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Research Design and Methodology

Kassu Jilcha Sileyew

Abstract

There are a number of approaches used in this research method design. The purpose of this chapter is to design the methodology of the research approach through mixed types of research techniques. The research approach also supports the researcher on how to come across the research result findings. In this chapter, the general design of the research and the methods used for data collection are explained in detail. It includes three main parts. The first part gives a highlight about the dissertation design. The second part discusses about qualitative and quantitative data collection methods. The last part illustrates the general research framework. The purpose of this section is to indicate how the research was conducted throughout the study periods.

Keywords: research design, methodology, sampling, data sources, population, workplace

1. Introduction

Research methodology is the path through which researchers need to conduct their research. It shows the path through which these researchers formulate their problem and objective and present their result from the data obtained during the study period. This research design and methodology chapter also shows how the research outcome at the end will be obtained in line with meeting the objective of the study. This chapter hence discusses the research methods that were used during the research process. It includes the research methodology of the study from the research strategy to the result dissemination. For emphasis, in this chapter, the author outlines the research strategy, research design, research methodology, the study area, data sources such as primary data sources and secondary data, population consideration and sample size determination such as questionnaires sample size determination and workplace site exposure measurement sample determination, data collection methods like primary data collection methods including workplace site observation data collection and data collection through desk review, data collection through questionnaires, data obtained from experts opinion, workplace site exposure measurement, data collection tools pretest, secondary data collection methods, methods of data analysis used such as quantitative data analysis and qualitative data analysis, data analysis software, the reliability and validity analysis of the quantitative data, reliability of data, reliability analysis, validity, data quality management, inclusion criteria, ethical consideration and dissemination of result and its utilization approaches. In order to satisfy the objectives of the study, a qualitative and quantitative research method is apprehended in general. The study used these mixed strategies because the data were obtained from all aspects of the data source during the study time. Therefore, the purpose of this methodology is to satisfy the research plan and target devised by the researcher.

2. Research design

The research design is intended to provide an appropriate framework for a study. A very significant decision in research design process is the choice to be made regarding research approach since it determines how relevant information for a study will be obtained; however, the research design process involves many inter-related decisions [1].

This study employed a mixed type of methods. The first part of the study consisted of a series of well-structured questionnaires (for management, employee’s representatives, and technician of industries) and semi-structured interviews with key stakeholders (government bodies, ministries, and industries) in participating organizations. The other design used is an interview of employees to know how they feel about safety and health of their workplace, and field observation at the selected industrial sites was undertaken.

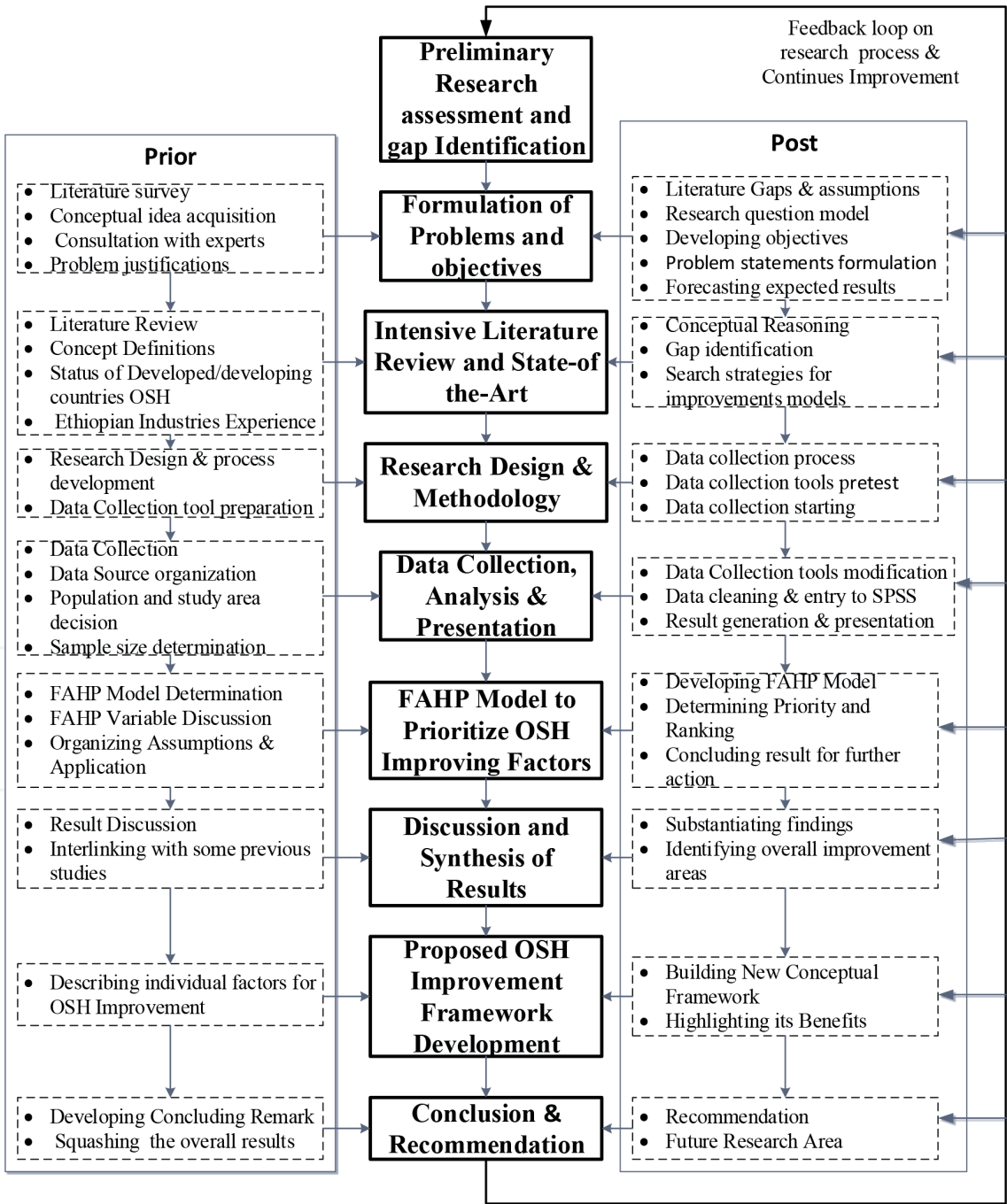


Figure 1. Research methods and processes (author design).

Hence, this study employs a descriptive research design to agree on the effects of occupational safety and health management system on employee health, safety, and property damage for selected manufacturing industries. Saunders et al. [2] and Miller [3] say that descriptive research portrays an accurate profile of persons, events, or situations. This design offers to the researchers a profile of described relevant aspects of the phenomena of interest from an individual, organizational, and industry-oriented perspective. Therefore, this research design enabled the researchers to gather data from a wide range of respondents on the impact of safety and health on manufacturing industries in Ethiopia. And this helped in analyzing the response obtained on how it affects the manufacturing industries' workplace safety and health. The research overall design and flow process are depicted in **Figure 1**.

3. Research methodology

To address the key research objectives, this research used both qualitative and quantitative methods and combination of primary and secondary sources. The qualitative data supports the quantitative data analysis and results. The result obtained is triangulated since the researcher utilized the qualitative and quantitative data types in the data analysis. The study area, data sources, and sampling techniques were discussed under this section.

3.1 The study area

According to Fraenkel and Warren [4] studies, population refers to the complete set of individuals (subjects or events) having common characteristics in which the researcher is interested. The population of the study was determined based on random sampling system. This data collection was conducted from March 07, 2015 to December 10, 2016, from selected manufacturing industries found in Addis Ababa city and around. The manufacturing companies were selected based on their employee number, established year, and the potential accidents prevailing and the manufacturing industry type even though all criterions were difficult to satisfy.

3.2 Data sources

3.2.1 Primary data sources

It was obtained from the original source of information. The primary data were more reliable and have more confidence level of decision-making with the trusted analysis having direct intact with occurrence of the events. The primary data sources are industries' working environment (through observation, pictures, and photograph) and industry employees (management and bottom workers) (interview, questionnaires and discussions).

3.2.2 Secondary data

Desk review has been conducted to collect data from various secondary sources. This includes reports and project documents at each manufacturing sectors (more on medium and large level). Secondary data sources have been obtained from literatures regarding OSH, and the remaining data were from the companies' manuals, reports, and some management documents which were included under the desk review. Reputable journals, books, different articles, periodicals, proceedings, magazines, newsletters, newspapers, websites, and other sources were considered

on the manufacturing industrial sectors. The data also obtained from the existing working documents, manuals, procedures, reports, statistical data, policies, regulations, and standards were taken into account for the review.

In general, for this research study, the desk review has been completed to this end, and it had been polished and modified upon manuals and documents obtained from the selected companies.

4. Population and sample size

4.1 Population

The study population consisted of manufacturing industries' employees in Addis Ababa city and around as there are more representative manufacturing industrial clusters found. To select representative manufacturing industrial sector population, the types of the industries expected were more potential to accidents based on random and purposive sampling considered. The population of data was from textile, leather, metal, chemicals, and food manufacturing industries. A total of 189 sample sizes of industries responded to the questionnaire survey from the priority areas of the government. Random sample sizes and disproportionate methods were used, and 80 from wood, metal, and iron works; 30 from food, beverage, and tobacco products; 50 from leather, textile, and garments; 20 from chemical and chemical products; and 9 from other remaining 9 clusters of manufacturing industries responded.

4.2 Questionnaire sample size determination

A simple random sampling and purposive sampling methods were used to select the representative manufacturing industries and respondents for the study. The simple random sampling ensures that each member of the population has an equal chance for the selection or the chance of getting a response which can be more than equal to the chance depending on the data analysis justification. Sample size determination procedure was used to get optimum and reasonable information. In this study, both probability (simple random sampling) and nonprobability (convenience, quota, purposive, and judgmental) sampling methods were used as the nature of the industries are varied. This is because of the characteristics of data sources which permitted the researchers to follow the multi-methods. This helps the analysis to triangulate the data obtained and increase the reliability of the research outcome and its decision. The companies' establishment time and its engagement in operation, the number of employees and the proportion it has, the owner types (government and private), type of manufacturing industry/production, types of resource used at work, and the location it is found in the city and around were some of the criteria for the selections.

The determination of the sample size was adopted from Daniel [5] and Cochran [6] formula. The formula used was for unknown population size Eq. (1) and is given as

$$n = \frac{Z^2 P(1-P)}{d^2} \quad (1)$$

where n = sample size, Z = statistic for a level of confidence, P = expected prevalence or proportion (in proportion of one; if 50%, $P = 0.5$), and d = precision (in proportion of one; if 6%, $d = 0.06$). Z statistic (Z): for the level of confidence of 95%, which is conventional, Z value is 1.96. In this study, investigators present their results with 95% confidence intervals (CI).

The expected sample number was 267 at the marginal error of 6% for 95% confidence interval of manufacturing industries. However, the collected data indicated that only 189 populations were used for the analysis after rejecting some data having more missing values in the responses from the industries. Hence, the actual data collection resulted in 71% response rate. The 267 population were assumed to be satisfactory and representative for the data analysis.

4.3 Workplace site exposure measurement sample determination

The sample size for the experimental exposure measurements of physical work environment has been considered based on the physical data prepared for questionnaires and respondents. The response of positive were considered for exposure measurement factors to be considered for the physical environment health and disease causing such as noise intensity, light intensity, pressure/stress, vibration, temperature/coldness, or hotness and dust particles on 20 workplace sites. The selection method was using random sampling in line with purposive method. The measurement of the exposure factors was done in collaboration with Addis Ababa city Administration and Oromia Bureau of Labour and Social Affair (AACBOLSA). Some measuring instruments were obtained from the Addis Ababa city and Oromia Bureau of Labour and Social Affair.

5. Data collection methods

Data collection methods were focused on the followings basic techniques. These included secondary and primary data collections focusing on both qualitative and quantitative data as defined in the previous section. The data collection mechanisms are devised and prepared with their proper procedures.

5.1 Primary data collection methods

Primary data sources are qualitative and quantitative. The qualitative sources are field observation, interview, and informal discussions, while that of quantitative data sources are survey questionnaires and interview questions. The next sections elaborate how the data were obtained from the primary sources.

5.1.1 Workplace site observation data collection

Observation is an important aspect of science. Observation is tightly connected to data collection, and there are different sources for this: documentation, archival records, interviews, direct observations, and participant observations. Observational research findings are considered strong in validity because the researcher is able to collect a depth of information about a particular behavior. In this dissertation, the researchers used observation method as one tool for collecting information and data before questionnaire design and after the start of research too. The researcher made more than 20 specific observations of manufacturing industries in the study areas. During the observations, it found a deeper understanding of the working environment and the different sections in the production system and OSH practices.

5.1.2 Data collection through interview

Interview is a loosely structured qualitative in-depth interview with people who are considered to be particularly knowledgeable about the topic of interest.

The semi-structured interview is usually conducted in a face-to-face setting which permits the researcher to seek new insights, ask questions, and assess phenomena in different perspectives. It let the researcher to know the in-depth of the present working environment influential factors and consequences. It has provided opportunities for refining data collection efforts and examining specialized systems or processes. It was used when the researcher faces written records or published document limitation or wanted to triangulate the data obtained from other primary and secondary data sources.

This dissertation is also conducted with a qualitative approach and conducting interviews. The advantage of using interviews as a method is that it allows respondents to raise issues that the interviewer may not have expected. All interviews with employees, management, and technicians were conducted by the corresponding researcher, on a face-to-face basis at workplace. All interviews were recorded and transcribed.

5.1.3 Data collection through questionnaires

The main tool for gaining primary information in practical research is questionnaires, due to the fact that the researcher can decide on the sample and the types of questions to be asked [2].

In this dissertation, each respondent is requested to reply to an identical list of questions mixed so that biasness was prevented. Initially the questionnaire design was coded and mixed up from specific topic based on uniform structures. Consequently, the questionnaire produced valuable data which was required to achieve the dissertation objectives.

The questionnaires developed were based on a five-item Likert scale. Responses were given to each statement using a five-point Likert-type scale, for which 1 = “strongly disagree” to 5 = “strongly agree.” The responses were summed up to produce a score for the measures.

5.1.4 Data obtained from experts’ opinion

The data was also obtained from the expert’s opinion related to the comparison of the knowledge, management, collaboration, and technology utilization including their sub-factors. The data obtained in this way was used for prioritization and decision-making of OSH, improving factor priority. The prioritization of the factors was using Saaty scales (1–9) and then converting to Fuzzy set values obtained from previous researches using triangular fuzzy set [7].

5.1.5 Workplace site exposure measurement

The researcher has measured the workplace environment for dust, vibration, heat, pressure, light, and noise to know how much is the level of each variable. The primary data sources planned and an actual coverage has been compared as shown in **Table 1**.

The response rate for the proposed data source was good, and the pilot test also proved the reliability of questionnaires. Interview/discussion resulted in 87% of responses among the respondents; the survey questionnaire response rate obtained was 71%, and the field observation response rate was 90% for the whole data analysis process. Hence, the data organization quality level has not been compromised.

This response rate is considered to be representative of studies of organizations. As the study agrees on the response rate to be 30%, it is considered acceptable [8]. Saunders et al. [2] argued that the questionnaire with a scale response of 20%

Instrument	Planned	Actual coverage	Success level
Interview/discussion	15	13	87%
Survey questionnaires	267	189	71%
Observation	20	18	90%
Workplace site exposure measurement	20	20	100%

Table 1.
Planned versus actual coverage of the survey.

response rate is acceptable. Low response rate should not discourage the researchers, because a great deal of published research work also achieves low response rate. Hence, the response rate of this study is acceptable and very good for the purpose of meeting the study objectives.

5.1.6 Data collection tool pretest

The pretest for questionnaires, interviews, and tools were conducted to validate that the tool content is valid or not in the sense of the respondents' understanding. Hence, content validity (in which the questions are answered to the target without excluding important points), internal validity (in which the questions raised answer the outcomes of researchers' target), and external validity (in which the result can generalize to all the population from the survey sample population) were reflected. It has been proved with this pilot test prior to the start of the basic data collections. Following feedback process, a few minor changes were made to the originally designed data collect tools. The pilot test made for the questionnaire test was on 10 sample sizes selected randomly from the target sectors and experts.

5.2 Secondary data collection methods

The secondary data refers to data that was collected by someone other than the user. This data source gives insights of the research area of the current state-of-the-art method. It also makes some sort of research gap that needs to be filled by the researcher. This secondary data sources could be internal and external data sources of information that may cover a wide range of areas.

Literature/desk review and industry documents and reports: To achieve the dissertation's objectives, the researcher has conducted excessive document review and reports of the companies in both online and offline modes. From a methodological point of view, literature reviews can be comprehended as content analysis, where quantitative and qualitative aspects are mixed to assess structural (descriptive) as well as content criteria.

A literature search was conducted using the database sources like MEDLINE; Emerald; Taylor and Francis publications; EMBASE (medical literature); PsycINFO (psychological literature); Sociological Abstracts (sociological literature); accident prevention journals; US Statistics of Labor, European Safety and Health database; ABI Inform; Business Source Premier (business/management literature); EconLit (economic literature); Social Service Abstracts (social work and social service literature); and other related materials. The search strategy was focused on articles or reports that measure one or more of the dimensions within the research OSH model framework. This search strategy was based on a framework and measurement filter strategy developed by the Consensus-Based Standards for the Selection of Health Measurement

Instruments (COSMIN) group. Based on screening, unrelated articles to the research model and objectives were excluded. Prior to screening, researcher (principal investigator) reviewed a sample of more than 2000 articles, websites, reports, and guidelines to determine whether they should be included for further review or reject. Discrepancies were thoroughly identified and resolved before the review of the main group of more than 300 articles commenced. After excluding the articles based on the title, keywords, and abstract, the remaining articles were reviewed in detail, and the information was extracted on the instrument that was used to assess the dimension of research interest. A complete list of items was then collated within each research targets or objectives and reviewed to identify any missing elements.

6. Methods of data analysis

Data analysis method follows the procedures listed under the following sections. The data analysis part answered the basic questions raised in the problem statement. The detailed analysis of the developed and developing countries' experiences on OSH regarding manufacturing industries was analyzed, discussed, compared and contrasted, and synthesized.

6.1 Quantitative data analysis

Quantitative data were obtained from primary and secondary data discussed above in this chapter. This data analysis was based on their data type using Excel, SPSS 20.0, Office Word format, and other tools. This data analysis focuses on numerical/quantitative data analysis.

Before analysis, data coding of responses and analysis were made. In order to analyze the data obtained easily, the data were coded to SPSS 20.0 software as the data obtained from questionnaires. This task involved identifying, classifying, and assigning a numeric or character symbol to data, which was done in only one way pre-coded [9, 10]. In this study, all of the responses were pre-coded. They were taken from the list of responses, a number of corresponding to a particular selection was given. This process was applied to every earlier question that needed this treatment. Upon completion, the data were then entered to a statistical analysis software package, SPSS version 20.0 on Windows 10 for the next steps.

Under the data analysis, exploration of data has been made with descriptive statistics and graphical analysis. The analysis included exploring the relationship between variables and comparing groups how they affect each other. This has been done using cross tabulation/chi square, correlation, and factor analysis and using nonparametric statistic.

6.2 Qualitative data analysis

Qualitative data analysis used for triangulation of the quantitative data analysis. The interview, observation, and report records were used to support the findings. The analysis has been incorporated with the quantitative discussion results in the data analysis parts.

6.3 Data analysis software

The data were entered using SPSS 20.0 on Windows 10 and analyzed. The analysis supported with SPSS software much contributed to the finding. It had

contributed to the data validation and correctness of the SPSS results. The software analyzed and compared the results of different variables used in the research questionnaires. Excel is also used to draw the pictures and calculate some analytical solutions.

7. The reliability and validity analysis of the quantitative data

7.1 Reliability of data

The reliability of measurements specifies the amount to which it is without bias (error free) and hence ensures consistent measurement across time and across the various items in the instrument [8]. In reliability analysis, it has been checked for the stability and consistency of the data. In the case of reliability analysis, the researcher checked the accuracy and precision of the procedure of measurement. Reliability has numerous definitions and approaches, but in several environments, the concept comes to be consistent [8]. The measurement fulfills the requirements of reliability when it produces consistent results during data analysis procedure. The reliability is determined through Cranach’s alpha as shown in **Table 2**.

7.2 Reliability analysis

Cronbach’s alpha is a measure of internal consistency, i.e., how closely related a set of items are as a group [11]. It is considered to be a measure of scale reliability. The reliability of internal consistency most of the time is measured based on the Cronbach’s alpha value. Reliability coefficient of 0.70 and above is considered “acceptable” in most research situations [12]. In this study, reliability analysis for internal consistency of Likert-scale measurement after deleting 13 items was found similar; the reliability coefficients were found for 76 items were 0.964 and for the individual groupings made shown in **Table 2**. It was also found internally consistent using the Cronbach’s alpha test. **Table 2** shows the internal consistency of the seven major instruments in which their reliability falls in the acceptable range for this research.

s/n	Qualitative data major groups	Items number	Alpha standardized)
1	Knowledge related factors	K01 to K08	0.864
2	Management related factors	M01 to M17	0.877
3	Technology and suppliers related factors	T01 to T10	0.792
4	Collaboration and support related factors	C01 to C07	0.781
5	Policy , standards and guidelines related factors	P01 to P08	0.888
6	Hazards and accidents related factors	H01 to H10	0.720
7	Personal Protective Equipment related factors	PPE01 to PPE10	0.931
	Total	70	0.966

K stands for knowledge; M, management; T, technology; C, collaboration; P, policy, standards, and regulation; H, hazards and accident conditions; PPE, personal protective equipment.

Table 2.
Internal consistency and reliability test of questionnaires items.

7.3 Validity

Face validity used as defined by Babbie [13] is an indicator that makes it seem a reasonable measure of some variables, and it is the subjective judgment that the instrument measures what it intends to measure in terms of relevance [14]. Thus, the researcher ensured, in this study, when developing the instruments that uncertainties were eliminated by using appropriate words and concepts in order to enhance clarity and general suitability [14]. Furthermore, the researcher submitted the instruments to the research supervisor and the joint supervisor who are both occupational health experts, to ensure validity of the measuring instruments and determine whether the instruments could be considered valid on face value.

In this study, the researcher was guided by reviewed literature related to compliance with the occupational health and safety conditions and data collection methods before he could develop the measuring instruments. In addition, the pretest study that was conducted prior to the main study assisted the researcher to avoid uncertainties of the contents in the data collection measuring instruments. A thorough inspection of the measuring instruments by the statistician and the researcher's supervisor and joint experts, to ensure that all concepts pertaining to the study were included, ensured that the instruments were enriched.

8. Data quality management

Insight has been given to the data collectors on how to approach companies, and many of the questionnaires were distributed through MSc students at Addis Ababa Institute of Technology (AAiT) and manufacturing industries' experience experts. This made the data quality reliable as it has been continually discussed with them. Pretesting for questionnaire was done on 10 workers to assure the quality of the data and for improvement of data collection tools. Supervision during data collection was done to understand how the data collectors are handling the questionnaire, and each filled questionnaire was checked for its completeness, accuracy, clarity, and consistency on a daily basis either face-to-face or by phone/email. The data expected in poor quality were rejected out of the acting during the screening time. Among planned 267 questionnaires, 189 were responded back. Finally, it was analyzed by the principal investigator.

9. Inclusion criteria

The data were collected from the company representative with the knowledge of OSH. Articles written in English and Amharic were included in this study. Database information obtained in relation to articles and those who have OSH area such as interventions method, method of accident identification, impact of occupational accidents, types of occupational injuries/disease, and impact of occupational accidents, and disease on productivity and costs of company and have used at least one form of feedback mechanism. No specific time period was chosen in order to access all available published papers. The questionnaire statements which are similar in the questionnaire have been rejected from the data analysis.

10. Ethical consideration

Ethical clearance was obtained from the School of Mechanical and Industrial Engineering, Institute of Technology, Addis Ababa University. Official letters were

written from the School of Mechanical and Industrial Engineering to the respective manufacturing industries. The purpose of the study was explained to the study subjects. The study subjects were told that the information they provided was kept confidential and that their identities would not be revealed in association with the information they provided. Informed consent was secured from each participant. For bad working environment assessment findings, feedback will be given to all manufacturing industries involved in the study. There is a plan to give a copy of the result to the respective study manufacturing industries' and ministries' offices. The respondents' privacy and their responses were not individually analyzed and included in the report.

11. Dissemination and utilization of the result

The result of this study will be presented to the Addis Ababa University, AAiT, School of Mechanical and Industrial Engineering. It will also be communicated to the Ethiopian manufacturing industries, Ministry of Labor and Social Affairs, Ministry of Industry, and Ministry of Health from where the data was collected. The result will also be available by publication and online presentation in Google Scholars. To this end, about five articles were published and disseminated to the whole world.

12. Conclusion

The research methodology and design indicated overall process of the flow of the research for the given study. The data sources and data collection methods were used. The overall research strategies and framework are indicated in this research process from problem formulation to problem validation including all the parameters. It has laid some foundation and how research methodology is devised and framed for researchers. This means, it helps researchers to consider it as one of the samples and models for the research data collection and process from the beginning of the problem statement to the research finding. Especially, this research flow helps new researchers to the research environment and methodology in particular.

Conflict of interest

There is no "conflict of interest."

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