Original article

Assessment of quality control and occupational health and safety hazards in a veneer production firm in Ghana

Evaluación del control de la calidad y de los riesgos para la salud y seguridad laboral en una empresa de producción en Ghana

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ABSTRACT

Introduction: Veneer manufacturing integrates mechanical processing, wood dust generation, thermal processes, chemical use, moving machinery and combustible materials, making product quality and occupational safety closely interconnected.

Objective; To assess employees' knowledge of quality control, occupational health and safety safety practices, and strategies for improving quality and safety in a veneer production firm in Kumasi, Ghana.

Methods: A cross-sectional survey using structured questionnaires yielded 216 usable responses (203 employees and 13 managers) from 233 questionnaires distributed (92.7% response rate). Data were analysed using descriptive statistics and item-level analysis of variance across years of service, educational level, job designation and job operation.

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Results: Managers demonstrated moderate-to-high practical quality control knowledge (3.21 ± 1.339), although knowledge of formal standards was limited. Employees' occupational health and safety knowledge was relatively low (2.90 ± 1.219) with notable gaps in policies, chemical protection, emergency procedures and hazard prevention. Safety practices were uneven, with stronger personal protective equipment and security practices but weaker fire protection and signage.

Conclussion: Most group differences were nonsignificant, except for education-related differences in knowledge of approved equipment and chemicals (F=4.189, p=.005). Strengthening training, inspections, communication, worker participation and policy review is recommended.

Keywords: veneer manufacturing; quality control; occupational health and safety; wood dust; personal protective equipment; safety management

RESUMEN

Introducción: La fabricación de chapas de madera integra procesos mecánicos, generación de polvo de madera, tratamientos térmicos, uso de productos químicos, maquinaria en movimiento y materiales combustibles, lo que hace que la calidad del producto y la seguridad laboral estén estrechamente vinculadas.

Objetivos: Evaluar los conocimientos de los empleados sobre el control de calidad, la seguridad y salud en el trabajo, las prácticas de seguridad y las estrategias para mejorar la calidad y la seguridad en una empresa de producción de chapas de madera en Kumasi, Ghana.

Métodos: Estudio transversal basado en cuestionarios estructurados, se obtuvieron 216 respuestas válidas (203 empleados y 13 directivos). Los datos se analizaron utilizando estadística descriptiva y análisis de varianza a nivel de ítem, considerando variables como los años de servicio, el nivel educativo, el puesto de trabajo y el área operativa.

Resultados: Los gerentes demostraron un conocimiento práctico de control de calidad de moderado a alto (3,21 ± 1,339), con conocimiento limitado de las normas formales. El conocimiento de los empleados sobre seguridad y salud ocupacional ,era relativamente bajo (2,90 ± 1,219), con notables deficiencias en políticas, protección química, procedimientos de emergencia y prevención de riesgos.

Conclusiones: Las prácticas de seguridad fueron desiguales; se observaron mejores medidas en equipos de protección individual y protocolos de seguridad y debilidades en protección contra incendios y señalización. La mayoría de las diferencias entre grupos no resultaron significativas. Se recomienda reforzar la formación, las inspecciones, la comunicación, la participación de los trabajadores y la revisión de las políticas.

Palabras clave: fabricación de chapas de madera; control de calidad; seguridad y salud en el trabajo; polvo de madera; equipos de protección individual; gestión de la seguridad

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Introduction

The wood processing industry remains important to Ghana's manufacturing base, but veneer production sits at the intersection of two persistent performance pressures: the need to produce dimensionally consistent, marketable wood products and the need to control hazards created by machines, dust, heat, noise, chemicals and combustible materials. These pressures should not be treated as separate managerial problems. Defects, rework, poor process control and unsafe work practices can arise from related weaknesses in operational discipline, worker competence, maintenance and communication. Contemporary quality research in wood products increasingly emphasises process monitoring, data-based control and systematic defect reduction rather than inspection of finished products alone.[1,2,3] Similarly, occupational safety research increasingly treats exposure control as a system involving engineering measures, administrative arrangements, worker behaviour and organisational learning rather than PPE alone.[4,5,6]

The quality dimension is particularly important in veneer production because recovery and product value depend on raw material characteristics, process parameters, moisture control, cutting accuracy, drying and subsequent handling. Recent evidence shows that technological parameters can materially influence veneer or plywood quality and recovery.[7,8] Data-driven control of veneer drying has also been shown to offer a route towards more consistent process performance,[2] while statistical process control can identify systematic variation that would otherwise be normalised within routine production.[3] These developments imply that knowledge of standards and

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procedures is necessary but insufficient. A firm must also translate knowledge into repeatable process controls, maintenance routines and corrective action.

The safety problem is equally substantial. Wood processing workers can be exposed to airborne dust, noise, machinery hazards, ergonomic stressors and other physical or chemical risks. Recent studies report respiratory consequences among woodworkers exposed to mixed hardwood dust and demonstrate that occupational exposure remains an important health concern in wood processing environments.[9,10,11] Evidence from Mozambique further links work-related airway disease with exposure conditions among wood processing workers,[12] while a recent systematic review identifies substantial health implications associated with several common wood dust species.[13] These findings strengthen the case for preventive controls that address exposure at source, ventilation, maintenance, work practices and appropriate respiratory protection.

The Ghanaian context adds an important institutional dimension. Earlier Ghanaian evidence documents weaknesses in wood processing safety practice, including inadequate PPE use and the need for stronger enforcement.[14] More recent Ghanaian research also shows the importance of training in wood processing safety.[15] The present study therefore examines quality control knowledge alongside worker OHS knowledge and safety practice within a veneer production environment.

The study was guided by an integrated conceptual perspective in which quality control measures, worker knowledge, occupational health and safety measures and perceptions of the safety environment interact. This is consistent with the Reasoned Action Approach, which emphasises the role of beliefs, perceived control and social influences in shaping behaviour, and with Social Cognitive Theory, which explains behaviour through reciprocal relationships among individual factors, behaviour and environmental conditions. The framework is particularly useful here because the observed problem may not be explained by worker characteristics alone. Where formal systems are weak, inaccessible or poorly communicated, knowledge and compliance can also be constrained by the environment in which workers operate.

Accordingly, the study pursued four objectives: to assess managers' knowledge of quality control measures in veneer production; to assess workers' knowledge of OHS measures; to assess workers' OHS practices; and to identify strategies for improving safety practice. The study contributes a firm-level account of how knowledge and organisational controls coexist in a Ghanaian veneer production setting and highlights where apparently positive safety arrangements may conceal important preventive weaknesses.

Literature Review

Quality control in veneer production

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Quality control in wood processing is increasingly understood as a continuous process rather than an end-of-line inspection activity. Modern approaches combine process monitoring, measurement, statistical control, equipment optimisation and feedback. Qiu and Cool (2023) demonstrate the value of data-driven quality control for industrial veneer drying,[2] while Yılmaz and Kökten (2024) show how statistical process control can be applied to plywood manufacturing.[3] Chandrasari and Syahrullah (2022) further illustrate how statistical process control can be paired with fault tree analysis to identify and reduce defect causes.[16] More recently, Prakosa et al, (2026) demonstrate how Six Sigma DMAIC and basic quality tools can be integrated to improve meranti plywood manufacturing.[1] Together, these studies suggest that quality performance depends on identifying variation at the point where it is generated and acting before defects accumulate.

The technological literature also reinforces the importance of process knowledge. Adamčík et al, (2025) examined optimisation of CNC milling parameters in plywood in relation to surface roughness,[7] while Madiope et al. (2025) showed that species selection and processing parameters influence veneer recovery.[8] Cool and Qiu (2024) similarly highlight process optimisation in veneer drying.[17] while Ozturk (2023) shows the potential of predictive modelling for identifying optimum veneer drying parameters.[18] Pipíška et al, (2023) demonstrate that pressure and veneer moisture conditions can affect bonded plywood properties,[19] while Demirkir et al (2013) show that panel manufacturing parameters can influence bonding strength,[20] and Kymäläinen et al, (2018) show that processing actions can alter veneer and plywood physical and mechanical properties.[21] These studies collectively indicate that managers need more than general awareness of quality. They need operational knowledge that can be translated into measurable parameters, inspection routines and corrective decisions.

The relevance of standards is therefore twofold. Standards provide a common definition of acceptable quality, but their value depends on access, interpretation and consistent implementation. Vashishtha (2024) presents quality assurance as a broader manufacturing capability,[22] while Azizah and Indrasari (2025) connect quality management with defect reduction within a plywood manufacturing supply chain.[23] Susanti (2023) similarly shows the value of failure mode analysis for prioritising defect prevention.[24] A manager who knows that a standard exists but cannot access the complete document, interpret its requirements or incorporate it into process control may possess nominal awareness without operational competence. The present study's distinction between general knowledge of quality practices and access to the formal standard is consequently important.

Occupational health and safety in wood processing

Wood processing environments combine multiple exposure pathways. Dust is a major concern because its health effects may include respiratory irritation, impaired pulmonary function and chronic disease. Ennin et al, (2024) found respiratory function effects among workers exposed to mixed hardwood dust,[10] while Ennin et al, (2025)

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reported pulmonary function concerns among woodworkers exposed to mixed tropical hardwood dust in Kumasi.[11] Chamba et al, (2023) further characterised wood dust particulates, endotoxins and beta-glucans among Mozambican workers, demonstrating that exposure is more complex than visible dust alone.[9] Recent evidence from Engelbrecht et al, (2025) and Elfatih et al, (2025) further reinforces the need to treat wood dust as a significant occupational exposure.[13,25]

Prevention therefore requires a hierarchy of controls. Recent work on wood dust exposure management stresses risk assessment, exposure reduction and preventive strategies rather than relying exclusively on personal protection.[4,5,6,26] A HIRADC-based approach also illustrates the importance of systematically identifying hazards, assessing their risk and determining appropriate controls before harm occurs (Fakultas Teknik, Universitas Widyatama, 2025). Irhamna (2025) reinforces this prevention logic through a systematic review of wood dust exposure and respiratory disorders.[27,28] This distinction matters for the present study because the availability of dust masks should not be interpreted as evidence that dust risk is adequately controlled. A strong safety system would also consider ventilation, extraction, housekeeping, machine maintenance and process design.

Other hazards are similarly important. Noise exposure remains relevant in timber processing, with Rathipe and Raphela (2022) examining occupational noise exposure among sawmill workers.[29] Psychosocial conditions also warrant attention because safety performance can be affected by stress, fatigue and organisational climate. Gutiérrez Alvarez et al, (2024) identified psychosocial risks among plywood industry workers,[30] while Moon (2024) demonstrated the relevance of safety leadership training for safety performance and climate in wood processing companies.[31] Ajmal et al, (2021) likewise linked safety management approaches with occupational health and safety performance, although their context differs from wood processing.[32] Recent Ghanaian work on safety performance indicators also supports the value of combining compliance, safety culture and organisational barriers when assessing workplace safety systems,[33] while role and project type can influence how safety outcomes are distributed in other high-risk work settings.[34] These adjacent findings are used cautiously because they arise from construction rather than veneer manufacturing.

Knowledge, practice and the implementation gap

A recurring problem in occupational safety is the difference between knowing a safety rule and consistently enacting it. Ghanaian evidence has previously shown weaknesses in safety practices in wood processing, particularly around PPE and enforcement.[14] Donkoh et al, (2024) similarly identified the importance of training and PPE provision in wood processing.[15] The present study extends this discussion by separating knowledge from practice and by examining specific domains of safety practice, including fire protection, PPE, security and signage.

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This distinction is analytically useful because high practice in one domain can coexist with low practice in another. For example, workers may wear PPE because the equipment is visible and routinely supplied while simultaneously operating in an environment where fire inspection, emergency communication or maintenance is inconsistent. Such a pattern would indicate partial institutionalisation of safety rather than a fully mature safety system.

Organisational systems also influence worker behaviour. Moon (2024) links safety leadership training with safety performance and climate,[31] while Narayan et al, (2025) demonstrate statistical analysis for predicting OHS conditions among sawmill workers.[35] The HIRADC approach further supports structured hazard identification, assessment and control.[27] The implication is that management systems, worker knowledge and exposure conditions should be assessed together.

Chandrasari and Syahrullah (2022) demonstrate the complementary value of statistical process control and fault tree analysis for plywood defect reduction,[16] while Susanti (2023) shows how failure mode analysis can be used to prioritise defect prevention.[24] These approaches reinforce the argument that quality management should identify the causes of variation and failure rather than simply record defective outputs. Vashishtha (2024) similarly emphasises quality assurance as a manufacturing capability rather than an isolated inspection activity.[22] In Ghana, Adei and Kunfaa (2007) identified occupational safety policy weaknesses in wood processing, providing an important local baseline for interpreting the present findings.[36] Ajmal et al, (2021) further emphasise the relationship between safety management and safety performance, although their context differs from wood processing.[32]

Conceptual framework

The conceptual framework positions quality control measures and occupational health and safety measures as organisational systems that shape what workers are expected to know, how they interpret risks and how they experience the safety environment. The framework therefore moves beyond treating quality and safety as independent technical activities. It assumes that formal controls become meaningful only when workers can access, understand and apply them in routine production. This logic is consistent with contemporary quality research, which emphasises process monitoring, measurable specifications, defect prevention and feedback, and with OHS research that emphasises systematic risk identification and preventive control.[1,2,4,5]

First, the quality control component represents the formal and operational mechanisms used to maintain veneer quality, including applicable Ghanaian standards, dimensional requirements, inspection responsibilities, sampling and testing, approved equipment and chemicals, and process requirements. The framework assumes that the existence of these controls creates an organisational reference point for worker knowledge. This is important because recent veneer and plywood studies show that product quality and recovery are sensitive to processing

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parameters, moisture conditions, drying, machining and other controllable process variables.[7,8,18,19] Statistical process control and failure analysis provide further mechanisms through which organisations can convert process observations into corrective action.[3,16,24]

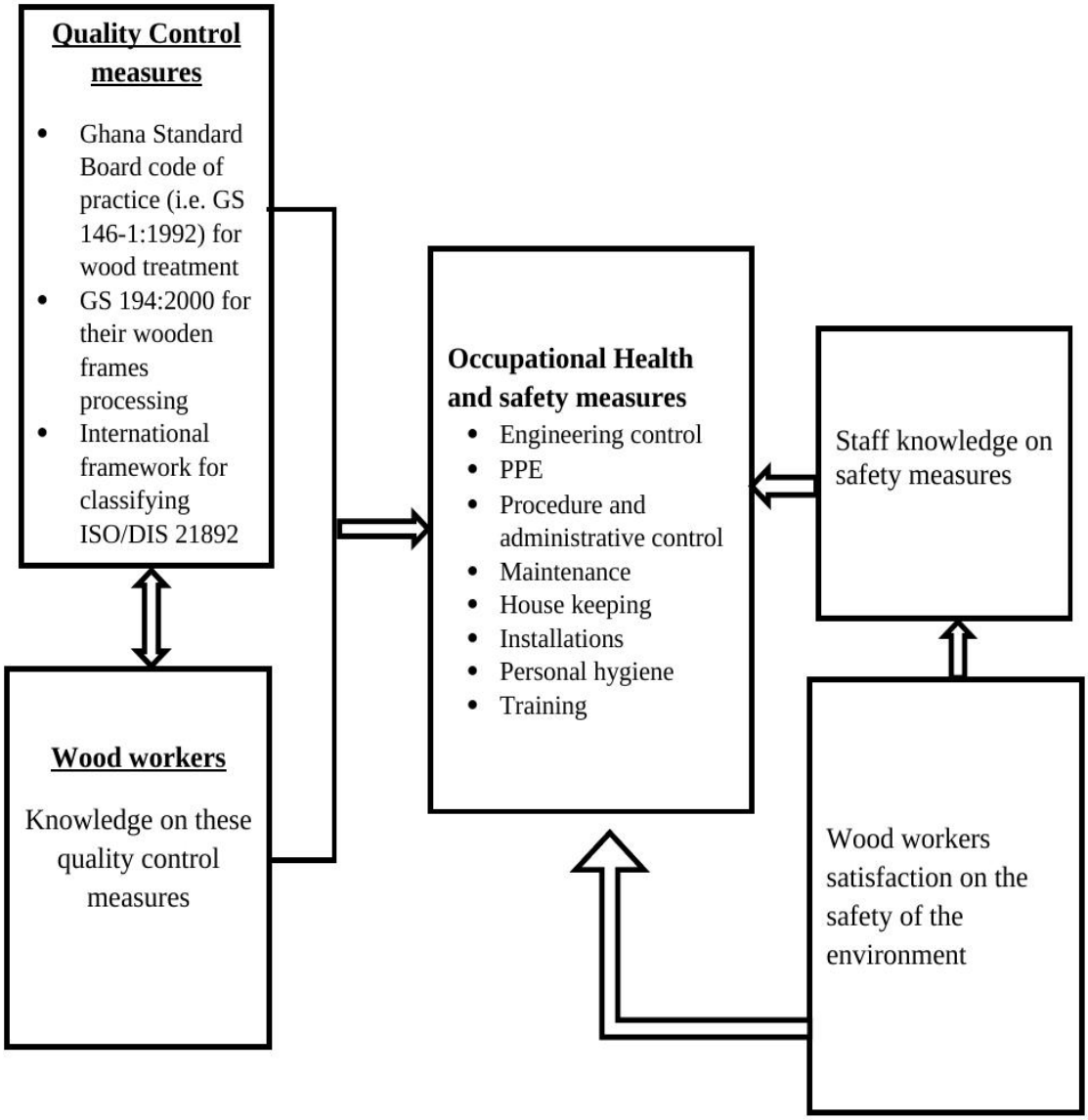
Second, the framework treats worker knowledge of quality control as an important link between formal organisational requirements and production behaviour. Knowledge is not equated with compliance, but it is considered a necessary condition for meaningful application because workers cannot reliably implement requirements that they do not understand or cannot access. The low access to the complete GS 146 1:1992 document observed in this study is therefore conceptually important. Contemporary quality assurance evidence similarly suggests that defect prevention depends on structured knowledge, monitoring and corrective processes rather than inspection alone.[1,22,23]

Third, the occupational health and safety component represents the organisational controls intended to prevent or reduce exposure to hazards. The framework includes engineering control, PPE, procedures and administrative control, maintenance, housekeeping, installations, personal hygiene and training. This broad treatment is supported by recent evidence showing that wood dust exposure is influenced by environmental and process conditions and that respiratory protection should be complemented by source control and exposure reduction.[4,6,9,26] Evidence from Ghana and comparable wood processing settings further indicates that safety performance is affected by training, PPE availability, management commitment and enforcement.[14,15,36]

Fourth, staff knowledge of safety measures is positioned as the cognitive component connecting organisational controls with everyday practice. Workers may recognise obvious hazards such as machines or fire risks while remaining less familiar with emergency procedures, chemical protection, reporting systems or psychosocial risks. This distinction is supported by evidence that wood processing hazards extend beyond visible physical dangers to respiratory, noise and psychosocial exposures.[10,29,30] The framework consequently anticipates that safety knowledge should be examined alongside the actual practice of controls rather than used as a substitute for practice assessment.

Finally, workers' satisfaction with the safety environment is treated as an outcome that can reflect how workers experience the combined quality of organisational controls, communication and implementation. The framework does not claim a causal pathway because the present cross-sectional design cannot establish temporal ordering. Instead, it provides an organising model for examining whether formal quality and safety arrangements coexist with adequate knowledge and positive perceptions of the safety environment. This systems interpretation is consistent with evidence linking safety leadership and organisational climate with safety performance[31] and with broader safety performance indicator approaches that combine compliance, culture and organisational barriers.[33]

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Source: Own elaboration.

Fig. 1. Original conceptual framework of the study on health and safety practices at the veneer production firm.

Methods

Research design and setting

The study used a quantitative, cross-sectional survey design within a veneer production firm operating in Kumasi, Ghana. The design was appropriate for obtaining a structured snapshot of knowledge, perceived practices and

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organisational safety arrangements across different operational groups. The study followed a positivist orientation, treating the measured responses as observable indicators that could be summarised and compared statistically. The use of structured survey data and subgroup statistical analysis is consistent with recent quantitative work examining OHS conditions among sawmill and wood processing workers,[35] although the present study is descriptive and comparative rather than predictive.

The population comprised 429 personnel distributed across logging operations, headrig operations, boiler operations, peeling operations, veneer drying and operational management. The population structure was 112 in logging, 74 in headrig, 54 in boiler operations, 83 in peeling, 89 in veneer drying and 17 managers. The study selected 216 employees and all 17 managers. Stratified random sampling was used for employees, with a census approach for managers. The resulting employee sample was proportionally distributed across the operational groups. The final response comprised 203 usable employee questionnaires and 13 manager questionnaires.

Instrument and measurement

Data were collected with a structured questionnaire divided into demographic information, managers' quality control knowledge, workers' OHS knowledge, OHS practice and safety improvement strategies. Responses to the substantive items were measured on a five-point agreement scale ranging from strongly disagree to strongly agree. The quality control section contained nine items. The OHS knowledge section contained twelve items. The OHS practice section covered fire protection, PPE, security and signage. The strategy section contained fifteen organisational safety improvement items. The breadth of the instrument reflects the multidimensional nature of wood processing safety documented in recent studies covering dust, respiratory outcomes, noise, psychosocial risks and management controls.[9,29,30,31]

The instrument was piloted at Samartex Timber and Plywood Limited in Samreboi, Ghana. Pilot participants were drawn from machine operators and other wood processing workers. Feedback was used to reduce ambiguity and improve the instrument. Internal consistency was assessed with Cronbach's alpha, with reported values between 0.76 and 0.84. These values provide reasonable evidence of internal consistency for the measured constructs. Because the present study is based on self-reported perceptions, the reliability evidence supports consistency of measurement but does not establish that the responses correspond exactly to observed safety behaviour or measured occupational exposure.

Data collection and analysis

Questionnaires were personally distributed and collected by the researcher. Descriptive statistics included frequencies, percentages, means, standard deviations, variance and kurtosis. For the five-point scales, a mean of 3.0

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was adopted as the decision threshold, with values above 3.0 interpreted as agreement or higher knowledge and values below 3.0 interpreted as lower knowledge or weaker practice. While this threshold provides a transparent descriptive rule, it should not be interpreted as a clinical or regulatory compliance standard. It is a criterion for summarising respondents' perceptions. The use of descriptive and inferential statistics is consistent with recent quantitative OHS research in wood processing, although the present study does not attempt to predict injuries or disease outcomes.[35]

Item-level analysis of variance was used to examine whether reported quality control knowledge differed across education categories, whether workers' OHS knowledge differed by years of service, whether OHS practices differed by job destination and whether safety improvement strategies differed by job operation. Statistical significance was evaluated at $p<.05$. Where a significant difference was detected, post hoc comparison was intended to be undertaken. The reported results contain one statistically significant item-level result for education and otherwise show no statistically significant group differences at the conventional 5% level. Importantly, the education ANOVA table contains five education categories that correspond to the employee profile rather than the 13 manager responses. It is therefore not statistically appropriate to describe that table as an education effect among managers. The manuscript consequently reports the table as an item-level education comparison and does not extend the result to a manager-only population.

The analysis was strengthened by reporting dispersion alongside means because high means can conceal disagreement. Self-reported perceptions may differ from observed practice; therefore, findings should be interpreted as perceived organisational conditions rather than substitutes for exposure measurement or safety audits. Recent respiratory evidence reinforces this limitation.[11,25,37]

Ethical considerations

Participation was voluntary. Management permission was obtained before data collection; respondents were informed about the purpose of the study and no personally identifying information was collected. Participants could decline participation or omit questions. Confidentiality and anonymity were emphasised to reduce the possibility of victimisation arising from responses concerning workplace safety.

Results

Response rate and participant profile

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A total of 233 questionnaires were distributed, comprising 17 manager questionnaires and 216 employee questionnaires. Thirteen manager questionnaires were returned and usable, producing a 76.5% manager response rate. Among employees, 203 usable questionnaires were returned, giving a 94.0% employee response rate. The overall response rate was 92.7%. The overall rate is calculated as 216 usable questionnaires divided by 233 distributed questionnaires. This level of participation provides a strong basis for describing the studied firm, although the manager subgroup remains small and should be interpreted cautiously.

The manager profile in table 1 shows a mature management group. More than half were aged 41 to 50 years, all were male, and 69.3% held either a first degree or master's degree in wood-related fields. Most had worked in the firm for more than ten years. This profile indicates substantial managerial experience. It is therefore more plausible to interpret the relatively strong quality control scores as reflecting accumulated operational experience and organisational learning rather than recent formal education alone.

The employee profile in table 2 shows a strongly male-dominated workforce, with 98.5% male respondents. Most employees were aged between 18 and 40 years, while the largest educational category was senior high or technical education. Most had worked between one and ten years. The demographic pattern is consistent with the physically intensive character of the production environment and provides a clear context for interpreting the education and tenure comparisons. Previous Ghanaian work has similarly examined safety knowledge and practice among wood processing workers, supporting the relevance of these worker characteristics to OHS assessment.[14,36]

Table 1. Demographic characteristics of managers

Characteristic	Response	n	%
Age group	31 to 40 years	1	7.7
	41 to 50 years	7	53.8
	51 to 60 years	5	38.5
Gender	Male	13	100.0
	Female	0	0.0
Educational level	Diploma or HND in wood	4	30.8
	First degree in wood technology	6	46.2
	Master's degree in wood science	3	23.1
Years working in a veneer production firm	6 to 10 years	3	23.1
	Above 10 years	10	76.9

Source: Research database.

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Table 2. Demographic characteristics of employees

Characteristic	Response	n	%
Gender	Male	200	98.5
	Female	3	1.5
Age group	18 to 30 years	91	44.8
	31 to 40 years	90	44.3
	41 to 50 years	20	9.9
	Above 50 years	2	0.9
Educational level	No formal education	9	4.4
	Primary education	14	6.9
	Junior high school education	50	24.6
	Senior high or Technical school education	90	44.3
	Tertiary education	40	19.7
Years of working in a veneer production firm	Less than a year	13	6.4
	1 to 5 years	87	42.9
	6 to 10 years	85	41.9
	Above 10 years	18	8.7

Source: Research database.

Managers' knowledge of quality control

Table 3 shows that managers had an overall quality control knowledge mean of 3.21 with a standard deviation of 1.339. Seven of the nine items exceeded the 3.0 decision threshold, whereas two items were below it. The highest rating concerned knowledge of standard dimensions in veneer manufacturing (3.77 ± 1.166), followed by knowledge of quality control and inspection responsibilities (3,62 ± 1,387). Knowledge of sampling and testing requirements and approved equipment and chemicals both recorded means of 3.54. The item pattern is therefore more informative than the aggregate label of high knowledge because it shows a clear distinction between applied production knowledge and formal standards knowledge.

The pattern is important because it indicates relatively strong procedural awareness. Managers appear to understand the operational aspects of quality control that are directly connected to routine production decisions. This finding is consistent with evidence that veneer and plywood quality depends on controllable processing parameters and systematic process monitoring.[2,7,8,17] It also suggests that the firm has retained a level of

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managerial capability sufficient to support routine quality decisions, although that capability should be strengthened by formal documentation and measurable process controls.

However, the two lowest items reveal a critical qualification. Knowledge of standards specifying material, size, construction, workmanship and finish was low (2,38 ± 1,193), while access to the complete GS 146 1:1992 code of practice was also low (2,31 ± 1,437). Thus, the overall mean should not be interpreted as evidence that the firm has comprehensive standards competence. Rather, managers appear more familiar with applied production practices than with the complete documentary basis of standardisation. This is consistent with the broader quality literature, which distinguishes routine process performance from formal quality assurance, defect analysis and documented control.[16,22,24]

This distinction has practical significance. Contemporary quality systems increasingly rely on documented process requirements, measurable specifications and feedback-based correction.[1,3] If managers lack access to or familiarity with the complete standard, production decisions may depend disproportionately on experience and informal knowledge. Such dependence can maintain acceptable routine performance while making the system vulnerable when personnel change, product specifications shift or defects become more complex. The risk is especially relevant in veneer production because drying, moisture, machining and processing parameters can influence final product properties.[18,19,21]

The result also contrasts with the generally stronger picture of quality control knowledge. It would therefore be misleading to conclude simply that the firm has high quality control knowledge. The more defensible conclusion is that managers possess moderate to high practical knowledge, but formal standards literacy remains a weakness. This is an important organisational distinction because documented standards create reproducibility and provide a reference for training, auditing and corrective action.

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Table 3. Knowledge of managers on quality control measures

Nº	Quality control knowledge item	M	SD	Variance	Kurtosis	Decision
1	Knowledge of the application of standard dimensions in manufacturing veneer	3.77	1.166	1.359	1.736	High
2	Knowledge of responsibilities and procedures about quality control and inspection of timber products	3.62	1.387	1.923	-0.869	High
3	Knowledge of requirements and methods of sampling and tests for wood for veneer	3.54	1.391	1.936	-0.149	High
4	Conversant with safe and approved equipment and chemicals	3.54	1.33	1.769	-0.743	High
5	Knowledge of acceptable minimum requirements for exercising total quality control in veneer production	3.38	1.261	1.59	0.237	High
6	Knowledge of quality and reliability of treating wood for producing veneer	3.23	1.423	2.026	-1.675	High
7	In line with international safety and environmental codes for producing veneer	3.15	1.463	2.141	-1.378	High
8	Well informed with standard specifying requirements regarding material, size, construction, workmanship and finish	2.38	1.193	1.423	-1.313	Low
9	Access to the whole document on GS 146 1:1992 Code of practice for wood production	2.31	1.437	2.064	-0.956	Low
	Average score	3.21	1.339	1.804		High

Note. Mean >3.0 = high knowledge; mean <3.0 = low knowledge.

Source: Research database.

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Effect of education level on reported quality control knowledge items

Table 4 requires a statistical qualification. The reported ANOVA compares five education categories that correspond to the employee education profile in table 2, rather than the three education categories represented among the 13 managers in table 1. The table should therefore not be interpreted as evidence of an education effect among managers. Within the reported item-level analysis, most F tests were not statistically significant at $p<.05$. The exception was knowledge of safe and approved equipment and chemicals, which produced $F=4.189$ and $p=.005$. This is statistically significant at the stated criterion and indicates that the education categories differed on this specific item.

The significant item-level result should also be interpreted conservatively. It does not justify the broader claim that education determines quality control knowledge, because the other eight comparisons were not significant and the table itself does not report an aggregate education test. A more defensible interpretation is that the education category was associated with one specific knowledge domain concerning safe and approved equipment and chemicals. This supports targeted technical education while avoiding an unsupported claim that formal education explains the overall quality control construct. The result is also consistent with the broader literature suggesting that quality competence depends on both technical knowledge and organisational process systems.[7,22]

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Table 4. ANOVA of education level and quality control knowledge items

Quality control item	Informal		Primary		JHS		SHS		Tertiary		F	p
	M	SD	M	SD	M	SD	M	SD	M	SD		
Standard dimensions in manufacturing veneer	2.8	1.4832	3.57140	1.1339	3.47060	1.4194	3.65000	1.2680	2.63640	1.3618	1.333	0.269
Responsibilities and procedures for quality control and inspection	3.2	1.3038	3.85710	0.8997	3.52940	1.2307	3.80000	0.9515	3.27270	1.1909	0.676	0.611
Requirements and methods of sampling and tests	3.8	1.7889	3.42860	1.2724	3.35290	1.4116	3.50000	1.0513	3.72730	1.1909	0.216	0.929
Safe and approved equipment and chemicals	3.8	1.0955	3.57140	1.3973	2.41180	1.1213	3.90000	1.2524	3.90910	1.3003	4.189	0.005
Acceptable minimum requirements for total quality control	4.0	1.0000	3.85710	1.5736	3.17650	1.6672	3.50000	1.0513	3.72730	1.3484	0.593	0.669
Quality and reliability of	3.6	0.5477	4.28570	0.9512	3.82350	1.2367	3.75000	1.0699	3.45450	0.8202	0.729	0.576

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treating wood												
International safety and environmental codes	4.0	0.7071	3.85710	1.4639	3.82350	1.1311	3.35000	0.8127	3.63640	1.2061	0.711	0.588
Standards for material, size, construction, workmanship and finish	4.2	0.4472	4.00000	0.8165	3.17650	1.4246	3.70000	1.0311	3.36360	1.1201	1.319	0.274
Access to whole GS 146 1:1992 code	3.4	0.8944	3.28570	1.1127	2.70590	1.7235	2.80000	1.3611	3.36360	1.4334	0.613	0.655

Note. p<.05 indicates a statistically significant difference.
Source: Research database.

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Workers (OHS) knowledge

Table 5 indicates an overall OHS knowledge mean of 2.90 and standard deviation of 1.219, which falls below the study's 3.0 threshold. The highest rated item concerned the proposition that accidents can be avoided through training and education (3,86 ± 1,211). Workers also recognised that shortcuts can cause accidents (M = 3.60) and that fire hazards can be reduced by removing combustible materials and separating flammable materials from ignition sources (M = 3.54). These responses suggest that workers understand several basic hazard prevention principles, but the overall mean indicates that this knowledge is not evenly distributed across the safety system.

The weakness lies in more system-oriented aspects of safety. Knowledge of workplace health and safety policies and procedures was below the threshold (2,84 ± 1,258). Knowledge concerning appropriate safety equipment for chemical protection was lower still (2,37 ± 1,205). Stress management, emergency exits, shared responsibility for safety and falling object prevention also recorded low means. The lowest was knowledge of procedures for preventing falling objects (2,07 ± 1,072). The pattern is important because recent wood processing evidence shows that risks extend beyond immediately visible machine hazards to dust, respiratory, noise and psychosocial exposures.[9,10,29,30]

The pattern suggests that workers understand visible or familiar hazards more readily than organisational and preventive systems. This interpretation is important because current OHS evidence emphasises systematic risk management, exposure assessment and preventive controls rather than isolated behavioural rules.[4,6] In a veneer production environment, a worker may know that PPE is useful but still lack the knowledge needed to recognise exposure pathways, interpret safety signs, understand emergency arrangements or participate in hazard reporting.

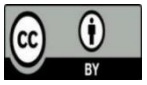
The findings are broadly compatible with recent evidence on wood processing hazards. Ennin et al, (2025) identified pulmonary concerns among woodworkers in Kumasi,[11] while Chamba et al, (2023) showed that wood dust exposure involves particulate and biological components.[9] Elfatih et al, (2025), Sil et al, (2025), and Supapvanich et al, (2024) further report respiratory or pulmonary concerns among wood and plywood workers.[25,37,38] The low knowledge of chemical protection and dust-related controls therefore has greater significance than a generic training gap. It may indicate that workers are insufficiently prepared to understand the health consequences of exposures that are not immediately visible. Recent systematic evidence also supports stronger exposure prevention and risk management rather than reliance on PPE alone.[5,13,28]

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Table 5. Knowledge of workers on occupational health and safety measures

Nº	OHS knowledge item	M	SD	Variance	Kurtosis	Decision
1	Accidents at the workplace can be avoided by training and education	3.86	1.211	1.467	0.157	High
2	Shortcuts cause accidents at the workplace	3.60	1.081	1.169	0.322	High
3	Eliminating fire hazards by removing combustible materials and storing flammable materials away from sources of ignition	3.54	1.201	1.443	0.183	High
4	Consequences in tampering with hazardous items, including cords, switches and electric control	3.47	1.405	1.974	-1.097	High
5	Wearing protective gear helps to avoid accidents	3.47	1.307	1.709	-0.679	High
6	Using equipment properly ensures safety and protection of workers	3.11	1.252	1.569	-1.119	High
7	Health and safety policies and procedures in the workplace	2.84	1.258	1.582	-1.262	Low
8	Using appropriate safety equipment avoids contact with chemicals	2.37	1.205	1.452	-1.017	Low
9	Reducing stress at the workplace avoids difficulty in concentration and depression	2.20	1.207	1.457	-0.613	Low
10	Emergency exits at the workplace	2.13	1.296	1.681	-0.865	Low
11	Both workers and owners are responsible for health and safety at the workplace	2.16	1.138	1.294	0.075	Low
12	Using appropriate procedures to prevent falling objects	2.07	1.072	1.150	-0.491	Low
	Average score	2.90	1.219	1.495		Low

Note. Mean >3.0 = high knowledge; mean <3.0 = low knowledge.
Source: Research database.


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Effect of years of service on workers' OHS knowledge

Table 6 shows that the reported years of service comparisons did not significantly differentiate workers' OHS knowledge across the measured items. For example, the shared responsibility item produced F=0.538 and p=.658. Other items similarly produced p values above .05. Although mean scores varied among employees with different lengths of service, the differences were not statistically convincing.

This result challenges the assumption that experience automatically produces safety competence. Experience can strengthen practical familiarity, but it may also reproduce established routines, including unsafe routines, if formal training and organisational learning are weak. The finding is therefore consistent with the need for structured refresher training rather than reliance on tenure as a proxy for competence. Moon (2024) demonstrates the importance of organised safety leadership interventions,[31] while Donkoh et al, (2024) highlight training as an important component of improving safety conditions in Ghanaian wood processing.[15] The finding also supports the use of formal risk identification and control systems rather than assuming that experience alone will produce safe behaviour.[27]

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Table 6. ANOVA of years of service and workers' OHS knowledge

OHS knowledge item	<1 year		1 to 5 years		6 to 10 years		>10 years		F	p
	M	SD	M	SD	M	SD	M	SD		
Shared worker and owner responsibility	3.5000	1.25550	3.6176	1.07350	3.2727	1.54863	4.0000	1.00000	0.538	0.658
Health and safety policies and procedures	3.5333	1.12697	3.7941	0.94643	3.1818	1.29601	3.3333	1.52753	1.460	0.235
Accidents can be avoided by training and education	3.7167	1.29001	3.8529	1.28234	3.5455	1.33550	3.6667	1.52753	0.348	0.791
Shortcuts cause accidents	3.3000	1.49915	3.2059	1.55270	3.5455	1.40500	3.3333	1.52753	1.028	0.387
Consequences of tampering with hazardous items	3.3000	1.55465	3.3824	1.53770	3.3182	1.67293	3.0000	0.47242	0.791	0.504
Protective gear helps avoid accidents	3.7667	1.29362	3.7647	1.30405	3.7727	1.37778	3.3333	0.57735	0.403	0.752
Safety equipment avoids chemical contact	3.5167	1.29525	3.6176	1.37101	3.3182	1.24924	3.3333	0.57735	0.687	0.564
Proper equipment use ensures safety	3.2667	1.44816	3.0882	1.48462	3.4545	1.47122	3.3333	0.57735	0.766	0.518
Emergency exits at workplace	3.3000	1.54371	3.0000	1.49747	3.6818	1.64422	3.3333	0.57735	1.301	0.283
Reducing stress avoids concentration difficulty	3.2000	1.38760	3.0294	1.40314	3.5000	1.33631	3.0000	2.00000	0.529	0.664
Procedures to prevent falling objects	3.2667	1.42456	3.0294	1.46650	3.6364	1.29267	3.3333	2.08167	0.814	0.491
Eliminating fire hazards	2.9500	1.55602	2.8529	1.52021	2.9545	1.58797	3.3333	2.08167	0.672	0.573

Note. p<.05 indicates a statistically significant difference.

Source: Research database.

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OHS practices

The practice results in table 7 show clear variation between safety domains. Fire protection had the lowest domain mean at 2.71. Portable extinguishers were reported as available (4,01 ± 1,095), and workers reported adherence to fire protection plans (3,34 ± 1,246). However, frequent checking of smoke detectors was low (2.19 ± 1.047), inspection of fire hoses and cabinets was low (2.08 ± 0.863), and posting of evacuation plans was very low (1.94 ± 1.181).

This combination is more concerning than the availability of extinguishers alone. Fire safety depends on detection, communication, equipment inspection and evacuation readiness as well as extinguishing capacity. A fire extinguisher that is present but not routinely inspected is not equivalent to a verified emergency control. The result therefore points to a preventive maintenance gap. The broader wood dust and manufacturing safety literature reinforces the importance of systematic exposure and workplace control rather than isolated resource provision.[5,6] The finding also demonstrates why safety assessment should distinguish resource availability from system reliability.

PPE practice was comparatively stronger, with a domain mean of 3.34. Workers reported that PPE was worn when required (3.81 ± 1.275), used correctly (3.80 ± 1.163) and that appropriate dust masks were regularly supplied (3.67 ± 1.244). However, regular checking and maintenance of PPE was weak (2.07 ± 0.851). This is a critical qualification. The apparent strength of PPE practice is therefore partly undermined by weak inspection and maintenance.

The result is especially relevant in light of current wood dust evidence. Respiratory protection may reduce exposure, but it should complement source control and environmental measures rather than replace them.[4,6,26] Evidence from Thai rubberwood workers further suggests that exposure may remain harmful even where permissible conditions are achieved.[39] The firm should therefore interpret the high PPE provision scores as one component of control, not evidence that dust risk is adequately managed.

Security measures recorded the highest domain mean at 3.36. Adequate lighting within and around workplaces was rated highly (3.94 ± 1.063), security measures were reported as present (3.81 ± 1.166), and emergency exits received a mean of 3.48. Car park lighting and security were weaker (2.20 ± 1.043). The pattern indicates that basic environmental security is comparatively well established, although peripheral areas require attention.

Signage produced a domain mean of 2.95, just below the decision threshold. Warning signs were adhered to (3.92 ± 0.937) and exits were clearly marked (3.61 ± 1.357), but maximum working loads on hoists and lifts were not conspicuously marked (2.14 ± 0.893), and the names of health and safety representatives were not adequately displayed (2.14 ± 0.884). This pattern again separates visible safety communication from deeper institutional

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communication. Workers appear able to respond to some immediate warning information but may have less access to information about equipment limits and safety accountability.

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Table 7. Practice of occupational health and safety measures

Domain	Practice item	M	SD	Variance	Kurtosis	Decision
Fire protection	Portable extinguishers are available for use	4.01	1.095	1.199	1.849	Agreed
	Fire protection plans are adhered to	3.34	1.246	1.552	-0.717	Agreed
	Smoke detectors are checked frequently	2.19	1.047	1.095	-0.725	Disagreed
	Fire hoses and hose cabinets are inspected	2.08	0.863	0.745	0.962	Disagreed
	Evacuation plans are posted	1.94	1.181	1.394	0.919	Disagreed
Personal protective equipment	PPE are worn by workers when required	3.81	1.275	1.626	-0.544	Agreed
	PPE are used in the correct manner	3.80	1.163	1.353	0.357	Agreed
	Appropriate dust masks are regularly supplied	3.67	1.244	1.548	-0.569	Agreed
	PPE are checked and maintained regularly	2.07	0.851	0.725	1.104	Disagreed
Security	There is adequate lighting within and around workplaces	3.94	1.063	1.129	-0.422	Agreed
	Security measures are put in place	3.81	1.166	1.361	0.347	Agreed
	There are sufficient exits to permit prompt escape in case of emergency	3.48	1.361	1.853	-1.324	Agreed
	Car parks are well lit and secured	2.20	1.043	1.088	1.515	Disagreed
Sign	Warning signs are adhered to	3.92	0.937	0.878	0.025	Agreed
	Exits are clearly marked	3.61	1.357	1.841	-0.592	Agreed
	Maximum working load of machines is conspicuously marked on every hoist or lift	2.14	0.893	0.797	0.233	Disagreed
	Names of health and safety representatives are displayed	2.14	0.884	0.782	0.277	Disagreed

Note. Mean >3.0 = agreed; mean < 3.0= disagreed. Source

Source: Research database.

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Effect of job destination on OHS practice

Table 8 indicates that job destination did not significantly differentiate the reported OHS practices. For example, smoke detector checking produced F=1.363 and p=.263, fire protection plan adherence produced F=2.480 and p=.070, and PPE use produced F=0.231 and p=.874. The p value of .070 for fire plan adherence is close to but above .05 and therefore should not be described as statistically significant. It may be a useful signal for further investigation, but the present data do not establish a group difference at the stated significance level. The subgroup table also appears to represent a narrower operational grouping than the full 203 employee sample, so the F and p values are interpreted as reported rather than reconstructed.

The general absence of significant job destination effects suggests that the observed safety weaknesses are not confined to one occupational group, subject to the limitations of the subgroup analysis. This supports a systems interpretation. If weak emergency planning, signage or maintenance is experienced across operational areas, interventions should be organisational rather than targeted solely at selected workers. The result also cautions against attributing safety performance mainly to individual job roles when management systems, communication and maintenance are shared across the facility. This interpretation aligns with evidence that safety performance reflects organisational climate and leadership as well as worker-level behavior.[31,33]

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Table 8. ANOVA of job destination and OHS practice

Practice item	Headrig		Boiler		Supervisor/Manager		Others		F	p
	M	SD	M	SD	M	SD	M	SD		
Smoke detectors are checked frequently	3.0952	1.64027	3.9231	1.55250	3.1304	1.48643	4.3333	0.57735	1.363	0.263
Fire protection plans are adhered to	2.9524	1.24403	4.0769	1.18754	3.3478	1.30065	4.0000	0.00000	2.480	0.070
Portable extinguishers are available	3.6667	1.19722	3.6923	1.43670	3.1304	1.39167	3.0000	1.00000	0.893	0.451
Fire hoses and hose cabinets are inspected	3.4286	0.97834	3.4615	1.50640	3.2609	1.25109	2.6667	1.52753	0.406	0.749
Evacuation plans are posted	3.7143	0.90238	3.2308	1.23517	3.4348	1.40861	3.6667	1.15470	0.482	0.696
PPE are used in the correct manner	3.6667	1.23828	3.7692	1.30089	3.4348	1.27301	3.6667	1.15470	0.231	0.874
PPE are worn when required	3.5714	1.39898	3.6923	1.18213	3.6087	1.19617	4.0000	1.00000	0.113	0.952
PPE are checked and maintained regularly	3.6667	1.19722	3.3077	1.43670	3.6087	1.33958	5.0000	0.00000	1.410	0.249
Appropriate dust masks are regularly supplied	3.0952	1.51343	3.8462	1.34450	3.3478	1.49571	4.0000	1.73205	0.864	0.465
Security measures are put in place	3.5000	1.67017	3.0769	1.55250	3.3478	1.55530	2.6667	1.52753	0.354	0.786
Adequate lighting within and around workplace	3.1905	1.53685	3.4615	1.33012	3.3913	1.37309	3.6667	0.57735	0.175	0.913
Car parks are well lit and secured	2.9048	1.48003	3.4615	1.66410	3.1739	1.37021	4.0000	1.00000	0.720	0.545
Sufficient exits for prompt emergency escape	3.2381	1.22085	3.6923	0.94733	3.3478	1.33514	4.0000	1.00000	0.636	0.595
Warning signs are adhered to	3.1429	1.31475	3.6154	1.26085	2.9565	1.18622	3.0000	2.00000	0.752	0.526
Exits are clearly marked	3.0476	1.35927	4.0769	1.25576	3.6087	1.19617	2.6667	2.08167	2.122	0.108
Names of health and safety representatives are displayed	3.3333	1.27802	3.7692	1.42325	3.7826	1.27766	4.0000	1.00000	0.599	0.618
Maximum working load marked on hoists, lifts, or winches	3.4762	1.28915	3.6923	0.94733	3.5217	1.47308	4.0000	1.00000	0.197	0.898

Note. $p<.05$ indicates a statistically significant difference. The p value of .070 for fire protection plan adherence is not statistically significant at the stated criterion.

Source: Research database.

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Strategies for improving safety

Table 9 indicates broad support for safety improvement strategies. High scores were recorded for PPE provision and use (3.58 ± 1.046), hazard communication and reporting arrangements (3.58 ± 1.046), emergency preparedness (3.47 ± 1.016), ventilation and airborne particle control (3.47 ± 1.016), machinery inspection (3.50 ± 1.017) and ergonomic attention (3.48 ± 1.172). These results indicate that workers recognise the need for a broad safety programme rather than a single intervention. The emphasis on ventilation, reporting, inspection and emergency preparedness is particularly consistent with current evidence on wood dust exposure prevention and organisational safety management.[4,6,26]

However, three items were relatively weak: regular safety meetings (2.62 ± 1.209), worker involvement in policy development and review (2.97 ± 1.438) and ready availability of first aid with training (2.68 ± 1.359). These weaknesses are significant because they concern the organisational infrastructure through which safety knowledge is maintained. A firm may provide equipment and still struggle to sustain safety learning if workers are not routinely involved in meetings, policy review and emergency preparedness. Safety leadership evidence supports this interpretation because organised coaching and leadership can influence safety climate and performance.[31]

The strategy table does not report a single overall strategy mean. Although the source thesis describes the strategy findings as generally positive, an overall mean should not be inferred by simply averaging the item means because the table does not state the method used to derive any aggregate score. The item pattern is sufficient to conclude that most proposed interventions were supported, while meetings, policy involvement and first aid were comparatively weaker. This item-level interpretation is more statistically defensible and is consistent with evidence favouring structured safety management, predictive analysis and preventive exposure control.[5,35]

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Table 9. Strategies for improving health and safety practices

Strategy item	M	SD	Variance	Skewness	Kurtosis
Employees receive comprehensive training on health and safety procedures in the veneer production process	3.2200	0.65127	0.424	-0.387	-0.954
Employees are provided with and regularly use appropriate PPE such as gloves, goggles and ear protection	3.5832	1.04625	1.095	-0.642	-0.214
Employees are well prepared to respond to emergencies or accidents in the workplace	3.4667	1.01625	1.033	-0.558	-0.311
Regular inspections and maintenance checks are conducted on machinery to ensure safety standards	3.5000	1.01681	1.034	-0.350	-0.653
Attention is given to ergonomic considerations in workstations to prevent musculoskeletal issues	3.4833	1.17158	1.373	-0.580	-0.559
Potential workplace hazards are communicated to employees and measures are in place for reporting safety concerns	3.5833	1.04625	1.095	-0.642	-0.214
Workplaces are well ventilated, and measures are in place to control dust and other airborne particles	3.4667	1.01625	1.033	-0.558	-0.311
Wellness programmes or initiatives are in place to promote employee health and wellbeing	3.5000	1.01681	1.034	-0.350	-0.653
Employees can report incidents or near misses, and these are promptly addressed	3.4833	1.17158	1.373	-0.580	-0.559
Company compliance with local and national health and safety regulations	3.3500	1.14721	1.316	-0.454	-0.453
Management frequently organises safety meetings	2.6167	1.20861	1.461	0.253	-0.865

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to discuss and address health and safety concerns					
Employees are involved in the development and review of health and safety policies and procedures	2.9667	1.43759	2.067	-0.188	-1.432
Workplace stress is monitored and managed to protect employee health and safety	3.2333	1.39450	1.945	-0.356	-1.195
First aid kits are readily available, and employees are trained in basic first aid procedures	2.6833	1.35911	1.847	0.268	-1.303
The company reviews and updates health and safety policies to incorporate best practices and lessons learned	3.2500	1.36077	1.852	-0.347	-1.114

Note. Mean >3.0 = high level of agreement with the strategy; mean <3.0 = low level.

Source: Research database.

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Job destination and safety improvement strategies

Table 10 shows that none of the reported strategy items had a statistically significant difference across job operations at p<.05. For example, comprehensive training produced F=0.602 and p=.617, PPE provision produced F=0.272 and p=.845, and machinery inspection produced F=0.640 and p=.592. The largest F value in the table was 1.886 for workplace stress management, with p=.142, which also remained nonsignificant. The reported p values therefore support the conclusion that no tested strategy item differed significantly across the displayed job operation categories.

The absence of significant group differences is useful because it suggests that the proposed interventions have broad relevance across the displayed operational categories, although the subgroup structure should be interpreted cautiously. The strategy programme can therefore be designed at the firm level, with specific task-based modules added where hazard profiles differ. This approach is compatible with safety performance indicator frameworks that combine general organisational controls with role or work context considerations.[33,34]

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Table 10. ANOVA of job operation and safety improvement strategies

Strategy item	Logging		Driver		Supervisor/Manager		Others		F	p
	M	SD	M	SD	M	SD	M	SD		
Comprehensive health and safety training	3.4762	1.12335	3.9231	0.86232	3.5217	1.08165	3.3333	1.15470	0.602	0.617
Appropriate PPE provision and use	3.4286	1.07571	3.6923	0.85485	3.3913	1.11759	3.3333	0.57735	0.272	0.845
Preparedness for emergencies or accidents	3.5714	0.97834	3.6923	0.94733	3.4348	1.12112	2.6667	0.57735	0.888	0.453
Regular machinery inspection and maintenance	3.3810	1.20317	*3.8462*	0.89872	3.4348	1.30823	3.0000	1.00000	0.640	0.592
Ergonomic attention	3.4762	1.12335	3.9231	0.86232	3.5217	1.08165	3.3333	1.15470	0.602	0.617
Hazard communication and safety reporting	3.4286	1.07571	3.6923	0.85485	3.3913	1.11759	3.3333	0.57735	0.272	0.845
Ventilation and airborne particle control	3.5714	0.97834	3.6923	0.94733	3.4348	1.12112	2.6667	0.57735	0.888	0.453
Wellness programmes	3.3810	1.20317	3.8462	0.89872	3.4348	1.30823	3.0000	1.00000	0.640	0.592
Incident and near miss reporting	3.4286	1.28730	3.3846	1.12090	3.3478	1.11227	2.6667	0.57735	0.379	0.768
Compliance with local and national regulations	2.4762	1.16701	2.4615	1.45002	2.7826	1.20441	3.0000	0.00000	0.399	0.755
Management safety meetings	3.0952	1.37495	2.9231	1.44115	2.8261	1.49703	3.3333	2.08167	0.190	0.903
Employee involvement in policy development and review	3.2857	1.48805	3.5385	1.26592	2.9565	1.39734	3.6667	1.52753	0.604	0.615
Workplace stress monitoring and management	3.0952	1.26114	2.6923	1.54837	2.4783	1.30974	1.3333	0.57735	1.886	0.142
First aid kits and basic first aid training	3.3333	1.39044	3.3846	1.19293	3.0435	1.49174	3.6667	1.15470	0.327	0.806
Policy review and updates	1.9048	1.09109	2.3846	1.38675	2.0870	1.23998	3.0000	1.73205	0.909	0.443

Note. $p<.05$ indicates a statistically significant difference.

Source: Research database.

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Discussion

The central finding of this study is the coexistence of relatively strong managerial quality control knowledge with comparatively weak worker OHS knowledge and uneven safety practice. This asymmetry is theoretically and practically important. It suggests that the firm may possess technical knowledge at the supervisory level without having fully translated that knowledge into a shared safety culture and consistently maintained control system. The result supports the conceptual framework, in which organisational controls, worker knowledge and safety environment are treated as interconnected rather than isolated components. Recent work in wood processing similarly indicates that safety performance depends on management systems, training, leadership and exposure controls rather than on a single intervention.[15,31,36]

The quality control results show that managers are confident about routine production requirements, sampling, equipment and chemical use. This is encouraging because quality improvement depends on operational competence. Recent studies show that veneer and plywood quality is sensitive to processing parameters and that data-based quality control can reduce process variation.[2,7,8,17] However, the weak scores for formal standards access and detailed specification knowledge reveal a vulnerability. A quality system based heavily on experience can work under stable conditions but may become inconsistent when personnel, products or process conditions change.[1,3,16,24] provide a stronger model in which quality is supported by structured measurement, failure analysis and continuous process control.

The education analysis reinforces the need for caution. The reported ANOVA shows one statistically significant item for safe and approved equipment and chemicals, but the education table is structured around employee education categories rather than the 13 managers. It therefore cannot support a broad claim about educational effects among managers. The appropriate interpretation is narrower: the reported education groups differed on one quality control knowledge item, while the other reported comparisons were not significant. This is precisely the kind of distinction that prevents overinterpretation of p values. The result suggests that targeted technical education may be useful for equipment- and chemical-related knowledge, but it does not establish education as a general determinant of quality control competence.

The worker OHS findings are more concerning. The overall mean of 2.90 indicates that knowledge is below the study threshold, but the item pattern is more informative than the aggregate score. Workers understand that training can prevent accidents and that shortcuts create risk, yet they are less familiar with policies, emergency exits, chemical protection, stress and falling object prevention. This resembles hazard recognition without full safety

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system literacy. Current literature supports this interpretation because wood processing hazards are multidimensional and include respiratory, physical, noise and psychosocial risks.[9,10,29,30] A safety programme that communicates only PPE requirements may therefore leave workers unable to recognise or control less visible risks.

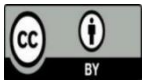
The PPE findings demonstrate the same tension. Workers reported relatively good use and availability of PPE, but maintenance and inspection were weak. This distinction matters because PPE is a control measure whose value depends on suitability, condition, correct use and maintenance. More importantly, current wood dust evidence emphasises exposure prevention through engineering and environmental controls in addition to personal protection.[4,6,26] Longitudinal evidence from rubberwood workers further cautions that exposure may remain harmful even where permissible conditions are achieved.[39] The firm should therefore avoid interpreting PPE availability as proof of adequate dust control.

The fire protection findings represent perhaps the most immediate organisational weakness. Extinguishers were available, yet smoke detectors, fire hoses and evacuation plans were poorly maintained or communicated. This is a difference between provision and readiness. A safety system becomes credible when controls are routinely inspected, tested and linked to a clear emergency response. A structured hazard identification and risk assessment approach could help prioritise these controls.[27] The finding therefore warrants priority attention even though some basic fire resources are present.

The signage findings also reveal a difference between visible warning communication and institutional transparency. Warning signs and exits were comparatively well managed, but equipment load limits and safety representative information were weak. This means that workers may receive warnings about immediate hazards without having equally clear information about equipment capacity or who is responsible for safety oversight. The latter is important for accountability. Safety performance indicator research similarly suggests that compliance and safety culture need to be considered together rather than reduced to isolated signs or rules.[33]

The lack of significant effects for years of service and job destination is equally important. Safety knowledge did not increase systematically with tenure, and most practice indicators did not vary significantly by job group. This means that informal experience alone is unlikely to close the knowledge gap. It also means that the safety problem should not be framed as the behaviour of a particular group. Instead, the evidence points to firm-level systems that shape the opportunities available to workers. This interpretation is consistent with evidence linking safety leadership and organisational climate with safety performance[31] and with the Ghanaian literature on management commitment and safety policy weaknesses.[14,36]

The strategy results provide an important counterpoint. Workers generally supported training, PPE, emergency preparedness, machinery inspection, ergonomic attention, hazard communication, ventilation and wellness measures. Thus, there appears to be a relatively strong readiness for improvement. Yet regular safety meetings,


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first aid readiness and worker involvement in policy review were weaker. These are precisely the mechanisms through which a safety system learns and adapts. The low rating for policy involvement is especially notable because the practice findings indicate gaps in emergency planning, signage and maintenance. Without routine review, weaknesses can persist even when workers recognise the need for improvement. Safety leadership evidence and predictive OHS research both support stronger organisational learning mechanisms.[31,35]

The combined results suggest that the firm's safety maturity is uneven rather than uniformly poor. PPE provision, basic security and warning signs are relatively strong, while controls requiring verification, maintenance, communication and organisational learning are weaker. This is more useful than labelling the workplace simply safe or unsafe because it identifies management priorities.[33]

The findings also have implications for quality performance. Quality control and OHS share dependencies on process discipline, equipment condition, worker competence and feedback. Recent studies support statistical process control, defect prevention and process optimisation in plywood and veneer manufacturing,[1,2,3,24] while OHS literature supports systematic exposure assessment and prevention.[4,5] An integrated system could therefore link machine maintenance, process monitoring, training, hazard reporting and corrective action.

The study has several methodological implications. The high overall response rate supports the descriptive picture, while the smaller manager response limits manager-level inference. Pilot reliability values of 0.76 to 0.84 indicate acceptable internal consistency. However, the cross-sectional design cannot establish causality, and self-reported measures may be affected by social desirability. The thesis methodology indicates that correlation analysis was undertaken, but no correlation coefficients were reported in the results; accordingly, no correlation-based claims are made in this manuscript. Future work should combine questionnaires with direct observation, exposure measurements, injury records and documentary audits.

The study also provides a basis for a more rigorous safety management model. The first layer should be engineering and environmental controls, including dust extraction, ventilation, guarding, fire detection and machine maintenance. The second should be administrative control through procedures, training, emergency planning, inspections and worker participation. PPE should remain a complementary control. This layered approach is consistent with wood dust prevention, occupational risk management and structured hazard assessment.[4,5,6,26,27]

Overall, the evidence indicates that the principal challenge is not simply a lack of safety resources. It is the incomplete institutionalisation of those resources through knowledge, maintenance, communication, accountability and continuous review. This is why high PPE scores can coexist with weak fire readiness and low OHS knowledge. The managerial priority should therefore be to strengthen the links between policy, worker understanding, physical controls, supervision and learning rather than adding isolated safety interventions. This conclusion is consistent

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with evidence from Ghanaian wood processing on safety policy and practice and with contemporary safety leadership research.[14,31,36]

The respiratory implications of the present findings also deserve attention. Recent studies report impaired pulmonary outcomes among wood and plywood workers exposed to dust.[11,25,37,38] Chamba et al, (2025) additionally report work-related airway disease among wood processing workers,[12] while Engelbrecht et al, (2025) synthesise evidence on health effects of several common wood dust species.[13] Longitudinal evidence from rubberwood workers further cautions that exposure conditions may remain harmful even where regulatory permissibility is achieved.[11,39] This strengthens the case for treating the study's dust mask findings as only one component of a wider exposure control programme.

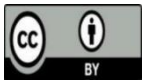
Limitations of the study

The study is limited by its single firm setting, cross-sectional design, self reported measures. The findings therefore should not be generalised to all Ghanaian wood processing firms without further evidence. Future studies should include multiple veneer and plywood firms across Ghana, direct observation, occupational dust and noise measurements, injury and near miss records, safety audits and longitudinal assessment of training interventions. Such work would allow the relationship between knowledge, exposure, compliance and actual safety outcomes to be tested more rigorously and would strengthen the evidence base for integrated quality and OHS management.

Conclusion and implications

This study assessed quality control knowledge and OHS conditions in a Ghanaian veneer production firm and identified a clear asymmetry between managerial quality control knowledge and worker safety knowledge. Managers showed relatively strong practical knowledge of quality control, but weaknesses remained in formal standards documentation. Workers demonstrated low overall OHS knowledge, particularly in relation to workplace policies, chemical protection, emergency arrangements, stress management, shared safety responsibility and falling object prevention. Safety practice was similarly uneven. PPE and basic security arrangements were comparatively strong, whereas fire protection and signage were weaker, especially where inspection, maintenance and formal communication were required. These findings are consistent with the broader wood processing literature showing that technical controls, worker knowledge, leadership and preventive exposure management need to operate together.

The findings imply that safety performance cannot be inferred from PPE availability or the existence of individual safety measures. Effective safety management requires a connected system in which hazards are identified,


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controls are maintained, workers understand procedures, emergency arrangements are visible and management reviews performance. The absence of statistically significant differences for years of service and most job destination comparisons further suggests that the main intervention should be organisational rather than targeted only at selected worker groups. The significant education item should be treated separately and narrowly rather than as evidence of a general education effect.

For practice, management should appoint a trained safety coordinator with explicit responsibility for monitoring compliance, inspection and corrective action. Fire detection equipment, hoses and evacuation arrangements should be inspected on a scheduled basis. Emergency plans should be displayed prominently, and maximum equipment loads and safety representative information should be clearly marked. PPE should continue to be supplied, but its condition, fit, suitability and maintenance should be systematically checked. Dust control should be strengthened through ventilation, extraction and housekeeping rather than relying only on masks. Regular safety meetings should be institutionalised, with workers involved in reviewing incidents, near misses and safety policies. These recommendations are consistent with current evidence on wood dust control, safety leadership and organisational risk management.

For quality management, the firm should improve access to applicable standards and integrate documented requirements into routine production checks. Quality and safety audits should be linked where machine condition, process variation or worker competence can influence both product defects and exposure risks. A combined management approach would be more consistent with contemporary wood manufacturing research on statistical quality control, process optimisation and structured defect prevention.

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Conflict of interest

The authors declare that they don't have conflict of interest.

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