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Dominant Factor Causing Work Accidents Based On The Loss Causation Model At Pt. Barata Indonesia

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ABSTRACT

Production activities in each industrial environment have risks of occupational hazards. Reports of work accident cases in Indonesia in the manufacturing industry sector over the last two years have increased from 114,000 cases in 2019 to 177,000 cases in 2020. Work accident investigation at PT. Barata Indonesia in 2022-2023 of the 626 workers, there were 6% of work accident cases. The loss causation model theory is a development of work accident theory at management factors to human factors or workers who are directly involved with materials. The research aims to analyze the dominant factors that most influence work accidents at PT. Barata Indonesia. Type of quantitative research with analytical observational research methods (cross-sectional). The research sample was 308 workers at PT Barata Indonesia. The data analysis used was chi-square and logistic regression. The result of this study is that the dominant factor that has the most influence on work accidents at PT Barata Indonesia is the immediate cause factor, namely compliance with work instructions with a significance of $0.002 < 0.05$, and a coefficient value of 2,124, and a CI: 1,304-3,460, meaning that there is a influence between compliance with work instructions on work accidents and a chance of getting a work accident 2 times higher when not complying with work instructions. Therefore, some preventive efforts are needed to prevent work accidents, especially in the manufacturing industry.

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INTRODUCTION

Production activities in industrial environments have a risk of danger due to work activities, so every company is obliged to implement Occupational Safety and Health to create a safe and comfortable workplace to reduce the number of work accidents (1). According to the ILO (International Labor Organization) in 2018, data on work accident deaths on the Pacific and Asian continents was 1.8 million people died and 374 million people were injured due to work. As a result, as many as 2.78 million workers die and 2.4 million suffer from occupational diseases every year, and as many as 380,000 suffer work accidents (2).

Based on data from the National Social Security Administering Agency (BPJS) for employment from 2019 to 2021, there was an increase in work accident cases. Data on work accident cases in the manufacturing industry sector in the last two years has increased by 55.2% from 114,000 cases in 2019 to 177,000 cases in 2020 (3). Based on BPJS Employment data from East Java province in 2018, claims due to work accidents were 27,461 cases and increased in 2019 to 30,835 cases with an additional compensation value of 25.83% (4).

Work accidents have several theories which have been developed sequentially. One of the well-known theories is the loss causation model theory by Frank E. Bird and Germain, this theory identifies management, basic causes, direct causes, contact events, and losses (5). Based on the development of work accident theories, the loss causation model theory is a complete theory for identifying work accidents by looking at management factors to human factors or workers who are directly involved with materials.

Based on a review of previous research by Wang J and Yan M (2019), related to the analysis of accident cases with better application models, work accident cases that commonly occur in industry are oil leaks and pipe explosions at Sinopec Donghuang, China. The loss causation model theory can show the source of the direct causes of work accidents down to the root causes of work accidents in sequence. This model provides a clear and useful method for safety practitioners and risk tools in conducting accident investigations and analysis so that organizations can use it as a tool to control work accidents (6),.

In research conducted by Naufal, Sulistiawati, and Wahyuni (2022) regarding the role of health workers in reducing the number of industrial work accidents through the stages of the work accident cause model, with this stage health workers are able to control work accidents, especially promotive and preventive measures and against the influence of policy making related to industrial Occupational Safety and Health (7). Therefore, this theory can identify the source of causes of work accidents.

PT. Barata Indonesia is a State-Owned Enterprise (BUMN) company that focuses on the food, energy and water processing industries. PT. Barata Indonesia allocates all the resources needed to achieve the implementation of an integrated management system which is guided by Indonesian Government Regulation PP No. 50 of 2012 Occupational Safety & Health Management System (SMK3). Based on data from work accident investigation reports at PT. Barata Indonesia in 2022 to 2023, out of 626 workers there were 6% work accidents. These work accident cases are 2% Medical Treatment Cases (MTC), 2% First Aid Cases (FAC), 0.5% Traffic Accidents (TA), 1% Property Damage (PD) cases, and 0.5% Environmental damage. (ED) case. The work accident cases that occurred resulted in the loss of 392 working hours and 49 lost working days.

Based on the results of interviews conducted with the occupational safety and health and environmental team in the factory area, work accidents were caused by several factors, namely lack of supervision by management regarding overtime working hours, inadequate occupational health and safety programs and inadequate delivery of information in them. Overall, job demands are still high so the number of incidents of unsafe acts and unsafe conditions is still high. If linked to the theory of causes of loss, then the chronology model of work accidents that occur at PT. Barata Indonesia starts from point one The lack of control factor is because workers often work overtime hours of more than 12 hours a day which can increase the occurrence of work accidents if supervision by management is not included in a standardized occupational health and safety program, the occupational health and safety information conveyed through the program is not evenly distributed over one shift so that workers' understanding of occupational health and safety not implemented well. The second point is the basic cause factor in terms of high job demands so that occupational health and safety is often ignored when doing work. The third point is the direct causal factor resulting from worker behavior and environmental conditions when ignoring occupational health and safety.

Corrective action that can be taken to prevent work accidents is to analyze more deeply the series of sources that cause work accidents with the aim of controlling work accidents that cause losses so that they can be avoided in order to optimize the Occupational Safety and Health policies that have been established at PT. Barata Indonesia.

METHOD

Quantitative research with analytical observational research methods (cross-sectional). The research sample used a simple random sampling technique, namely all levels of workers at PT. Barata Indonesia as many as 308 workers who met the inclusion criteria as research samples, namely workers who were healthy and willing to be respondents in research and workers who were able to contribute and communicate well. And the exclusion criteria in this study were workers who did not come to work because they were on leave or sick. The instrument used in this research was filling out a questionnaire to obtain data regarding lack of control factors, basic cause factors, and immediate cause factors. The questionnaire used in the research has been tested for validity and reliability with the overall results of the variables being valid (0.4438) and reliable (>0.60). The data analysis used is in the form of non-parametric statistical tests, namely chi-square statistical tests and logistic regression statistical tests using the SPSS version 26 computer program. Research ethical feasibility has been obtained from the Research Ethics Committee of the Faculty of Health, Muhammadiyah University of Gresik with number: 255/KET/ II .3.UMG/KEP/A/2023.

RESULTS
Univariate Analysis

Tabel 1. Frequency Distribution of Worker Characteristics

Characteristics	f	%
Age		
17-25 years old	40	13,0
26-30 years old	126	40,9
31-40 years old	114	37,0
41-64 years old	28	9,1
> 65 years old	0	0
Education		
Elementary School	2	0,6
Junior High School	18	5,8
Senior High School	204	66,2
Diploma	33	10,7
Bachelor	51	16,6
Length of Service		
New < 3 years old	197	64,0
Old > 3 years old	111	36,0

Based on Table 1, it shows that of the total number of 308 workers, the age characteristics of workers resulted in the majority being workers aged 26-30 years with a percentage of 40.9%, and no workers aged > 65 years 0% were found. So it is included in the productive working age.

The educational characteristics of workers produce the most workers with senior high school education with a percentage of 66.2%, and the fewest workers with elementary school education with a percentage of 0.6%. So it is included in the higher education level.

The characteristics of workers length of service resulted in the greatest number of workers with a new length of service < 3 years with a percentage of 64% and workers with a old length of service > 3 years with a percentage of 36%. So it is included in the new length of service.

Tabel 2. Frequency Distribution of Workers Based on Research Variables

Variabels	f	%
Occupational Health and Safety Program		
Adequate	119	38,6
Inadequate	189	61,4
Occupational Health and Safety Standard		
Adequate	189	61,4
Inadequate	119	38,6
Roles and Responsibilities		
Clarity	151	49,0
Obscurity	157	51,0
Occupational Health and Safety Knowledge		
Good	136	44,2
Not Good	172	55,8
Work Training		
Applied	163	52,9
Not Applied	145	47,1
Maintenance of Work Equipment		
Applied	167	54,2
Not Applied	141	45,8

Work Standard		
Appropriate	288	93,5
Not Approriate	20	6,5
Compliance with Work Instruction		
Compliance	149	48,9
Not Compliance	159	51,6
Work Accident		
Serious	130	42,2
Not Serious	178	57,8

Based on table 2, the results of data distribution from 308 workers at PT. Barata Indonesia shows that the occupational health and safety program is largely inadequate with a percentage of 61.4%. The occupational health and safety program is inadequate because there are too few in number and variety due to the program's lack of variety in scope (8).

Occupational health and safety standards are mostly adequate with a percentage of 61.4%. Good Occupational Health and Safety standards can be ensured by workers who understand the stages in carrying out work activities well and clearly so as to prevent work accidents (9).

Obscurity employee roles and responsibilities with a percentage of 51.0%. occupational health and safety roles and responsibilities are carried out by all parties in the company, from the highest level of management to workers in the field (10).

The occupational health and safety knowledge possessed by most workers is not good with a percentage of 55.8%. occupational health and safety knowledge relates to behavior towards good occupational health and safety implementation, occupational health and safety knowledge includes definitions, objectives, dangers and prevention (11).

Work training is mostly applied with a percentage of 52.9%. Based on Law Number. 13 of 2003 concerning employment, that every worker has the right to develop work competencies according to their talents, interests and abilities through work training under the responsibility of the company which is applied at the training site or at the workplace (12).

Maintenance of work equipment is mostly applied with a percentage of 54.2%. Maintenance of work tools is applied by every worker who is responsible in their field and is replaced periodically (13).

Almost all workers not appropriate work activities in accordance with work standards with a percentage of 93.5%. Appropriate work standards can increase work productivity because you can know exactly the limits of safe actions that must be taken when working (14).

Most workers do not comply with work instructions when carrying out work activities with a percentage of 51.6%. Compliance with work instructions is a matter of orders that already exist and are mutually agreed upon (15).

Most workers experienced not serious work accidents with a percentage of 57.8%. Work accidents that result in losses for workers such as minor injuries can cause the loss of one day of work, moderate injuries can cause the loss of two days of work, serious injuries can cause the loss of more than two days of work, death can cause loss of public trust and loss of the company's good name as a result. fatal work accident (16).

Bivariate Analysis

Tabel 3. Relationship between the Occupational Health and Safety Program and Work Accidents

Occupational Health and Safety Program	Work Accident				Total	
	Serious		Not Serious			
	f	%	f	%	f	%
Adequate	41	31,5	78	43,8	119	61,4
Inadequate	89	68,5	100	56,2	189	38,6
Total	130	100	178	100	308	100
P-value			0,039			

Based on table 3, the results of the analysis of the relationship between the occupational health and safety program and work accidents show that the majority of occupational health and safety programs that are can cause work accidents are not serious (43.8%). Meanwhile, inadequate occupational health and safety programs mostly cause serious work accidents (68.5%). The p-value is 0.039 < 0.05, meaning there is a

relationship between the occupational health and safety program and work accidents.

Tabel 4. Relationship between Occupational Health and Safety Standards and Work Accidents

Occupational Health and Safety Standards	Work Accident				Total	
	Serious		Not Serious			
	f	%	f	%	f	%
Adequate	81	62,3	108	60,7	189	61,4
Not Adequate	49	37,7	70	39,3	119	38,6
Total	130	100	178	100	308	100
P-value	0,863					

Based on table 4, the results of the analysis of the relationship between occupational health and safety standards and work accidents show that inadequate occupational health and safety standards mostly cause work accidents that are not serious (39.3%). Meanwhile, adequate occupational health and safety standards mostly cause serious work accidents (62.3%). The p-value is $0.863 > 0.05$, meaning there is no relationship between occupational health and safety standards and work accidents.

Tabel 5. Relationship between Roles and Responsibilities with Work Accidents

Roles and Responsibilities	Work Accident				Total	
	Serious		Not Serious			
	f	%	f	%	f	%
Clarity	74	56,9	77	43,3	151	49,0
Obscurity	56	43,1	101	56,7	157	51,0
Total	130	100	178	100	308	100
P-value	0,024					

Based on table 5, the results of the analysis of the relationship between roles and responsibilities and work accidents, Obscurity roles and responsibilities mostly cause work accidents that are not serious (56.7%). Meanwhile, clarity of roles and responsibilities mostly causes serious work accidents (56.9%). The p-value is $0.024 < 0.05$, meaning there is a relationship between roles and responsibilities and work accidents.

Tabel 6. Relationship between Occupational Health and Safety Knowledge and Work Accidents

Occupational Health and Safety Knowledge	Work Accident				Total	
	Serious		Not Serious			
	f	%	f	%	f	%
Good	45	34,6	91	51,1	136	44,2
Not Good	85	65,4	87	48,9	172	55,8
Total	130	100	178	100	308	100
P-value	0,006					

Based on table 6, the results of the analysis of the relationship between occupational health and safety knowledge and work accidents show that not good occupational health and safety knowledge mostly causes serious work accidents (65.4%). Meanwhile, good occupational health and safety knowledge mostly causes non-severe work accidents (51.1%). The p-value is $0.006 < 0.05$, meaning there is a relationship between occupational health and safety knowledge and work accidents.

Tabel 7. Relationship between Work Training and Work Accidents

Work Training	Work Accident				Total	
	Serious		Serious			
	f	%	F	%	f	%
Applied	57	43,8	106	59,6	163	52,9
Not Applied	73	56,2	72	40,4	145	47,1
Total	130	100	178	100	308	100
P-value	0,009					

Based on table 7, the results of the analysis of the relationship between work training and work accidents show that job training that is not applied mostly causes serious work accidents (56.2%). Meanwhile, most of the work training that was applied caused work accidents with non-severe conditions (59.6%) The p-value was 0.009 < 0.05, meaning there was a relationship between work training and work accidents.

Tabel 8. Relationship between Work Equipment Maintenance and Work Accidents

Maintenance of Work Equipment	Work Accident				Total	
	Serious		Not Serious			
	f	%	F	%	f	%
Applied	74	56,9	93	52,2	167	54,2
Not Applied	56	43,1	85	47,8	141	45,8
Total	130	100	178	100	308	100
P-value	0,485					

Based on table 8, the results of the analysis of the relationship between maintenance of work equipment and work accidents show that maintenance of work equipment that is not applied mostly causes work accidents that are not serious (47.8%). Meanwhile, most applied work equipment maintenance causes serious work accidents (56.9%). The p-value is 0.485 > 0.05, meaning there is no relationship between work equipment maintenance and work accidents.

Tabel 9. Relationship between Work Standards and Work Accidents

Work Standard	Work Accident				Total	
	Serious		Not Serious			
	f	%	f	%	f	%
Appropriate	117	90,0	171	96,1	288	93,5
Not Appropriate	13	10,0	7	3,9	20	6,5
Total	130	100	178	100	308	100
P-value	0,057					

Based on table 9, the results of the analysis of the relationship between work standards and work accidents show that workers who not appropriate work that does not comply with work standards mostly cause serious work accidents (10.0%). Meanwhile, workers who appropriate work in accordance with work standards mostly cause work accidents that are not serious (96.1%). The p-value is 0.057 > 0.05.

Tabel 10. Relationship between Compliance with Work Instructions and Work Accidents

Compliance with Work Instruction	Work Accident				Total	
	Serious		Not Serious			
	f	%	F	%	f	%
Compliance	50	38,5	109	61,2	159	51,6
Not Compliance	80	61,5	69	38,8	149	48,4
Total	130	100	178	100	308	100
P-value	0,000					

Based on table 10, the results of the analysis of the relationship between compliance with work instructions and work accidents show that workers who do not comply with work instructions mostly cause serious work accidents (61.5%). Meanwhile, workers who comply with work instructions mostly cause non-severe work accidents (61.2%). The p-value is 0.000 < 0.05, meaning there is a relationship between compliance with work instructions and work accidents.

Tabel 11. Bivariate Selection

Factors	Independent Variabels	P-value	OR	CI 95%	Information
(Lack of Control)	Occupational Health and Safety Program	0,039	1,693	1,054-2,719	Qualify
	Occupational	0,863	0,933	0,586-1,486	Not Qualify

	Health and Safety Standard				
	Roles and Responbilities	0,024	0,577	0,365-0,911	Qualify
(Basic Cause)	Occupational Health and Safety Knowledge	0,006	1,976	1,240-3,148	Qualify
	Work Training	0,009	1,885	1,193-2,980	Qualify
	Maintenance of Work Equipment	0,485	0,828	0,525-1,305	Not Qualify
	Work Standard	0,057	2,714	1,051-7,008	Qualify
(Immediate Cause)	Compliance with Work Instruction	0,000	2,528	1,588-4,022	Qualify

Based on the table above, information is obtained that there are 6 independent variables that meet the requirements to be included as qualify in the logistic regression statistical test with a p-value < 0.25, including (lack of control), namely the occupational health and safety program, roles and responsibilities, basic causes, namely occupational health and safety knowledge, work training and work standards, immediate causes namely compliance with work instructions.

Multivariate Analysis

Tabel 12. Multivariate Analysis Result

Independent Variabels	P-Value	OR	95%(Cl)	Information
Occupational Health and Safety Program	,168	1,423	0,862-2,347	Not significant
Roles and Responbilities	,030	,589	0,365-0,950	Significant
Occupational Health and Safety Knowledge	,096	1,524	0,928-2,506	Not significant
Work Training	,161	1,421	0,870-2,320	Not significant
Work Standard	,195	1,972	0,707-5,504	Not significant
Compliance with Work Instruction	,002	2,124	1,304-3,460	Significant

Based on the table above, information is obtained that the results of the logistic regression test analysis of 6 independent variables that influence work accidents, the variable compliance with work instructions is the most dominant variable for work accidents with a significance value of 0.002, meaning the greater the compliance with work instructions that are not implemented when preparation for work, while working, and after work will increase the risk of work accidents. The OR value is 2.124 (95% CI: 1.304-3.460), meaning that compliance with work instructions that are not implemented has a 2.12 chance of causing work accidents. Therefore, clarity in the roles and responsibilities of management is needed as an effort to increase workers compliance with work instructions according to their respective work areas to prevent work accidents.

DISCUSSION
Relationship between Lack of Control Factors and Work Accidents at PT Barata Indonesia

Occupational Health and Safety Programs, has an important role in increasing work productivity, an adequate occupational health and safety program is proven by the availability of work safety facilities for its good implementation (17). The results of this research show that the occupational health and safety program has an influence on accidents work, and an OR value of 1.693 (95%CI: 1.054-2.719) meaning that an inadequate occupational health and safety program has a 1.69 times greater chance of experiencing a work accident. Elements of the success of the occupational health and safety program according to Hidayanti (2023) include: leadership and supervision, Personal Protective Equipment (PPE), occupational health and safety management training, occupational health and safety inspections, work inspections, occupational health and safety program evaluation, work procedures and analysis, work control, accident investigation, preparedness emergency response (emergency preparedness), promotion of occupational health and safety, and safety outside of work (18).

Roles and Responbilities, on this variable, the research results show that there is an influence of roles and responsibilities on work accidents, and the OR value is 0.577 with (95%CI: 0.365-0.911) meaning that obscurity roles and responsibilities have a 0.57 times greater chance of experiencing a work accident. According to research Prastawa (2021) that the roles and responsibilities of occupational health and safety are supported by management in ensuring clarity and authority over its implementation (19). This is in line with research Boudreau (2020) that the clarity of occupational health and safety roles and responsibilities is supported by the role of management as a manifestation of fulfilling workers' rights to safety in the work environment (20). Management's commitment to clarifying occupational health and safety roles and responsibilities influences the prevention of work accidents and the productivity of 85 workers with a p-value of 0.003 < 0.05 (21). According to Yong (2019) that the roles and responsibilities for implementing occupational health and safety apply to all workers in various environmental fields to maintain and care for environmental conditions so that they are not dangerous, in the health sector to avoid work-related diseases and in the safety sector to prevent work accidents, so that with clarity of roles and responsibilities there will be no work accidents (22).

Relationship between Basic Cause Factors and Work Accidents at PT Barata Indonesia

Knowledge Occupational Health and Safety, in this variable, the research results show that there is an influence of occupational health and safety knowledge on work accidents, and the OR value is 1.976 with (95% CI: 1.240-3.148) meaning that a not good occupational health and safety knowledge has a 1.97 times greater chance of experiencing a work accident. According to research Getuli (2020) that increasing occupational health and safety knowledge is by utilizing advanced information technology such as building information modeling (BIM) and virtual reality (VR) which are used simultaneously (23). This is in line with research Butt J (2020) that occupational health and safety knowledge based on manufacturing digitalization can increase professional performance and reduce costs (24). The use of technology as a form of development in preventing work accidents through occupational health and safety visualization is known to increase occupational health and safety knowledge (25).

Work Training, In this variable, the research results show that there is an influence of work training on work accidents, and the OR value is 1.885 with (95% CI: 0.193-2.980) meaning that work training that is not applied out has a 1.88 times greater chance of experiencing a work accident. According to research Peres (2019) that work training in industry 4.0 based on virtual reality (VR) replaces real sensory perception with computer perception in 3D object animation, the results show that there is an increase in immersive experience (26). This is in line with research Doolani (2020) that in work training using VR, workers can simulate or practice directly planning accident hazards to fail safely so that VR training can influence changes in worker behavior (27). VR-based work training has been proven to effectively and efficiently save time and costs with the concept of learning to see, listen and do (28).

Work Standards, In this variable, the research results show that there is an influence of work standards on work accidents, and the OR value is 2.714 with (95%CI: 1.051-7.008) meaning that work standards that are not appropriate have a 2.71 times greater chance of experiencing a work accident. Work standards are influenced by management in utilizing technology through digital transformation of work standards (29). This is in line with research Agasva and Budiantoro (2020) that work standards influence the quality and performance of companies in achieving occupational health and safety success (30). Utilization of technology in creating work standards using work domain analysis that can be used long term, reform and design of work standards covering 90 system objects, processes, functions, measures and objectives, the gap between mandatory and optional (31). Work standards influence workers' safety and welfare motivation, improvement is carried out by giving reminders to workers to make the best use of holidays without thinking about work (32). This is in line with research Rakhmanita, Tri and Anggraini (2019) that work standards are part of the company's work culture (33). Evaluation of work standards needs to be carried out with the aim of improving work standards based on relevant regulations, management commitment and the opinions of workers (34).

Relationship between Immediate Cause Factors and Work Accidents at PT Barata Indonesia

Compliance with Work Instructions, in this variable the research results show that there is an influence of compliance with work instructions on work accidents, and the OR value is 2.528 (95%CI: 1.588-4.022) meaning that workers who do not comply with work instructions that are not carried out have a 2 chance. 52 times more likely to experience a work accident. According to research Pimminger (2021) compliance with work instructions can be improved through digital instructions, namely the industrial internet of things, as a result, work instructions can be well structured and increase worker discipline (35). This is in line with research Juan (2021) that compliance with work instructions is a form of worker discipline and responsibility in implementing occupational health and safety while working (36) that. Worker discipline is influenced by strict supervision and sanctions from the authorities (37). Compliance with work instructions is influenced by work safety motivation with the availability of adequate work instructions (38).

Dominant Factors That Influence Work Accidents

Multivariate analysis was carried out to find out which factors were the most influential among the factors related to work accidents. The direct cause factor, namely compliance with work instructions, is the dominant factor that has the most influence on work accidents at PT. Barata Indonesia. Compliance with work instructions with a significance value of 0.002 < 0.05, and a coefficient value of 2.124 and CI: 1.304-3.460 means that there is an influence between compliance with work instructions on work accidents and the chance of experiencing a work accident is 2 times higher when you do not comply with work instructions.

Based on Law No.01 of 1970 concerning Work Safety, compliance with work instructions is an effort to prevent work accidents (39). This is in line with research Susanto, Restiaty, and Nopiyanti Evi (2023) that occupational health and safety promotion is an effort to implement an occupational health and safety culture by ensuring workers always comply with behavior according to work processes so that work accidents do not easily occur (40).

CONCLUSION

The conclusion of this research is that the factors that influence work accidents at PT. Barata Indonesia is a lack of control factor, namely the occupational health and safety program, and roles and responsibilities, a basic cause factor, namely occupational health and safety knowledge, and job training, and a direct cause factor (immediate cause), namely compliance with work instruction. The dominant factor that most influences work accidents at PT. Barata Indonesia is the direct cause factor, namely compliance with work instructions. The results of this study show a relationship between compliance with work instructions and work accidents, where the chance of experiencing a work accident is 2 times higher when you do not comply with work instructions.

RECOMMENDATION

It is hoped that PT. Barata Indonesia in order to increase workers compliance with work instructions by promoting occupational health and safety in the form of print and electronic media that are adapted and placed in each work area, safety motivation and providing adequate work instructions by utilizing technological and PT. Barata Indonesia must always carry out roles and responsibilities in accordance with their respective fields of work.

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