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Review Article

Process Safety Leadership and Culture in the Palm Oil Milling Industry

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Abstract:

In various industries, the importance and evolution of process safety leadership and culture have been stressed by several studies. Nevertheless, the palm oil milling industry remains an understudied domain. This paper undertakes a critical review of the most recent developments in the palm oil milling process and unit operations that trigger concerns about process safety to leaders in the palm oil milling industry with guidelines about the requisite process safety leadership and culture to be understood with a view to enhancing safety outcomes. In addition, the paper explores the principle of 3C for explicating constant accidents along with the four-level safety culture in the palm oil milling industry. To do so, the author presents case studies of two Malaysian key palm oil companies.

Key words: palm oil industry; palm oil milling; process safety; leadership; culture

Introduction

The fruits of the oil palm tree are known to yield palm oil, an edible vegetable oil. As the largest traded vegetable oil worldwide, it surpasses all other vegetable oils, including rapeseed, soybean, and sunflower. With a yearly production of around 46.5 and 19.8 million tons, respectively, in 2020-21, Indonesia and Malaysia are the principal palm oil-generating countries, accounting for 85% of the world's total palm oil production [1]. In 2020-21, global palm oil production registered a major surge to 73 million tons from 16.1 million tons in 1995-96[1]. Since palm oil is relatively cheap and offers myriad advantages in edible as well as non-edible products, the worldwide demand for palm oil is gradually rising. The palm oil processing value chain encompassing the milling, refining, and oleochemicals sectors – is used to produce Palm oil and its derivatives. Although the industry of palm oil processing has recently focused on process safety, plenty of room for improvement still exists, especially in wake of the multiple incidents that have taken place during the 24-month timespan. These incidents have been summarized in Table 1.

Date	Incident Description	Casualty	Reference
May 2021	Crude oil tanks caught fire at a oleochemicals plant in Telok Panglima Garang Industrial area, Selangor.	One killed while three others suffered injuries	[35]
January 2021	Small explosion at a palm oil processing plant in the Tanjung Langsat Industrial area in Pasir Gudang, Johor.	One killed while two others suffered injuries	[36]
October 2020	Palm oil mill in Johor caught fire and was burning for at least 14 hours.	No casualties was reported	[37]
September 2020	Worker was killed after he fell into a boiling tank at a palm oil mill in Malacca.	One killed	[38]

July 2020	Fire broke out at a biodiesel plant at Pasir Gudang, Johor.	No casualties was reported	[39]
May 2020	Worker died from electrocuted at a palm oil mill in Johor.	One killed	[40]

Table 1 Incidents recorded in Malaysian palm oil processing industry from 2020-2021

Various studies, such as the needs of occupational safety and health management system and process safety management, have been conducted on personal and process safety in the palm oil industry [2,3,4]. A few of them have placed their emphasis on process safety leadership and culture [5,6], but no study has focused on the palm oil milling industry's process safety aspects thus far, to the best of the author's knowledge. The current paper not only explores the palm oil milling process and its unit operations along with the accompanying safety concerns but also examines the factors causing repeat accidents. Furthermore, the paper explains this relationship using an analogy as per the Principle of 3C and also discusses the four-level safety culture in the palm oil milling industry. In doing so, the author utilized two key palm oil companies in Malaysia: Sime Darby Plantation Berhad and Genting Plantations Berhad as case study illustrations

2.0 Palm Oil Milling Operations

Typical palm oil milling process flow can be elucidated as types of activities in their respective stations (Figure. 1). The fresh fruit bunches (FFB) are carried to the palm oil mills from the plantation sites. Reception, sterilization, threshing, digestion and pressing, clarifying and purification, and kernel recovery all form part of the milling operation. The main products produced by palm oil mills include crude palm oil and palm kernels. The biomass generated includes pressed mesocarp fibers, palm kernel shells, empty fruit bunches, and decanter solids. On the other hand, the liquid by-product includes palm oil mill effluent (POME)—the combination of many waste streams, e.g., sterilizer condensate, heavy phase from clarification, and wastewater from wet separation. To generate power and facilitate various processes, a palm oil mill has a boiler station that produces steam to drive steam turbines [7,8,9].

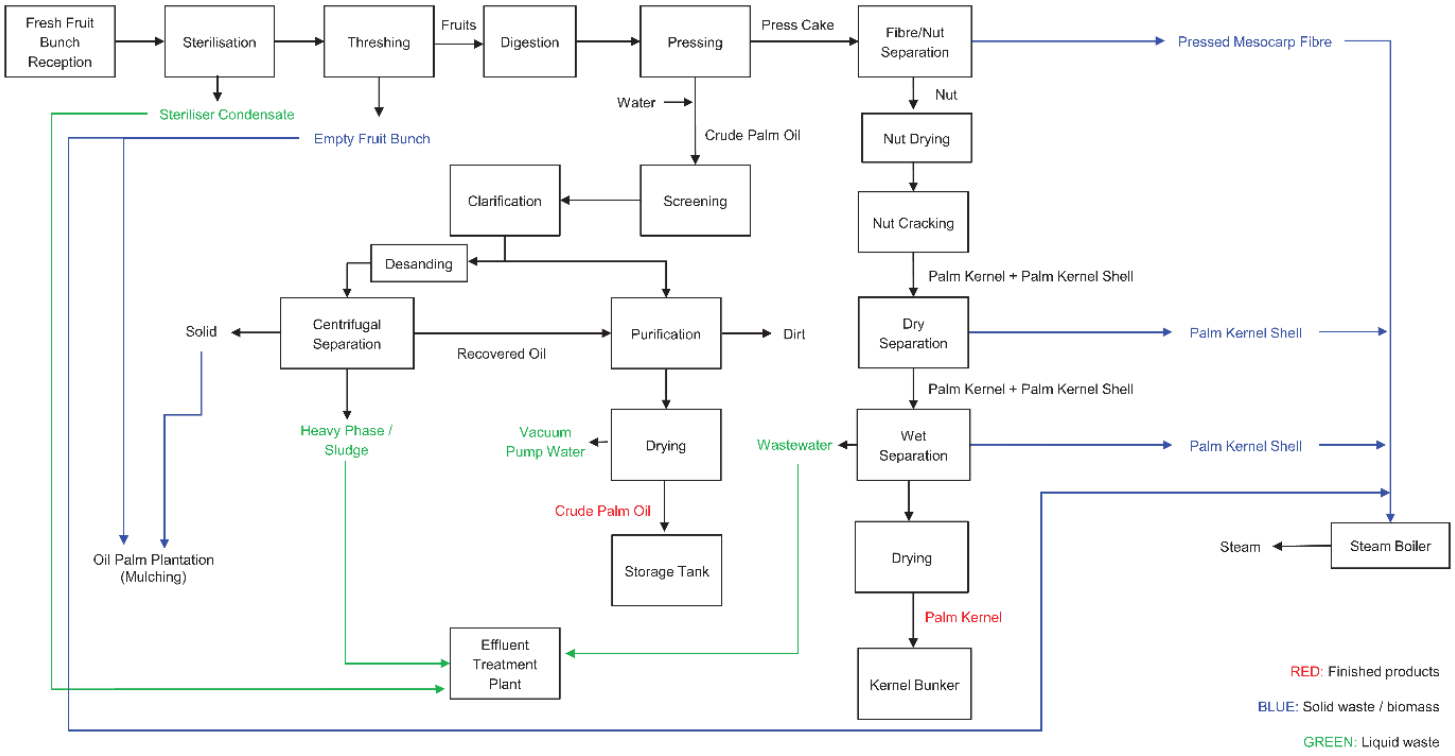

Figure. 1: Typical palm oil milling process flow

3.0 Causes for Repeat Accidents in Palm Oil Milling Industry

According to Judith Hackitt, former chair of the Health and Safety Executive, a nongovernmental agency based in the UK, only old accidents are repeated by new people and there is no such thing as new accidents. Broadly a repeat accident refers to an accident that has already taken place several times in the measurement period. In the palm oil milling industry, it is possible to explain these accidents using the Principle of 3C—Condition, Competence, and Commitment—that are responsible for repeat industrial disasters. The three parameters are as follows: poorly maintained facility and equipment (Condition), an individual's incompetence in the workplace (Competency), and the leader's low commitment to process safety (Commitment).

3.1 Condition

Despite the lack of a standard definition for equipment and/or facility condition, it generally denotes a system's capability to be utilized for the intended purposes. A facility or equipment that is poorly managed jeopardises a plant's safety. According to Hussin et al.[10] and Myrto et al.[11], one of the underlying causes of accidents in the chemical process industry is technical or process equipment failure. Although the palm oil milling does not form part of the chemical process industry, a poorly maintained facility can cause accidents within this industry as well as it shares several equipment types employed in the chemical process industry, including pressure vessels, storage tanks, boilers, and piping. This is in line with the study conducted by Kamarizan and Markku[12], who pointed out the vulnerability of the equipment to accidents. When the operators or maintenance crews do not comply with maintenance and safety regulations regarding equipment facilities, the risk of disaster increases drastically. This risk exacerbates further when changes are made to the original design without following adequate assessments or procedures.

3.2 Competency

Numerous prior studies have held human errors responsible for process-related accidents [13,14]. Incompetent and inexperienced personnel may inadvertently cause accidents by committing errors directly about the process itself and also by creating deficient designs and/or inadequately implementing the management systems. Notably, despite being cognizant of risks and process distortions, many people remain complacent. According to the Merriam-Webster English language dictionary, complacency relates to feelings of self-satisfaction with an existing situation, when it is accompanied by unawareness of actual challenges or hazards. Hence, it does not come as a surprise that many accidents take place during non-routine tasks or maintenance activities [15,16]. As a case in point, explosions occurred at a Texas-based wastewater site (1990), at a shut-down fertilizer plant in Iowa (1994), and an oilfield in Mississippi (2006) during a non-standard maintenance task [17].

3.3 Commitment

The commitment of leadership to process safety assumes great significance, and improvements cannot be made in the absence of their support [18,19]. According to Bell and Healey [20], many process safety events are directly linked to leadership behaviour, which is why leadership plays a key role in process safety incidents. However, some leaders fail to realize the inherent risks of process safety violations and non-adherence due to their absolute trust in the design of the original system. Oftentimes, investment in process safety is viewed as a sinking cost that does not augment the financial performance of the business; hence, money spent on process safety is sometimes considered to be a wasteful expenditure. As a result, employees can take shortcuts and create a workaround that may lead to increased risk. These things may inadvertently communicate to employees the importance of safety to leadership. In the BP disaster, leaders enacted shortcuts to save time and money for the over-budget project, which lead to several oil spills and explosions [20]. To ensure efficaciously engineered controls, everyone in the organization needs to conduct themselves in a certain manner at all times. Although it may believe that success can be measured only by improving the bottom line, the leadership team can better reinforce these control behaviours at a high rate.

4.0 Major Characteristics of Safety Leadership

The key impediment to process safety improvement is the lack of commitment from leadership. This gives rise to a critical question: How is the safety leadership and safety culture in the palm oil milling industry in Malaysia?

Successful change requires more from the leader as compared to a long-term vision. Settling the stage for the safety culture in an organization, safety leadership shapes the behaviours and attitudes of team members, the manner in which they comply with safety rules and procedures, and the physical work environment. Safety refers to the collective values and attitudes of a workgroup concerning the perceived importance of safety. These attitudes and values are shown in day-to-day work patterns, which have a direct impact on a plant's operational safety and performance [21]. By controlling the resources and creating the culture, leaders shape employees and outcomes on multiple levels [22] in their businesses. Given the important role played by leadership in ensuring safety results, it is necessary to understand the salient characteristics of a leader and how health and safety can further be enhanced by leadership.

While the above issues can be addressed in myriad ways, the author has propounded four salient characteristics to ensure effective safety leadership in the palm oil milling industry: Inspiring, Recognizing, Challenging, and Collaborating.

4.1 Inspiring

Inspiring refers the extent to which a leader presents a positive vision of safety that appeals the employees. Bass[23] argued that the inspiring concept shows similarity to the inspirational motivation dimension of the transformational leadership style. Safety inspiring can promote safety participation as it enables employees to see both the meaning and value of a supportive environment [24]. From a self-regulatory motivational perspective, individuals may evince more interest in activities that they value [25]. Hence, leaders should inspire and work with their teams to easily achieve the common safety goals. Leaders should make the employees understand utmost importance of observing safety processes at workplaces. This engenders a sense of urgency and motivates others to follow the processes and guidelines. The employees get interested to invest time and effort to engage in safety activities that aim at realizing safety protocols. Leaders can periodically review safety vision and seek out opportunities to get involved in safety activities and share their personal stories with their teams, revealing genuine commitment of leaders to safety.

4.2 Recognizing

Psychological and personality characteristics are reported to be the major determinants that predict how well employees work together [26], a trait that is a requisite for effective safety culture. Hence, it becomes important for organizations to identify and acknowledge the efforts made for safety and look for meaningful ways to celebrate safety successes. Recognition enables an employee to see that their organization values them, and acknowledges their contribution to the success of both their team and the company. This assumes significant especially when organizations want to transform their safety culture.

4.3 Challenging

Promotion of safety awareness is an important feature for palm oil milling operation where the information flow is very rapid and poor decisions may result in serious consequences [27]. Therefore, leaders need to remain vigilant when monitoring process safety and should lead by setting example in regard to being receptive to viewpoints of all stakeholders and team members. Organizations must evolve formal, open, transparent mechanisms to encourage new ideas in order to strike a perfect balance

between safety opportunities and risks. Respectfully challenging the status quo enables all employees to become partners in improving best practice and effecting required changes to improve process safety. Greater sense of teamwork, improved employee morale, and a safer environment can be ultimately created by an active engagement and collaboration.

4.4 Collaborating

Collaboration promotes an integration of ideas and interdependency among multiple stakeholders throughout an organization. Collaborative communication strategies involve an unimpeded, continual cycle of information flow among the team members and organization [28]. Further, leaders should promote collaboration on process safety by getting people from across all the business verticals together to discuss safety performance, risk profiles, safety culture, etc. In addition, leaders should involve the employees in process safety, such as in projects to develop new design and/or safer procedures and encourage employees to report incident and share its learning. Also, mechanisms for getting employee input should be adequately resourced and their inputs reflected in decision-making and planning.

5.0 Effective Process Safety Culture

Leaders are in a unique position to influence health and workplace safety. Based on author's experience and observation, applying the four-level process safety culture (that includes 4 stages: Right, Relationships, Replication and Respect stages, as shown in Figure. 2) could help the palm oil milling industry in successfully implementing process safety. This model seems similar to the Hudson Ladder, though it highlights leadership's effect on safety culture and explains how leaders perform their influencing roles to facilitate the needed changes throughout the safety journey. Each of the four levels of safety culture builds on the previous ones, enabling us to have better organization and understanding of safety culture. As the organizations progress through each of the levels, leading and advancing safety culture becomes easier. This ultimately leads to creation of an effective safety culture in an organization.

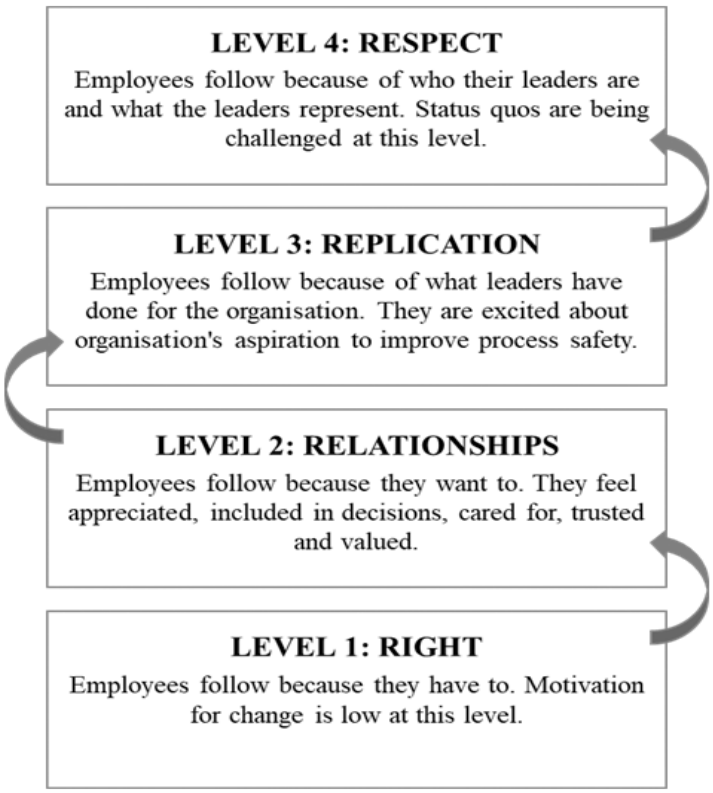

Figure. 2: The four-level process safety culture in the palm oil milling industry

Getting it "Right" is a positional power role when employees acknowledge the legitimate power that comes with being in a leadership position. Although leaders rely on company rules, policies, and regulations to influence their employees, motivation for change is typically low at the first level (of getting right). The second level is about building "Relationships". At this level, leaders do their best to seek improvement in safety. Building on leader-employee relationship [29], when expected contributions from employees and leaders are congruent, leaders can be regarded as an inspiring model to perform their role as a supervisor to enhance performance, using performance feedback and encouragement. The third level is to create "Replication". Employees follow leaders because of the contribution made by leaders for the organization. Employees are motivated by set goals and are excited about the organization's aspiration to improve process safety. We earn "Respect" by ensuring total process safety. Employees are inspired and follow the paths shown by leaders because of their good leadership traits. For example, leaders improve the organizations' reputations by uplifting the safety standards. Status quo in an organization is challenged at this stage. To sum up, the four-level process safety culture features both micro and macro aspects. In terms of micro aspects, each culture level features a reference to the collection of the beliefs, perceptions, and values that employees share in relation to process safety in an organization. In terms of macro aspects, the model incorporates several leadership actions that facilitate evolution of the safety culture.

To understand the relevance of the four-level safety culture in the palm oil milling industry, the process safety measures followed by Sime Darby Plantation Berhad and Genting Plantations Berhad are discussed. Table 2

gives a summary of the safety improvements achieved by these two companies.

Process Safety Culture	Sime Darby Plantation	Genting Plantations
Level 4: Respect	The organization challenged the status quo and built a pilot plant that incorporates supervisory control and data acquisition technology with aim to study the possibilities to improve process safety. Organization efforts in uplifting process safety have been recognized with multiple national awards.	Organization efforts in uplifting process safety have been recognized with national award. Improvement made by the organization has not only minimized human error and but also improved process safety.
Level 3: Replication	Employees appreciate the behavioral-based safety awareness assessment launched by the organization. They are motivated to do so because they want to improve or correct the situation and eliminate or reduce the chance of an unsatisfactory act occurring.	Employees are motivated by organization's aspiration to improve process safety. They work together with the leaders to advance process safety management by implementing a number of significant technological innovations.
Level 2: Relationships	Employees did their best when leaders asked them to improve safety because they felt appreciated and valued. In particular, awards have been handed out by leaders to recognize employees' efforts.	It is believed that employees did their best when leaders asked them to improve safety. This is probably because of the employees felt appreciated and cared for. This is evidenced by the decrease in accident and fatality rate after the organization embarking on safety journey.
Level 1: Right	When the organization first introduced key performance indicators, employees followed leaders' instructions because of legitimate authority - although here was no evidence to support the claim.	When the organization first embarked on safety journey, employees followed leaders' instructions because of legitimate authority - although here was no evidence to support the claim. It is also believed that the motivation of change was low because the accident and fatality rate was high at that time.

Table 2 Safety improvements performed by Sime Darby Plantation and Genting Plantations

5.1 Case Study 1: Sime Darby Plantation Berhad

Sime Darby Plantation Berhad is the leading producer of certified sustainable palm oil worldwide [30]. To enhance ownership and ensuring accountability in implementing safety procedures in operations, it introduced key performance indicators (KPIs) at different levels, and the best performers were awarded to recognize efforts. Behavior-based safety awareness assessment that engenders a positive intervention culture was launched. This motivated employees to identify and tag unsafe acts or conditions, step in where required to improve the situation and reduce the risk of unsatisfactory acts, policies or hazards. With this feedback, the leadership team challenged the *status quo* and built a pilot plant that incorporates supervisory control and data acquisition technology [31] with the objective to explore the possibilities to improve both the team productivity as well as process safety. Notably, this is the first pilot mill in Malaysia to be equipped with high-tech automation system in the industry. Throughout the transformation journey of the process safety, Sime Darby Plantation Berhad won the National Occupational Safety and Health Award [32] several times. Clearly, Sime Darby Plantation stands at the pinnacle of the four-level safety culture.

5.2 Case Study 2: Genting Plantations Berhad

Genting Plantations Berhad is the plantation arm of the Genting Group, and is a leading oil palm plantation company in Malaysia, having huge landbank and large operations in both Malaysia and Indonesia. This company also invested heavily in biotechnology, focusing on the application of genome technology for crop improvement. It initially focused on personal safety or occupational safety and subscribed to OHSAS 18001, MS 1722 and other relevant standards a decade earlier. This resulted in significant decrease in number of accidents and the fatality rate [33]. The leadership team gradually advanced the company to process safety management by implementing a number of significant technological innovations. They focused on the design and engineering of facilities, hazard assessment, and human factors among other things. They changed their sterilization process from manual to automated system which ensures better process safety. In it, steam can't be admitted in the pressure vessel if doors are improperly closed, and doors can't be opened if the vessel is still under pressure. Also, they changed from laborious capstan and bollard system to hydraulic indexing system. The latter is provided with several programmable logic controllers, industrial human machine interface, automatic sensors and instrumentation. Hydraulic indexing system safeguarded operators and workers from injury (wedged between steel cages). Further, the management changed the hoisting crane system to tipper system to safeguard their operators from injury caused by failure of crane and/or steel wire rope. All these improvements minimize human error and improve overall process safety overall, thereby helping to reduce accident cases. In addition, Occupational Safety and Health Award (Systematic Occupational Health Enhancement Level Programme Category) was bestowed upon Genting Plantations in 2020 for making significant safety improvement at high risk workplaces [34]. This kind of safety transformation was possible as the safety culture was at level four.

6.0 Conclusion

As the preferred vegetable oil in the future, palm oil is very versatile in its applications. Given that the majority of employees work close to

moving mechanical parts, pressure vessels, steam, hot liquids, and other hazardous contaminants and materials, the palm oil milling process involves unit operations that lead to process safety concerns. This paper showed that the Principle of 3C: poorly maintained facility and equipment (Condition), incompetence of an individual in the workplace (Competency), and low commitment to process safety from leadership (Commitment) can explain repeat accidents within the palm oil milling industry.

This paper introduces the four-level process safety culture to help the palm oil milling industry attain success in implementing process safety. This model stresses the impact of leadership on safety culture, explaining how leaders perform their roles to facilitate the requisite transformations throughout the safety journey. Given that the palm oil milling industry is only part of the palm oil processing value chain, it must examine the process safety leadership and culture for the remaining sectors in the value chain.

Author contributions

Wai Onn Hong: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing.

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Conflicts of Interest/Competing Interests

The author declares no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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