Opportunities for the Development of Safety and Health Protection Systems in the Small and Medium Enterprise (SMEs) Sector

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ABSTRACT

The Occupational Health and Safety Program (OHS) is a method attempting to lower the risk of accidents and occupational diseases. The OHS is aimed at reducing the risks of occupational diseases and accidents in the small and medium-enterprises (SME) sector. This study aims to see the gaps in OHS that only focused on medium-sized industries so that the SME sector does not experience the effects of OHS. In-depth and systematic literature reviews were conducted, and the classification of the disaster type and its object from those sources was performed. The results show that there are gaps in the OHS, which can be seen both from the mitigation and identification methods used, which open up opportunities for further research, especially in the development of new investigative methods, as well as to improve the design of protection systems. The findings of this study will be the latest research based on perspectives in the global scope by looking at the relevant perspectives that have been run and compared systematically to be able to create opportunities for the updating of the risk mitigation process OHS in SME industrial sector.

1. INTRODUCTION

One of the economic sectors that significantly contribute to the gross domestic product (GDP) is small and medium Enterprise (SME) [1]. The growth and development of SMEs can provide employment opportunities as well as increase public income [2]. In order to stay viable, SME must automate at least several particular industry processes. By doing so, they can take advantage on rapidly developing technology and able to protect their products from extinction in the world market [3]. Every industry must establish a system for managing occupational safety and health in order to increase labour productivity. This is one of the requirements for the development of industry [4].

The Occupational Health and Safety Program (OHS) is a method attempting to lower the risk of accidents and occupational diseases. Therefore, it establishes a safe and healthy workplace [5]. An industry that has potential risks from the production processes must implement health and safety system at work [6]. Entrepreneurs require the skills and mindsets to protect themselves, to support the application of OHS in SME. Moreover, the workplace also can promote general knowledge of OHS, skill-development, as well as specific information on their job [7]. In increasing the awareness of self-care and work safety, the OHS law is needed to support better working conditions [8].

The issue on OHS that frequently arises for all these time on SME sectors is unidentified workplace accidents, because it is not accommodated by the preventive concept that can assess how reliable the OSH system there. The Safety Integrity Level (SLI) is a way for assessing the dependability [9]. However, the SLI has only been used for medium-scale industries. It becomes the focus on the research regarding the gap. Thus, it can support further research and conduct a combination of previous research.

This research was carried out using a systematic library study method to see the gaps. It will be the latest research based on perspectives in the global scope by looking at the relevant perspectives that have been run and compared systematically to be able to create opportunities for the updating of the risk mitigation process OHS in the SMEs sector that aims to know the achievements of the OHS Mitigation segmentation and the factors that influence it.

Research on occupational safety and health in small and medium-sized industries (SMEs) is becoming crucial in today's global context. With rapid growth in the SMEs sector contributing significantly to the gross domestic product (GDP), as well as the potential to create jobs and increase public income, it is important to ensure that the working environment within the SMEs is safe and healthy. This research is urgent because there is a need to identify gaps and improve understanding of occupational safety and health practices in SMEs. With the risks associated with the production process in SMEs, this research is urgently needed to develop an effective and reliable occupational safety and health system. Furthermore, this research can help in balancing the need for occupational safety and health with the competitive challenges faced by SMEs in the global market. By clarifying the importance of occupational safety and health in the context of SMEs, this research can provide a solid foundation for

sustainable policy and practice improvements, which will ultimately benefit not only workers and entrepreneurs but also society as a whole.

2. METHODOLOGY

The combination of Systemic Literature Review (SLR) and Systemic Literature Mapping (SLM) method is used to perform systematic literature surveys for research opportunities. The SLR approach is used in the first phase to classify the planned areas of research [10]. The classification that shows up depends on the search terms entered [11]. Further, the sequential steps are: 1) Planning: initiates identification using the predefined keywords; 2) Executing: search for literary sources from various publications as the first step in conducting research stage; 3) Reporting: involves presenting systematical literary review materials as the last step [12, 13]. Following the SLR step, the mapping of the literature results is continued by using SLM to determine the prospective research that should be conducted next. SLM is started by identifying the primary concern of the completed SLR, and the concern then dismounted into a derivative system as the second layer. Furthermore, the system's element becomes the third layer, the methodology as the fourth layer, and the outcome of research as the last layer for the mapping of the previous study. All layers are related to the system that has been conducted previously [14].

2.1 Review planning

110 pieces of literature on macro ergonomics, occupational safety, SLI were examined as part of the review process, using some keywords such as "Protection System," "Safety Integrity Level," "Macroergonomic", "Small Medium Enterprise", "Hazard Mitigation", and "Occupational Health and Safety".

The literature search is done automatically. The Open Knowledge Browser is used to find all journal articles published between 2017 and 2023 in Europe Insight, Proquest, SAGE Journals, Science Direct, SpringerLink, and Taylor & Francis Online. Through this procedure, information about the continents that have been conducting research on the proposed course of study is found. Figure 1 shows the distribution of articles by continents: Asia has 45 articles, Europe has 21 articles, Africa has 21 articles, and America has 23 articles.

Based on Figure 1, Indonesia has discussed a considerably number of research which covers the topic of work safety in various sectors. According to data released by The Ministry of Manpower of the Republic of Indonesia, the number of accidents at work in Indonesia in the last 3 years increased to 23% by 2022, and 64.7% of such incidents occurred in workplace. In this case, special attention is needed in the production process so that it can reduce the number of work accidents.

### 2.2 Application of review criteria (planning step)

The next stage is the scanning process of the literatures that have been collected based on the determined topics and the previous established limitations. The literatures used were publications in English that had been published in the last five years [15, 16]. Of the 110 literatures that have been analyzed, 50 were eliminated due to exceeding the limitation of publication year. Figure 2 shows the distribution of the literatures per year.

Furthermore, this stage only uses literature with keyword formulations to answer SLR questions (Hisnul, Setiadi, and Rahayu, 2022) [1], which consists of:
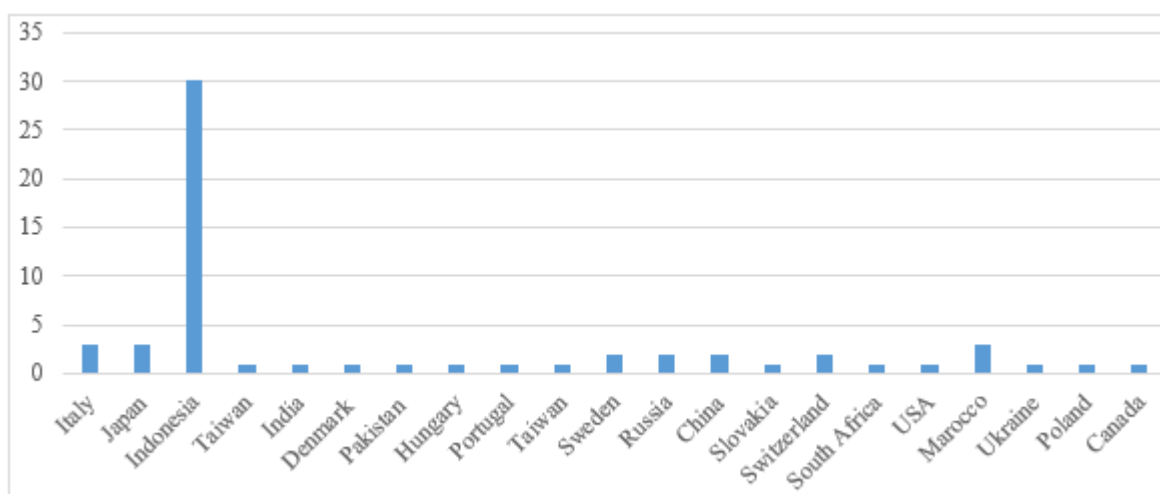1. Question 1: How many literatures that discuss the application, implementation, and the impact of OHS on performance and results?
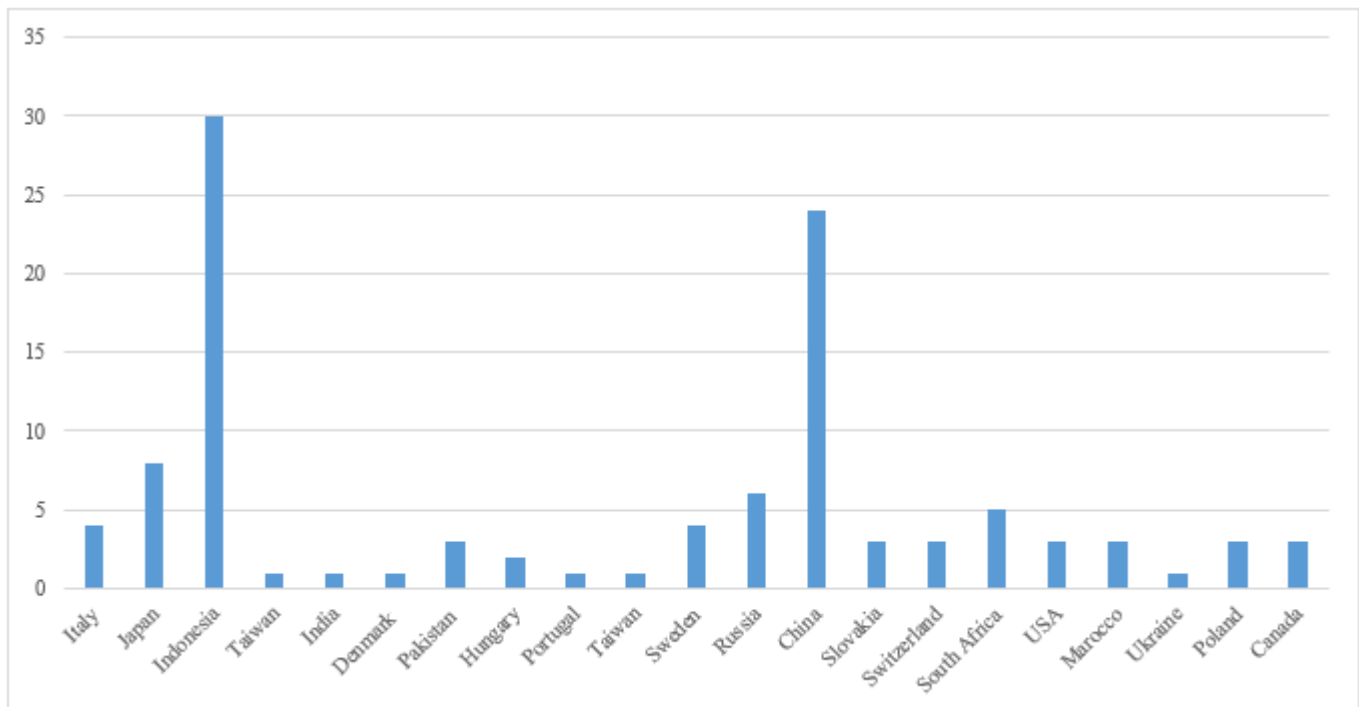
Figure 1. Distribution of the Journal of Safety Integrity Level (SLI), Macroergonomics, and occupational safety in various countries
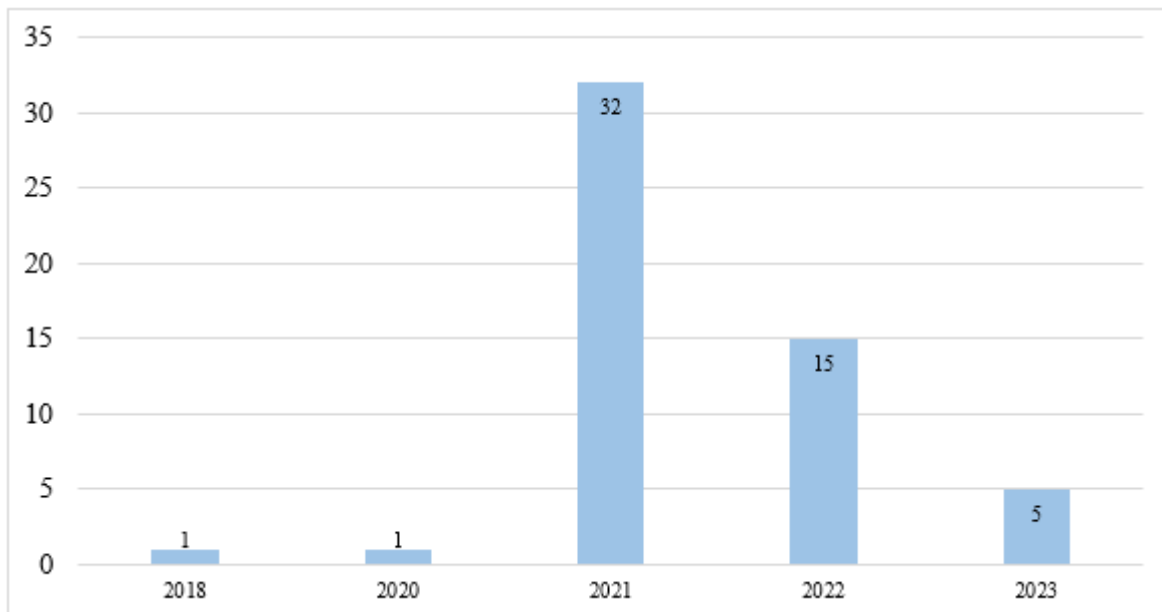
Figure 2. Distribution of the year the literature was published

Figure 3. Distribution of the Journal of Specify Keywords in various countries

2. Question 2: How many literatures which are related to the research objectives of the first question that consist of the types of accidents that can be mitigated, system development, model development, reduction on worker's disability risks due to workplace accident as well as defects on protection systems, and risk mitigation?
3. Question 3: How many literatures that contain the finding in the integration of OHS method, the role of investigation methods, the improvement of work efficiency, and model development?

2.3 Analysis of review results (conducting step)

The next stage is conduction. This step used the limitations of keywords arose from research questions including "safety integrity level", "macro ergonomics", "Small and Medium Enterprises", and "work safety", including the methods that consisted of HIRACD, FTA, and Hazop.

This process obtained 60 publications for in-depth study resources. The countries where the literature sources are published can be seen in Figure 3.

In-depth review on those 60 publications were conducted systematically, in which the review perspectives were focused on bibliography, focus of problem, area case studies, publication content, and then sharpened by investigating the case of work accidents occurred in the area case study object. In addition, the clustering was carried out based on reviewing the aspect of each literature, consisted of years of publication item to the writer names, types of publications, and scope of the publication in detail.

After that, the methods, samples, and modules of analysis are shown in case studies descriptions. Then at the final stage, the clustering is reviewed based on research motivation, objectives, description of findings, strengths and weaknesses of research, and opportunities for further research. Moreover, the investigation on the types of work accidents that have been protected by the OHS method policy is conducted at this stage. The review process can be seen in the Table 1 which refers to systematic review patterns. As the example is literary review written by Ahmed Salaheldine Darwish in 2020 [17].

Table 1. Example review protocol

Bibliography	
Year	2020
Title	Applying LOPA and Fuzzy Logic to Identify SIL Requirement for Safety Critical Functions in a Direct Reduction Iron Industry
Type of Publication	Journal
Name of Publication	Alexandria Engineering Journal
Scope of Publication	International
Details of Case Study	
Object of Case Study	Oil & Gas Industry
Method	LOPA & Fuzzy Logic
Sample and Population	Employees
Model Analysi	Risk Identification
Safety Risk Mitigation	
Kind Accident	Gas Poisoning
Focus and Content Publication	
Motivation	Identifying OHS Risks in The Oil & Gas Sector
Goals	Early protection against work accidents.
Advantages	Provides layered protection from the fusion of Fuzzy logic and LOPA
Disadvantages	The risk of mitigation remains on the assets (equipment)
Opportunity	Making an Operator as a Variable

3. RESULTS AND DISCOURSE (REPORTING STEP)

The review procedure is carried out during the reporting stage using the concepts from Table 1 and literature review. The table displays the connections between texts, the findings of the study, and the chances to develop the research.

3.1 Bibliography analysis

After reviewing 60 journals relevant to research topics, it was found that research on the topic of occupational safety issues were the most popular in 2021, with a total of 32 publications. However, the number decreased in the following year as shown in Figure 2. The research was published in several scientific sources, as presented in Figure 4.

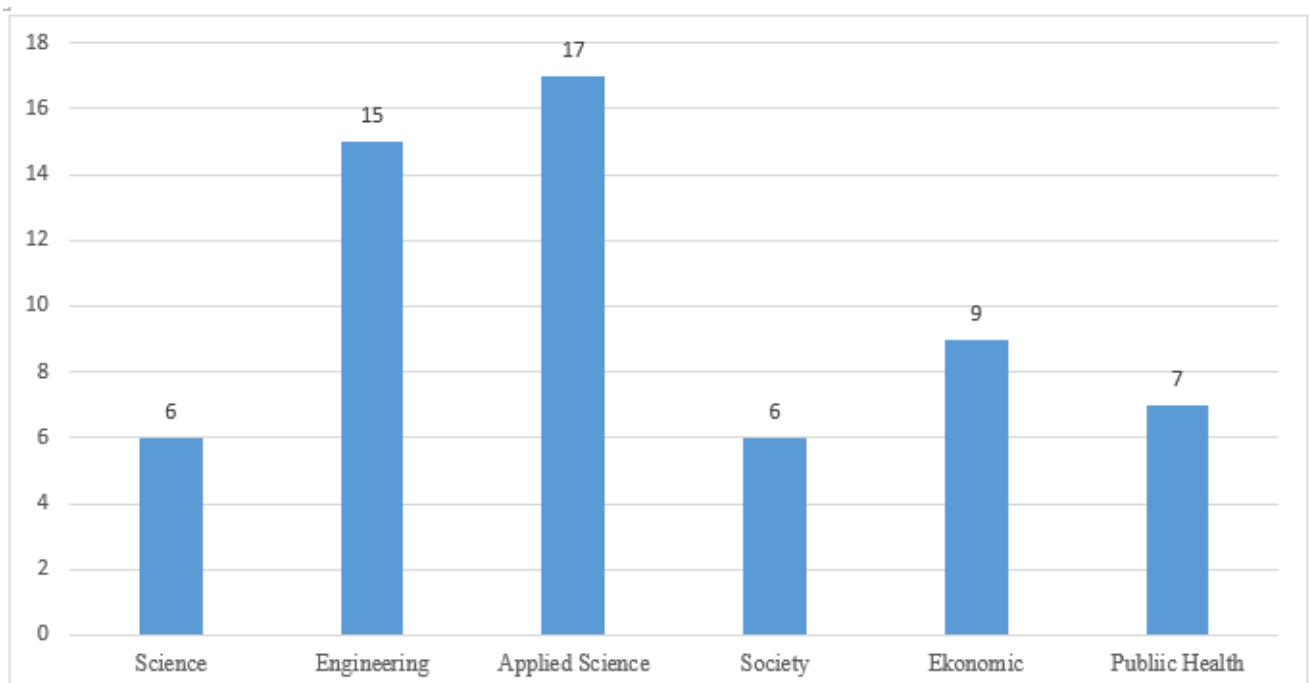In the past five years, scientific scope topics with an emphasis on Science 6, Engineering 15, Applied Science 17, Social 6, Economics 9, Public Health 7, and Literature have been published in journals. This demonstrates how crucial workplace safety is across all industries.

The scope of scientific area that addresses the issue of occupational health and safety in the last five years has been published in journals with the focus as follows: 6 literatures on Science, 15 on Engineering, 17 on Applied Science, 6 on Social Science, 9 on Economics, and 7 on Public Health. It shows the importance of occupational health and safety issue in all sectors.

3.2 Detailed case study analysis

3.2.1 Analysis of research question 1

The first research question is: How many literatures that discuss the application, the implementation, and the impact of OHS on work performance and result?

Figure 4. Distribution of the scientific scope area that discusses the issue of work safety in the last five years

Based on the results of the review conducted to answer the first research question were found literatures discussed the application, implementation, and the influence of OHS. It could be seen in pie diagram 1 (Figure 5).

In the literature review that had been conducted, 43% of them were related to OHS system application, and the objects of study were the oil & gas, mining, and manufacturing industries. As an illustration, [18] stated that using safety precautions could lower the likelihood of accidents, and 27% of the literature research demonstrated the implementation of work safety models for productivity. These studies demonstrated that the adoption of work safety systems had a positive impact on productivity [19, 20], and that productivity was decreased from the awareness of OHS [8]. Moreover, 11% discussed the comparison in the using of OHS methods, in

which one of them compared the use of the Safety Integrity Level (SIL) with the Safety Instrument Function (SIF) [21].

It was also found that 4% of the OHS studies were associated with financial risk, and one of them examined the financial risks caused by work accidents [22].

3.2.2 Analysis of research questions 2

The second research question is: How many literatures related to the research objectives of the first question that consist of the types of accidents that can be mitigated, system development, model development, reduction on worker's disability risks due to workplace accident as well as defects on protection systems, and risk mitigation? Several studies addressed to the second research issue were found, as indicated in pie diagram 2 (Figure 6).
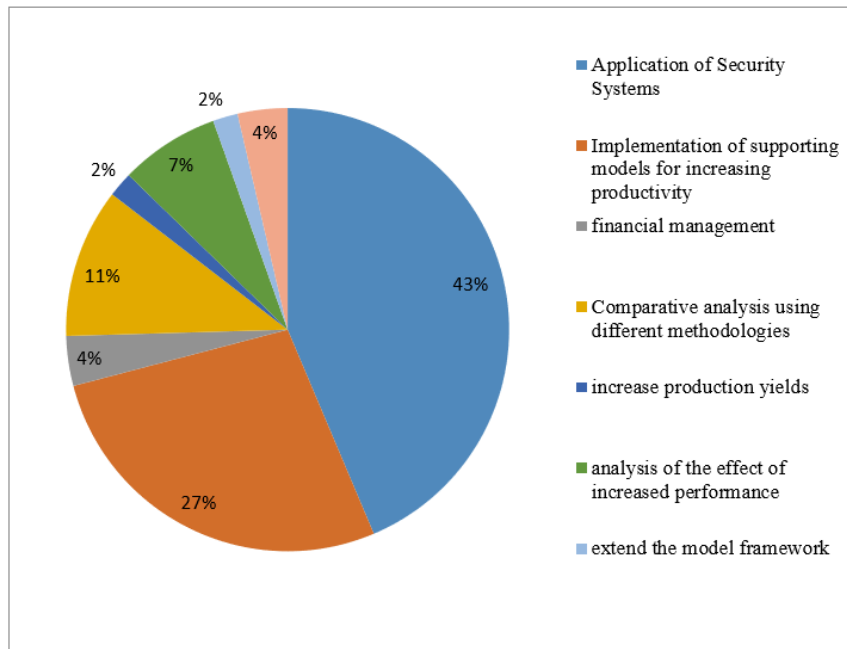

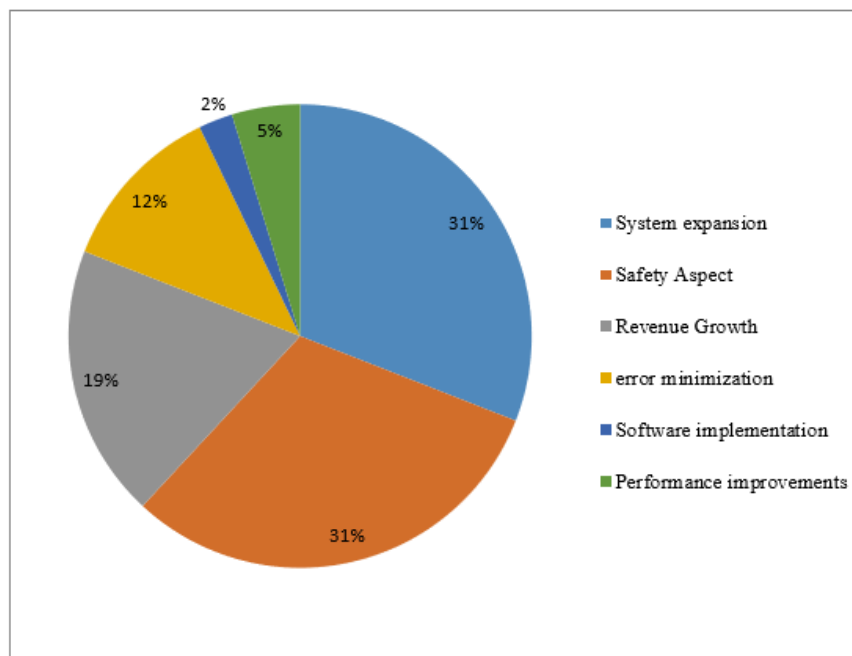**Figure 5.** Pie diagram percentage distribution of research areas for research question No. 1

Figure 6. Pie diagram 2 percentage distribution of research purpose area for research question No. 2

The number of literature that discusses the development of systems for security protection related to the first research question was 31%, which resulted in the expansion of security protocols for equipment in the telecommunications industry [23], security improvement regression in social scope [7], and the development of OHS enforcement [18, 24, 25]. Furthermore, it was found that 31% of the literature review discussed the findings on the addition of safety aspects, 19% on the opinion growth on the implications of implementing OHS and Macro Ergonomic Analysis Design (MEAD), 12% on the reduction of product defects, 5% on the implications for software design, and 2% on performance improvements.

3.2.3 Analysis of research questions 3

The third research question is: How many literatures that find the integration of OHS method, the role of investigative methods, the improvement of work efficiency, and model development?

It was discovered from the review of the literature, the research that integrated methods in mitigating OHS was only 13% effective in improving the implementation system of occupational safety and health, one of which provides recommendations for the implementation of ergonomics and work safety in the workplace after providing the first and second research questions [26]. It is illustrated thoroughly in pie diagram 3.

We can see that 19% of planned investigative models, 30% of operating system enhancement, 6% of risk cost, 24% of operating system design, and 8% of new method analysis over

the literature distribution is depicted on this pie diagram 3 (Figure 7).

3.3 Detail of case study analysis

Based on the literature review, the purpose of this review is to highlight the gap in OHS that only focused on medium-sized industries so that the small and medium-medium-enterprises sector does not experience the effects of OHS. According to data from the Indonesian Ministry of Employment, the number of work accidents in Indonesia was 265,334 cases between January-November 2022. The number increased by 13.26% compared to the entire year of 2021, which was 234,270 cases. Figure 8 shows the study material on OHS.

Manufacturing industry was the research object of OHS with the most number, consisted of 10 literatures. Apart from the relatively strict regulations in this sector, the availability of high-value equipment assets was the reason for the equal implementation of OHS regulations [27]. In fact, research on occupational safety in the medical sector has also been carried out, one of which suggests providing Personal Protective Equipment (PPE) in every hospital [28].

Meanwhile, in the technology development sector, a lot of research has been carried out on security protection devices [29], and the design of rechargeable battery technology that require security protection [30]. Then, risk reduction process is carried out in the food processing sector by using the HIRACD method [5].
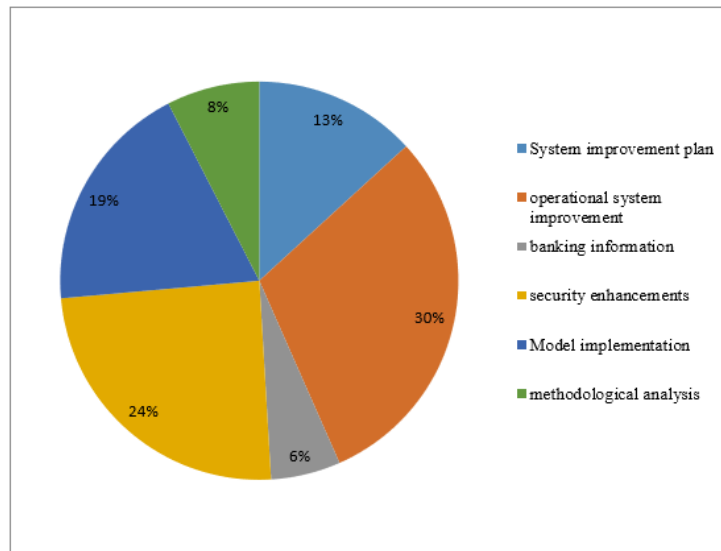

Figure 7. Pie diagram 3 percentage of distribution of OHS research handling solutions for research questions No. 3

Table 2. Distribution of the types of work accident risks that are protected, the methods used

Accident Type	Mitigation Methods	Object
Function Failure	Safety Integrity Level	Oil & Gas
Fire	Safety Integrity Level	Generator
Gas Leak	Safety Integrity Level	Oil & Gas
Poisoning	LOPA	Manufacture
Hot temperature	HIRDC, FTA	Manufacture
Struck down by Equipment	HAZOP	Infrastructure
Reposture	MEAD, MSP	Waste treatment
Fall down	HIRDC, FTA	Infrastructure
Skin Radiation	LOPA	Manufacture
Burns	HIRDC, FTA	Oil & Gas
Transportation Accident	Mechanism Analysis and Signed Directed Graph	Transportation

Table 3. Distribution of research gaps

Research Opportunities	Reference
System Improvement Plan	[3, 22, 23, 26, 31-33]
Operating System Improvement	[1, 8, 21, 24, 25, 27, 30, 34-41]
Information On Work Risk Cost Value	[42-44]
Operational System Design	[5, 7, 18, 38, 45-54]
Model Implementation	[19, 37, 43, 55-61]
New Analysis Method	[2, 57, 62-64]
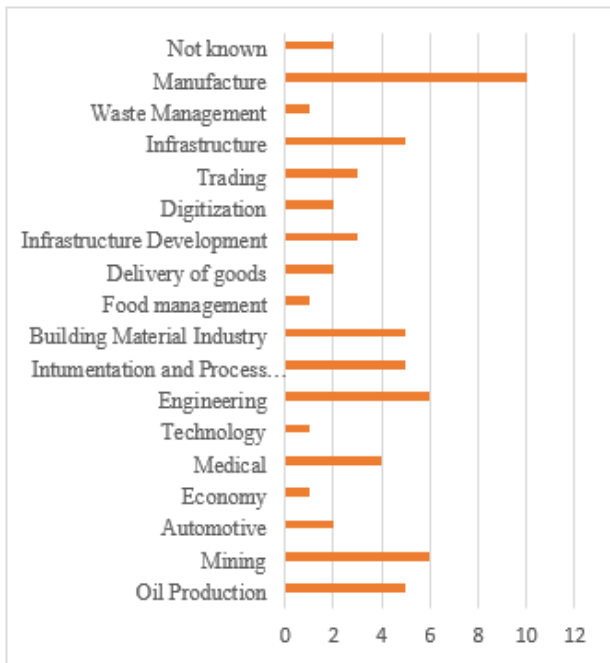
Figure 8. Distribution of research gaps on occupational safety that only focus on industry

3.4 Focus and content analysis

In the detailed study analysis phase earlier, information on the industries that had undertaken research on occupational safety as well as certain macroeconomics-related literature was collected.

The focus of the analysis's content in this section will show the types of risks in work accident that get protection, as well as the research method and location. Table 2 provides references to these details.

3.5 The map for research gap

In-depth and systematic reviews of the 60 literatures were conducted, and the classification of the disaster type and its object from those sources was performed. The result was that there were research gaps, as shown in Table 3.

There are chances to conduct unexplored or unfinished research based on the identified research gaps in Table 3. Indeed, research development can also consider areas of study based on risk mitigation which so far are still centered on assets, not yet on human as operators.

4. CONCLUSION

According to the background information in the literature study, there are still workplace safety and health applications where the approaches employed for identification and

mitigation are not given the full attention they need. According to a review of the literature, medium-sized microenterprises should be of particular concern. The mitigation of risks implemented by the type of accident is still concentrated on handling accidents that are of a short-term nature and have not yet resulted in injuries that will result in work-related illnesses. This creates opportunities for additional research, especially on the development of novel investigational techniques and improvement strategies.

Based on the of this literature review, there are areas of OHS that still have not been maximized, which can be seen both from the mitigation and identification methods used. The literature review shows that the sector that should be of concern is micro, small and medium enterprises (MSMEs). In addition, after reviewing the type of accident, risk mitigation is still focused on handling accidents that is considered as short term, and have not yet led to the handling of injury factors that will result in work-related illnesses. The results open up opportunities for further research, especially in the development of new investigative methods, as well as to improve the design of protection systems.

REFERENCES

[1] Hisnul, S.B., Rahayu, S. (2022). UMKM dimasa pandemi COVID 19 Berdampak pada teknologi dan digital pada pusat oleh-olhe rahma di desa Kendalrejo. Jurnal Ekonomi dan Bisnis, 11(1): 49-58. https://doi.org/10.34308/eqien.v11i1.693

[2] Farisi, S.A., Fasa, M.I., Suharto. (2022). Peran UMKM (Usaha Mikro Kecil Menengah) dalam meningkatkan kesejahteraan masyarakat. Jurnal Dinamika Ekonomi Syariah, 9(1): 73-84. https://doi.org/10.53429/jdes.v9iNo.1.307

[3] Bhat, V., Bhat, S., Gijo, E. (2021). Simulation-based lean six sigma for Industry 4.0: An action research in the process industry. International Journal of Quality & Reliability Management, 38(5): 1215-1245. https://doi.org/10.1108/IJQRM-05-2020-0167

[4] Seftiyadi, I., Hakim, A. (2021). Edukasi budaya kerja K3 (Keselamatan dan Kesehatan Kerja) pada UMKM wajid Mangga. Abdima Jurnal, 2(1): 1645-1650.

[5] Monoarfa, V., Ridwan, N.B.M. (2022). Penerapan Keselamatan dan kesehatan kerja (K3) menggunakan metode HIRARC pada UMKM pabrik tahu. Mopolayio: Jurnal Pengabdian Ekonomi, 2(1): 1-6.

https://doi.org/10.37479/mopolayio.v2i1.41

[6] Wahana, A., Marfuah, H. (2021). The use of augmented reality to build occupational health and safety (OHS) learning media. Journal of Physics: Conference Series UPINCASE, 1823: 1-6. https://doi.org/10.1088/1742-6596/1823/1/012060

[7] Tong, T., Chen, F.L., Chen, C.C., Lin, Y.W. (2021). The impacts of an occupational health and safety course on college students. Taiwan Public Health, 40(1): 55-71. https://doi.org/10.6288/TJPH.202102_40(1).109048

[8] Aram, S.A., Saalidong, B.M., Appiah, A., Utip, I.B. (2021). Occupational health and safety in mining: Predictive probabilities of Personal Protective Equipment (PPE) use among artisanal goldminers in Ghana. PLoS ONE, 16(9): 1-15. https://doi.org/10.1371/journal.pone.0257772

[9] Karol, R. (2022). Calculation of the dangerous failure rate of the safety function. Applied Sciences, 12(5): 1-15. https://doi.org/10.3390/app12052382

[10] Rizki, M., Suhardi, B. (2021). Literature review: Macroergonomics in the industry of transportation. Asian Journal of Social Science and Management Technology, 3(6): 135-141.

[11] Xie, L. (2019). Operational data-driven prediction for failure rates of equipment in safety instrumented systems: A case study from the oil and gas industry. Journal of Loss Prevention in the Process Industries, 60: 96-105. https://doi.org/10.1016/j.jlp.2019.04.004

[12] Wahono, R. (2015). A systematic literature review of software defect prediction: Research trends, datasets, methods and frameworks. Journal of Software Engineering, 1(1): 1-16.

[13] Fitriani, D., Putra, A. (2022). Systematic literature review (SLR): Eksplorasi Etnomatematika pada makanan tradisional. Journal of Mathematics Education and Learning, 2(1): 18-26. https://doi.org/10.19184/jomeal.v2i1.29093

[14] Cahyono, W.N. (2021). Finding novelty of research with systematic literature mapping (SLM) finding novelty of research with systematic literature mapping (SLM). Journal of Physics: Conference Series, 1764: 012186. https://doi.org/10.1088/1742-6596/1764/1/012186

[15] Ketenagakerjaan, I. (2022). Profil Keselamatan dan Kesehatan Kerja Nasional Indonesia Tahun 2022. https://satudata.kemnaker.go.id/publikasi/75.

[16] Qurtubi, Yudhistira, G.A., Febrianti, M.A., Rachmadewi, I.P., Purnomo, H. (2022). The role of e-commerce: A systematic literature review. International Journal of Interactive Mobile Technologies, 16(13): 118-129. https://doi.org/10.3991/ijim.v16i13.30611

[17] Salaheldine, A., Salem, M., Farag, H. (2020). Applying LOPA and fuzzy logic to identify SIL requirement for safety critical functions in a direct reduction iron industry. Alexandria Engineering Journal, 59(5): 3575-3585. https://doi.org/10.1016/j.aej.2020.06.003

[18] Penelas, A.D.J., Pires, J.C.M. (2021). HAZOP analysis in terms of safety operations processes for oil production units: A case study. Applied Sciences, 11(21): 10210. https://doi.org/10.3390/app112110210

[19] Anizar, S.L.S., Siahaan, J.R.H., Pasha, T., Romadhan, A.P. (2022). Analisis pengelolaan limbah cair pada instalasi pengolahan air limbah (IPAL) dengan metode macroergonomics analysis and design (MEAD). TALENTA Conference Series, 5(2): 702-710.

https://doi.org/10.32734/ee.v5i2.1639

[20] Fotiadis, S., Evangelinos, K.I., Konstantakopoulou, F., Nikolaou, I.E. (2023). Assessing CSR reports of top UK construction companies: The case of occupational health and safety disclosures. Sustainability, 15(8): 6952. https://doi.org/10.3390/su15086952

[21] Fu, J., Li, H.H., Chi, Y.J., Zhen, J., Xu, X.F. (2021). SIL evaluation and sensitivity study of diverse redundant structure. Reliability Engineering and System Safety, 210: 107518. https://doi.org/10.1016/j.ress.2021.107518

[22] Purnamawatia, I.G.A., Utama, M.S., Suartana, I.W., Marhaeni, A.A.I.N. (2021). Financial education, psychological and spiritual on financial behavior. Turkish Journal of Computer and Mathematics Education, 12(12): 2932-2944. https://doi.org/10.17762/turcomat.v12i12.7966

[23] Peserico, G., Morato, A., Tramarin, F. (2021). Functional Safety networks and protocols in the industrial internet of things era. Sensors, 21(18): 6073. https://doi.org/10.3390/s21186073

[24] Schmidt, K., Holtermann, A., Jorgensen, M.B., Svendsen, M.J., Rasmussen, C.D.N. (2021). Developing a practice and evidence-based guideline for occupational health and safety professionals to prevent and handle musculoskeletal pain in workplaces. Applied Ergonomics, 97: 103520. https://doi.org/10.1016/j.apergo.2021.103520

[25] Lovas, S., Nagy, K., Sandor, J., Adam, B. (2021). Presumed exposure to chemical pollutants and experienced health impacts among warehouse workers at logistics companies: A cross-sectional survey. Environmental Research and Public Health, 3(6): 7052. https://doi.org/10.3390/ijerph18137052

[26] Havish, F.P.A., Putra, B.I. (2022). Design of work systems in air cooler production using work load analysis (WLA) and macroergonomic analysis and design (MEAD) methods at PT GIJ. Procedia of Engineering and Life Science SENASAINS, 2(2). https://doi.org/10.21070/pels.v2i2.1291

[27] Djaelani, M., Retnowati, E. (2023). Pengaruh pengawasan kerja dan penerapan program keselamatan dan kesehatan kerja konstruksi. Jurnal Satyagraha, 5(2): 32-38. https://doi.org/10.47532/jis.v5i2.481

[28] Molewa, M.L. (2021). Assessment of occupational health and safety practices at government mortuaries in Gauteng Province: A cross-sectional study. Pan African Medical Journal, 38(76): 1-11. https://doi.org/10.11604/pamj.2021.38.76.21699

[29] Ivanov, V. (2019). Construction of methods for ensuring the required level of safety integrity in the automated systems of control over technological processes. Eastern-European Journal of Enterprise Technologies, 6(2): 70-78. https://doi.org/10.15587/1729-4061.2019.187716

[30] Gabbar, H.A., Othman, A.M., Abdussami, M.R. (2021). Review of battery management systems (BMS) development and industrial standards. Technologies, 9(2): 28. https://doi.org/10.3390/technologies9020028

[31] Mahmoudi, J. (2021). SIL analysis of subsea control system components based on a typical OREDA database. Wiley, 37(8): 3297-3313. https://doi.org/10.1002/qre.2909

[32] Kilay, A.L., Simamora, B.H., Putra, D.P. (2022). The influence of E-payment and E-commerce services on supply chain performance: Implications of open

innovation and solutions for the digitalization of micro, small, and medium enterprises (MSMEs) in Indonesia. Journal of Open Innovation, 8(3): 119. https://doi.org/10.3390/joitmc8030119

[33] Tian, W., Zhang, S., Cui, Z., Liu, Z., Wang, S., Zhao, Y., Zou, H. (2021). A fault identification method in distillation process based on dynamic mechanism analysis and signed directed graph. Processes, (9): 229. https://doi.org/10.3390/pr9020229

[34] Ali, F.H., Liaqat, F., Azhar, S., Ali, M. (2021). Exploring the quantity and quality of occupational health and safety disclosure among listed manufacturing companies: Evidence from Pakistan, a lower-middle income country. Safety Science, 143: 105431. https://doi.org/10.1016/j.ssci.2021.105431

[35] Negari, N.L., Riski, A., Pradjaningsih, A., Kamsyakawuni, A. (2022). Decision-making using fuzzy TOPSIS for selecting beginner UMKM that receive business funding. Journal of Physics: Conference Series ICCGANT, 2157: 012021. https://doi.org/10.1088/1742-6596/2157/1/012021

[36] Masoku, H., Parung, H., Latief, R.U., Arifuddin, R. (2021). The Measurement of proaktive and reaktive performance towards occupational health and safety program. IOP Conf. Series: Earth and Environmental Science GIESED, 921: 012081. https://doi.org/10.1088/1755-1315/921/1/012081

[37] Inoue, S., Fujiwara, T., Yamada, S. (2021). Application of software reliability model for safety assessment of E / E / PE safety-related software. International Journal of Mathematical, Engineering and Management Sciences, 6(4): 1044-1054. https://doi.org/10.33889/IJMEMS.2021.6.4.061

[38] Putro, D.S. (2023). Strategi Perbaikan implementasi manajemen keselamatan dan kesehatan kerja (K3) TPAS wisata edukasi talang agung kabupaten malang. Serambi Engineering, 6(3): 2017-2023.

[39] Putri, D.S.B., Wahyudin, W., Hamdani, H. (2021). Analisis sistem kerja untuk meningkatkan produktivitas pegawai negeri sipil dengan pendekatan macroergonomic analysis and design. Serambi Engineering, 6(4): 2449-2458. https://doi.org/10.32672/jse.v6i4.3521

[40] Suhartono, R., Suhendar, E., Wibisono, D. (2022). Analisis dan desain meja kerja menggunakan macroergonomic analysis and design pada PT. Control systems para nusa, Jurnal Teknologi dan Manajemen, 2(2): 81-88. https://doi.org/10.52330/jtm.v20i2.39

[41] Ahluwalia, L., Nani, D.A., Sari, T.D.R. (2022). Merk produk dan penyusunan laporan keuangan di pekon panggungrejo, kabupaten pringsewu. Journal of Technology and Social for Community Service (JTSCS), 3(1): 38-42. https://doi.org/10.33365/jsstcs.v3i1.1739

[42] Idris, I., Rini, I., Widyarti, E.T. (2021). The mediating role of MSME's growth on financial inclusion. Academy of Entrepreneurship Journal, 27(4): 1-11.

[43] Aqil, M., Hur, J. (2021). Multiple sensor fault detection algorithm for fault tolerant control of BLDC motor. Electroniecs, 10(9): 1038. https://doi.org/10.3390/electronics10091038

[44] Undari, W., Lubis, A.S. (2021). Usaha mikro kecil dan menengah (umkm) dalam meningkatkan kesejahteraan masyarakat 1,2. Jurnal Penelitian Pendidikan Sosial Humaniora, 6(1): 32-38.

[45] Kosmowski, K.T., Piesik, E., Piesik, J., Sliwinski, M. (2022). Integrated functional safety and cybersecurity evaluation in a framework for business continuity management. Energies, 15(10): 3610. https://doi.org/10.3390/en15103610

[46] Szurgacz, D., Zhironkin, S., Cehlár, M., Vöth, S., Spearing, S., Ma, L. (2021). A step-by-step procedure for tests and assessment of the automatic operation of a powered roof support. Energies, 14(3): 697. https://doi.org/10.3390/en14030697

[47] Putra, A.B., Putra, B.A., Suhendra, A., Arumsari, P. (2021). Analysis on risk management of occupational health and safety on ongoing building project. IOP Conference Series: Earth and Environmental Science, 794: 012025. https://doi.org/10.1088/1755-1315/794/1/012025

[48] Mahfirah'eni, R., Suhardi, B. (2021). Implementation of macroergonomics in human safety. Asian Journal of Social Science and Management Technology, 3(6): 151-155.

[49] Nurjaman, J., Agustina, S., Kosimaningrum, W.E. (2021). Studi analisis risiko pada fasilitas pencampuran dan pengisian di industri minyak pelumas menggunakan integrasi hazop (hazard and operability) dengan lopa (layer of protection analysis). Jurnal Integrasi Proses, 10(2): 109-111. https://doi.org/10.36055/jip.v10i2.11782

[50] Kusuma, R.J., Priyanto, B. (2023). Analysis of the level of occupational safety and health (OSH) risk in the Surakarta furniture center building project. International Research Journal of Innovations in Engineering and Technology (IRJIET), 7(4): 11-17. https://doi.org/10.47001/IRJIET/2023.704003

[51] Csath, M. (2021). Crisis situations: how should micro, small and medium enterprises handle them with a long term view? Development And Learning Inorganizations: An International Journal, 35(3): 10-12. https://doi.org/10.1108/DLO-04-2020-0086

[52] Molewa, M.L. (2021). Assessment of occupational health and safety practices at government mortuaries in Gauteng Province: A cross-sectional study. Pan African Medical Journal, 38(76): 1-11. https://doi.org/10.11604/pamj.2021.38.76.21699

[53] Azarys., N.T., Soejanto, I., Lucitasari, D.R. (2022). Work system improvement using macroergonomic analysis and design (MEAD). In Proceedings of International Conference on Engineering Optimization and Management in Industrial Applications (ICEOMIA 2022), Yogyakarta, Indonesia, pp. 134-143.

[54] Evangelinos, K., Skoulouddis, A., Jones, N., Isaac, D., Sfakianaki, E. (2023). Exploring the status of corporate social responsibility disclosure in the UK building and construction industry. International Journal of Global Environmental Issues, 15(4): 377-399. https://doi.org/10.1504/IJGENVI.2016.081068

[55] Srinivasan, S., Ramesh, T., Paccapeli, R., Fanucci, L. (2022). Industrial functional safety assessment for WSN using QoS metrics. Heliyon, 8(11): e11255. https://doi.org/10.1016/j.heliyon.2022.e11255

[56] Maesy, M., Nyrgrahaeni, N., Hadisupadmo, S., Widyotriatmo, A. (2018). Perancangan dan implementasi safety instrumented system pada miniatur pasteurisasi menggunakan programmable logic

controller abstrak pendahuluan teori dasar. Jurnal Otomasi Kontrol Dan Iistrumentasi, 10(1): 15-27. https://doi.org/10.5614/joki.2018.10.1.2

[57] Eliasson, K., Dahlgren, G., Hellman, T., Lewis, C., Palm, P., Svartengren, M., Nyman, T. (2021). Company representatives' experiences of occupational health surveillance for workers exposed to hand-intensive work: A qualitative study. Environmental Research and Public Health, 18(4): 1-19. https://doi.org/10.3390/ijerph18042018

[58] Farid, M., Anggraini, W.C. (2021). Analisis keselamatan dan kesehatan kerja (K3) menggunakan metode hazard and operability (studi kasus. PT. igasar). Jurnal Teknologi dan Informasi Bisnis, 3(1): 223-227. https://doi.org/10.47233/jteksis.v3i1.218

[59] Purba, S.U., Sukwika, T. (2021). The influence of the occupational safety and health program against work productivity in the project division. Journal of Applied Management Research, 1(1): 65-77. https://doi.org/10.36441/jamr.v1i1.260

[60] Waterson, P., Robertson, M.M., Kleiner, B.M., Ramly, E., Rogers, C.C. (2022). Innovative macroergonomic approaches: Responsibilities. Opportunities, and Challenges, In Proceedings of the 2022 HFES 66th International Annual Meeting, pp. 631-635.

[61] Bsiss, M., Nadir, F.E., Amami, B. (2022). Safety integrity level of shut-off valve in a burner management system. E3S Web of Conferences ICIES, 351: 01010. https://doi.org/10.1051/e3sconf/202235101010

[62] Lestari, S.A., Huda, L.N., Ginting, R. (2023). Macro ergonomic analysis and design for optimizing the work environment: A literature review. Jurnal Sistem Teknik Industri (JSTI), 25(1): 56-64. https://doi.org/10.32734/jsti.v25i1.9286

[63] Sukwika, T., Pranata, H.D. (2022). Analisis keselamatan dan kesehatan kerja bidang freight forwader menggunakan metode HIRADC. Jurnal Teknik, 20(1): 1-13. https://doi.org/10.37031/jt.v20i1.182

[64] Padhil, A., Purnomo, H. (2018). Macroergonomic approaches as a solution to local wisdom-based tourist village development planning. InMATEC Web of Conferences 2018, 154: 01080. https://doi.org/10.1051/matecconf/201815401080