies of automation: increasing levels of automation can increase, rather than decrease, the problems of supporting the human operator. New technology and human error. Chichester, UK: Wiley, 276-283.
3. Baxter, G., Rooksby, J., Wang, Y., & Khajeh-Hosseini, A. (2012, August). The ironies of automation: still going strong at 30?. In Proceedings of the 30th European Conference on Cognitive Ergonomics (pp. 65-71).
4. Bhandari, S., Hallowell, M.R., Van Boven, L., Gruber, J., Welker, KM. (2016). Emotional States and Their Impact on Hazard Identification Skills, *Construction Research Congress*, p. 2831. doi:10.1061/9780784479827.282
5. Bhandari, S., Hallowell, M.R., Van Boven, L., Golparvar-Fard, M. (2018). What is situational awareness? Empirical relationships among hazard recognition skill, risk perception, and risk tolerance, *Proceedings of the 2018 Construction Research Congress.*
6. Chauvin, C., Lardjane, S., Morel, G., Clostermann, J. P., & Langard, B. (2013). Human and organisational factors in maritime accidents: Analysis of collisions at sea using the HFACS. *Accident Analysis and Prevention*, *59*, 26–37. https://doi.org/10.1016/j.aap.2013.05.006
7. Dao, B. and Hasanzadeh, S. (2018). "The Association between Risk Perception and the Risk-Taking Behaviors of Construction Workers," *Construction Research Congress.*
8. Duffy, V.G. (2014). Improving sustainability through usability in *International Conference of Design, User Experience and Usability*, June (pp.507-519) Springer, Cham.
9. Duffy, V.G., Hirleman, E.D., Groll, E., Laskin, A. and Wang, F. (2019). Smart geoengineering systems, NSF 2026 Idea Machine (shown at: https://www.nsf.gov/news/special_reports/nsf2026ideamachine/index.jsp listed alphabetically in tab among top 100).
10. Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. *International Journal of Production Economics, 162*, 101–114. https://doi.org/10.1016/j.ijpe.2015.01.003

11. Fischhoff, B. (1986). Decision making in complex systems. In E. Hollnagel, G. Mancini and D. Woods, *Intelligent decision support in process environments* (pp. 61-85). Springer, Berlin, Heidelberg.
12. Gasparotti, C., Georgescu, L., & Voiculescu, M. (2008). Implementing a sea pollution and safety management system in the navigation companies. *Environmental Engineering and Management Journal*, *7*(6), 725–729. https://doi.org/10.30638/eemj.2008.097
13. *Google Scholar*. (n.d.). https://scholar.google.com/, last accessed: 03/01/2020
14. Gray, W. D., Sabnani, H., & Kirschenbaum, S. (1993). [Review of the book Human Error]. *International Journal of Man-Machine Studies*, 39, 1056-1057.
15. *Harzing's Publish or Perish*. (n.d.). homepage: https://harzing.com/resources/publish-or-perish, last accessed: 03/01/2020
16. Hetherington, C., Flin, R., & Mearns, K. (2006). Safety in shipping: The human element. *Journal of Safety Research*, *37*(4), 401–411. https://doi.org/10.1016/j.jsr.2006.04.007
17. Holland, J. H., Holyoak, K. J., & Nisbett, R. E. és Thagard, PR (1986). *Induction. Processes of inference, learning, and discovery*.
18. Kmiecik, E. (2018). The impact of human errors on the estimation of uncertainty of measurements in water monitoring. *Advances in Intelligent Systems and Computing*, *589*, 162–172. https://doi.org/10.1007/978-3-319-60645-3_16
19. Kuai, S., & Yin, C. (2017). Temporal and spatial variation characteristics of air pollution and prevention and control measures: Evidence from Anhui Province, China. *Nature Environment and Pollution Technology*, *16*(2), 499–504.
20. Lehto, M. R., & Cook, B. T., (2012). Occupational Health and Safety Management. In G. Salvendy (Ed.), *Handbook of Human Factors and Ergonomics, Fourth Edition* (pp. 701-733). Hoboken, NJ: Wiley & Sons, Inc.
21. Leplat, J., Duncan, K., & Rasmussen, J. (Eds.). (1987). New technology and human error. J. Wiley.
22. *MAXQDA*. (n.d.). homepage: https://www.maxqda.com/, last accessed: 03/01/2020
23. *Mendeley*. (n.d.). homepage: https://www.mendeley.com/?interaction_required=true, last accessed: 03/01/2020
24. Rasmussen, J. (1983). Skills, rules, and knowledge; signals, signs, and symbols, and other distinctions in human performance models. *IEEE transactions on systems, man, and cybernetics*, (3), 257-266.
25. Radjiyev, A., Qiu, H., Xiong, S., & Nam, K. (2015). Ergonomics and sustainable development in the past two decades (1992–2011): Research trends and how ergonomics can contribute to sustainable development. *Applied ergonomics*, *46*, 67-75.
26. Reason, J. (1990). *Human error*. Cambridge university press.
27. *ResearchGate*. (n.d.). https://www.researchgate.net/, last accessed: 03/01/2020
28. Schöneich-Argent, R. I., Hillmann, F., Cordes, D., Wansing, R. A. D., Merder, J., Freund, J. A., & Freund, H. (2019). Wind, waves, tides, and human error? – Influences on litter abundance and composition on German North Sea coastlines: An exploratory analysis. *Marine Pollution Bulletin*, *146*(June), 155–172. https://doi.org/10.1016/j.marpolbul.2019.05.062
29. Sharit, J. (2012). Human Error and Reliability Analysis. In G. Salvendy (Ed.), *Handbook of Human Factors and Ergonomics, Fourth Edition* (pp. 734-796). Hoboken, NJ: Wiley & Sons, Inc.
30. *SpringerLink*. (n.d.). https://link.springer.com, last accessed: 03/01/2020
31. *VOSviewer*. (n.d.). homepage: https://www.vosviewer.com/, last accessed: 03/01/2020
32. *Web of Science*. (n.d.). homepage: https://apps.webofknowledge.com, last accessed: 03/01/2020