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Concept Paper

Process Safety Leadership and Culture in the Palm Oil Milling Industry

Wai Onn Hong*

WE ACT Services Sdn Bhd, Jalan Prima Tropika, Taman Prima Tropika, 43300 Seri Kembangan, Selangor, Malaysia, hongwaionn@gmail.com, Tel: +60 3 8991 8688

Abstract: Several studies have highlighted the importance and evolution of process safety leadership and culture in various industries. However, none has focused on the palm oil milling industry yet. This paper critically reviews the latest developments in the palm oil milling process and unit operations leading to process safety concerns. It also discusses the Principle of 3C that is applied to explain repeat accidents and the four-level safety culture in the palm oil milling industry. For this purpose, the author presents case studies of two key palm oil companies in Malaysia. Overall, this paper offers guidelines to leaders in the palm oil milling industry about the required process safety leadership and culture to be understood in order to improve their safety outcomes.

Keywords: *Palm oil industry; p*alm oil milling; process safety; leadership; culture

1. . Introduction

Palm oil, edible vegetable oil, is obtained from the fruits of the oil palm tree. It is the largest traded vegetable oil worldwide, surpassing all other vegetable oils such as soybean, rapeseed, and sunflower. Indonesia and Malaysia are the principal palm oil-producing countries having annual production of about 46.5 and 19.8 million tons, respectively, in 2020-21. This constitutes 85% of the total production of palm oil worldwide (USDA, 2021). Global palm oil production has registered a significant increase to 73 million tons in 2020-21 from 16.1 million tons in 1995-96 (USDA, 2021). The demand for palm oil is gradually rising since palm oil is relatively cheap and has numerous advantages both in edible and non-edible products. *Palm oil and its derivatives are* produced along the palm oil processing value chain that encompasses milling, refining, and oleochemicals sectors. Although the palm oil processing industry has implemented personal safety for decades and has recently focused on process safety, there appears a lot of room for improvement. This is apparent due to the multiple incidents occurring within a short 12-month's period. Table 1 summarizes these incidents.

Several studies have been conducted on personal and process safety in the palm oil industry such as the needs of occupational safety and health management system and process safety management **(**Kamarden et al., 2014; Hong, 2017; Myzabella et al. 2019). Few studies focused on process safety leadership and culture (Trish, 2020; Frederico et al. 2021), but to the best of the author's knowledge, no study has so far focused on process safety aspects of the palm oil milling industry. In the current paper, the palm oil milling process and its unit operations are discussed and the resultant safety concerns are examined. It also investigates the factors that cause repeat accidents and explains this relationship using an analogy as per the Principle of 3C. The four-level safety culture in the palm oil milling industry is also discussed. The author used two key palm oil companies in Malaysia: Sime Darby Plantation Berhad and Genting Plantations Berhad as case study examples.

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

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Date	Incident Description	Casualty	Reference
May 2021	Crude oil tanks caught fire at a oleo-chemicals plant in Telok Panglima Garang Industrial area, Selangor.	One killed while three others suffered injuries	The Edge Markets, 2021
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	Malay Mail, 2021
October 2020	Palm oil mill in Johor caught fire and was burning for at least 14 hours.	No casualties was reported	The Star, 2020a
September 2020	Worker was killed after he fell into a boiling tank at a palm oil mill in Malacca.	One killed	The Star, 2020b
July 2020	Fire broke out at a biodiesel plant at Pasir Gudang, Johor.	No casualties was reported	Argus Media, 2020
May 2020	Worker died from electrocuted at a palm oil mill in Johor.	One killed	DOSH, 2020

2. Palm Oil Milling Operations

Typical palm oil milling process flow is best described in the form of activities in their respective stations (Fig. 1). From the plantation sites, the fresh fruit bunches (FFB) are carried to the palm oil mills. The milling operation includes reception, sterilization, threshing, digestion and pressing, clarifying and purification, and kernel recovery. Crude palm oil and palm kernels are the primary products produced by palm oil mills. Pressed mesocarp fibers, palm kernel shells, empty fruit bunches, and decanter solids are the biomass generated, while palm oil mill effluent (POME)—the combination of many waste streams, e.g., sterilizer condensate, heavy phase from clarification, and wastewater from wet separation—is the liquid byproduct. A palm oil mill has a boiler station that produces steam to drive steam turbines in order to generate power, and facilitate various processes (PORIM, 1985; Mahlia et al., 2001; Schmidt & Rosa; 2020).

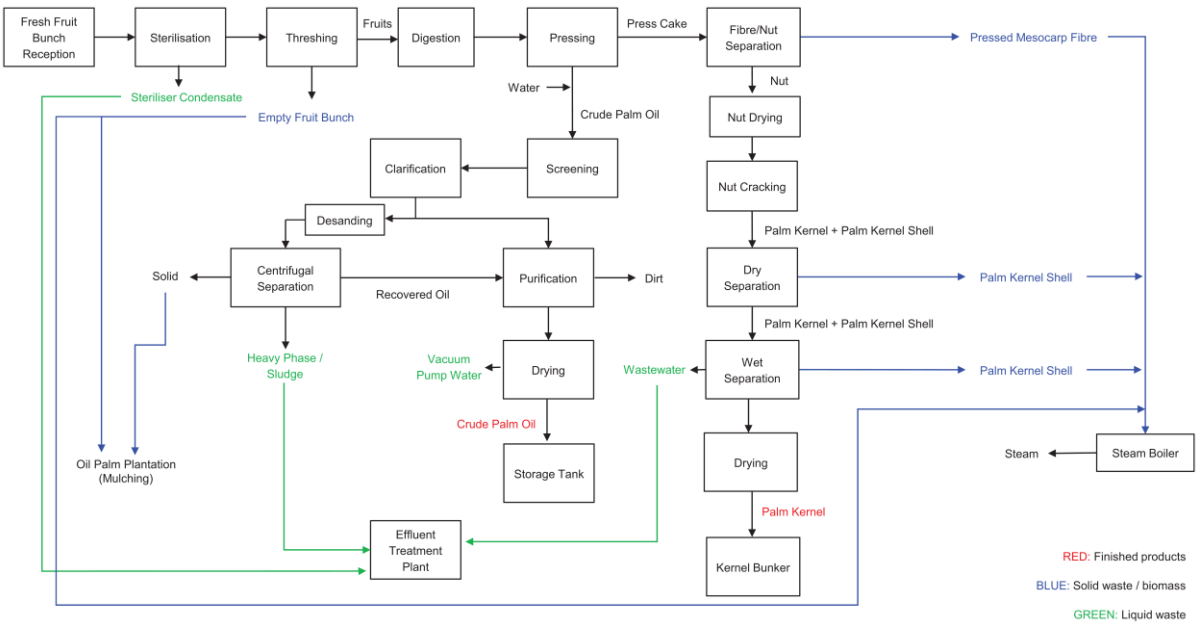

Figure 1. Typical palm oil milling process flow.

3. Causes for Repeat Accidents in Palm Oil Milling Industry

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Judith Hackitt, former chair of the Health and Safety Executive, a UK nongovernmental agency, remarked that there are no new accidents, rather old accidents are repeated by new people. A repeat accident can be broadly defined as an accident that has already occurred multiple times in the measurement period. Repeat accidents within the palm oil milling industry could be explained by the Principle of 3C. The Principle of 3C posits that 3 Cs—Condition, Competence, Commitment—lead to repeat accidents and industrial disasters. These 3 parameters are poorly maintained facility and equipment (Condition), incompetence of an individual in the workplace (Competency), and low commitment to process safety from leaderships (Commitment).

3.1 . Condition

While there is no standard definition for facility and/or equipment condition, it generally refers to the capability of a system to be used for the intended purposes with danger to safety. A poorly maintained facility or equipment can pose a serious threat to the safety of a plant. Hussin et al. (2015) and Myrto et al. (2006) reported that technical causes or process equipment failures are one of the root causes of accidents in the chemical process industry. While palm oil milling is not part of the chemical process industry, a poorly maintained facility can be one of the leading causes of an accident in this industry. This is apparent because it shares many types of equipment used in the chemical process industry, such as storage tanks, pressure vessels, boilers, and piping. This is aligned to the study of(Kamarizan and Markku, 2013) where they reported that these are the most accident-prone equipment. There is a dramatic rise in the risk of disaster when the operators or maintenance crews do not adhere to maintenance and safety regulations regarding equipment facilities. The risk is further exacerbated when the original design is changed without following adequate procedures or assessments.

3.2 . Competency

People control all the activities essential to mitigate the risk of accidents. Nonetheless, several previous studies have reported about many process-related accidents occurring due to human errors (Gunasekera and Alwis, 2008; Dhillon, 1989). Inexperienced and incompetent personnel may cause accidents unintentionally by making errors directly related to the process itself, as well as commit errors by creating deficient designs and/or poorly implementing the management systems. Besides, many people remain complacent despite being clearly aware of risks, deficiencies, and process distortions before them. Merriam-Webster English language dictionary and America's most trusted dictionary for English word definitions, meanings, and pronunciation associates the meaning of complacency with feelings of security and self-satisfaction with an existing situation, despite a person being unaware of actual dangers or deficiencies. This explains why many people normally pay more attention when the plant or machine is running. Therefore, unsurprisingly, many accidents occur during non-routine tasks or maintenance activities (Hale et al. 1998; Peter and Stein, 2013). For instance, explosions occurred at a wastewater site in Texas (1990), an oilfield in Mississippi (2006) during a non-standard maintenance task, and at a shut-down fertilizer plant in Iowa (1994) (Gravina et al., 2017)

3.3 . Commitment

A leadership team’s commitment to process safety is important, and things cannot change or improve without their support (Smith et al. 1978; O'Dea and Flin, 2001). Bell and Healey (2006) reported that management and leadership play a significant role in process safety incidents, and many process safety events are directly linked to leadership behavior. However, some leaders do not understand risk inherent in process safety violations and nonadherence and trust completely the original system’s design and think that no process or activity requires further improvement. They ignore the fact that for effectively engineered controls, all people across the organization must behave in critical

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ways all the time. The leadership team can better reinforce these control behaviors at a high rate, though it has a strong bias towards messages about success and believes that success can be measured only by improving the bottom line. Therefore, management business decisions are often taken without properly understanding the impact of process safety non-compliance. Investment in process safety is viewed as a sinking cost that does not appear to result in a quick improvement in the financial performance of the business; hence, money spent on process safety is sometimes considered to be a wasteful expenditure. In case, the leadership team wants budget cuts, employees can take shortcuts and create a workaround that may lead to increased risk. These things may inadvertently communicate to employees about no importance of safety to leadership. In the BP disaster, shortcuts to save time and money for the over-budget project were enacted by leaders, resulting in a series of events, explosions, and oil spills (Bell and Healey, 2006).

4. Major Characteristics of Safety Leadership

Lack of commitment from leadership is the key barrier for process safety improvement. This leads to an oft-repeated question: How is the safety leadership and safety culture in the palm oil milling industry in Malaysia?

Successful change requires more from the leader than a vision requires. Safety leadership sets the stage for the safety culture in an organization. It shapes attitudes and behaviors of team members, how they adhere to procedures and safety rules, as well as the physical work environment. Safety culture can be defined as the collective values, beliefs, and attitudes of a workgroup relating to the perceived importance of safety, which are often exhibited in day-to-day work-related behaviors, directly impacting the operational safety and performance of a plant or factory (Health and Safety Commission, UK, 1993).

Leaders influence employees and outcomes on multiple levels (Urrila, 2021) in their businesses by controlling the resources and creating the culture. Since leadership is crucial to safety results, there is a need to understand the key characteristics of a leader and how leadership can further improve on health and safety.

There are several answers to the above, but the author proposed four key characteristics that are critical to the 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 (1985) 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 (Griffin and Hu, 2013). From a self-regulatory motivational perspective, individuals may evince more interest in activities that they value (Schunk and Ertmer, 2000). 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 (Amar and Mullaney, 2017), 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

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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 (Naderpour et al. 2014). Therefore, leaders need to remain vigilant when monitoring process safety and should lead by setting example in regard to being receptive to view points 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 (VanVactor, 2012). 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. 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: Reactive, Dependent, Independent and Interdependent stages, as shown in Fig. 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.

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 (Audenaert et al. 2018), 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

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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. Table 2 gives a summary of the safety improvements achieved by these two companies.

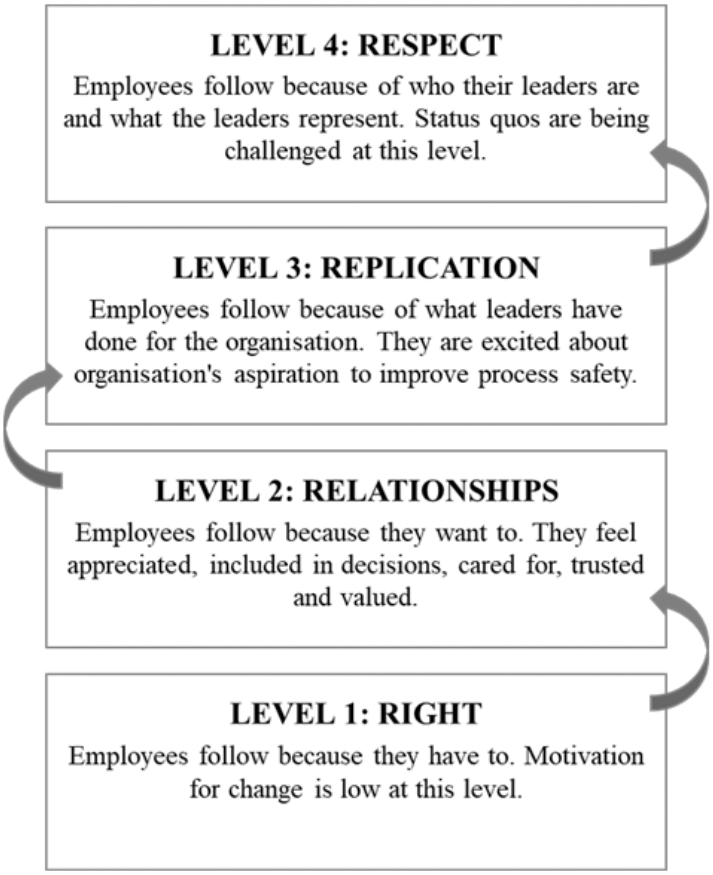

Figure 2. The four-level process safety culture in the palm oil milling industry.

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

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	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

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	situation and eliminate or reduce the chance of an unsatisfactory act occurring.	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.

5.1. Case Study 1: Sime Darby Plantation Berhad

Sime Darby Plantation Berhad is the leading producer of certified sustainable palm oil worldwide (Sime Darby Plantation, 2021a). 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 (Baharudin et al. 2019) 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 (Sime Darby Plantation, 2021b) 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 (Hong, 2013). 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 im-

provements 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 (Genting Plantations, 2021). This kind of safety transformation was possible as the safety culture was at level four.

6. . Conclusion

Palm oil is the vegetable oil of choice in the future and is very versatile in applications and uses. Palm oil milling process involves unit operations that lead to the process safety concerns as most employees work close to moving mechanical parts, pressure vessels, steam, hot liquids, and other hazardous contaminants and materials. Meanwhile, repeat accidents within palm oil milling industry could be explained by Principle of 3C: poorly maintained facility and equipment (Condition), incompetence of an individual in the workplace (Competency), and low commitment to process safety from leaderships (Commitment).

In this paper: the four-level process safety culture is introduced to guide the palm oil milling industry for success in implementing process safety. This model stresses on leadership's effect on safety culture and explains how leaders perform their influencing roles to facilitate the much-needed transformations throughout the safety journey. Since palm oil milling industry is only part of the palm oil processing value chain, it is suggested to conduct an investigation to evaluate the process safety leadership and culture for rest of the sectors in the value chain.

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