7th European Conference on Industrial Engineering and Operations Management
Augsburg, Germany, July 16-18, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/EU07.20240028
Published: July 16, 2024

Status of Integrated Management System (IMS) in Heavy Equipments Manufacturing Industry-A Case Study

Deoraj Prajapati
Punjab Engineering College (Deemed to be University) Chandigarh
India

Parminder Singh
Punjab Engineering College (Deemed to be University) Chandigarh
India

Abstract

This paper presents the status of Integrated Management System (IMS) implementation in a heavy equipments manufacturing industry in India. The purpose of this research is to get an idea of how the management and employees felt about the IMS implementation and whether they feel the benefits after implementing it using a survey questionnaire. It is found that ISO 9001 (Quality management systems) and ISO 14001 (Environmental management Systems) are mostly adopted by adopted by the plants of this company with 22.67% each. The Lean Manufacturing (LM) techniques; that were incorporated in the plants are TQM with 18% and followed by Kaizen technique with 16%. It is found that, 45% of the respondents selected "Highly Agreed" option that implementing IMS is helping towards sustainable development. The parameters: “Increased productivity” and “better risk analysis & management” are considered as the most influencing reasons to implement IMS in the plants with a mean value of 4.40. Correlation analysis; under the “barriers in implementing IMS” shows that “Lack of awareness” and “Lack of information & insufficient training” have strong correlation between them with a value of coefficient correlation (r) of 0.859.

Keywords

Integrated Management System (IMS), Heavy equipments manufacturing industry, Statistical analysis, Survey Questionnaire and IMS parameters.

1. Introduction

The main aim of Quality Management (QM) is to improve the outcome (product or service). In other words, the superior quality of the product may be achieved by using QMS. It helps in reducing cycle time and costs. QM ensures increased revenues and productivity of the organisation. It also helps in reducing waste and manage the inventory efficiently. Organizations typically adopt management systems (MSs) individually. Initially, the Quality Management System (QMS) was the main system implemented within these organizations. Subsequently, other systems were introduced over the following years. However, there was significant overlap in clauses among these systems, leading to conflicts and added complexities, as each MS was governed by different teams. Consequently, the intended simplification of management and cohesion as a unified group was compromised. To address this, multiple management systems are now combined in a manner that operates as a cohesive unit while accommodating the requirements of each individual MS. One prevalent integrated management system (IMS) consists of a fusion of International organization for standardization (ISO 9001), QMS, ISO 14001 (used for Environmental Management Systems-EMS) and ISO 45001(used for Occupational Health & Safety Management System-OHSMS). There are numerous rationales or incentives behind the adoption of Integrated Management Systems (IMS) within an organization; like cost reduction, enhancement of company reputation, fostering synergies among various MSs, minimizing paperwork, sustaining development and enhancing system efficiency etc.

1.1 Literature Review

Mackau et al. (2003) developed a model, consisting a vision workshop and Continuous Improvement (CI) circles. Case study was done for 3 months of implementation. It was observed that a highly transparent & user-oriented management system was created. Salomone et al. (2008) discussed about the experiences of implementing IMS in Italian firms. For this, a survey was administered and distributed among the firms that had ISO 9001, ISO 14001 and OHSAS 18001certifications. The paper deals with the topics related to IMS such as the drivers or motivators, obstacles, benefits of IMS and the pressure on an organisation when implementing each MS individually. Company size was found to be the greatest influences among other factors affecting the implementation. Rahman et al. (2010) investigated about the implementation of 5S practices in manufacturing industries. It was established that an audit was good way to evaluate the implementation. For this, they selected two companies and the audits were conducted and comparisons were made. Though both companies had employed the practices well, still some issues like improper organization of tools and equipment were noted. The companies strongly agreed that adopting 5S practices is highly beneficial and top management may play a crucial role. Krishnan & Parveen (2013) compared the lean tools adopted in manufacturing indutries and service sector (healthcare facilieties). Data was collected using articles published for the period 2002-2012. Comparison was done using histogram & TQM and found to be most used tool in both the sectors. Arya & Choudhary (2015) examined the effects of implementing Kaizen in small- scale manufacturing industry. For this, data were collected by weekly visits to the industry. Quality tool like fishbone diagram was used to analyse the data and identify the main problems. QMS was the most implemented MS, as was observed from responses. 95% of them stated that their organisation had implemented MSs as IMS. Difficulties in implementation such as lack of human resources (being the top choice) were concluded. Ribeiro (2017) focussed on the available literature on Management Systems and Integrated Management System by author. A questionnaire survey was developed and sent to Portuguese organisations. Singh et al. (2018) conducted a study to evaluate various lean manufacturing tools adopted in manufacturing industries in northern India. The level of importance of different lean tools and their benefits after successful implementation to enhance the performance of the companies are discussed in the paper. A survey was conducted to determine the importance and the contribution of 23 chosen lean tools. The data collected was then analyzed in SPSS and JIT was found to be the most important lean tool that can increase productivity and minimize the rejections. A study was done by Nunhes (2019) using a systematised content analysis of the most cited papers in Scopus and Web of Science from 2006 to 2016. The main objective of this study was to unify the available literature of IMS to point out its start and help in future research.

The analysis revealed that 6 out of 28 elements were identified as principal elements and related to an IMS development and maintenance pillar. It was concluded that the study could be used as a reference for a better understanding of the literature of IMS and how to use it effectively. Ikram et al. (2020) developed a structured framework in order to weigh the criteria for implementation of IMS using Fuzzy analytic hierarchy process (AHP) and fuzzy Visekriterijumsko Kompromisno Rangiranje (VIKOR) approach. The six principles were chosen as the main categories having 28 sub-criteria. AHP was applied and systematic management was identified as the most important criteria followed by standardization. The utmost prioritised sub- criteria was found to be align and integrate responsibilities followed by inter-relationships between systems. Barbosa et al. (2021) used the Item Response Theory (IRT) for investigating observable variables based on polytomous scales with the main objective to validate an instrument measure the impacts of the Integrated Management System (IMS) using IRT. This instrument evaluated the multidimensional impact of integrated management systems on organizational performance from the workers' perspective. Kou et al. (2022) proposed new data management method that is suitable for backfill experiments. First, this study analysed the main system requirements, including experimental business process modelling, experimental process combing, and a multidimensional query of experimental data. Then, the backfill test business flow and data flow were summarized to establish the backfill test business model and experimental index system. Jang et al. (2022) applied the off-site construction (OSC) method to resolve productivity stagnation and lack of skilled workforce and to reduce greenhouse gas emissions in the construction industry. In this study, they examined the characteristics of OSC projects and derived key management items through literature review, case analysis, and expert meetings to develop an integrated management system for OSC projects (OSC-IMS). Dussadee & Ramaraj (2023) investigated the economic and sustainable aspects of utilizing organic waste from agriculture for biofuel production. The advantages and disadvantages of organic waste in agriculture. They discussed the potential of organic waste in mitigating climate change, enhancing agricultural practices, and producing sustainable energy. This approach effectively mitigates the release of greenhouse gases, preserves soil quality, and enhances biodiversity. They proposed waste management technology to enhance organic waste management in agriculture. Bakhit (2023) applied the International Atomic Energy Agency's safety standards for management systems with Integrated Management System (IMS) for Nuclear Materials Authority (NMA) Egypt. He used integrating documentation, process maps, and the organizational structure. The implementation process of IMS at NMA Egypt was developed by utilizing the Plan, Do,

Check & Act (PDCA) cycle, with clear steps and a defined timetable for each phase of implementation. Loy-Benitez et al. (2024) emphasized the importance of AI-driven management subsystems in facilitating automatic tunnel boring machine (TBM) operations and highlighted the recent significant developments in this area, delineating three primary parallel subsystems: modelling, monitoring, and control. Furthermore, they assessed each subsystem's practical implications and identifies specific challenges, proposing avenues for research such as integrated management systems. The paper also advocates for continued exploration of TBM automation, emphasizing the integration of existing management sub-systems from an operational standpoint.

1.2 Introduction of Industry

This company is engaged in designing, manufacturing, construction, engineering, installation, testing, commissioning and servicing a wide range of products to most of the core sectors like power transmission industry, transportation, renewable energy, oil & gas and defence etc. The Company has a certified accreditation from ISO 9001: 2015 for QMS. In addition to this, the company also have certifications for ISO 14001 and OHSAS 18001 for environment and health & safety respectively. It has a network of 16 manufacturing units, two repair units, four regional offices, eight service centers, eight overseas offices, 15 regional centers, seven joint ventures, and infrastructure allowing it to execute more than 150 projects at sites across India and abroad. The company has established the capability to deliver 20,000 MW yearly of power equipment to address the growing demand for power generation equipments. This public sector company has been catering to the nation's nuclear program since 1976 by way of design, manufacture, testing and supply of critical nuclear components like Reactor Headers, Steam Generators, Steam Turbine Generators, Heat exchangers and Pressure vessels etc.

2. Methodology

The survey questionnaire was crafted utilizing Survey Planet software and distributed to employees of the industry's plants through emails. Responses were collected using the online platform and subsequently analysed using MS Excel and MINITAB. As the initial phase of the study, namely Data Collection, a questionnaire was formulated; based on the findings of the literature review to facilitate the survey process. This questionnaire was specifically tailored to elicit responses regarding the implementation of Integrated Management Systems (IMS), which are instrumental in overseeing quality management within organizations. The survey questionnaires as shown in Table 1A (Annexure-A) were sent to the employees of the 10 plants. During the initial phase, some questionnaires were sent to a selected group of employees and some employees found it challenging to comprehend. Consequently, to enhance clarity, a second language, Hindi, was incorporated along with English, and the English questions were also revised for simplicity. The complete survey questionnaire can be found in Annexure-A. Moreover, the reliability analysis of the collected data was evaluated using Cronbach's alpha but not included in this paper due to limit of pages. Subsequently, data analysis and interpretation were done by Microsoft Excel and Minitab software. The data were collected from the employees of 10 plants of this industry and 50 Nos. of responses (filled questionnaire) were received out 150 questionnaires.

3. Statistical Analysis

Questions 1 to 3; shown in Table 1A (Annexure-A) are considered optional, hence analysis of these questions has not been done. To assess the reliability of the survey items, Cronbach's alpha test was conducted using MINITAB-17. The resulting alpha value was determined as 0.9446. Any value of Cronbach's alpha more than 0.70 is considered good and indicates that data collected are reliable. The tabular data of reliability test have not been included in this paper due to limit of pages. The **Question (4)** pertains to respondents' work experience measured in years, which can serve as a valuable source of information given that individuals with extensive work experience are often regarded as experts in their respective fields. It is found from the collected data that 50% of the responses were provided by employees with 20-30 years of work experience, followed by 30% with up to 10 years of experience. Similarly; 15% employees are having more than 30 years of experience and only 5% employees have 10-20 years of experience.

Question (5) illustrates the different Management Systems (MSs) adopted by the company in its various plants. This question was included in the questionnaire to know about the various MS systems integrated in plants and to get the overall idea of the employees' awareness of these MSs in general. The Figure 1 is showing the responses given by the employees with the help of Pie chart.

It can be observed from Figure 1 that ISO 9001 (QMS) and ISO 14001 (EMS) are adopted by the company in equal proportions of 22.67% each; followed by ISO 45001, that is Occupational Health & Safety having 20%.

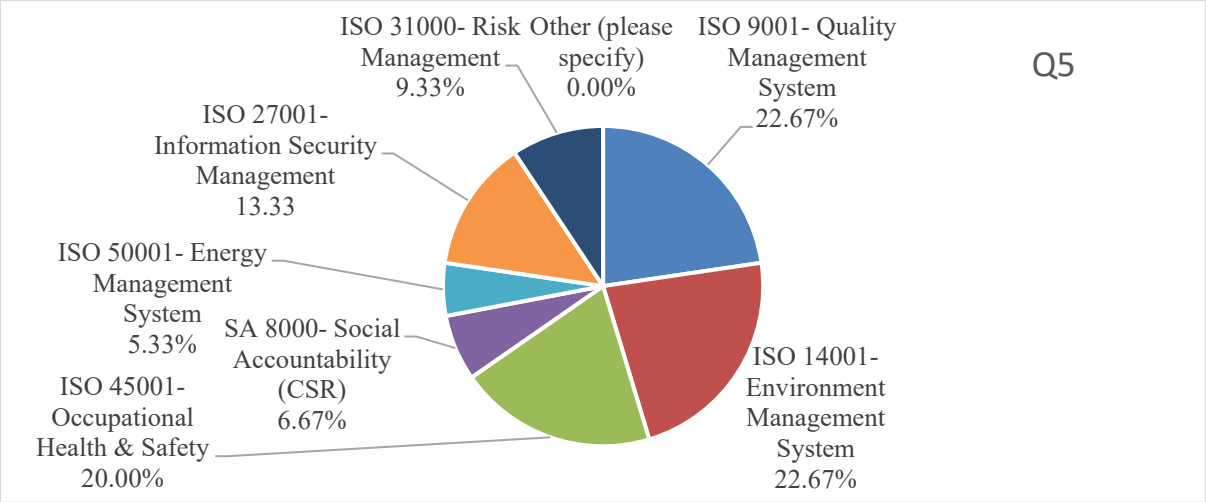

Figure 1. Various management systems using by plants

Question (6) in the questionnaire was to ascertain the reasons or the motivations behind the implementation of IMS. This question has six sub-parts listing various reasons. The respondents have rated it on the five- point Likert scale. Table 1 shows the mean, and standard deviation (SD) of the responses for this question.

Table 1. The motivation behind the implementation of IMS

S. NO.	MOTIVATION/ REASONS	MEAN	SD
1.	Increased productivity	4.4	0.753
2.	Cost reduction	3.95	0.759
3.	Safer work environment	3.9	0.911
4.	Sustainable development	4.15	0.670
5.	Better risk analysis & management	4.4	0.680
6.	Improve the company image	4.05	0.998

The parameters “Increased productivity” and “Better risk analysis & management” are considered as the most influencing reasons to implement IMS in plant with a mean of 4.4."Sustainable development" is found to be the second most important parameter; having a mean of 4.15. **Question (7)** was to determine the importance of various benefits of employing IMS from the employees’ point of view. The benefits were listed in the form of sub- parts of the question. The Table 2 shows the mean, and standard deviation (SD) of the responses.

Table 2. The Benefits of implementing IMS

S.NO.	BENEFITS	MEAN	SD
1.	Reduction in documentation/ paperwork	4.20	1.105
2.	Customer satisfaction	4.35	1.039
3.	Reduction in audits	3.95	0.825
4.	Better communication between departments	4.30	0.978
5.	Continuous improvement	4.30	1.128
6.	Improved image of the company	4.15	0.933
7.	Reduction in cost	3.85	0.933
8.	Reduction in time required for implementation	4.35	0.988
9.	Synergy between different Management system standards (MSSs)	3.85	1.039
10.	Environmental benefits	4.00	1.123
11.	Transparency in management	4.15	1.039

It can be seen that the parameter *"Customer satisfaction" and Reduction in time required for implementation*" were considered as the biggest advantage of implementing IMS in the plant having a mean of 4.35. **Question (8)** was to identify which of the problems were considered more significant than the others while implementing IMS. In this question, the parameter "Lack of employee motivation" was considered as one of the most prominent barriers in implementing IMS in the power plant having a mean of 4.75 and SD of 0.550. The second important factor was "Lack of information & insufficient training" with a mean of 4.45 and SD of 0.94. **Question (9*)*** of the questionnaire was asked about the lean manufacturing practices that were incorporated in the plant. Figure 2 illustrates the various LM practices that were adopted. From the Figure 2, the parameters and TQM is found to be used the most in the plant, having equal significance of 18% and follows closely by Kaizen technique with 16%.

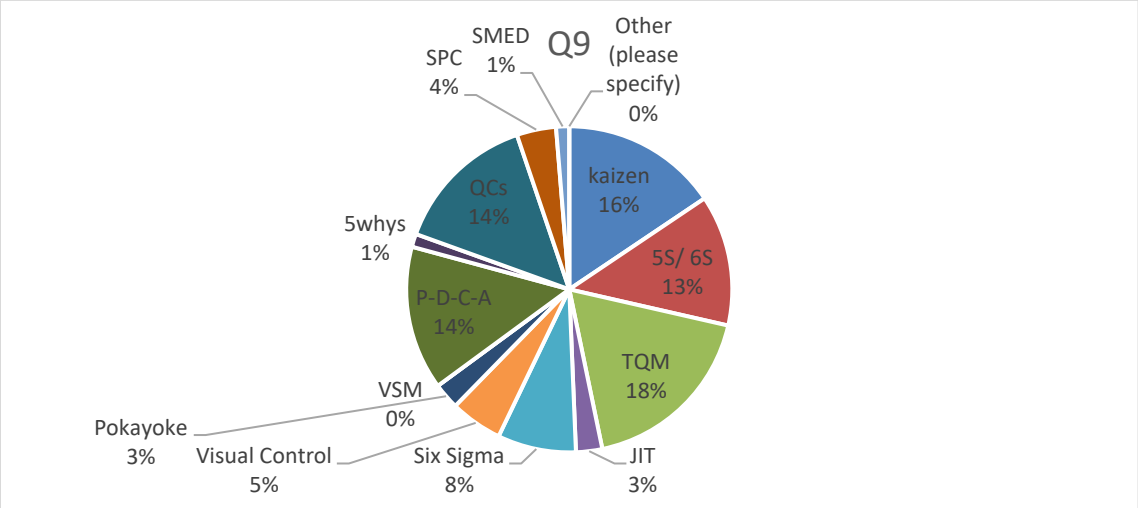

Figure 2. Distribution of Lean Manufacturing (LM) practices adopted

There are three pillars of sustainable development, namely economic, environmental and social aspects. These three pillars were considered as the factors to recognise the efforts put in by the company. The questions from Q10 to Q13 were about sustainable development as a result of implementing IMS and how much the employees are aware of it. These questions were to gain an insight into the level of commitment the company had for sustainability with ensuring the best quality.

Question (10) was simply to ask the respondents whether implementing IMS had helped towards sustainable development and from the collected data, it was found that, 45% of the respondents selected "Highly Agree" and 40% have agreed in the support of Qn. 10. Only 15% have given the opinion as "Neutral" in this question. **Question (11)** is focussed on the economic side of sustainable development. The respondents were asked to indicate how much the plant was dedicated towards sustainability. Table 3 shows the mean and standard deviation (SD) of the responses.

Table 3. Economic aspect of sustainable development

S.NO.	ASPECTS	MEAN	SD
1.	Infrastructure for the public benefit (healthcare centres, sports centres, public welfare)	4.15	0.812
2.	Employees' salaries, incentives, rewards & recognition	4.15	0.745

From Table 3, it can be observed that the parameters "Infrastructure for the public benefit (healthcare centres, sports centres, public welfare)" and "Employees' salaries, incentives, rewards & recognition" have same means, viz. 4.15 and 4.15. **Question (12)** was intended to determine the environmental aspect of sustainable development and Table 4 shows the mean and standard deviation (SD) of the environmental aspect of sustainable development responses.

Table 4. Environmental aspect of sustainable development

S.NO.	ASPECTS	MEAN	SD
1.	The goal to reduce energy consumption	3.8	1.105
2.	The goal to minimise water consumption	3.7	1.080
3.	To reduce atmospheric emissions like greenhouse gases (GHGs), CFCs, etc.	4.05	1.099
4.	Minimising the waste generation	3.7	1.218
5.	Using materials (raw material, packaging, etc.) efficiently	3.7	1.080

Question (13) is related to the social aspect of sustainable development and Table 5 shows the mean and standard deviation (SD) of the responses.

Table 5. Social aspect of sustainable development

S.NO.	ASPECTS	MEAN	S.D.
1.	Preventing occupational injuries and diseases	4.25	0.850
2.	Average number of hours of training per year	3.85	1.136
3.	Equality between the wages of men and women	4.10	0.852
4.	Customer/ stakeholders satisfaction	4.20	0.894
5.	Data/ information security	3.90	0.788

From Table 5, the parameters "Preventing occupational injuries and diseases" and "Customer/stakeholders satisfaction" have the highest means of 4.25 and 4.20 with standard deviations of about of 0.850 and 0.894 respectively.

3.1 Correlation Analysis

The relation between two random variables is termed as correlation. It is a mathematical association, although it usually refers to the degree of linear relation between a pair of variables. There are various coefficients of correlation, generally denoted by 'ρ' or 'r'. The most commonly used coefficient is known as Pearson correlation coefficient. It's value ranges from -1.0 to +1.0. When r = 1.0, it is known as perfect positive correlation. It means that one variable affects the other perfectly. When $0 < r < 1$, it is called as limited positive correlation. In this case, if one variable increases, the value of the other variable also increases but in a limited way. The probability of this happening is greater when value of r is closer to 1.0.

For the questions having sub-parts, correlation matrix was developed to see if there was a relation between any of the parameters. For the Question (6), the reasons for implementing IMS have been discussed. Six factors were taken into consideration. Table 6 indicates the correlation matrix for Q6.

Table 6. Correlation matrix for the motivation behind the implementation of IMS

Parameters	Increased productivity	Cost reduction	Safer work environment	Sustainable development	Better risk analysis & management	Improve the company image
Increased productivity	1	-	-	-	-	-
Cost reduction	0.480	1	-	-	-	-
Safer work environment	0.353	0.482	1	-	-	-
Sustainable development	0.408	0.230	0.426	1	-	-
Better risk analysis & management	0.332	0.319	0.380	0.539	1	-
Improve the company image	0.307	0.257	0.378	0.377	0.155	1

From the Table 6, it can be observed that the parameters do not have much strong relation with each other. There are various reasons for implementing IMS found in literature and these parameters are only some of them. For Question

(7), the advantages of IMS implementation have been considered. There are many advantages that are mentioned in literature and eleven of them were selected for the questionnaire. Table 7 displays the correlation matrix for the benefits of implementing IMS. For Question (8), the barriers or obstructs in the way of implementing IMS have been explored.

Table 7. Correlation matrix for the benefits of implementing IMS

	Reduction in documentation/ paperwork	Customer satisfaction	Reduction in audits	Better communication between	Continuous improvement	Improved image of the company	Reduction in cost	Reduction in time required for implementation	Synergy between different Management system standards (MSSs)	Environmental benefits	Transparency in management
Reduction in documentation/ paperwork	1	-	-	-	-	-	-	-	-	-	-
Customer	0.502	1	-	-	-	-	-	-	-	-	-
Reduction in	0.378	0.494	1	-	-	-	-	-	-	-	-
Better communication	0.299	0.384	0.430	1	-	-	-	-	-	-	-
Continuous improvement	0.285	0.713	0.422	0.375	1	-	-	-	-	-	-
Improved image of the company	0.045	0.356	0.448	0.353	0.571	1	-	-	-	-	-
Reduction in	0.316	0.619	0.371	0.123	0.544	0.429	1	-	-	-	-
Reduction in time required for	0.594	0.519	0.333	0.423	0.422	0.246	0.379	1	-	-	-
Synergy between different Management	0.372	0.667	0.358	0.372	0.375	0.392	0.602	0.370	1	-	-
Environmental	0.214	0.378	0.337	0.168	0.445	0.611	0.564	0.319	0.485	1	-
Transparency in management	0.273	0.355	0.394	0.502	0.287	0.488	0.171	0.351	0.500	0.412	1

From the Table 7, it can be observed that all the parameters are limited positive, ranging from 0 to +1. The parameter “Continuous improvement” and “Customer satisfaction” show a good relation between them.

The Table 8 shows the correlation matrix for the barriers in implementing IMS.

Table 8. Correlation matrix for the barriers in implementing IMS

	Insufficient Financial & Human Resources	Lack of information & insufficient training	Lack of management & administration	Lack of employee motivation	Lack of awareness	Rejection of the new system	Misunderstanding of integration	Reduced flexibility after implementation
Insufficient Financial & Human Resources	1	-	-	-	-	-	-	-
Lack of information & insufficient training	0.641	1	-	-	-	-	-	-
Lack of management & administration support	0.381	0.510	1	-	-	-	-	-
Lack of employee motivation	0.725	0.681	0.530	1	-	-	-	-
Lack of awareness	0.564	0.859	0.435	0.583	1	-	-	-
Rejection of the new system	0.501	0.609	0.686	0.564	0.590	1	-	-
Misunderstanding of integration concepts	0.599	0.458	0.497	0.679	0.491	0.612	1	-
Reduced flexibility after implementation	0.453	0.357	0.340	0.419	0.429	0.624	0.641	1

From Table 8, it can be comprehended that all the variables are limited positive. “Lack of awareness” and “Lack of awareness Lack of information & insufficient training” show a relatively strong correlation between them having a value of 0.859. Also, the parameters “Lack of employee motivation” and “Insufficient Financial & Human Resources” are found to have a correlation value of 0.725 which indicates a good relation between these variables. Table 9 indicates a correlation matrix for the economic aspect of sustainable development. It can be observed that it is not a strong enough relation between the two parameters.

Table 9. Correlation matrix for the economic aspect of sustainable development

	Infrastructure for the public benefit (healthcare centres, sports centres, public welfare)	Employees' salaries, incentives, rewards & recognition
Infrastructure for the public benefit (healthcare centres, sports centres, public welfare)	1	-
Employees' salaries, incentives, rewards & recognition	0.532	1

Table 10 shows the correlation matrix for the environmental aspect of sustainable development

Table 10. Correlation matrix for the environmental aspect of sustainable development

	The goal to reduce energy consumption	The goal to minimise water consumption	To reduce atmospheric emissions like greenhouse gases (GHGs), CFCs, etc.	Minimising the waste generation	Using materials (raw material, packaging, etc.) efficiently
The goal to reduce energy consumption	1	-	-	-	-
The goal to minimise water consumption	0.906	1	-	-	-
To reduce atmospheric emissions like greenhouse gases (GHGs), CFCs, etc.	0.767	0.750	1	-	-
Minimising the waste generation	0.722	0.721	0.693	1	-
Using materials (raw material, packaging, etc.) efficiently	0.720	0.683	0.727	0.807	1

From Table 10, it can be observed that the relation among the parameters are limited positive correlation. The parameters "The goal to minimise water consumption" and "The goal to reduce energy consumption" have shown a strong relation between them having a value of 0.906. Interestingly, it should be noted that almost all the parameters have good relation with each other. Table 11 indicates the correlation matrix for the environmental aspect of sustainable development. It can be noted that all the parameters have limited positive correlation. The highest value is found to be 0.600, which cannot be deemed as a strong relation between the parameters.

Table 11. Correlation matrix for the environmental aspect of sustainable development

	Preventing occupational injuries and diseases	Average number of hours of training per year	Equality between the wages of men and women	Customer/ stakeholders satisfaction	Data/ information security
Preventing occupational injuries and diseases	1	-	-	-	-
Average number of hours of training per year	0.600	1	-	-	-
Equality between the wages of men and women	0.596	0.441	1	-	-
Customer/ stakeholders satisfaction	0.565	0.418	0.546	1	-
Data/ information security	0.586	0.579	0.570	0.594	1

4. Discussions

The current investigation involves gathering data on the adoption of IMS via the development of a questionnaire administered in the plants. Data analysis was done by MS Excel and MINITAB (version 17). This paper presents the computed mean and standard deviation of collected data parameters using tables and graphical modes. An online

questionnaire survey was designed and administered to gather the data on Integrated Management System (IMS) implementation in the 10 plants of this public sector company. The Questionnaire was a mix of multiple-choice, five-point Likert scale and open-ended questions. The reliability and validity were checked with the help of MINITAB version 17. Additionally, correlation matrices were generated to examine potential relationships between the parameters.

5. Conclusions

From the collected data on the implementation of the Integrated Management System (IMS) in the 10 plants of the company. The questionnaire comprised a combination of multiple-choice questions, five-point Likert scale items, and open-ended inquiries. The parameters “Increased productivity and better risk analysis & management " are considered as the most influencing reasons to implement IMS in the plants with a mean of 4.4. The parameter " Lack of management & administration support " was considered as one of the most prominent barriers in implementing IMS in the plant having a mean of 4.15 and SD of 1.039. Correlation matrix for the “Benefits of implementing IMS” shows that there is a very good correlation between the parameters: “Continuous Improvement” and “Customer Satisfaction” with a coefficient correlation (r) of 0.713. Similarly, parameters: “The goal to minimise water consumption” and “The goal to reduce energy consumption” for the ‘Environmental aspect of sustainable development’ have a strong relation between them having a value of ‘r’ as 0.906.

Conflict of Interest

The authors declare that there is no financial conflict of interest (e.g. Consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) in connection with this article.

Acknowledgements

The authors would like to thank the administration of plants for valuable suggestions and support throughout this study.

References

Anrafel de Souza Barbosa, A., Silva, L., Morioka, S., Silva, J. and Souza, V., Item response theory-based validation of an integrated management system measurement instrument, *Journal of Cleaner Production,* Vol. 328, 2021.

Arya, A. and Choudhary, S., Assessing the application of Kaizen principles in Indian small-scale industry, *International Journal of Lean Six Sigma*, Vol. 6, No. 4, pp. 369-396, 2015.

Bakhit, A., Implementation of the Integrated Management System in the nuclear sector in accordance with International ISO Standards and the requirements of the International Atomic Energy Agency, *British Journal of Global Ecology and Sustainable Development,* Vol. 12, pp. 29-50, 2023.

Dussadee, N. and Ramaraj, R., Integrated management of organic agricultural waste enhancing soil quality, mitigating climate change and advancing biofuel production, *The 5th International Conference on Renewable Energy, Sustainable Environmental, Agricultural and Artificial Intelligence Technologies,* pp. 42- 50, 2023.

Ikram, M., Zhang, Q. and Sroufe, R., Developing integrated management systems using an AHP-Fuzzy VIKOR approach, *Business Strategy and the Environment*, Vol. 29, No. 6, pp. 2265-2283, 2020.

Jang, Y., Lee, J. and Son, J., Development and Application of an Integrated Management System for Off-Site Construction Projects, *Buildings,* Vol. 12, pp. 1-21, 2022.

Kou, Y., Liu, Y., Li, G., Hou, J., Luan, L. and Wang, H., Design and Implementation of an Integrated Management System for Backfill Experimental Data, *Advances in Civil Engineering,* Vol. 2022, pp. 1-9, 2022.

Krishnan, V. and Parveen, C., Comparative Study of Lean Manufacturing Tools Used in Manufacturing Firms and Service Sector, *Proceedings of the World Congress on Engineering*, London, U.K., Vol. I, July 3 - 5, 2013.

Loy-Benitez, J., Kyu Song, M., Choi,Y., Lee, J., and Lee, S., Breaking new ground: Opportunities and challenges in tunnel boring machine operations with integrated management systems and artificial intelligence, *Automation in Construction,* Vol. 158, pp. 1-23, 2024.

Mackau, D., SME integrated management system: a proposed experiences model, *The TQM Magazine*,Vol. 15, No. 1, pp. 43-51, 2003.

Nunhes, T., Bernardo, M. and Oliveira, O., Guiding principles of integrated management systems: Towards unifying a starting point for researchers and practitioners, *Journal of Cleaner Production*, Vol. 210, pp.977-993,

2019.
Rahman, M., Khamis, N., Zain, R., Deros, B. and Mahmood, W., Implementation of 5S Practices in the Manufacturing Companies: A Case Study, *American Journal of Applied Sciences*, Vol. 7, No. 8, pp. 1182-1189, 2010.
Ribeiro, F., Santos, G., Rebelo, M. and Silva, R., Integrated Management Systems: Trends for Portugal in the 2025 horizon', *Procedia Manufacturing*, *Vigo, Spain, June 28-30, 2017*, Vol. 13, pp. 1191-1198, 2017.
Salomone, R., Integrated management systems: experiences in Italian organizations, *Journal of Cleaner Production*, Vol. 16, No. 16, pp. 1786-1806, 2008.
Singh, J., Singh, H. and Singh, G., Productivity improvement using lean manufacturing in manufacturing industry of Northern India, *International Journal of Productivity and Performance Management*, Vol. 67, No. 8, pp. 1394-1415, 2018.

Annexure: A

Table 1A. Survey Questionnaire

S.NO.	Questions	
1.	Name (optional)	
2.	Designation	
3.	Department (optional)	
4.	Work Experience in the current company (in yrs.)	
	0-10 / 10-20 / 20-30 / 30+	
5.	Management systems that have been integrated into the plant.	
	1.	ISO 9001- Quality Management System
	2.	ISO 14001- Environment Management System
	3.	ISO 45001- Occupational Health & Safety
	4.	SA 8000- Social Accountability (CSR)
	5.	ISO 50001- Energy Management System
	6.	ISO 27001- Information Security Management
	7.	ISO 31000- Risk Management
	8.	Other (please specify)
6.	What was the Motivation behind the implementation of IMS in your opinion?	
	1.	Increased productivity
	2.	Cost reduction
	3.	Safer work environment
	4.	Sustainable development
	5.	Better risk analysis & management
	6.	Improve the company image
7.	What do you think about the Benefits of implementing IMS in the plant/company?	
	1.	Reduction in documentation/ paperwork
	2.	Customer satisfaction
	3.	Reduction in audits
	4.	Better communication between departments
	5.	Continuous improvement
	6.	Improved image of the company
	7.	Reduction in cost
	8.	Reduction in time required for implementation
	9.	Synergy between different Management system standards (MSSs)
	10.	Environmental benefits
	11.	Transparency in management
8.	What barriers/ obstacles have you experienced or observed in implementing the IMS?	
	1.	Insufficient Financial & Human Resources
	2.	Lack of information & insufficient training
	3.	Lack of management & administration support
	4.	Lack of employee motivation
	5.	Lack of awareness
	6.	Rejection of the new system

	7.	Misunderstanding of integration concepts
	8.	Reduced flexibility after implementation
9.	Which of the following lean manufacturing (LM) practices are implemented at your workplace?	
	1.	Continuous improvement (kaizen)
	2.	5S/ 6S
	3.	Total Quality Management (TQM)
	4.	Just in time (JIT)
	5.	Six Sigma
	6.	Visual Control
	7.	Error proofing/ Pokayoke
	8.	Value stream mapping (VSM)
	9.	Plan- Do-Check-Act (PDCA) cycle/ Deming cycle
	10.	5whys
	11.	Quality Circles (QC)
	12.	Statistical process control (SPC)
	13.	Single minute exchange of die (SMED)
	14.	Other (please specify)
10.	Do you think implementing IMS policy in the plant has helped towards sustainable development?	
	1 = Highly Disagree	2 = Disagree | 3 = Neutral | 4 = Agree | 5 = Highly Agree | 6 = Don't Know
11.	The Economic aspect of Sustainable Development. Please indicate the level of dedication given to the	
	1.	Infrastructure for the public benefit (healthcare centres, sports centres, public welfare)
	2.	Employees' salaries, incentives, rewards & recognition
12.	The Environmental aspect of Sustainable Development. Please indicate the level of dedication given to	
	1.	The goal to reduce energy consumption
	2.	The goal to minimise water consumption
	3.	Reducing atmospheric emissions like greenhouse gases (GHGs), CFCs, etc.
	4.	Minimising the waste generation
	5.	Using materials (raw material, packaging, etc.) efficiently
13.	The Social aspect of Sustainable Development; Please indicate the level of dedication given to the	
	1.	Preventing occupational injuries and diseases
	2.	Average number of hours of training per year
	3.	Equality between the wages of men and women
	4.	Customer/ stakeholders satisfaction
	5.	Data/ information security
14.	What else can be added/ eliminated to your department by the company to contribute more towards	

Biographies

Dr. DEORAJ PRAJAPATI is working as a Professor in the department of Mechanical Engineering, Punjab Engineering College (Deemed to be University) Chandigarh, India. He has teaching and research experience of more than 25 years and published more than 145 research papers in international and national journals of repute and in the proceedings of the conferences. He is also reviewer of 8 international journals. He also guided 6 Ph.D. and more than 32 post graduate theses and guiding one research scholars at present. He has also chaired many international and national conference in India and abroad.

PARMINDER SINGH is research scholar in the department of Mechanical Engineering, Punjab Engineering College (Deemed to be University) Chandigarh, India. He has published more than 6 research papers in international and national journals of repute and in the proceedings of the conferences.