Temporal Structuring and the Improvisation of Management Control in Palm Oil Processing

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Response to Editor

We are grateful for your support throughout the revision process. We are thankful for your valuable feedback which we found to be both constructive and encouraging. We have considered all recommendations, and suggested readings/prior works provided, and carefully incorporated them into our revision as detailed below.

While as editor, I'm happy that you have met all reviewer requirements, I would like you to take one further look at your paper title. In referring to fluid control, it reads like an engineering journal paper. In your structured abstract, you correctly talk about 'management control'. Can I suggest you try one more version of your paper title that uses the term 'management control'?

Our Response

We have revised our title to follow your recommendation. The new title is: '***Temporal Structuring and the Improvisation of Management Control in Palm Oil Processing'.*** We are very grateful for your continuous support for the improvement of the quality of our manuscript. It is very much appreciated.

Temporal Structuring and the Improvisation of Management Control in Palm Oil Processing

Purpose:
The key motivation of our research is to explore the complexities of management control in a complicated process of palm oil production setting. We seek to unpack the ways in which refinery operations staff (re)construct adaptive practices to manage temporal uncertainties and competing obsessions to effectively control the volatile and highly uncertain palm oil production processes of a large refinery in Malaysia.

Design/methodology/approach:
Our research adopts a qualitative methodology, framed around an ethnographic case study that utilises multiple methods of data collection and analysis including observations, interviews, and document analysis. We observe how the key production processes and conduct eighty-one interviews with managers and workers who engage in inter-retro-actions around organizational decisions to prioritise a market aesthetic that results in highly uncertain manufacturing processes in the complex setting of palm oil refining.

Findings:
Using the lens of improvisation in a complex organizational process (Amit & Knowles, 2017; Cunha, Giustiniano, Rego, & Clegg, 2017; Karl E. Weick, 2024), we explore the ambitious yet complex production dynamics, and the competing control pressures to meet an acceptable aesthetic quality within an acceptable cost of palm oil production. Our findings provide insight into how actors construct improvised incremental control across the palm oil production processes. Our findings provide a better understanding of how complex production processes such as palm oil face temporal uncertainties that lead to the necessity to craft temporal adaptive process routines.

Originality/value:
We contribute by revealing the temporality of flexible control where actors cultivate temporary buffers or momentary improvisations to manage temporal uncertainties in a complex process industry setting. We uncover the fluid site of control where actors engage in temporary coordination of in-present-improvisational actions to alter temporal uncertainties due to attending to competing targets. We contend that much can be learned about interpersonal autonomous control in managing volatility and repairing control breakdowns in complex production processes that cannot simply be forecasted with sufficient accuracy. We believe that interpersonal reflection-in-actions becomes a necessity when standardized or controlled environments seek to achieve contradictory goals.

Keywords:
temporal uncertainties, palm oil production, temporal buffers, temporal coordination and autonomy, improvised incremental control

1. Introduction

> *We are producing consumer goods. We pack using our own brand. Our products go straight to end users... of course our main concern is quality… especially colour. Because when we put our [palm] oil side by side on the shelf at the supermarket, we want our oil at least to be on a par with the other brands, if not better. But at the back of our mind, we always want to achieve the yield and cost targeted in the budget. (Refinery senior manager – Plantation 1)*

The operational manager's remark above represents key struggles in managing and balancing competing control focuses within the palm oil production process. Palm oil production routines involve a constant control of the aesthetic qualities of the palm oil in order to maintain product competitiveness, while simultaneously meeting management demands for process efficiency and productivity. The control of the physical aesthetic qualities of palm oil is crucial, as the environmental and health impacts have attracted significant attention and criticism internationally, in addition to social and agricultural issues related to land grabs, and expulsion of small farmers (Ebong, Owu, & Isong, 1999; Guest, 2017; Harika, Eilander, Alssema, Osendarp, & Zock, 2013; McNamara, 2010). Despite the potential health benefits from the high vitamin A content of red palm oil (Gibon, 2012; Kritchevsky, 2000), this authentic oil colour has failed to convince customers who mostly prefer a translucent golden yellow colour (Aguiar, Martinez, & Caleman, 2018; Kiritsakis & Christie, 2000). This light coloured oil fits with the standard aesthetic quality associated with other vegetable oils (Chong, 2012). As a result, the production routines involve intensive controls of the complex and costly processing to transform the natural colour of crude palm oil (CPO), which is dark red and cloudy, into a fully refined stage - a bright gold colour. This situation contrasts competing obsessions in the control of resource constraints and production efficiency (yield and cost) in the production process (Ebong et al., 1999; Guest, 2017; Harika et al., 2013; McNamara, 2010). Key production workers have to engage in inter-retro-actions (Montuori, 2003) around micro-control decisions to transform the highly variable and unpredictable quality of the palm oil fruit into aesthetically pleasing products within budget.

The palm oil manufacturing processes we study reflect the essential unknowability of crop and crude oil variability and the micro control activities required to achieve a complexity of competing control obsessions, where the futility and the importance of flexibility in controlling uncertain process routines cannot be fully understood (Cunliffe & Eriksen, 2011; Pickering, 2006; Schultze & Stabell, 2004). The control imperative of complex processes requires a continuous balancing of all interests and diversity of practices through the maintenance of temporal efforts in navigating tensions and contradictions within organizational functions (Ahrens & Mollona, 2007; Sundin, Granlund, & Brown, 2010). Prior studies have acknowledged how management control systems play a role in enabling firms to balance multiple conflicting objectives and to navigate the difficulties in knowing whether all stakeholders have been satisfied (Ahrens & Chapman, 2004; Sundin & Brown, 2017; Sundin et al., 2010; Wouters & Wilderom, 2008). However, in the context of organizational processes, control is often misconceived as generative systems that produce repetitive, recognizable patterns of interdependent action carried out by multiple participants (Feldman & Pentland, 2003; Pentland & Feldman, 2005).

The control of systemic routine in organizational processes is largely misunderstood as rigid, mundane, mindless, highly structured patterns of actions that follow continuous procedures and explicit rules (Cohen, 2007; Pentland & Feldman, 2008). In the context of palm oil production, actors are often situated in ever changing uncertainties or instabilities that may

often be both temporal and inherent within complex operations. The competing objectives and obsessions that linger around palm oil production routines require actors to craft and subject themselves to additional temporal structures in order to ensure the entrainment of various demands (Kunzl & Messner, 2023). These ideas motivate us to explore the complexities of management control in a complicated production setting. We focus on the following question: how do refinery workers and managers (re)construct adaptive practice to manage temporal uncertainties and competing obsessions, and to effectively control each stage of the palm oil production routines?

In the complex palm oil production process setting that we investigate, we believe that improvisation in complex organizational processes (Amit & Knowles, 2017; Cunha et al., 2017; Karl E. Weick, 2024) provides a foundation for exploring temporal uncertainties to achieve competing ambitious targets. Our findings from the exploration of a complex palm oil processing of a large company in Malaysia provide insight into how managerial pressures, to meet an acceptable aesthetic quality within an acceptable cost of production, (re)shape the way refinery staff constitute control of oil production routines. We reveal the way actors (re)construct a situated yet innovative incremental control by cultivating temporary buffers or engage in momentary improvisations to manage temporal uncertainties in the complex production processes. They need to engage temporary coordination of in-present-improvisational actions to alter their work practice amid typically unpredictable and recurring changes in crude palm oil inputs and other complex elements of the refinery production process.

We seek to contribute by tracing the temporal dimension of flexible control system (Ahrens & Chapman, 2004; Ahrens & Mollona, 2007; Lukka, 2007; Mouritsen, 1999; Wouters & Wilderom, 2008). We provide insights through unpacking the site of continuous temporal control in a complex process industry setting. The momentary improvisations represent the fluid thought process of interrelated actors, and how they shape, contend and shift the ever-changing complexities, idiosyncrasies and interdependencies. The operating actors in our case cultivate improvised incremental control to co-exist with situated uncertainties that emerge from attending overly ambitious yet contradictory targets in a complex process. We also seek to provide insights into the role of interpersonal autonomous control in managing volatility and repairing control breakdowns/halts in complex processes (Pfister & Lukka, 2019; Wouters & Wilderom, 2008). Temporal coordination allows actors to exercise temporal autonomy, to further craft situated, temporal and incremental adaptation control practices and priorities, as they seek to manage quality and efficiency targets. We also seek to attend to the calls to enrich the study of improvisation in complex and ambitious competing target situations (Cunha et al., 2017; Cunha, Klegg, & Kamoche, 2012; Karl E. Weick, 2024). We provide insights on how actors cope with competing goals by engaging in continuous interpersonal reflection-in-action that serves as the basis for taming temporal tensions through interpersonal reflexive learning to reframe or at times switch between contradictory pressures.

In the next section, we review the existing literature on the role of control systems in uncertain environments to identify a gap in previous studies, where the temporal context of uncertainty in organizational processes warrants further exploration. We combine the ontology of unknowability and improvisation as a theoretical framing that helps us to make sense of the empirical evidence. We then explain how we conducted the ethnographic case study of Golden Corp's palm oil production processes. Subsequently, an analysis of the empirical findings is presented, followed by a discussion, and concluding remarks.

2. Literature Review: The Role of Control Systems in Uncertain Environments

Organizational control systems are often referred to as constituting the organizational steering processes in the environments in which they operate to achieve both short and long

term objectives (Abernethy & Stoelwinder, 1995; Mills, 1983; Otley, 2014). They consist of a set of control mechanisms employed by management to influence organisational actors, and to increase the probability of the organizational activities and processes in which they are involved in ways consistent with organizational objectives, and the dominant organisational coalition (Abernethy & Chua, 1996; Malmi & Brown, 2008). The control system, however, is not static nor unchanging with the increasingly complex organizational structures of operations and constantly changing environments (Otley, 2014). Organizational processes are dynamics and can change quickly or radically as organizations face high levels of uncertainty (Bourne, 2014). Uncertainties might arise from natural or extreme conditions surrounding organizational processes, or external factors, such as the political and economic climate, or the actions, demands or pressures from competitors, customers, suppliers or regulators (Merchant & Van der Stede, 2007).

The active roles of management control systems deserve much more attention to allay their conception as simple mechanisms to understand the issues of control as socio-technical problems embedded in uncertain organizational contexts (Argyris, 1957; Ridgway, 1956; Wildavsky, 1964). Tensions and contradictions that emerge within organizational subcultures around the implementation of controls, can result in diversity as well as continuity of organizational practices (Ahrens & Mollona, 2007). The organizational control system can only partially be imposed by managerial regulation, as it involves self-regulatory activities that are the products of agreements negotiated by a variety of organizational groups or stakeholders (Dermer, 1988). In such situations, the enabling role of control systems is crucial, which allows flexibility for the organizational members to operate at their own discretion to manage uncertainties, tensions and contradictions (Ahrens & Chapman, 2004). The enabling role of control systems allows organizations to strategize beyond conventional business processes to embrace spontaneity, to facilitate enterprise adaptability, and to influence the fulfilment of wider information sharing to accommodate different interests (Grafton & Mundy, 2017; Jack & Mundy, 2013; Mundy, 2010; Wouters & Wilderom, 2008).

The critical conception of enabling control systems becomes a way to resolve the traditional dichotomy between mechanistic controls aimed at efficiency and organic controls aimed at flexibility. Ahrens and Chapman (2004) suggest that the concept of enabling control reconciles the efficiency concerns while allowing flexibility to deal with any specific circumstances faced by actors. This practice of enabling and coercive formalization allows the combination of control practices with the management of strategic uncertainties (Chenhall, 2003, 2006; Chenhall, Hall, & Smith, 2013; Ittner, Larcker, & Randall, 2003; Strauss & Tessier, 2019). Such combinations of controls enable organizational actors to develop the ability to repair the various processes as required by conducting a systematic analysis of control processes to improve transparency. These enabling control systems allow organizations to go beyond centralistic managerial control by embracing wider internal stakeholder concerns to improve transparency and flexibility in using different systems in response to specific situations.

Van der Meer-Kooistra and Scapens (2008) argue that organizations with complex processes are often situated within paradoxical demands, such as to balance the pursuit of innovation and exploitation, or quality and efficiency. Organizations are also often entreated to provide divisional autonomy while maintaining corporate control or to aim at achieving economic performance while ensuring employee welfare (Glaser, Hornung, & Höge, 2019). Organizations are required to implement both firmness and flexibility within their control systems when facing such paradoxical or contradictory demands that persist in both the design of governance practices and the actions of individuals or groups of employees and stakeholders (Kober & Thambar, 2022). How control systems unfold in contexts of temporal and high levels of uncertainty may require actors to switch between paradoxical, yet obsessive demands. These

situations need to be the subject of further research. It is just such a context that our study aims to investigate.

3. The Art of Improvisation for Controlling Uncertainties in Complex Processes

3.1. Flexibility of the (un)known and (in)formal controls of organizational routines

Organizations often experience persistent tensions and conflicting obsessions in complex processual conditions (Amyar, Hidayah, Lowe, & Woods, 2019; Ferri, Sidaway, & Carnegie, 2021; Hidayah, Amyar, & Lowe, 2024; Kober & Thambar, 2021; Lewis, Brown, & Sutton, 2019; Smith & Tracey, 2016). Uncertainties are inherent within organization routines, where the processes can involve repetitive interdependent actions carried out by multiple actors (Feldman, 2003; Feldman, Pentland, D'Adderio, & Lazaric, 2016). Organizations seek to orchestrate multiple interests and logics into distinct recognizable patterns or routines while facing continuous changes surrounding the organizations' context and operations (Goh & Pentland, 2019; Otley, 2014). Organizations find themselves in constant struggles to control uncertainties that emerge from institutional constraints, limited capacities, and different boundary constraints that lead to the crafting of the actors' conceptions of mobility and mindful extemporization of organizational practices (Amit & Knowles, 2017). Pickering (2006) suggests that control in organizational processes reflects a 'cybernetic ontology of unknowability and becoming, which offers a stance to recognise that the world can always surprise us and that we can never dominate through inevitably incomplete knowledge. Such situations require systemic processes that can adapt performatively to environments they can never be fully controlled.

Organizational members have no choice but to engage in innovative and flexible ways to control the complex situated practice they are deeply involved in (Deken, Berends, Gemser, & Lauche, 2018; Pradies, Tunarosa, Lewis, & Courtois, 2021). In organizational control processes, actors are often situated in unexpected contextual changes, which require them to adapt quickly (Abrantes, Passos, Cunha, & Silva, 2023). It requires an enabling approach that allows flexibility in implementing known-formal control routines to co-exist with organizational changes (Ahrens & Chapman, 2004; Lukka, 2007; Mouritsen, 1999; Pfister & Lukka, 2019; Wouters & Wilderom, 2008). Actors are often left to navigate the uncertainties that organizations face by diverging from pre-established protocols where required. Complex processes and stretch targets require ways of modifying, or altering the routine of organizational processes to adapt to the changing circumstances on the spot (Amit & Knowles, 2017; Pfister & Lukka, 2019; Sitkin, See, Miller, Lawless, & Carton, 2011). Such a flexible approach to control system provides avenues for framing recalibrations, combinations, and innovations in navigating the (un)known and (in)formal aspects of organizational processes (Amit & Knowles, 2017; Breyer, Ehmer, & Pfänder, 2011).

Lukka (2007) highlights that in the everyday life of complex control systems, loose coupling between the formal and informal domains of rules and routines often serves as a solution. Flexible control allows users to repair/mend to avoid breakdowns or halts, and even improve the work process by reviewing, revising, and refining control measures (Wouters & Wilderom, 2008). Flexible reconciliation of central control references or standards with local complexities leads to the mobilisation of local contingencies, knowledge and experience in supplementing established central objectives (Ahrens & Chapman, 2004). Flexibility is reflected in the positive reframing of standardized controls that are re-enacted through the interrelation of personal and cultural controls to establish navigational space to respond to externally induced stretch targets or pressures (Pfister & Lukka, 2019). In that case, autonomous informal controls play an important role, where personnel and cultural controls

complement or interdependence to facilitate the internalization of stretch or often contradicting complex targets.

Flexible controls allow a deviation or navigation from original goals, through which actors seek to deal with unpredictable situations, potential halts or disruptions to organizational routines (Amit & Knowles, 2017). These situate actors to mobilise ongoing adjustments and modifications, and to hold back their eagerness to implement strictly formal controls. Actors become involved in continuous refinement of organizational choices related to organizational processes, efficiency measures, and the selection, implementation, or execution of organizational decisions, as ways to manage the imperfect understanding of multifaceted and often contradictory situations (Ciborra, 2000; M. M. Crossan & Hurst, 2006; March, 1991; Vera & Crossan, 2007). These involve a constant engagement in improvisation, renewal of knowledge and experience to develop their capacity to evaluate, navigate, and tackle shifting conditions. This perspective enables us to further unravel the way actors embrace changes in maintaining routine organizational processes while engaging in improvisation, through which flexible controls are employed to manage unpredictability, time pressures, and business demands (Lukka, 2007).

3.2. Improvisation: Controlling routines under temporal uncertainties in complex processes

> *A complex world … requires the ability to improvise – to deal with ... the unforeseen, the surprise… Increasingly, organizations require us to have the ability to both react appropriately to unforeseen events, and actually generate those events – to act creatively and innovatively (Montuori, 2003, p. 240).*

Improvisation has often become a necessity in dealing with complex or stretch goals, the unpredictability of organizational day-to-day control of routine works, tasks and responsibilities in organizational processes. In such a context, complexities within organization processes are inseparable when facing ambitions or difficult targets, which require routine works within a narrow scope and limited time (Cunha et al., 2017; Lillrank, 2003; Montuori, 2003). Improvisation in such a situation offers ways of reworking unanticipated events, or on-the-spot attempts to (re)create order when faced with unprecedented disruptions or breakdowns that arise within complex organizational processes (Barrett, 1998; Karl E Weick, 1998; Karl E. Weick, 2024). Complex processes with stretch, complicate or overambitious targets can never be tamed by collecting more knowledge but must be organized by engaging in flexible systems and improvisation (Amit & Knowles, 2017; Larsen & Bogers, 2014; Pfister & Lukka, 2019). Derived from the Latin word *improvivus* or unforeseen, improvisation involves the role of actors in continuously reconstructing processes and designs (Karl E Weick, 1993; Karl E Weick, Sutcliffe, & Obstfeld, 2008), or simultaneously strategizing the adaptation of the predictable and responding to the unpredictable (Brown & Eisenhardt, 1997; M. Crossan, Cunha, Vera, & Cunha, 2005; Vera & Crossan, 2004). Actors tend to seek a way to resolve frustrations, or impediments due to uncertainty and organizational complexities or even paralysis by exploring the experimental, interactive, deliberate, collaborative, and temporary effort of responding to competing situations or objectives (Putnam, Fairhurst, & Banghart, 2016; Sheep, Fairhurst, & Khazanchi, 2017).

Improvisation is always situated between the known and the unknown, between planned action/strategy and unintended reaction/approach, or between the unique and the routine (Breyer et al., 2011, p. 188). Improvisation does not mean that there is no adequate degree of control. But along with the learned, scheduled, and schematized processes, the newly invented approach is deployed to cater for the unexpected or unknown, which might deviate from the entrenched organizational practices (Miner, Bassof, & Moorman, 2001; Moorman & Miner, 1998a, 1998b). This situation creates a mixture of 'in-control' and 'not in-control' processes

(Streatfield, 2003, p.9). In that case, improvisation is not merely the organization's on-the-spot or spontaneous responses to complexities and uncertainties that demand change. The process of improvisation is dynamic and involves non-linear actions or unpredicted situations that may become conditions/causes for further innovative (re)actions (Larsen & Bogers, 2014; Mead George, 2002). The routines within the processes in organizations always involve the unknowns, no matter how well the known procedures are defined and controlled in advance. It requires the ability to engage dynamically in different ways of improvising to cope with or compensate for, some degree of unknown uncertainty in organizational processes.

In the context of ambitious or seemingly impossible performance targets, the known/controlled processes is in constant shift, which situates organizational actors to engage with temporal forms of improvisation when facing unknown/emergent and often uncontrollable or conflicting demands/ambitions (Leybourne, Lynn, & Thanning Vendelø, 2014; Pina e Cunha, Giustiniano, Rego, & Clegg, 2017; Sitkin et al., 2011). Such conditions often lead actors to engage in sequencing improvisational adaptation through micro, situated, and temporal interventions to manage complex pressures, ambitious demands, or uncontrollable challenges (Ciuchta, O'Toole, & Miner, 2021; Leybourne et al., 2014). Improvisation emerges as an ad-hoc response, where temporal uncertainties can be expected, but it is unknown where and when they will occur (Amit & Knowles, 2017; Pina e Cunha et al., 2017). Such uncertainties lead actors to develop temporal buffers or momentary improvisational actions to navigate disruptions when there is not enough time to (re)negotiate how to alter complications, incompleteness, or breakdowns/halts to controls in organizational processes (Geiger, Danner-Schröder, & Kremser, 2021; Geiger & Harborth, 2024; Wouters & Wilderom, 2008). Temporal buffers involve flexible ways in reshaping, contending, and shifting of actors' cognitive structures to develop interrelated, yet potentially distinct, fluid thought processes to interpret, navigate complex stimuli (Patil, Srinivas, Tussing, & Rhee, 2024). It enables actors to cultivate a rational and adaptive managerial control to overcome temporal uncertainties and to navigate the routine of organizational processes to work in dynamic, volatile and uncertain environments (Ciuchta et al., 2021; Larsen & Bogers, 2014). In producing temporal buffers, actors engage in temporal coordination, or joint actions to create or maintain alignment of routine works and tasks to control temporal uncertainty in organizational processes (Bechky & Okhuysen, 2011; Faraj & Xiao, 2006; Hilbolling, Deken, Berends, & Tuertscher, 2022).

Improvisation is driven to be temporal present-in action that involves actors' retrospective surfacing of the material and social circumstances surrounding organizational practices (Karl E. Weick, 2024). Such an approach aims at navigating the (un)known routines to balance the integration of (in)formal controls. Geiger et al. (2021) argue that in a processual context, improvisational actions might lead to the necessity to switch into different actions, as sudden turns of events might require instantaneous responses. This pendulum swing of present-in-actions may be structured in ways to accommodate changes that happen in local processes, to generate a designed form of evolvability and to create small, incremental shifts that evolve from one moment to another (Fisher, Demir-Caliskan, Hua, & Cronin, 2021; Pina e Cunha et al., 2017). As actors are swayed into fulfilling temporal demands and various challenges at different times, improvisation is shaped to be contextually sensitive to fit different struggles involving different organizational elements. Such an approach is deployed to overcome different views, where improvisation can be viewed as positive in one context but negative in another. In such cases, actors seek to engage in incremental and situated forms of temporal coordination. Different actors are given or taken temporal autonomy to improvise, adapt and uncouple autonomously depending on the situated contingency so that they can develop rhythms when transitioning between organizational routines (Pérez-Nordtvedt, Payne, Short, & Kedia, 2008). The overall sequencing of improvisation allows the exploration of actors'

engagement in situated yet innovative incremental control and coordination in various moments and across different times, which we use to unpack the temporal uncertainties and competing control obsessions that affect processual routines in palm oil production processes.

4. Methodology

Between 2012-2018, we conducted an ethnographic case study in a Malaysian palm oil company, namely Golden Crop Co (GCC). Our unit of analysis focuses on the practices of midstream production operations, i.e., the refining and fractionation processes. Our ethnographic case study allowed us to get involved and immersed within GCC palm oil production as a site of social interactions and practices to understand and reveal complexities within the operational processes (Dumont, 2023; Letiche, De Loo, & Moriceau, 2024). GCC is a large palm oil company with a significant market presence and extensive production, marketing and distribution facilities in Malaysia. GCC was established in 1975. The company consists of midstream (oil refining and fractionation) and downstream (packing and distribution) production activities. During our ethnographic study, GCC grew in line with the Malaysian Government's Third Industrial Plan (2006-2020) by expanding the business to achieve an oil refining capacity of 600 MT per day by operating three cooking oil refining plantations that serve its midstream processes, one downstream plantation and eleven depots for the production and packaging of shortening, creamers, margarine/spreads, mayonnaise, instant noodles and other palm oil-based non-food products such as soap and personal items. The depots are operated to store products and distribute downstream products in line with the sales and market share targets. GCC's ambition is to expand further in international markets, while continuing to focus on bulk sales and servicing re-packers, while also dealing with increasing demand from walk-in export customers. GCC managers are aware of how the varying levels of ripeness of the flesh palm fruit upon harvesting often lead to uncertainties from the nature of crude oil extraction (Tzuan, Hashim, Raj, Baseri Huddin, & Sajab, 2022). GCC faces the increasing need to secure high quantities of CPO to meet internal and external production demands. All incoming CPO supplies are subjected to a quality check at the receipting centre. However, sometimes, they will accept lower off-specification CPO if there is a critical shortage of supplies in the market. GCC often considers supplier negotiations or discount offers for a lower quality CPO load if it is still within the producible range.

We first approached GCC to create a connection with the network of Malaysian Palm oil producers and distributors. Through regular meetings and discussions with producers and distributors in this network, we were able to learn more about the complexities around palm oil production processes, which attracted our interest in the topic. We were quite fortunate in using the network to discuss our brief objectives and plan for researching them through an ethnographic case study. We managed to obtain an appointment with the GCC's CEO to discuss our research plan and further negotiate access for direct observations and interviews with relevant staff in all parts of the palm oil production processes. We were approved to arrange an initial schedule for a visit to different locations of GCC's operation. During the first visit in January 2012, we had the opportunity to interview one human resource officer and one operation officer for an overview of the organisation's operations and locations. The managers and workers were subsequently to prove to be cooperative in helping us to negotiate schedules for data collection, and the extended period of immersion that we needed in the field. We allowed ourselves to develop our research questions by gaining rich insight into participant perspectives (Slutskaya, Game, & Simpson, 2018). Our sites of observation between 2012-2016 were the refinery in the southern part of Malaysia (about 350 km from Kuala Lumpur), the midstream and downstream production activities, and the depots that are situated at 11 different locations across the states in Malaysia.

We visited and conducted interviews and observations in four stages, which include the head office in Kuala Lumpur, and multiple locations of the company operations in different parts of Malaysia. The four stages of interviews and observations allowed us to understand the technical production processes, the controls employed, and the documentation involved in day-to-day operations, the organisation of the company policies, and the relevant business activities. We sought to gain an in-depth understanding of the refinery related operational and managerial activities. We further visited GCC in 2017 to share the findings of our ethnographic case study, and to gather additional information and feedback that we used to finalise our findings. These enable us to revisit temporal comparisons between conditions at the different sites or points of observation to incorporate subsequent events and to generate a process-based theorization (Köhler, Rumyantseva, & Welch, 2023).

4.1. Data collection

As part of our ethnographic study, we collected data through site observation that enabled us to immerse ourselves in in-depth social interactions and practices (Dumont, 2023; Letiche et al., 2024). The ethnographic observations we conducted included: semi-structured interviews, informal conversations, as well as observations/examinations of the company's documents. A total of 81 formal interviews were conducted between 2012-2016. During the data collection, we conducted 35 interviews at the refinery, 16 at the depots and 30 at the head office. The list of interviews and observations is listed in Appendix 1. Interviews at the refinery were primarily with plant operators and supervisors in the different sections of process operations. In addition, production executives, engineers, factory managers, laboratory officers and other administrative executives were also interviewed. On average, the length of each interview was 1 hour and 45 minutes.

Almost all interviews were recorded. Detailed notes were taken for the one interview that was not recorded. Besides the formal interviews, informal and unrecorded conversations were also conducted during this time. This was done especially during staff work breaks. Most of the information gathered from the informal conversations aimed to get a 'feel' for the deeper, personal feelings of the people and their relations with each other as well as their feelings towards the organisation. We made a practice of creating a written note at the end of each day during the data collection process to reflect our understanding and experience during the day.

Observations were done broadly in two ways - i.e., daily activity and at meetings. Daily activity observations included observing employees at the office and operations sites during their normal working hours, during breaks and after office hours. Informal observations enabled us to identify new issues and to explore indications about the validity of information sources. A schedule of somewhat formal observations was conducted at the refinery, including at the different sub-sections and individual parts of the refinery plant and within the refinery offices during formal office hours. The informal observations were mainly done during lunch breaks and after office hours. They took place on an opportunistic basis in the refinery canteen where most of the employees (both operational workers and managerial personnel) hung around during these times.

In line with Bryman and Bell (2011), we also caution that "the more familiar you are with a social situation, the less you may be able to recognize the tacit cultural rules that are at work". Therefore, we always prepare notes at the end of each day, to record and reflect on the conversations with different groups of people at different times. That helps us to observe behaviour that might provide evidence that is directly and indirectly related to the scope of the study. We observed 11 meetings at the refinery. The main meetings attended at the refinery were the 'morning meeting' between the refining and fractionation supervisors and plant employees regarding daily production planning and performance. We also observed a two-day budget retreat meeting, where they discussed and developed the overall organization budget

for the next year. In addition to the formal and informal interviews and observations, we collected a range of documents used and produced within the organisation, such as samples of accounting reports, production reports, minutes of meetings and various operating manuals (listed in Appendix 2). This documentary evidence totalled more than six thousand pages.

4.2. Data analysis

The data analysis processes were designed to make sense of the interactions between actors in the organization and the meaning attached to their everyday activities within the context (Reinecke & Ansari, 2015). We took a broad approach to understanding how actors managed temporal uncertainties and competing obsessions, and to effectively control each stage of the complex production routines in which they were engaged. All interviews were transcribed. During the transcription process, patterns and themes were identified and used to try to construct explanations that could make sense of the data. At this stage, the data were analysed to identify the overall production process of palm oil. While transcribing the interviews using Microsoft Word, themes and patterns were manually recorded in a separate worksheet in two ways i.e., record the theme and cross-reference it to the transcripts (at specific elapsed times, and by drawing mind map style diagrams to provide further depictions of what appeared to be interesting/important linkages. Some of the recurrent themes were related to temporal uncertainties and complex challenges faced by the operators in the flow of production, quality issues and controls, functional and individual performance measures, communication between divisions, supports and demands from the head office, and market demands. These themes emerged and were commonly reinforced across interviews conducted at the refinery and the head office.

We allowed ourselves to develop our research question and objective by gaining rich insight into participant perspectives (Slutskaya et al., 2018). The main objective of this research is to explore the way refinery workers and managers (re)construct adaptive or improvised practices to manage both temporal uncertainties and competing obsessions in order to effectively control each stage of palm oil production routines. These pressures and tensions were revealed among several themes that emerged during the second round of systematic and careful reading of the transcripts - i.e. the tension between quality controls and the managerial demands on yield and cost of production, together with responses to the contradictory demands, actions to flex control systems, and regular revisions of practices.

Observation notes and documents collected were used to see the link between the various operations work stages and the management groups as well as to see the bigger picture of the flow of controls throughout the organisation. The notes and document records were also used to cross check the consistency of the interview data collected, and the storyline constructed. The theorisation process was done in parallel with the writing up of the case interpretations. Concepts within the theory employed (i.e., temporal uncertainties, temporal coordination, temporal autonomy, improvisational adaptability) informed the construction of the storyline during the second round of data analysis.

5. Findings

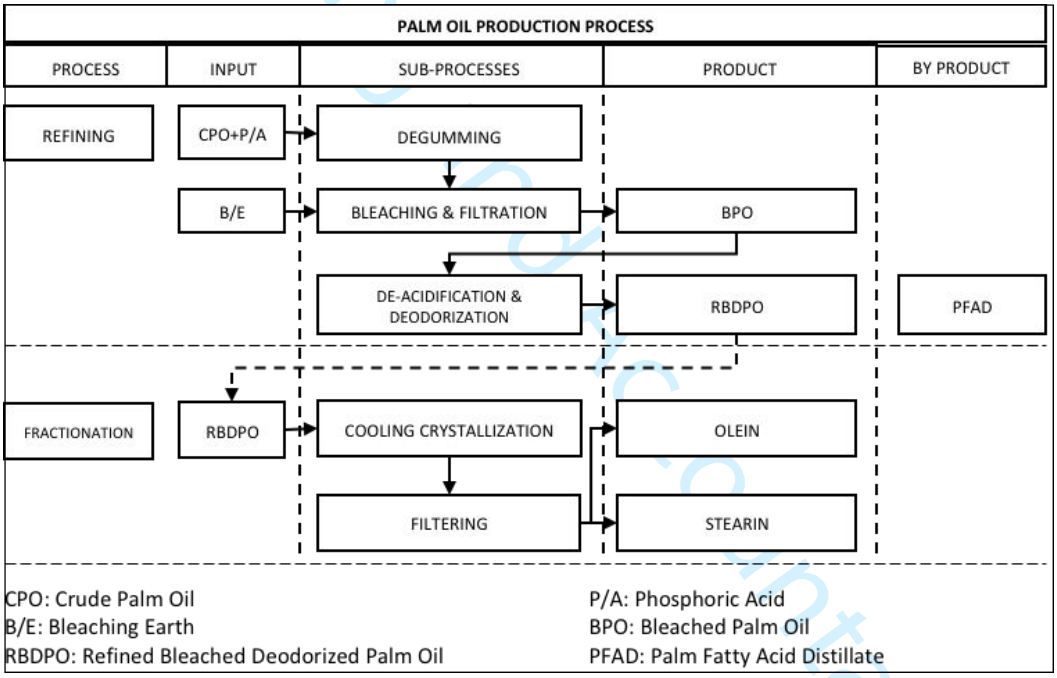
5.1. Temporal uncertainties and control obsessions in palm oil production routines

Our analysis identifies how the palm oil processes are subject to frequent disturbance as managers and operators respond to temporal uncertainties in processing differing qualities of palm seed and crude oil. In line with Pina e Cunha et al. (2017) palm oil production reflects an ambitious or seemingly impossible target of performance while every major element of the production processes can produce surprising outcomes. Palm oil production routines involve highly repetitive interdependent actions that are carried out by multiple actors who have differing objectives, interests, and conflicting control obsessions among different sections of

the plant and beyond. The refinery managers seek to ensure that all refining and fractionation processes are controlled in ways to achieve the market aesthetic of palm oil quality. The production process is also stretched to maintain efficiency, measured by oil colour level and targeted yield/throughput within the budgeted cost

Such control obsessions are targeted with a process complexity that is shown in Figure 1 below. The refining and fractionation processes are operated by managers and plantation workers within a context of uncertainty that they can never fully anticipate or control. The complexity and volatility of the refinery process further impact the cost of production. Such a situation creates problems for managers at headquarters who set the target for maintaining production efficiencies. The production system becomes even more unpredictable as managers and operators face temporal uncertainties in each part of the Crude Palm Oil (CPO) production routines, as shown in Figure 1 below. Temporal uncertainties emerge and create different challenges that are unknown until they happen, and how the surprises will affect time constraints and coordination in each part of the production processes. The relative quality of the CPO influences the sub-materials that need to be used, and the application and extent of process treatments within the refining plant (Challapalli, 2016).

Figure 1 Palm Oil Refining and Fractionation Process at GCC



As shown in Figure 1 above, the main target is to transform the natural red and cloudy appearance of CPO into *Olein* or edible palm cooking oil (CPO that has been refined, bleached, deodorized, cooled, filtered, and pressed) to create a bright golden/yellow colour at least cost. *Stearin* is also produced as a co-product or joint product with *Olein*. *Stearin* is further processed into viscose fat products, such as margarine, shortening, vegetable ghee, and vanaspati. In addition, the refining process aims to reduce the non-desired output, namely *Palm Fatty Acid Distillate* (PFAD), which is a by-product, or waste/residue of the refining process. The main controlling yardstick imposed on the production operators is to maximize the yield and minimize the cost of production. These efficiency targets and macro control measures are set during the preparation of the budgets around July of each year.

The first control obsession is to achieve the aesthetic quality of Olein or edible palm cooking oil by processing CPO in two stages, complex refining and fractionation. The refining

process transforms CPO into refined bleached deodorized palm oil (RBDPO) that is further processed at the fractionation plant. In fractionation, the RBDPO goes through the cooling and filtration processes to produce Olein and its joint product Stearin. The refining process includes *degumming*, *bleaching and filtration*, *de-acidification* and *deodorization* stages. *Degumming* is the first process to remove foreign particles by heating CPO in a heat exchanger at a high temperature (about 90 - 110°C). Phosphoric acid is added to break off the particles and gums from the oil. The main control at this stage is; 1) to maintain the quality of CPO, 2) to determine the right amount of phosphoric acid, and 3) to adjust the appropriate temperature, flow rate or retention time of oil in the heat exchanger to allow greater separation of foreign particles from the oil. Temporal uncertainties in the degumming process may vary with these complex variables. The plant operators constantly seek to control and adjust to achieve the optimal amount and interim quality of the processed oil after the degumming process.

The temporal uncertainties persist in the second part of the refining process, the *bleaching and filtration* stages. These stages involve bleaching the CPO to produce lighter-coloured oil by adding bleaching earth (a very fine powder consisting of silicon dioxide) to trap gums and remove foreign particles from the oil. In this process, the bleaching earth to be added varies from 0.5 to 2.0% per metric tonne of oil to achieve what is called slurry oil (the mixture of oil, phosphoric acid, and bleaching earth). Similar to the previous stage, the temporal uncertainties come from setting the appropriate flow rate to ensure the optimal role of bleaching earth to achieve an even mix of elements, and to capture all gums and the residual phosphoric acid. This slurry oil continuously needs to be agitated in the bleacher tank for approximately 30 minutes and is then pumped through the filtration tank to produce the Bleached Palm Oil (BPO).

The last stage of the refining process involves *de-acidification* and *deodorization* treatment to remove the smell from the BPO. The temporal uncertainties are attached to the control of the appropriate temperature of this BPO reheating process so that it does not get too high, which can increase oil loss that will reduce RBDPO throughput/yield. The operators need to maintain the reheating temperature of at least 260°C to minimize the release or vaporisation of PFAD. Once the desired release of PFAD has been achieved, cold PFAD is sprayed in order to re-liquidate the vaporized PFAD, and finally produce RBDPO. Managers/supervisors and workers are all under pressure to ensure the production routines are conducted at a fast and even flow rate to achieve desired outcomes at a lesser cost, as seen from the following statement of the head office senior operation manager:

> *We have KPIs for the refinery - for example, the throughput for each process: the yield and the oil loss. The refinery submits the daily and monthly reports on the production to us. The reports will indicate if they [the refinery production team] were unable to achieve the throughput. The details that I normally will focus on are the throughput, yield, oil loss and quality of oil…well, quality is expected…. if there is anything not okay with the yield, I'll call them directly or I'll email them to find out about this. For the daily report… it is important because from there I'll know the smoothness and efficiency of the production process if there is any breakdown… whether it is serious, the quality and all that… eventually this is important for the end of the month because this determines whether we will achieve the targeted quantity in the budget or not. (Senior General Manager-Operation, Interview in GCC Headquarter)*

While the colour aesthetic is a control obsession to be achieved by intervening in the refinery processes in various ways, there are always production efficiency criteria that Golden Corp demands. The evaluations are primarily measured by throughput/yield based on RBDPO and PFAD extracted from the CPO per hour and within the budgeted/planned cost of

production. The yield of the refining process is calculated based on the throughput of RBDPO and PFAD extracted from the CPO. The uncountable balance is considered as oil loss (this is mainly oil that sticks to the bleaching earth in the filtration process and during vaporization in the de-acidification and deodorization process). The magnitude of the work pressure (to achieve yield and cost of production) can be sensed among the operators and supervisors working at the refinery. Their comments below clearly demonstrate that although the target yield is continuously checked and controlled, achieving and/or maintaining the aesthetic oil quality seems to be of utmost concern when operations are running smoothly.

> *The first concern is quality. Although the management [head office] is pressing us on throughput [yield] and cost, my first concern is still quality. What is the point of meeting the target yield but can't sell, right? So as much as we can, we will try to achieve our yield target and minimise our cost - quality is still my first concern. (Production Manager 2 – Observation of Morning Refinery Management Meeting)*

> *The quality is the most important thing to control. There's no point trying to maximize throughput if we don't meet the quality requirement. (Refinery Operator – Observation of Fractionation Process in Plantation 1)*

Among the three performance measures, top management regards yield as the highest emphasis in evaluating the refinery performance. However, there is considerable pressure on the refining operational staff and the production managers to prioritise the quality of oil colour over yield and cost. The yield is also calculated based on the total usage of CPO, the amount of RBDPO being produced, and the level of PFAD being extracted. For example, if in one day 1,000 metric tons (MT) of CPO is used to produce 900 MT of RBDPO, then the RBDPO yield would be 90%. If it also produced 60 MT of PFAD, it means 6% of PFAD is generated from the processing. Such a production scenario also results in a 4% volume loss. Efficiency is measured using targets set to achieve high yields from production and minimise costs. At the same time, the company management reflects the wider market demands that palm oil conform to an established aesthetic quality, which is achieved partly through controlling the fractionation process.

The fractionation process includes *cooling crystallization* and *filtering* stages to separate Olein and Stearin. In the cooling process, RBDPO is loaded into the crystallizers with a set of pre-determined recipes. The temporal uncertainties are attached to how well the recipe setting or the combination of adjusting water temperature, stirrer speed and cooling time provided, are set to separate the solid Stearin from the liquid Olein. The process variables, such as temperature level, vacuum, retention time, moisture level, CPO quality, and the amount of sub-materials being used, will determine the chemical and physical reactions. All play significant roles in transforming the oil colour to that desired. In the fractionation process, variables such as *water temperature* being used for cooling, the *speed* of the stirrer and variations in the process *time* also play a role in determining Olein quality.

Just like the efficiency measurement in the refinery, the calculation of yield for fractionation is based on the Olein extracted from the RBDPO after Stearin separation. The unaccounted balance here is also considered as yield loss (oil loss). Beyond the frenetic operational activity, managers in charge of overall refinery production also continuously monitor the production processes to make sure that oils (RBDPO produced from the refinery and Olein from the fractionation plants) are within the target quality. Production workers are torn between conflicting demands to achieve the best quality outcomes against yield and cost of production targets. They are left to implement different control parameters in the production

processes despite the natural variation of CPO that poses a significant challenge to achieving an acceptable quality of output (Appendix 3). This situation triggers adaptive improvisation to cope with the two contradictory pressures – which will be discussed in the next section.

5.2. Temporal improvisation: Sequencing incremental control of quality and efficiency

The complex yet ambitious production environment induces managers' and workers' mobility and mindful extemporization to manage the temporal uncertainties in each stage of the palm oil processual routines (Amit & Knowles, 2017; Cunha et al., 2017). They engage in sequencing and/or the making of micro, situated, and temporal interventions or improvisational adaptation as ways of managing the routine of palm oil production processes, while seeking to control emergent but uncontrollable challenges, and conflicting pressures/demands (Ciuchta et al., 2021; Leybourne et al., 2014). The production operators engage in a fluid thought process to create sequences of intraday operational improvisation as an ad-hoc response to each of the emerging temporal challenges in fulfilling quality and efficiency requirements. The laboratory analyst below explains how they engage in adaptations to work routines from the early stage of the palm oil production process.

> *We run the tests to firstly give some indication to the production staff on the characteristics of the material and utilities they need to use to produce [good quality refined oil] with this quality of raw material; secondly, this also helps us justify the outcome of production. (Laboratory Analyst, Observation in Refinery Plantation 1)*

As explained by a laboratory analyst above, the quality specification of CPO is checked at the initial stage, in accordance with the Palm Oil Refiners Association of Malaysia (PORAM) Quality Standard Specification. The acceptance or rejection of CPO is determined based on its Free Fatty Acid (FFA) level, Volatile Matter (VM), and Deterioration of Bleachability Index (DOBI) as parameters to decide the cause of temporal uncertainties and the actions needed in the refining process. To increase the potential to achieve the maximum outcome of Olein, the CPO is also tested for the moisture level, the Iodine Value (IV) and the Peroxide Value (PV) that indicates the presence of peculiar taste and the degree of unsaturation of oil and fat. The objective is to store the acceptable CPO for further processes at the refinery plant. However, there are times when the shortage of acceptable CPO occurs and requires the refining staff to accept the 'out of specs' CPO as a rational and adaptive behaviour to this dynamic, and uncertain environment. The refinery supervisor below argues that the initial control of the production routines has to be altered in a way that differs from the laboratory personnel's recommendation.

> *Sometimes we have to make difficult decisions... If the input [CPO] quality is good, the production process can go very smoothly, and we can sometimes even save on other materials [ingredients]. Good quality CPO doesn't need much bleaching [earth] and phosphoric acid. We can even put the flow rate to the maximum and just the minimal heat will do because it won't be difficult to break the particles [out] from the oil. (Refinery supervisor 1 – Interview in Refinery Plantation 2)*

This unpredictable situation demands an improvisational or non-linear cognitive process, yet incremental actions towards the agreed production controls. In seeking to meet the efficiency target, the refining process may proceed with the limited choice of raw material due to a shortage of good quality CPO, or the manager's choice to negotiate competitive or discounted prices with suppliers. Such shifts in quality are often hidden under the struggles to

fulfil the target to reduce the material cost as a way to control the overall production efficiency. As a result of workers are left to deal with the lower quality of CPO at the production process. Consequently, the refinery operators need to be in constant consultations with the lab staff to ensure that the quality of the BPO is sampled every two hours. This testing is especially aimed to ensure that the oil colour is being shifted to achieve the target. The result of this test will determine whether corrective action needs to be taken, as mentioned by the supervisor below:

> *We can have two problems [from the results from the lab]... we can have an FFA problem [high quantity free fatty acid so less oil extracted and/or] we can have a colour problem... If, let's say, it is caused by the colour, then we have to go back to square one... we [transfer the product back to the] feed tank and consider it as CPO [and] we dose in [add] bleaching earth again. (Refinery Supervisor 2 – Observation in Refinery Plantation 3)*

The refinery supervisor remark above shows that ad-hoc improvisational responses are prepared to face further temporal uncertainties that occur due to the decision to use cheaper and/or lower quality inputs. The refinery operators engage in constant revision of heat levels and flow rate within different stages of the refining process to ensure the target colour is fulfilled. This shows that improvisational practices require complex and unstructured managerial control (Larsen & Bogers, 2014). They are aware that such improvisational actions might lead to the necessity to perform different actions, as a sudden turn of events might require instantaneous responses (Geiger et al., 2021). The fractionation operators employ flexible ways in interpreting problems and navigate the situated uncertainties that they face (Patil et al., 2024). Workers and managers deploy temporal buffers or momentary improvisational actions as the strategy to navigate disruptions when there is not enough time to (re)negotiate how to alter complications or breakdowns/halts to aesthetic quality control in the refinery processes (Geiger et al., 2021; Geiger & Harborth, 2024; Wouters & Wilderom, 2008). Their mindset is always to prepare for any corrective actions or ways to achieve the colour target or reducing/reprocessing the oil/BPO, whichever that need to be performed at this stage.

> *The decision on how much to mix is done here among the supervisor and operators constantly [in an iterative manner] for each batch of oil that comes to us. We normally get the approval from the manager… the supervisor will tell them [the operators] during the morning meeting. But you know… they [management] don't encourage mixing… we still mix… if not, crystals won't form. We understand their concern about the cost of production and yield, but if the RPO's quality is bad, and we still continue to filter there will be much sticking [RPO trapped in the filter]… then we have to do a lot of grubbing, risking tearing the filter cloth… and the yield also will not be that much plus the output quality also will not be good. So… as much as we can, we avoid mixing, but if it is necessary, we'll do it. (Fractionation supervisor 2 – Interview in Refinery Plantation 2)*

The fractionation supervisor remark above can be seen as a reflection that temporal buffers become the way to manage tensions around achieving yield, which can often be emphasised as the end of the month approaches. Temporal buffers or momentary improvisational actions involve actors' retrospective surfacing of the material and social circumstances surrounding the refinery process (Karl E. Weick, 2024). In an extreme case, retrospective improvisational action is the only choice when operators need to stop the incoming CPO, pump back the oil from the intermediate tank, treat the oil as raw/unprocessed CPO, and reprocess the oil, as described by the above fractionation supervisor. They seek to

control the pressure through momentary improvised actions as a designed form of evolvability by using small, incremental shifts that evolve from one to another (Fisher et al., 2021).

It is at this time that yield performance reports need to be submitted to the HQ and can attract intense attention. However, no matter how intense the pressure is, outcomes are never totally within the control of the management or the plant workers. Temporary buffers serve as a flexible and adaptive approach for the managers and workers to embrace the ever-changing practices in the complex production process. Despite knowing that the action of mixing the oils directly affects the yield and is not encouraged by management, at times, the operators and supervisors at the plant must go against some management directives in order to enable production processes to run effectively. The interventions and adaptations that emerge from the required frequent intraday judgements, and the improvised actions by operators and supervisors at the plant are structured in a way to accommodate the dynamic changes that take place in production processes. In producing temporal buffers, refinery operators engage in temporal coordination, or joint actions to create or maintain alignment of routine works and tasks to control temporal uncertainty in palm oil processes (Bechky & Okhuysen, 2011; Faraj & Xiao, 2006; Hilbolling et al., 2022), as reflected in the following vignettes from one of the daily morning production management meetings in Refinery Plantation 1:

Vignette 1

Fractionation supervisor: *Here [the quality report]…RPO colour 3.0. How?*

Factory manager: *For Olein we target to achieve colour 2.8. So supposedly we need to use RBDPO, which achieved 2.5 or 2.6. What we have now is 3.0. Refinery…how [has this happened]?*

Refinery supervisor: *We are trying actually to get better [result]. But even now we are already using bleaching earth of 10kg/MT.*

Laboratory officer: *Incoming CPO has a very high colour and PV 2.5.*

Refinery supervisor: *See! With this incoming CPO quality, we will surely have colour problem.*

Factory manager: *I think they [the supplier] also don't have much new stock… the incoming fruit also has problems because of this weather. I think what we are receiving now is from their old stock.*

Fractionation supervisor: *Our yield is also low. If we use the 3.0 oil we will have to do a lot of mixing. So…you know…the yield will be very bad.*

Factory manager: *Our CP8's IV is now becoming like CP10*[1]*. Our yield also…we should get at least 78% for CP8. But now we don't even achieve that. Quality and yield are worse*

[1] CP8 is a better quality oil than CP10 (see table 2) and requires longer processing times.

than before. Is the squeezing, ok? What about the pressure and all of that?

***Fractionation supervisor**: Yeah. We've checked. No tear [holes] or anything like that. Filter is good. Pressure is good. We check that all the time. This is mainly caused by the oil quality. Because of that we also have to mix [and reprocess] a lot. And obviously when we mix, yield also reduces.*

***Factory manager**: Ok. For now, we have no choice. Just continue with the mixing [at fractionation]. And at refinery, add more bleaching. Lab, please do some analysis of incoming CPO. The quality fluctuates quite badly recently. Maybe you can do the analysis by mill, and we see what we can do with it. Maybe I can bring this issue to management if we can have this information.*

The vignette above illustrates that temporal coordination takes place as managers and supervisors try to shape temporal buffers or in-present improvisation in the face of the constant struggle among the people from different divisions involved with the production process. The laboratory testing shows that the oil colour is still not at target quality, in spite of the adaptations made within the refinery processes. In this situation, the only option is to add additional chemical materials, which necessarily will increase the cost and reduce yield (as the additional bleaching takes time) in reprocessing the oil. Operators and supervisors often face contradictory demands as they may be required to mix the poor quality of RBDPO it with significant quantities of previously processed Olein. The added Olein would enable Stearin crystallization that brightens and/or modifies colour quality. However, this action will necessarily lower Olein's yield from the process. In such a case, acceptable oil quality might be achieved, but it will likely compromise the efficiency of the process, as some of the Olein has effectively been processed twice. In this case, improvisation is not merely the organization's on-the-spot or spontaneous responses to complexities and uncertainties but also may involve changes in demand.

Managers and production workers arrived at a realisation that the palm oil processual routines are dynamic, which requires temporal in-present-actions that might alter the known procedures that they defined and controlled in advance. Temporal uncertainties in such complex processes necessitate incremental control and situated forms of temporal coordination. In such cases, actors seek to allow others to exercise temporal autonomy to improvise, adapt and uncouple from control procedures (however briefly) autonomously depending on the situated contingency (Pérez-Nordtvedt et al., 2008). Opposing views of the positive and negative aspects of the improvised actions, such as the decision to include lower quality CPO or the iterative decisions in adding chemical materials or treatments, are put aside to optimally run the production and to achieve specified quality. Actors seek to control the challenges by coordinating an incremental, situated, or temporally adaptive (re)prioritisation of the production routines (Cunha et al., 2012; Vera & Crossan, 2007). Temporal coordination of the adaptive routines is embraced reflecting the constant interventions that are needed to balance the demands of quality and yield, as illustrated in how the feedback from the laboratory triggers the action below.

> *We actually run the production like blind people. We rely 100% on the lab results to manoeuvre our production process. When we get results from the lab … we can see what actions to take. Let's say the lab test shows a good colour of 2.2 - that's very good, right? Our target is 2.3 or 2.4*[2]*. That means we don't need that much bleaching earth. From 10kg/MT maybe I can reduce to 9kg/MT and maybe can also reduce the phosphoric acid usage. Some savings on cost can happen here. All this is based on the lab results. If the results show off quality, then we may have to reduce the flow rate, increase bleaching earth and phosphoric acid and so on.* (Refinery Senior Manager - Observation in Refinery Plantation 1)

The quote above shows an example of temporal coordination that can be seen from the way refinery operators respond to two hourly laboratory test results of oil colour (e.g. BPO is taken at the bleaching step, RBDPO is taken at de-acidification and deodorization step, and Olein is taken after the fractionation). Following an outcome like this, operators and the supervisor at the plant engage in temporal coordination that allows actors to exercise temporal autonomy to shift production priorities to focus on yield and cost. Although a 2.2-colour reading is 'better' (lighter) than 2.3 or 2.4 (as per target), it is less good for cost and yield. '*Too good colour'* may have resulted from higher usage of bleaching earth (i.e. extra cost) and a higher portion of the refined oil is lost as it becomes trapped with the filtered bleaching earth (i.e. reducing yield). So, the 2.2-colour outcome produces the next pendulum action as the operators swing back toward yield and cost targets.

Within this pendulum of improvised action, processual routines are subject to frequent delicate adaptation so that an optimum efficiency of production can be achieved or retained. Managers and plant operators are fleetingly involved in constant revisions of control practices, as changes of demands and contradictory priorities are set and reset. The plant operators engage in flexible control of quality and efficiency targets, as the mechanism to cope with the complex yet competing production requirements. These interventions represent irregular temporal progressions or adaptations that are necessary to ameliorate the constant contradictory efficiency-quality controls in the production processes. What may appear to be routine interventions involve many quite delicate shifts between palm oil quality or yield that are coordinated under temporal uncertainty, in order to ensure the process remains within the desired tolerances. In the end, the top management knows that there are so many uncontrollable parameters at the production site that complete knowledge of the production process is not possible (Pickering (2003).

6. Discussion

Our paper has explored the situated improvisational adaptation within complex and unstable palm oil production processing. Our findings show the effects of ambitious yet contradictory production control consequent on the search for the aesthetic quality of palm oil colour amid a persistent desire to attain efficiency goals throughout the production process. Through the lens of improvisation in complex organizational process (Amit & Knowles, 2017; Cunha et al., 2017; Karl E. Weick, 2024) our findings show how actors are situated to (re)construct sequences of incremental control to embrace flexibility and innovative adaptability in monitoring and controlling the temporal uncertainties in palm oil production processes. Managers and operational workers swing between continuous in-present-improvisational actions, where instability is folded into the normal routines. As a result, palm oil production must embrace instability, waste, and failure to continuously seek to briefly stabilise a form of organizing to achieve the elusive aesthetic quality.

[2] The lower the colour the better the quality.

6.1. Temporality of improvised incremental control in a complex production process

We seek to contribute to the discussion of the enabling role of flexible control system (Ahrens & Chapman, 2004; Ahrens & Mollona, 2007; Lukka, 2007; Mouritsen, 1999; Wouters & Wilderom, 2008) by unpacking the temporal nature of flexible control, uncertainties, and improvisational actions in a complex process industry setting. We argue that improvised incremental control is cultivated temporally to co-exist with situated uncertainties that emerge from attending to ambitious yet contradictory targets in a complex process. In our case, temporal improvised incremental control represents the way actors' (re)construct incremental control revisions that involve small effects aiming at achieving the desired efficiency. Such interventions, however, create significant impact on the overall endeavour in meeting the quality target. Our findings provide a persuasive understanding of the temporality of improvisational incremental control in an organizational setting with ambitious yet often conflicting performance goals. We offer insights into how organizations often dismiss the difficulties in determining a clear static set of controls, which requires variability of strategies, procedures, and priorities at different stages in complex production processes. These represent the complexity and the requirement to resort to human adaptations and improvisations to effectively control such complex processing systems.

Through temporality, our study contributes by showcasing a site that exhibits fluidity of control in a complex process industry environment. Complexities, idiosyncrasies and interdependencies in palm oil processes are shaped, contended and shifted in temporal patterns. Adding to Ahrens & Mollona (2007), our study unpacks a manufacturing setting that is very different to the fast food industry. Palm oil production is representative of many large-scale process plants across food processing, or equally as complex as crude oil refining or chemicals, or paper mill manufacturing process. These types of process industry settings are not covered, in much depth, in the management accounting literature. We contribute by unsettling some a conception of such process manufacturing settings as being controlled in what might be described as a rigid or mechanical manner, with little uncertainty or human intervention.

Expanding Otley's (2014) view on non-static control environments, we showcase that multiple divergent temporal demands are addressed as a continuously becoming controlling fabrication. Actors engage in sequences of momentary improvisation or temporal buffers through fluid thought processes as they interpret and navigate the complex stimuli (Patil et al., 2024). Every part of the process involved temporal uncertainty, and the need for improvisation and/or on-the-spot accommodation of diverse and uncertain outcomes, thus making it difficult to maintain the competing efficiency and quality levels that were desired. In line with Weick (1979; 2024), frequent changes in the obsessed quality level have instilled a sense of urgency to seek continuous feedback (laboratory test results are an example in our case) that fuels improvisers into complex choreography in response to errors and failures in the formal controls and production processes. In that case, there was no other choice than framing a range of temporal yet eclectic innovative controls to contain variance and failure within the production processes.

Insight on the temporality of improvised incremental control provides avenues for researchers to explore how control practices are dynamically adjusted to cope with the temporally unpredictable, disruptive nature, and the ever-changing constraints inherent in complex processes. The temporal perspective of improvised incremental control applied to process routines may enable researchers to resist the temptation to treat complex process situations with conflicting performance targets as if they can easily be controlled, harnessed or tamed (Cunha et al., 2017; Cunha & Putnam, 2017). We argue by taking such an approach, researchers could shed light on the role of actors in volatile contexts, where control system limits are reached, and improvisation takes over. Where improvisations amid temporal

uncertainties, are used to manage if not resolve contradictions in work practices. While organisational control in situations of uncertainty is not new, we argue that insufficient attention has been given to the role of improvisation in temporal nature, and the limits of a control-based ontology. The combination of both perspectives enables researchers to focus on the alignment of local circumstances that are uncertain, ambiguous, and complex in developing practical recommendations for responding to competing control issues.

6.2. Temporal coordination: Interpersonal autonomous control in complex processes

We seek to contribute to the discussion of the role of autonomy in repairing/mending control breakdowns/halts or incompleteness (Pfister & Lukka, 2019; Wouters & Wilderom, 2008) by highlighting the role of interpersonal autonomous control in cultivating temporal coordination to manage volatility in complex processes. We argue that temporal coordination is the key interpersonal control to crafting temporal autonomous adaptative control practices and priorities. Temporal coordination allows interrelated actors to develop rhythms by exercising temporal autonomy when evolving and transitioning between complex process routines. In our case, it involves learning and deploying abilities in organizing reflexivity as managers and workers seek to manage quality and efficiency targets. They continuously (re)create interpersonal autonomous control to embrace instability and variability attached to competing performance targets in the complex palm oil processes.

A reflection on control and coordination allows us to provide insight into how different groups of actors with conflicting interests and objectives seek to share temporal autonomy as a way to understand the effects of complexity and uncertainty in complex refinery processes such as palm oil. We contend that much can be learned about actors' negotiation in complex process industry settings of this type by considering our evidence. Temporal coordination enables interrelated actors to interpret, navigate and adapt to different problems at hand and to shape situated incremental control solutions. Temporal autonomy allows actors to reshape, contend and shift control for each of the conflicting demands at different times. It also enables actors to flexibly switch between different strategies to tackle problems/challenges/potential halts that they have observed in different parts of a complex process. Temporal coordination allows actors to engage in retrospective and prospective surfacing of potential remedies or ways to navigate times and efforts to accommodate competing targets over time.

We extend calls to enrich the study of improvisation in complexly ambitious yet competing target situations (Cunha et al., 2017; Cunha et al., 2012; Cunha & Putnam, 2017; Karl E. Weick, 2024) by exploring how actors with competing goals engage in interpersonal reflexive learning and the reframing of strategies where organisations struggle in engaging the opposite poles of control obsessions. We offer insight into actors' continuous interpersonal reflection-in-action that serves as the basis for taming temporal tensions and contradictions and re-group to manage or switch between them at different times of increased pressures. In our case, instability, uncertainty, and inconsistency become the source of various groups of actors' stabilisation process, thus maintaining the demands for aesthetic quality and economic efficiency at the same time was implausible. From the beginning of the process, actors ought to coordinate continuously to engage in constant variations of practices and flexible control of the processes.

We argue that temporal autonomy is accomplished through a combination of rhythmizing routine performances and performing temporal improvisational adaptations. The less or more coordinated actions we describe in different stages of the palm production process show how instability is folded into the complex routines. In our case, different groups of actors aim to prioritize stability and coordinate temporal control responses to persisting tensions to achieve both aesthetic quality and efficiency by accepting the most effective unplanned interventions and adjustments in process operations. Temporal autonomy that is shared among

actors allows the coordination of the palm oil food production process to embrace errors and establish a form of improvisational organizing to achieve the aesthetic level of quality at the desired cost and process efficiency. Both temporal coordination and shared temporal autonomy provide a space for flexibility and improvisational ability when complex production processes need to embrace unexpected outcomes from overly ambitious goals.

7. Conclusion and Implication

This research explores the complexity of management control in a complicated palm oil production process, where temporal uncertainties derive from pressures to achieve operational efficiency while also fulfilling the established market aesthetic of high quality cooking oil. The palm oil production is operated beyond stable and standardized control processes. Formal measures such as efficiency budgets and key quality indicators that would facilitate the monitoring of performance cannot be implemented in a linear manner (Ahrens & Mollona, 2007; Otley, 2014). It involves complex operational processes that are organized in an improvisational and incremental way to achieve stability.

Our findings contribute by unpacking the temporality of sequences of incremental control that are cultivated by interrelated actors through temporal coordination in response to the impact of micro-level challenges in attaining efficient and aesthetically acceptable quality production outcomes. In our case company, the production environment is disrupted by shifting priorities and uncertainty is embraced by engaging in temporal improvised incremental control throughout the production process. Actors' engagement in temporal coordination serves as a means to navigate effective adaptation that enables production operatives and managers to cope with the competing demands and ambitious targets caused by the search to balance economic efficiency and aesthetic quality. Persisting and unresolvable tensions arise from the demand to achieve efficiency while maintaining the quality of the end product. Our case portrayed a situation where actors engage in two competing demands that are important and cannot be undermined in the operational and organizational processes (Pfister & Lukka, 2019; Wouters & Wilderom, 2008). The complexity of the operational process results in temporal uncertainties that enhance pressures on the actors to improvise and engage in constant revisions to operating practices.

The findings of this research may be helpful to managers and consultation agencies/professionals of organizations that are complex and volatile in nature, with highly uncertain processing operations such as agriculture, mining, oil explorations and refineries where inputs and processes are complex and unpredictable. Reflecting on our findings, managers and professionals in organizations could learn how to respond to the inherent tensions that emerge from competing control obsessions in organizational processes by engaging in temporal structuring of process routines. They need to engage in temporal coordination, which allows actors to exercise temporal autonomy that enables them to craft situated incremental control actions. These show the futility of placing too much faith in formal and standardised control systems. It is precisely these systems that our findings illustrate being overwhelmed and replaced by carefully constructed improvisations. Adaptive incremental control enables managers in organizations to ensure the evolvability of organizational process routines as they face difficulties in meeting key performance indicators, or often in implementing strict conventional standardized monitoring and control measures that are impossible to follow.

We report that the case organization we observed relies on adaptive incremental control (at different levels of organization and management), which requires constant small revisions to routines and practices over short time periods. We suggest that these actions around the complex production process can be arranged to be flexible enough to allow improvisation from that enables actors to create delicate temporal progressions in work routines (Schad et al.,

2016). Interpersonal autonomous adaptations may require in-present cognitive shifts in order to effectively respond to ambitious and conflicting targets in complex production environments. There is almost no ending to the learning and improvisation process, as actors have to constantly revise courses of action – by engaging in temporal coordination to alter contradictory goals at the operational and process supervision levels. Here, we offer our reflection on the limitations of our study. Our analysis and search for critical insight might be influenced by our subsequent returns to the research site and our close engagement with the participants of our ethnographic research. We might overlook the extent to which incremental improvisation could be misused to achieve personal/group targets/ambitions in certain circumstances. Future research might concentrate on the ethical and sustainability aspects of palm oil production, or on other food production processes that are complex with contradictory or ambitious targets in nature. This research could also be extended to more recognisable process industries such as oil refining, paper, forestry (beyond cultivation and harvest) and chemicals where there must also exist variation in inputs and likely a degree of unpredictability and flexible control in processing. The micro processes of organizational life, where actors are situated within technology and socio-cultural elements, would also be an interesting research avenue.

8. References

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8. Appendices

Appendix 1: List of Interviews and Observations

No.	Date	Interviewee
Head Office		
Preliminary Visit		
1	06/01/2012	Human Resource Officer
2	06/01/2012	Operations Officer
First Field Visit		
3	05/06/2012	Officer at the History Gallery of the Organisation
4	07/06/2012	Senior General Manager – Operations (Head of Department)
5	07/06/2012	Chief Executive Officer
6	06/06/2012	Senior Manager – Finance (Head of Department)
7	02/08/2012	Senior Executive – Finance
8	02/08/2012	Senior Executive – International Business
9	03/08/2012	General Manager – Human Resource (Head of Department)
10	06/08/2012	Manager – Marketing and Product Development
11	06/08/2012	Senior Executive - Logistic
12	06/08/2012	Executive - Logistic
13	07/08/2012	Executive - Procurement
14	07/08/2012	Management Trainee – Domestic Sales and Distribution
15	08/08/2012	Manager - Marketing and Product Development
16	09/08/2012	Executive – Feed Stock Purchasing
17	10/08/2012	Manager – Domestic Sales and Distribution
18	13/08/2012	Executive – Domestic Sales and Distribution (Modern Trade)
19	13/08/2012	Senior Executive – Finance
20	14/08/2012	Management Trainee – Finance
21	14/08/2012	Management Trainee – Finance
22	16/08/2012	Executive - Marketing and Product
23	16/08/2012	Executive – Operations
24	16/08/2012	Senior Executive - Finance
25	27/08/2012	Senior General Manager - Marketing and Product Development
26	27/08/2012	Senior General Manager - Domestic Sales and Distribution
27	27/08/2012	General Manager – International Business
28	28/08/2012	Senior Manager – Finance (Head of Department)
29	29/08/2012	Senior General Manager – Operations (Head of Department)
30	03/09/2012	Chief Executive Officer

Second Field Visit - Depots		
31	02/02/2013	Head of Depot (Depot 1)
32	12/02/2013	Finance Executive (Depot 1)
33	03/03/2013	Head of Depot (Depot 2)
34	15/03/2013	Head of Depot (Depot 3)
35	05/04/2013	Head of Depot (Depot 4)
36	15/04/2013	Sales Executive (Depot 4)
37	15/04/2013	Salesperson (Depot 4)
38	22/05/2013	Head of Depot (Depot 5)
39	22/05/2013	Sales Executive (Depot 5)
40	05/06/2013	Clerk – Admin and Store (Depot 6)
41	15/06/2013	Head of Depot (Depot 7)
42	25/06/2013	Head of Depot (Depot 8)
43	05/07/2013	Head of Depot (Depot 9)
44	16/07/2013	Clerk – Admin (Depot 10)
45	18/08/2013	Head of Depot (Depot 11)
46	18/08/2013	Salesperson (Depot 11)

Second Field Visit - Refinery		
47	14/09/2013	Refinery Senior Manager
48	15/09/2013	Senior Supervisor - Operation
49	18/09/2013	Assistant Executive
50	20/09/2013	Accounts Operation Clerk
51	14/10/2013	Export Operation Clerk
52	15/10/2013	Domestic Sales
53	16/10/2013	Accounts Executive
54	10/11/2013	Admin Clerk – Procurement
55	14/11/2013	Accounts Executive
56	15/11/2013	Account Receivable Clerk
57	16/11/2013	Admin Executives – Administration, Procurement, Human Resource Accounts Receivable
Third Field Visit - Refinery		
58	02/02/2014	Assistant Manager – Quality Control
59	12/02/2014	Refinery Supervisor
60	03/03/2014	Fractionation Operator
61	15/03/2014	Fractionation Supervisor
62	05/04/2014	Production Manager
63	15/04/2014	Packed Product Supervisor
64	15/04/2014	Packed Product Assistant Supervisor
65	22/05/2014	Production Manager
66	22/05/2014	Packed Product Supervisor
67	05/06/2014	Production Clerk
68	15/06/2014	Warehouse Executive
69	25/06/2014	Assistant Manager
70	05/07/2014	Manager of Quality Control
71	16/07/2014	Factory Senior Manager

Fourth Field Visit - Refinery		
72	01/02/2016	Refinery Operator
73	12/02/2016	Refinery Supervisor
74	03/03/2016	Refinery Operator
75	15/03/2016	Refinery Operator
75	05/04/2016	Production Executive
77	15/04/2016	Production Executive
78	15/04/2016	Laboratory Officer
79	22/05/2016	Production Manager
80	22/05/2016	Refinery Manager
81	05/06/2016	Fractionation Manager

LIST OF MEETING OBSERVATIONS

No.	Date	Briefings/Meetings Attended
Head Office		
First Field Visit		
1	10/06/2012 – 12/06/2012	Budget Retreat Meeting
2	06/08/2012	Marketing/Operation Meeting
3	08/08/2012	Meeting on Export Launching
4	09/08/2012	Meeting with Advertising Company
5	14/08/2012	Head of Department Meeting
Refinery		
First Field Visit		
6	14/06/2012	Safety Briefing and Briefing Notes for Visitor – Official Plant Visit
7	18/06/2012	Meeting with packaging material supplier
8	20/06/2012	Refinery "morning" meeting
9	21/06/2012	Refinery "morning" meeting
10	22/06/2012	Meeting with supplier of contract workers
11	22/06/2012	Internal Audit Closing meeting
12	22/06/2012	Official Plant Visit – Packed Product
13	26/06/2012	Refinery "morning" meeting
14	29/06/2012	Refinery "morning" meeting

Third Visit - Observation		
72	01/02/2016	Refinery "morning" meeting
73	12/02/2016	Refinery "morning" meeting

Appendix 2: List of Documents and Notes

List of Documents and Notes	
1	Distribution of Oil Palm Planted Area by Category
2	Report of Main Supporting Agencies
3	Employees Report - Head Office

4	Employees Report - Refinery
5	Refinery Production Capacity Report by Plant
6	Report on Sales Capacity and Number of Employees at Each Depot
7	Yield and Quality Target for the Refining Plant
8	Yield and Quality Target for the Fractionation Plant
10	Control Measures at the Refining Plant
11	Process Guidelines at the Production Sites
12	Sampling of Oil Report for the Midstream Production
13	The Refining Process Guidelines
14	Temperature Control Report
15	Control of Bleaching Earth Dosage Guidelines
16	The Fractionation Process Guidelines
17	Report of Quality (High FFA) Result
18	Report of Issues of Processing Variable (Vacuum) and Quality (FFA Level)
19	Production Practice and Budget Setting and Variance Report
20	Organizational Chart of Golden Crop Co. – Head Office
21	Organizational Chart of Golden Crop Co. – Refinery
22	Variance Reports
23	Production Reports
24	Minutes of Meetings
25	Manuals and Standard Procedures
26	Observation Notes
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Appendix 3: Quality Control Parameter

Site/Sample of:	Time	Quality Control parameter
1. Receipt point		
CPO	Delivery	FFA, VM,IV,PV,DOBI,DF
2. Refinery plant		
BPO	2 hourly	Colour, Black Particle
RBDPO	2 hourly	FFA, Colour, Black Particle
PFAD	2 hourly	FFA, VM
3. Fractionation plant		
RBDPL	Batch	FFA, Colour, IV, Clouding point
RBDPS	Batch	FFA, Colour, IV, VM

4. All Storage tanks comprising CPO, RBDPO, PFAD, RBDPL, RBDPS.	7.00am everyday	

The above table shows the quality control parameters at each stage of the process. The lab sampling for the refining and fractionation process is conducted for quality control. Each tanker of incoming CPO from the suppliers will go through a quality check before they are accepted and unloaded into the storage tank. On average, daily incoming CPO is about 700MT from a range of three to ten different mills. The summary of daily CPO received will be recorded in the 'daily oil analysis' report. Besides that, the report also comprises a summary of the quality of oil in all tanks in their facility (samples taken every morning)