IMPROVING BUSINESS PROCESSES THROUGH ENHANCED UNDERSTANDING OF THE INTERACTIONS OF LEAN, WASTE, AND COGNITIVE FACTORS IN WORKPLACES

Mahesh Babu Purushothaman

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Dedication

This thesis is the result of the dedication of my family who supported me throughout this journey, and hence it is dedicated to them, with love.

A huge thanks to my dear wife, Gayathri, and sons, Nithu Krishnaa and Sujay Narendra. Special thanks to my mum, Mrs. R. Manikam, my sister, Suguna Devadass, and my in-laws: Devadass, Selvam, Balu, Malika, and Priya. A warm thank you to my nieces, Krushika Santhana Krishnan, Sweatha, and to my nephew, Asvanth. A note of thanks to my friends, Chandar, Devi, Ram Mohan, and Vidhya for being with me all along.

Special thanks to all my past leaders, colleagues, and friends. All of your wishes and support made this journey possible.

Personal statement

This thesis is a personal knowledge-enhancing journey, which AUT provided. With love and affection, a big thank you to Dr Jeff Seadon, Dr Dave Moore, Josephine Prasad, Liz Chandy, Anna Matich, the GRS team and those who supported me.

Abstract

Over the last two decades, very few studies have identified bias influence on Lean and waste. Many operational analytical models assume people are rational, without cognitive influence, whereas research in economics, finance, and marketing incorporate how people influence their models, unlike operations. This study sought to answer the following research question (RQ) and sub-questions:

RQ: What are the interactions between cognitive biases' interventions, Lean tools, and waste types in organisational processes?

Sub-questions:

- How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?
- What are the system-wide cognitive bias interventions in workplaces that interact and influence waste and Lean tools in organisational processes?
- What are the different types of waste prevalent in organisations?
- What is the interaction between Lean tools and waste types?

The research set out to obtain insights on the cognitive biases' interaction with Lean tools and waste in organisations. The study adopted a qualitative narrative inquiry methodology within an interpretivism theoretical framework and constructivism epistemology to answer the above questions. The research design covered participants in different positions, work contexts, and varied experiences throughout a chosen process to gather their understandings of that particular process and their work habits. The research methodology and design were subjected to ethics review; only participants who volunteered were recruited, and confidentiality was assured in writing. The research design ensured reliability, validity, confirmability, credibility, and transferability for future implementation.

The research was conducted at five organisations, which implemented Lean practices or demonstrated a willingness to take up Lean, involving seven different currently operating processes and recruited multi-cultural voluntary participants. The multiple sites and sources, combined with a system-wide case study approach adopted for data collection, included data, theory, methodological and environmental triangulation. In this research, the in-depth qualitative focus was attained through process observation,

participant observation, and semi-structured interviews with open-ended questions. The participant position and experience distribution P values were well below 0.05, signifying the reliability of participants' input to the study. This research used content analysis, narrative analysis, and framework analysis methods for data analysis to obtain interactions between cognitive bias, Lean tools, and waste.

The findings establish that biases play an important role in Lean tools' effectiveness and waste elimination. The study evidence supports the theory that there are system-wide interactions between cognitive biases, Lean tools, and waste in an organisational process.

In general, this research adds the following distinctive contributions to the literature:

- A method to identify cognitive biases in a business process through a system-wide approach;
- A method to ascertain stressors in a business process through a system-wide approach;
- It identifies and classifies ten different waste categories in organisation and business processes through a system-wide approach;
- It identifies new biases present in business processes;
- It generalises biases that influence business process productivity;
- It maps the interaction of generalised biases with 25 specific Lean tools and ten waste categories; and
- It develops a Circle Slice Diagram for plotting the influence of three factors: cognitive bias, Lean tools, and waste categories.

List of Abbreviations and Acronyms

AUT - Auckland University of Technology

AUTEC - AUT Ethics Committee

BOM - Bill of Materials

CFT- Cross-Functional Team

CHIP - Collective Happening In the Process

DC - Distribution Centre

HR – Human resources

IT - Information Technology

JIT - Just-In-Time

KPI - Key Performance Indicators

OEE - Original Equipment Effectiveness

PDCA - Plan, Do, Check, Act

RCA - Root Cause Analysis

RQ – Research Question

SMED - Single Minute Exchange of Die

SOP - Standard Operating Procedures

TPM - Total Productive Maintenance

TT - Takt Time

VSM - Value Stream Mapping

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Declaration

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma at a university or other institution of higher learning.

In accordance with the School of Engineering, Computer, and Mathematical Sciences guidelines, this thesis does not exceed 80,000 words (excluding bibliographies and appendices).

Signed:

Date: 30/04/2019

Mahesh Babu Purushothaman

Auckland University of Technology

Co-Authored Works

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Mahesh Babu, P., Seadon, J., & Moore, D. (2017). Improving productivity and staff wellbeing at a manufacturing facility in India using integrated Lean and HFE principles. Paper presented at HFESNZ Conference 2017: Wellbeing – Design – Practice, Wellington, New Zealand, 6-7 September 2017.

Mahesh Babu, P., Seadon, J., & Moore, D. (2017). A critical review of the organisational waste in the construction industry. Paper presented at Proceedings of the 5th NZBERS, Auckland, New Zealand, 17-18 October 2017.

Mahesh Babu, P., Seadon, J., & Moore, D. (2019, March). Improving Productivity and Staff Wellbeing at a Manufacturing Facility in India Using Integrated Lean and Humans Factors/Ergonomics. Paper presented at ICEMSO 2019: 21st International Conference on Engineering, Manufacturing and Supply Operations, Sydney, Australia.

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Thanks to the AUT staff, PhD students and friends who supported my journey.

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1. Introduction

1.1. Introduction to the chapter:

This chapter introduces the manufacturing philosophies and tools used in practice in section 1.2, followed by the Lean processes and waste in section 1.3, Lean barriers in section 1.4, and cognitive influences in section 1.5, which introduces the current research gap. This gap is further mentioned in section 1.6, which discusses the research question, followed by a discussion of the research significance in section 1.7. The chapter is concluded with the chapter summary in section 1.8.

1.2. Manufacturing philosophies and tools.

From the time the micro-blade industry flourished in eastern Asia during the end of the last glacial maximum, around 15000 years ago (Kimura & Girya, 2016), to the modern era, manufacturing methods have made cultures strong and prosperous. In the mid-1700s, the industrial revolution practiced division of labour and migrated the factory system towards greater efficiency by manufacturing high volume interchangeable parts on a relatively large economic scale (Schonberger, 1982). The European skilled "craftsmanship" factories gave way to unskilled and semi-skilled workmanship, a trend followed by North America (Schonberger, 1982).

By the late nineteenth century, an "American" way of manufacturing large volumes was prevalent, which mastered the art of designing interchangeable parts and line assembly (Ristuccia & Tooze, 2013). During the mid-20th century, the Japanese developed and adopted Lean, which manufactured multiple products or mixed models in a more efficient way (Womack, Jones, Roos, & Carpenter, 2007). Subsequently, rapid production (Jacobs & Andre Sr, 2000), concurrent production (Schonberger, 1982), flexible manufacturing (L. Han, Xing, Zhou, Chen, & Gao, 2016 Chen, & Gao, 2016), and agile (Paolucci & Sacile, 2016) systems evolved. Globalisation and the economy drove organisations to adopt an advantageous manufacturing system (Wen, Wee, & Wu, 2015).

1.3. The Lean process and waste

Intensified global competition and sustainable growth drove the manufacturing sector to adopt scientific manufacturing systems that provided an immense competitive advantage

(Wen et al., 2015). Comprehensive studies show that the Lean philosophy adopted principles from across all the manufacturing systems, as illustrated in Figure 1 below.

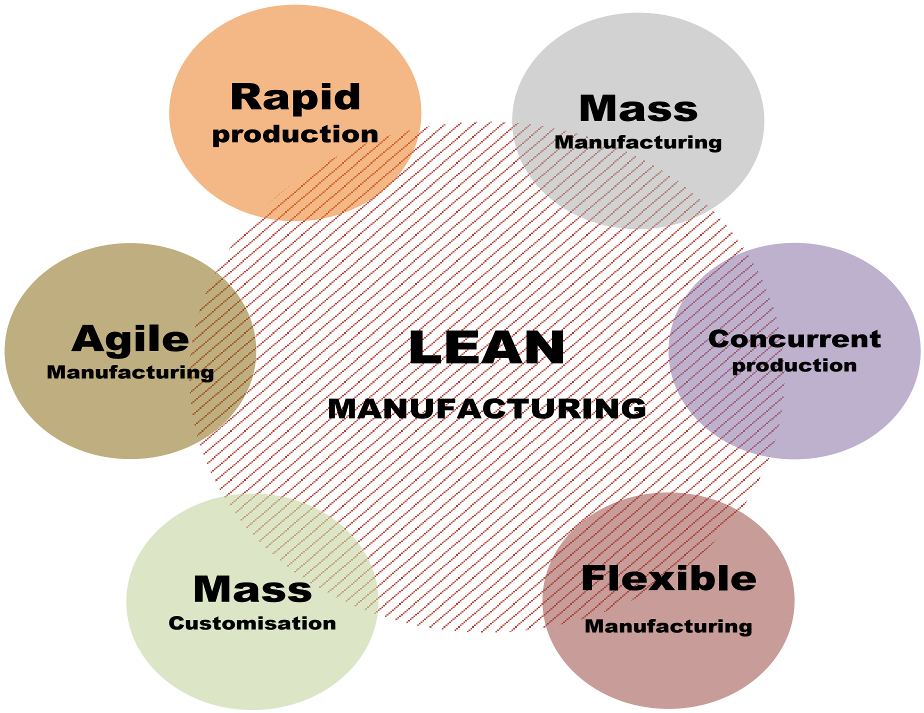

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Figure 1: Manufacturing philosophies

Global competition, economic factors, and environmental concerns are key factors for an organisation to sustain and grow. Organisations adopt Lean philosophies to address these key factors (Womack & Jones, 2010). In the process of growth, Lean addresses the elimination of waste in the manufacturing process which escalates cost and environmental concerns (Jorgensen, 2006; Womack & Jones, 2010). Lean has attained significance, as it improves productivity through long-term continuous improvement projects (Susilawati, Tan, Bell, & Sarwar, 2015 & Sarwar, 2015).

Further, Lean offers quantitative waste reduction techniques and uses an array of proven tools from all manufacturing systems (Fercoq, Lamouri, & Carbone, 2016). Lean offers improvement in productivity via focused waste reduction that meets stakeholders' expected profit margins (Helleno, De Moraes, & Simon, 2016). Lean manufacturing processes products based on a customer's pull rate within a stipulated time (Womack et al., 2007). Lean utilises optimum resources, adopts levelled process, and with optimum inventory, advocates for waste reduction in every process, which reduces the overall process cost (Womack et al., 2007). The waste has been classified into seven major categories: over-production; over-processing; waiting; motion; transportation; defects; and inventory. Over time, researchers have added other waste types, like unused employees (Wee & Wu, 2009), environment (Dues, Tan, & Lim, 2013), and talent (Graban, 2009). Additionally, this thesis discusses further types of waste and their influence on Lean tools.

Toyota pioneered Lean concepts and benefited from them to become a world leader in car manufacturing, which caught other manufacturers' attention, and they then implemented the system as well (Womack & Jones, 2010; Womack et al., 2007). Lean implementation has proven internal benefits, like eased costs, tall profits, capacity utilisation, and effectiveness (Womack & Jones, 2010). Lean has improved productivity, performance, cost, layout and workforce utilisation in Malaysian industries (Zakaria, Mohamed, Ab Rahid, & Rose, 2017). Above all, Lean is a method of processing in a procedural way, as per customer requirements (Yogesh & Prabagaran, 2016), which uses means and practices to manage optimum operations (Bhatia & Ucharia, 2016). Lean production strives to attain level scheduling (Dauda, 2008), and Lean tools drives an organisation towards flawlessness, expediting continuous improvement of business processes by eliminating waste or wasteful actions (A. Pearce, 2014). In addition, Lean management grows a competitive advantage (Pasutham, 2012). However, Lean implementation is not easy to achieve (Bamber & Dale, 2000); and Lean implementation and sustenance have not been without barriers (Upadhye, Deshmukh, & Garg, 2016; B. Zhou, 2016).

1.4. Lean barriers

Lean offers lucrative business opportunities, though it faces barriers (B. Zhou, 2016). Leaner supply chains are often disrupted, and have high hidden costs because of low inventory levels and the supply chain's capability (Habermann, 2009). Breakdowns in supply chains are cited as one of the main threats to firm profitability both in terms of revenue loss and customer dissatisfaction (Habermann, 2009; A. Pearce, 2014). In spite of keen participation, Lean's success factors depend on the business manager's knowledge and attitude (A. Pearce, 2014). Various other authors list the barriers of Lean as shown in Table 1 below.

Table 1: Lean barriers

Lean barriers	**Reference**
Clarity and strategy of management, fix it fallacy, lack of process thinking, and ownership	Antony, Krishan, Cullen, and Kumar (2012)
Credence, responsibility, work modus, and communication	Losonci, Demeter, and Jenei (2011)
Extrinsic incentives bias (job security and pay) and intrinsic incentives bias (learning new skills)	Keyser, Sawhney, and Marella (2016)
Fear of Change of Job	Bieraugel (2015)
Fear of failure	Bieraugel (2015); Emiliani (1998); Salonitis and Tsinopoulos (2016)
Financial culture, structure abilities, and proficiency	Saad et al. (2006)
Involvement, empowerment, resistance, perseverance, cooperation, cross-functional conflicts	R. Jadhav, S. Mantha, and B. Rane (2014)
Lack of committed leadership and lack of employees trust	Sim and Rogers (2008)
Lack of control and standardisation	Bhuvanesh Kumar and Parameshwaran (2018)
Lack of resources, skills, knowledge, and expertise	Womack, Byrne, Fiume, Kaplan, and Toussaint (2005)
Long term commitment and culture	Bhasin (2012)
People, lack of resources, and communication	Luciano and Pidd (2011)

1.5. Cognitive influences

Lean barriers are broadly due to human, technical, organisational, and economic factors (Kumar & Kumar, 2014). People are a critical part of the Lean system and barriers include human attitudinal issues, the involvement of employees, workers' resistance, and cultural factors (Bose & Sinha, 2012). People factors and expertise are the key barriers in small and medium industries in The United States of America (B. Zhou, 2016). Human barriers to Lean include cognitive stress and collaboration (Rane, Sunnapwar, & Rane, 2016). Collaboration means discussion, decision-making, and attitude alignment (Kvarnstrom, 2008). Significantly, decision-making plays an important role in operation and continual performance of an organisation (Kahneman & Tversky, 1977, 1984, 2000). However, the decision-making process has subjectivity, and is influenced by human factors such as biases and framing effects (Kahneman & Tversky, 1977, 1984, 2000).

The cognitive bias that often arises from an adjustment from a prior decision, which could be deficient (Pranoto, 2005). A bias, which can affect a process may be positive or negative (Weyman & Barnett, 2016). Biases are evident in receiving data (Busenitz & Barney, 1997), understanding data (Drory & Meisler, 2016), analysing data (Mineka & Sutton, 1992), planning, resources accumulation (D. Chen, Moskowitz, & Shue, 2016; Kahneman &

Tversky, 1977), execution of a decision (Whiting et al., 2016), reiteration, outputs, and knowledge recording (Whiten & Byrne, 1988).

The field of cognitive psychology identifies a list of biases prevalent in society (Kahneman & Tversky, 1977, 1984, 2000). Researchers in economics, finance, and marketing have incorporated bias influence in their models (Gino & Pisano, 2008). While many developed countries have adopted Lean principles in the manufacturing and supply chain; system-wide influences of cognitive biases on Lean tools and waste are yet to be understood. Enhanced understanding can result in improved productivity and well-being from a business process perspective.

1.6. Research Question

This research seeks to add to the knowledge on the system-wide cognitive bias influences on Lean methodologies and waste in organisational processes. The current study focuses on understanding the system-wide interactions between cognitive biases, Lean tools, and waste in an organisational process, and seeks to answer the following research question (RQ) and sub-questions:

RQ: What are the interactions between cognitive biases' interventions, Lean tools, and waste types in organisational processes?

Sub-questions:

- How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?
- What are the system-wide cognitive bias interventions in workplaces that interact and influence waste and Lean tools in organisational processes?
- What are the different types of waste prevalent in organisations?
- What is the interaction between Lean tools and waste types?

Bias is a term that is used in many fields. In the current research, the term bias refers to cognitive bias. Cognitive bias is usually a singular noun, which means "the action of supporting or opposing a particular person or thing in an unfair way, because of allowing personal opinions to influence your judgment" (Cambridge-dictionary, 2015). Bias is habitually inadvertent, unconscious, and ignorant, and contradicts conscious beliefs (Joyce, 2007).

1.7. Research Benefits/Significance

Cognitive biases, when induced, can increase anxiety or stress (Mathews & MacLeod, 2002). For example, attentional bias is associated with anxiety and depression (Mineka & Sutton, 1992). Likewise, cognitive biases have negative effects on job change in the field of engineering, healthcare, personal care, hospitality, and information technology (Wrzesniewski & Dutton, 2001), which has necessitated the need for prevention and management of psychosocial risks (Leka & Jain, 2016). The psychosocial health of the work environment lies in the hands of legislative authorities, risk assessment bodies, and organisations' employees (Kyaw-Myint, Strazdins, Clements, Butterworth, & Gallagher, 2017). Significantly, the literature review suggests bias is inherent to humans and efforts. However, biases are yet to be associated with and related to industries' process-related problems. The fundamental rationale of this research was that major cognitive human-bias factor challenges have implications for employees' work practices and waste in organisations which, when addressed, could reduce stress on the people involved.

Following the global trend, despite digital technology influencing the manufacturing sector, labour productivity and multi-factor productivity in New Zealand fell by 0.7 percent and 0.4 percent, respectively, in the five years from 2011, indicating other factors at play (NZ, 2017). One such contributor was the human factor, which could lead to waste in terms of delay, over processing and errors. Though numerous studies have been done in New Zealand on Lean, Human Factors Engineering and waste, a gap existed in identifying their interaction. This study is a step forward to enhance productivity, through the application of Lean practices while reducing biases that result in waste to make an organisation more resilient. Productivity, competitiveness and waste reduction initiatives drive an organisation to its future profit and sustainability. Consideration of productivity, along with people's stress reduction, should be the goal of any organisation that considers social responsibility as one of its priorities.

Lean methodologies are adopted globally to reduce waste, which also induces stress on people (Womack et al., 2007). Equally, organisations adopt Human Factors Engineering management to deal with human well-being. Though Lean and Human Factors Engineering are widely adopted practices, they are not combined effectively to address productivity improvement while reducing work stress. The literature survey has identified the gap that bias, a prominent cognitive factor that influences Lean and waste, which can reduce work stress, has not been studied system-wide in a Lean and organisational process context.

This research is significant for the following three key reasons:

- The aim of this study is to understand the cognitive factors influencing Lean tools and waste. In the process, ten categories of waste are identified, and the interactions of common cognitive biases on 25 Lean tools and the ten waste categories are plotted, which aid in improving productivity and reducing stress to employees. The findings are significantly relevant to industries around the globe;
- This research adopts a system-wide approach to critically analyse biases and their impacts on the system, Lean tools, waste, and stressors. The study identifies process deficiencies and designs a research method to identify biases' influence on Lean tools, reduce waste, and to improve the work life of the people, which is of interest for academics and future researchers; and
- The objective of this study is to establish the interactions among Lean, waste, and cognitive factors resulting in improved productivity and people's well-being simultaneously.

The strengths of this study are that it adopts a system-wide approach that investigates the interaction of human cognitive bias factors related to organisational processes and aligned work life. In conclusion, the interventions proposed in the study on the cognitive biases at a systems level could combine Lean and human factors, which may have relevance to organisations, employees, and academics in many countries around the globe. This has the potential to improve organisations' productivity, reduce waste and work stress, and enhance human well-being at work.

1.8. Summary

This chapter introduced manufacturing philosophies, Lean, Lean barriers, waste, and cognitive factors, and established the gap in the existing literature. The research objective and questions evolved from the gap were:

The objective: To establish system-wide interactions between cognitive biases, lean tools, and waste in an organisational process.

RQ: What are the interactions between cognitive biases' interventions, Lean tools, and waste types in organisational processes?

Sub-questions:

- How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?
- What are the system-wide cognitive bias interventions in workplaces that interact and influence waste and Lean tools in organisational processes?
- What are the different types of waste prevalent in organisations?
- What is the interaction between Lean tools and waste types?

The research's significance is that the interventions of the study on the cognitive biases at a systems level could combine Lean and Human Factors Engineering. The research is relevant to organisations and employees in many countries around the globe and could improve productivity, reduce waste and work stress, and enhance human well-being.

2. Literature review

2.1. Introduction

This chapter details the literature review on three factors, namely: Lean, waste, and cognitive biases. The ever-growing knowledge and new research input to Lean are frequent and significant. Though much of the literature offers significant and valuable context to the many upcoming research projects, in this chapter reference is made only to those studies that aid the research: connecting Lean, waste, and cognitive biases. Section 2.2 provides an overview of Lean. This is followed by section 2.3, which discusses the different types of waste in the organisational process, and identifies the waste generated by organisations that excessively use or underutilise any resource, method, and substance while performing an activity, which negatively affects their business, people, and the environment. The next section, 2.4, provides insights on cognitive biases, followed by a discussion on bias and the link to the research questions. The chapter is concluded with a chapter summary in section 2.5.

2.2. Lean

After World War II, Toyota Motor company pioneered the concept of Lean production under Toyoda and Ohno, which was adopted by other Japanese industries (Womack et al., 2007). The legitimate success of a mixed-model Lean approach at Toyota was inevitable and car manufacturers around the globe quickly embraced Lean production (Womack et al., 2007). Over a period, Lean had spread its wings and was adopted by various industries, including for example: health care (Womack et al., 2005 Kaplan, & Toussaint, 2005); construction (Gao & Low, 2014); education (Comm & Mathaisel, 2005; Radnor & Bucci, 2011); transportation (Sternberg et al., 2012); government (M. Janssen & Estevez, 2013); and hospitality (Lancaster, 2011).

Womack et al. (2007) state: “Lean Production, a term coined in 1988 by International Motor Vehicle Program researcher John Krafcik, is Lean because it utilised less of every resource compared to mass production”. In the process, the value adders contributed to a maximum number of tasks, held responsibilities and were bolstered by a system for tracing every problem and/or defect to its ultimate cause (Womack et al., 2007). Lean, through the elimination of waste, created more value for customers, provided savings enhanced productivity (Bhat & Shetty, 2013; Fliedner, 2008), and improved the process that delivered value to the customer (Lacerda, Xambre, & Alvelos, 2016). Lean manufacturing, through a systematic approach and host of tools, identified and eliminated waste that improved productivity and sustained growth (Bhamu & Sangwan, 2016).

The Lean manufacturing process, with the aid of its tools, focused on adding value to the customer, concentrating on the production stream through proper scheduling and made product flow continuously through maintenance of equipment (Breyfogle, 2007). In addition, Lean adopted interlinked policy management tools that combined with a relentless pursuit of perfection through its factory focus to deliver goods on time at an appropriate price (Breyfogle, 2007). From the literature, the tools can be grouped into 5 categories:

- Value to customer: The tools, which add direct value to the customer;
- Scheduling: The tools that focus on the delivery of products to meet customer requirements and shareholders' revenue expectations;
- Maintenance: The tools that focus on maintaining equipment;
- Policy: The tools that aid management to focus on policy, goals and monitoring; and
- Factory Focus: The tools that focus on the value adder's working environment.

A summary of the literature of Lean tools linked to each category is shown in Table 2 below.

Table 2: Lean tool categories

Category	**Lean Tool**							
Value to the customer	Value Stream Mapping	Gemba	Muda	Root Cause Analysis	Poka-Yoke	Jidoka	Kaizen	Plan, Do, Check, Act
Scheduling	Takt time	Bottleneck analysis	Continuous Flow	Heijunka	Just in Time	Kanban	Single Minute Exchange of Die	Standardised Work
Maintenance	Total Productive Maintenance	Overall Equipment Effectiveness	Six Big Losses					
Policy	Hoshin Kanri	SMART Goals	Key performance indicators					
Factory Focus	Visual Factory	Andon	5S					

Together, various studies indicate that a host of tools are used in industry. Sub-section 2.2.1 to sub-section 2.2.5 below review the significance of the tools referred to in Table 2 and highlight their interlinking, followed by a discussion on Lean tools and waste's relationship identified in current literature.

2.2.1. Value to customer:

The primary focus of a Lean manufacturing process, is to deliver value to the customer, and it is essential to understand the flow of value addition throughout the process (Mittal & Verma, 2016). The ***value stream mapping (VSM)*** tool aids in mapping the way in which the value addition is performed throughout the chain or production stream (Dogan & Unutulmaz, 2016). VSM focuses on graphical representation, containing a stream of activities and relevant data, worked backward from customer delivery through the entire process (Singh & Sharma, 2009). In the process, similar product groups are combined to plot a VSM (D. Chen et al., 2016). The relevant information and controls in the process, such as the production schedule, material storage, and material movement, are also added to the VSM, which aids in visualising and understanding (Singh & Sharma, 2009).

There are two stages of VSM: the current state and the future state (Dogan & Unutulmaz, 2016; Mittal & Verma, 2016). The current state, which plots the current method of value addition, identifies the value added and non-value added activities that form a base to eliminate non-value added activities and to plot the future state (Dogan & Unutulmaz, 2016; Mittal & Verma, 2016; Shook & Marchwinski, 2014). The future state VSM identifies the opportunity for improvement in the near future that aids in raising the consciousness on opportunities for improvement (Shook & Marchwinski, 2014). Documenting current state and future state VSM forms a blueprint for continuous improvement projects (Dogan & Unutulmaz, 2016; Mittal & Verma, 2016).

A detailed VSM facilitates a common understanding among all stakeholders and highlights the areas to focus on for elimination of non-value added activities (Dogan & Unutulmaz, 2016; Gellad & Day, 2016; Mittal & Verma, 2016; Singh & Sharma, 2009). Improvements from the application of VSM are substantial. For example, Lacerda et al. (2016)'s study on VSM noted a reduction of 62% in cycle time, 72% in work force, 15.22 shifts per month, 6.49 m^2 warehouse space, Euro 54,728 cost per year, and 25% work in process inventory. VSM concentrates on mapping the flow of value addition and highlighting potential waste. Lean further offers management tools to identify potential deficiencies in the system.

The tool that helps to identify workplace deficiencies is ***Gemba***, which puts forward the need to periodically visit the real place where the value added activities happen (Daiya, 2012). In a Gemba walk, the team, individuals and management visit the process location and purposefully evaluate the flow and deficiencies (Shipman, Lake, Van Der Volgen, & Doman, 2016). A Gemba walk provides opportunities that move staff from their mechanical tasks to a processing line and identifies wasteful activities (Castle & Harvey, 2009; Gesinger, 2016). For example, Gemba research in health care evidences (Castle & Harvey, 2009):

- Patient waiting time reduction of 50%;
- Eliminating nurse's deliver-note-process and walking to consulting booths; and
- Eight hours of nursing cost per day saving by eliminating a front sheet patient record.

Gemba provides opportunities to visit process lines to study and analyse ways to reduce waste and improve productivity (Imai, 1997). In order to reduce waste, it is essential to understand the types of waste prevalent in the system. Lean provides a tool to focus on the categories of waste.

The tool that focuses on identifying waste is ***Muda***. Muda focuses on anything that does not add value or anything that the customer is not willing to pay for (Ohno, 1988). Further, apart from Muda, the Lean system eliminates (***Mura***) the overload to capacity, equipment, facility or human resource and (***Muri***) the unevenness in production volume (Ohno, 1988).

Muda, or waste, in Lean manufacturing is generally classified into seven types (Ohno, 1988):

- Over-production;
- Over-processing;
- Transport;
- Waiting time;
- Inventory;
- Motion; and
- Defects.

A Muda focus reduces inventory and cost, and improves process productivity, competitiveness, and profit sustenance (El-Nanrouty & Abushaaban, 2013). Further, Muda removes the production scheduling fluctuations that cause overload and idle time (Rawson, Kannan, & Furman, 2016; Simpson, Sykes, & Abdullah, 1998; Thurer, Tomasevic, & Stevenson, 2016). Various authors have proven the application of Muda. For example:

- Idle time Muda identification led to reduced one labour and thereby cost (Zakaria et al., 2017);
- Muda reduced 20% energy and 10% water consumed at L&T, India (Anerao & Deshmukh, 2016); and

- Muda resulted in the financial benefit of $195 million from 2006 to 2012 for Denver Health, USA (Gabow, 2016).

However, drawbacks include that Muda creates undue stress in lieu of downtime, defects, delays, and disasters (Ohno, 1988). The identification of waste leads to understanding the causes of the waste generation. Lean motor assists with a tool to find the causes associated with the waste.

The tool that aids in understanding the causes of waste is the ***Root cause analysis*** **(RCA)** (Yousem, 2016). The root cause is the underlying reason for waste, defects or unfavourable incidents, which, if eliminated or corrected, provide a defect-free product or favourable condition (Andersen & Fagerhaug, 2006). RCA is the problem-solving systematic structured investigation technique that aims to identify the fundamental cause (Andersen & Fagerhaug, 2006). Further, RCA identifies the fundamental cause without focusing on the mistake of the individual (Yousem, 2016) and aims to find a fresh set of hypotheses on reasons of failure (Aarti, 2015). RCA uses various quality control tools, such as (Gandhi & Singh, 2016; Harel et al., 2016; Latino, Latino, & Latino, 2016; S. Patel, 2016; Peerally, Carr, Waring, & Dixon-Woods, 2016):

- Why-why or 5 why analysis;
- 5W and 1H analysis;
- Cause and effect diagram;
- Control charts;
- Histogram;
- Process flow diagram;
- Check sheet;
- Pareto diagram;
- Failure mode and effect analysis; and
- Gemba.

The uses of RCA are defect prevention and productivity/performance improvement (Harel et al., 2016). Substantiating this, Rangel et al. (2016)'s study provides evidence that Petropiarp's RCA increases the run life of progressive cavity pumps by 56%, while 31% of failures decrease in the first year of pump operation. Lean further augments RCA with a tool that prevented defects systematically.

The tool that aspires to prevent defects systematically is ***Poka-Yoke*** (Shingo, 1986). The term "poka" in Japanese means "inadvertent mistake: and "yoke" implies "to prevent" (Shingo, 1986). Poka-Yoke's purpose is to eliminate product defects by preventing, stopping, or correcting them or drawing attention from humans as they occur (P. K. Patel, Nair, & Patel, 2013). Poka-Yoke's design essentially makes it impossible to commit mistakes in the process, or they are easily detected and corrected (Robinson, 1997). Poka-Yoke's uses are evidenced by:

- 95% reduction in defects due to Poke-Yoke of misaligned lead frame loader in integrated circuit assembly manufacturing process (Hakim, 2016); and
- 30% productivity increase and 25% quality enhancement that improved the competitiveness of a textile plant in Ensenada city (Sandra, Jesús, Carlos, & Cristóbal, 2016).

Poka-Yoke systems are necessarily focused on automation. Lean offers a tool for automation that focuses on reducing defects and increasing productivity.

The automation tool, ***Jidoka (Autonomation)*** focuses on automation with human intelligence, where the equipment has autonomous design features to distinguish the good and the bad parts when unmonitored by an operator or to stop operation whenever an abnormal or defective condition is detected (Sugimori, Kusunoki, Cho, & Uchikawa, 1977). Notably, Jidoka is not limited to machine processes (Monden, 2011). Jidoka works in conjunction with manual operations as well (Monden, 2011). The purpose of implementing Jidoka is to detect defects, stop and correct (Pessoa & Trabasso, 2017), improve safety and reduce production cost (Sugimori et al., 1977). In the process, Jidoka facilitates continuous automated monitoring that aids a single operator to handle multiple processes, resulting in productivity improvement (Shook & Marchwinski, 2014).

Effective Jidoka improved the foreign production volume of Toyota from 15 million to 40 million vehicles and that of Hyundai from 0.1 million to 1.6 million in 8 to 10 years (Suh, 2016). However, automation lacks human intelligence, involvement, and interface, and a heavy dependence on automation resulted in Toyota's 8.5 million vehicles being recalled in 2010 due to quality concerns about the braking system (Dibia & Onuh, 2010). Such defects provide opportunities for improvement; Lean offers a tool to aid continuous improvements.

The tool that focuses on continuous improvement is ***Kaizen*** (Womack et al., 2007). Kaizen focuses on continuous, collective and incremental improvement in the process (Womack et al., 2007). Kaizen, through regular proactive teamwork, achieves incremental improvements in operations (Imai, 1997; Masaaki, 1986). Systematic and continued Kaizen holds a competitive edge in terms of quality, productivity, cost, and delivery (Vento, García-Alcaraz, & Macías, 2017). Kaizen has a positive influence on improvements in job satisfaction and reduced work discomfort (Von Thiele Schwarz, Nielsen, Stenfors-Hayes, & Hasson, 2016).

Substantiating this, Garcia, Song and Tesser (2010) provide evidence that Lincoln Industries saved more than $US 1,630,000 in a year in Kaizen projects, and Barnes Aerospace, a precision aircraft parts manufacturer, improved productivity by 24%, reduced delivery times by 61%, and held a competitive advantage. However, Kaizen's success depends on efficient interaction, trust, mutual respect, a positive mind-set (Audenino, 2012), people participation, cohesiveness, and the ability to take up real issues rather than perceived issues for improvement (Abouhenidi, 2014). Further, Kaizen's success depends on its systematic implementation (Masaaki, 1986).

Plan, Do, Check and Act (PDCA) has been adopted as an effective methodology that aids in the implementation of Kaizen, reduces waste, and improves productivity (Sobek II & Smalley, 2011). The PDCA, or Deming, cycle originated by Edwards Deming in Japan in 1950 (Moen et al., 2016), has four phases (Lanke, Ghodrati, & Lundberg, 2016; LeMahieu, Nordstrum, & Greco, 2017; Ozkaynak, Unertl, Johnson, Brixey, & Haque, 2016; Paushter & Thomas, 2016; Wickramasinghe & Wickramasinghe, 2016):

- ***Plan***: Plan to achieve identified improvement objectives through quantitative analysis and fixing the root-cause;
- ***Do***: Implement the plan;
- ***Check***: After the changes have been implemented, the effects are checked, and the objectives and quantitative targets are compared to ascertain the closeness to the intended result. In the case of quality improvement, Check is replaced with a "Study" phase, where the results are analysed and summarised to decide on next steps; and
- ***Act:*** Establish the new process, create standards after the results are satisfactory. When results are unsatisfactory or further improvements are needed, the first three phases are repeated.

Toyota further improved PDCA to a simple management tool, A3 analysis (Womack et al., 2007). Addressing the goal of structured-approach improvement, A3 reports are in a structured PDCA pattern that document the basic approach and results (Sobek II & Smalley, 2011) on a single sheet of A3 paper (Clark, 2016). A3 analysis is a systematic Lean process improvement method, which focuses on eliminating delay causes and non-value added activities (Locker, Preston, Rexrode, Huntsinger, & Banavage, 2016). Supporting its uses, Prashar (2017)'s small paper mill case study evidences the benefits of PDCA implementation as a 35% reduction in specific energy consumption with a cost saving of $US 64,610 in 3 months and a 15.5% reduction in steam consumption that saved $US

26,900 in 3 months. PDCA adds value to the customer, while internal revenue generation primarily depends on on-time delivery, Lean focuses on scheduling with a host of tools.

2.2.2. Scheduling

Scheduling tools focus on customer delivery needs (Duggan, 2012). The primary focus is to convert the lead time prerequisites of customers into internal process time requirements (Duggan, 2012). The tool that aids calculation of internal process time is ***Takt Time*** (Bahensky, Roe, & Bolton, 2005; Khaswala & Irani, 2001). The Takt Time is defined as the maximum allowable process cycle time to meet customer demand (Bahensky et al., 2005; Khaswala & Irani, 2001).

Mathematically, the Takt Time is time/piece demanded by a customer (Cochran, Foley, & Bi, 2017 2017):

TT = TA / D (Cochran et al., 2017)

where TT is the Takt Time; TA is the available time for a particular period; D is the average customer demand for that period considering an allowable planned inventory and long-term customer demand (Cochran et al., 2017). Available time excludes scheduled breaks and planned stoppages, such as scheduled maintenance and meetings, and is measured in seconds for calculating the improvement to the minute level (Cochran et al., 2017).

Takt Time defines the production time for each product family and helps to synchronise the production to sales pace (Duggan, 2012). Substantiating this, Heinonen and Seppänen (2016)'s study on Takt Time in planning project observed a lead-time reduction of 73%. Further, when Takt Time is calculated, it highlights the bottle neck process that does not meet the cycle time requirements (Duggan, 2012).

In a multiple processes manufacturing situation, processes that do not meet the cycle time requirements develop into a bottleneck to slow down and reduce utilisation of the other processes (Shi & Yan, 2006). A bottleneck process is the process that stops or slows down the flow of the manufacturing process (Dewa & Chidzuu, 2012). A bottle-neck process constrains the throughput time of a product (Antony, Vinodh, & Gijo, 2016; Peltokorpi et al., 2016). Lean focuses on systematically analysing the bottleneck process; the method is termed as ***Bottleneck analysis*** (Dewa & Chidzuu, 2012). The uses of bottleneck analysis are to identify constrained processes that affect cost, time and energy, to facilitate productivity improvements (De Kogel & Becker, 2016). Substantiating this, Rane, Sunnapwar, Chari, Sharma, and Jorapur (2017)'s study using bottleneck analysis in a lock manufacturing plant showed an output increase by 60 %, a utilisation of men and machines increase by 65 %, total time spent by material reduced by 10 %, and cost reduced by 35%. The elimination of bottle-necked processes pave the way for continuous flow in a process.

Lean adopts a ***Continuous flow*** methodology to ensure a smooth process flow that reduces work in process inventory (Rother & Harris, 2001). In a Lean production stream, processes are located next to each other as per the actual sequence of value addition to facilitate continuous flow (Drew, McCallum, & Roggenhofer, 2016). In the continuous flow environment, individual items are directed to the next process, and each process finishes its value addition just ahead of the subsequent process requirement (Dennis, 2016). Ideally, from the raw material stage, the item rolls continuously all the way through the production stream until it has been converted into a finished product (Rother & Harris, 2001). The continuous flow has no backlogs. However, there are situations where waste occurs, such as idle time of machines and operator that is compensated for by the reduction in work-in-process inventory and movement of semi-finished items (Dickson, Singh, Cheung, Wyatt, & Nugent, 2009). For example, companies that use continuous flow, such as Ford, reduced effort by 90%; Pratt and Whiteny reduced cost by 35%; and GE aircraft engines reduced lead-time of manufacturing from 30 to 10 days (Womack & Jones, 2010). However, the drawback is that any change in product flow needs alteration in facility layout (Keil et al., 2011). Continuous flow ensures smooth flow (Keil et al., 2011). However, the problems escalate when there are multiple models scheduled in the same production line (Keil et al., 2011).

Lean adopts a scheduling tool, termed ***Heijunka,*** to effectively fit multiple models in the same production line. Heijunka is defined as “the distribution of production volume and mix, evenly over time” (Dennis, 2016). In order to achieve the distribution of production volume, Heijunka focuses on forecasts and past ordering history and fixes the daily-levelled production quantity (Landry & Ahmed, 2016). The levelling is of two types (Friddle, 2016):

- Quantity levelling that focuses on the production of daily average demand derived from forecasts and past ordering history and adding a buffer inventory, based on the working day calendar; and
- Type levelling that spreads the different types of products evenly amongst all designated lines each working day with spare capacity for changeover flexibility.

Heijunka aims for high capacity utilisation through control of the variability in job scheduling (Huttmeir, De Treville, Van Ackere, Monnier, & Prenninger, 2009). In addition, Heijunka, by involving all internal and external suppliers, achieves work levelling and lower unevenness that reduces production lead times, inventory, and strain on operators and sales (Reyner & Fleming, 2004). Substantiating, Teksan, Ünal, and Taşkın (2013)'s Heijunka study on a large tissue paper manufacturer in Turkey showed a reduction of 4 to 10 days finished product inventory and 35% transportation cost within the production network. The levelled production depends on the availability of parts on time (Landry & Ahmed, 2016).

Lean adopts the ***Just-in-time (JIT)*** methodology that focuses on producing or receiving "the right item at the right time at the right quantity" (Dennis, 2016). JIT, irrespective of the drawback of inefficiencies in a process, is capable of quick response to demand and changes, with optimum inventory (Hutchins, 1999; Sugimori et al., 1977) and reduced production lead-time (Sugimori et al., 1977). However, the restraint is that successful JIT implementation depends on the effective production schedule coordination with suppliers, whose dependability in quality and delivery need to be at considerable levels (Kannan & Tan, 2005).

Madanhire and Mbohwa (2016)'s findings substantiate this argument, with 57% of delivery delay attributed to incapable suppliers. However, Isa and Tay (2008)'s study on a 5-grade scale with Malaysian companies practising JIT found respondents reported space saving (mean = 3.42), cost saving (mean = 3.33), on time delivery (mean = 3.28) and enhanced product quality (mean = 3.28). By contrast, JIT increases environmental concerns (Sartal, Martinez-Senra, & Cruz-Machado, 2018).

A JIT system works on a signal methodology that triggers the material requirement of the processing station (Sugimori et al., 1977). The method adopted to trigger the material requirement, is ***Kanban***, which focuses on achieving JIT (Ohno, 1988; Womack et al., 2007). Effectively integrating JIT and Kanban practices into operations strategies adds value and aids the organisation to respond to competitive pressure (Kannan & Tan, 2005). In the Kanban method, the preceding process supplies material to the processing station after the processing station sends a card or signal, called Kanban, to the preceding process station (M Thurer et al., 2016). Each card or signal indicates the specific lot quantity to supply (Gaury, Pierreval, & Kleijnen, 2000). The number of cards or signals the processing station sends are pre-determined and define the maximum work-in-process inventory between these two stages (Gaury et al., 2000). However, Kanban had issues, such as lost cards or missed signals, that encourage various organisations to adopt E-Kanban systems, the electronic signal processing integrated with material accounting systems (Drickhamer, 2005; Naik, Kumar, & Goud, 2013).

E-Kanban facilitates real-time information on actual consumption, delivery performance and actual replenishment times which are used appropriately to fine-tune the supply requirements (Cutler, 2013). Naik et al. (2013)’s study on toothbrush maker, Oral–B, substantiates this by showing an inventory reduction with 70% E-Kanban implementation that turned the company from closure in 2000 to market competitive by 2004. Silva, Ferreira, Thürer, and Stevenson (2016)’s research at a Portuguese domestic water heating equipment manufacturer on implementation of constant order-cycle Kanban observed a reduction of not-on-time replenishment routes from 50% to 3% coupled with a reduction in the mean route time from 31 to 25 min. In contrast, Sartal et al. (2018) showed that Kanban is linked to JIT-increased environmental concerns. Kanban reduces concerns on inventory and inter-process communication (Cutler, 2013). However, the line faces issues, such as changeovers (Agustin & Santiago, 1996).

The multi-model low volume production where frequent changeovers are imminent, necessitated adaptation of the ***Single Minute Exchange of Die (SMED)*** concept (Moxham & Greatbanks, 2001). SMED focuses on the quick exchange of the dies and changeovers within 10 minutes, and wherever it is difficult to achieve, it aims for reduction to be closer to it (Agustin & Santiago, 1996).

SMED attempts to obtain a systematic reduction of changeover time by:

- Performing the die or changeover setups for the next changeover when previous part production is on the machine (Braglia, Frosolini, & Gallo, 2016); and
- Facilitating easy and standardised setup tasks, while and prior to loading in the machine (Braglia et al., 2016).

The SMED Process has the following steps of implementation (Dave & Sohani, 2012):

- *Observe* and record the current methodology of changeover from one model to another model and study the changeover;
- *Separate* the internal and external activities of the changeover. Internal activities are those required to be done while the tool is loaded on the machine and external activities are those done prior to loading on the machine;
- *Streamline* the process of changeover after several iterations to achieve the below ten-minute timeline;
- *Record* the standard process of changeover of the adopted iteration to the minute details in a standard operating procedure; and
- *Continuous* training on the changeover to be imparted to all people associated with the process.

SMED implementation at JSW Steel's Bar Rod Mill demonstrated a reduction of changeover time by 21.34% and cycle time saved by 4.91 minutes that saved $2,840,00 per annum (Gandhi & Singh, 2016). Further, SMED and quick changeovers needs a standardised method of operation (Dave & Sohani, 2012).

Lean thinking adopts standardised work, which stabilises processes and changeovers (Marchwinski, Shook, & schroeder, 2008). Standardised work focuses on the current safe, efficient and best practice for accomplishing the work that meets all the quality requirements (T. D. Martin & Bell, 2016). Standardisation details all essential steps in every process precisely and in a commonly understood way (Womack et al., 2007), details the sequence rhythmically and indicates permissible inventory (Marchwinski et al., 2008). Standardisation sets a standard to measure, provides a platform for the process dependence, gauges process improvement requirements previously done, and identifies future improvement (Pereira et al., 2016 Alves, Oliveira, Lopes, & Figueiredo, 2016). Standardised work procedures reduce task time variation (Arnheiter & Maleyeff, 2005), and are also used for documentation, training and safety (Shook & Marchwinski, 2014).

Standardisation reduces risk, time, and cost (Loken & Apostolov, 2016). The standardised work aids improvement in layout, workflow and operating methods with emphasis on human motion, quality, productivity, and resource utilisation to meet Takt Time (Hall, 2004). Standardised work supports the way in which operations are performed. In addition, the delivery of products depend on equipment maintenance, availability, and effectiveness (Previero, 2013).

2.2.3. Maintenance

Lean adopts tools that focus on maintainance to optimise the effectiveness of all manufacturing equipment (Previero, 2013). The prime tool in this category is ***Total Productive Maintenance (TPM)*** (Duffuaa & Raouf, 2015; Nakajima, 1988), that sets its sight on achieving minimum losses and maximum equipment effectiveness (Previero, 2013). TPM establishes a comprehensive productive maintenance system for the equipment's lifetime with total employee involvement (McKone, Schroeder, & Cua, 1999), through motivation and voluntary small-group activities (McKone et al., 1999; Tsuchiya, 1992). The focus of TPM is high productivity, employee morale, job satisfaction (Prabhuswamy, Nagesh, & Ravikumar, 2013), zero breakdown and zero defects (Previero, 2013).

TPM works on the elements, traditionally known as *the pillars of TPM*, which focus on equipment reliability and trouble-free functioning by adopting proactive and preventative techniques to produce defect-free parts (Nakajima, 1988; Venkatesh, 2007). 5S and Kaizen form the base of TPM (Nakajima, 1988; Venkatesh, 2007), the other pillars are:

- *Autonomous maintenance* (Jishu Hozen): The value adders are assigned the responsibility to prevent deterioration of the machine by performing daily cleaning, lubrication, inspection and tightening apart from minor component change with a proper training imparted by the maintenance staff (Duffuaa & Raouf, 2015; Nakajima, 1988; Venkatesh, 2007);
- *Planned Maintenance*: Planned maintenance is based on predicted frequency for change of parts derived from previous failures and breakdowns that ensure the longevity of machine life (Nakajima, 1988; Venkatesh, 2007);
- *Quality maintenance*: Systematic proactive maintenance of the equipment that produces defect-free quality products continuously (Nakajima, 1988; Venkatesh, 2007);
- *Training and Education*: This pillar focuses on creating and continuously upgrading the expertise level of employees to perform effectively and independently and to keep their morale at the highest level (Venkatesh, 2007);
- *Safety-Health Environment*: This pillar aims to create a safe workplace, which has no accidents, health hazards or environmental damage by adopting the right process or procedures (Venkatesh, 2007);
- *Early Equipment Management*: This pillar focuses on achieving optimal performance of new machines faster, based on the experience obtained from similar machines and previous maintenance improvement activities (Hooi, Hooi, Leong, & Leong, 2017; Nakajima, 1988); and
- *Office TPM*: Aims to reduce losses such as cost, communication, office equipment breakdown, and information retrieval time to improve productivity, efficiency and flow in administrative functions (Agustiady & Cudney, 2016).

The uses of TPM are:

- Eliminating the major causes of poor machine performance (Dennis, 2016; Paranitharan, Babu, Pandi, & Rajesh, 2016);
- Involving operators in the routine maintenance of their equipment (Furman & Kuczyńska-Chałada, 2016);

- Improving maintenance efficiency (Ebrahim & Pieterse, 2016; Reza, Gayosso, Loya, Fernandez, & Macías, 2016);
- Improving skills and knowledge (Dennis, 2016; Paranitharan et al., 2016; Reza et al., 2016);
- Collaborating for a common goal (Ebrahim & Pieterse, 2016; Reza et al., 2016)
- Motivating and energising value adders, staff, and top management, with a long-term perspective on the enhancement of facility management (Chand & Shirvani, 2000);
- Transforming reactive maintenance practices to proactive through the shared responsibility of machine maintenance (Chand & Shirvani, 2000);
- Reducing losses and rework that aid the company to increase profitability and brand image, both of which ensured its competitiveness (Mwanza & Mbohwa, 2015);
- Increasing employees' competency level (Maran, Thiagarajan, Manikandan, & Sarukesi, 2016).
- Improving cost effectiveness, product quality, on-time delivery, and volume flexibility (Wickramasinghe & Wickramasinghe, 2016); and
- Reducing scrap, increasing customer satisfaction ratings, and enhancing equipment reliability (Kithinji, 2016).

TPM is substantiated with the performance measure of equipment that focuses on the individual efficiencies of the machines (Gupta & Vardhan, 2016). Lean adopts ***Overall Equipment Effectiveness (OEE)***, the performance efficiency measure of equipment, focused on production losses (En-Nhaili, Meddaoui, & Bouami, 2016). OEE has been set as a function of availability (A), performance (P) and quality rate (Q) and is calculated as (Muchiri & Pintelon, 2008):

OEE = A x P x Q,

where:

- Availability rate, (A) = Operating time / Loading time x 100,
- Operating time = Loading time - Down time,
- Performance efficiency, (P) = Theoretical cycle time x Actual output (units) / Operating time, and
- Quality rate (Q) = (Total production- Defect amount) /Total production (units) x 100.

Availability rate measures the effectiveness of maintaining tools and capability to produce a product; performance efficiency measures the effective equipment utilisation during production; and Quality rate measures the effectiveness to eliminate scrap, rework, and yield loss during the production process (Pomorski, 1997). In addition, the usability (U) factor, which measures the effectiveness of setup and adjustment factors was added for measuring OEE (Badiger & Gandhinathan, 2008).

Usability (U) = running time / operating time x 100

Therefore, OEE = A x P x U x Q.

Various authors substantiated the uses of OEE. For example:

- $US 37.4 million saving that was 193% over target, down-time reduced from 1600 to 1200 average hours and mining tonnage increased by 25% on average daily at a South African mine (Fourie, 2016);
- Equipment efficiency improved from 58% to 88% in one year and productivity improved 74% without additional investment in an Indian automobile facility (Gupta & Vardhan, 2016);
- The machine shop rejection and rework decreased from 5290 to 860 PPM/month and reduced production loss that saved production cost by 30% in an Indian automobile facility (Gupta & Vardhan, 2016); and
- Efficiency improved 5 to 7% on CNC machines (Nallusamy, 2016).

The OEE depends on the reduction of losses in a process (Badiger & Gandhinathan, 2008). The potential losses in a process are divided into ***Six Big losses*** that affect the OEE of the equipment (Ayane & Gudadhe, 2015; Nakajima, 1988):

- *Equipment failures/breakdown losses* that include loss of time and quantity of defective products, from faulty equipment;
- *Set-up and adjustment losses,* the time losses that result from downtime between change over and defective products that occur during the initial start-up of operations;
- *Idling and minor stop losses* are caused by temporary malfunction or whenever a machine idles;
- *Reduced speed losses* are losses due to machines not being operated at designed speed or parameters;

- *Reduced yield losses* are the losses which occur between the start-up of the machine to stabilisation; and
- *Quality defects and reworks* are losses due to quality defects and rework caused by malfunctioning of production equipment.

OEE is linked to the six big losses. The first two losses are defined as down-time loss and linked to calculate the availability of a machine (Badiger & Gandhinathan, 2008). The third and fourth are speed losses that equate to the performance efficiency and the final two losses are defect losses linked to quality rate (Badiger & Gandhinathan, 2008). The categorising of the key losses that affect the manufacturing process help to gauge the plant's efficiency (Sowmya & Chetan, 2016). Various authors substantiated the uses of six big losses. For example:

- Increase in OEE from 4% to 19.5% when the six big losses were reduced (Sowmya & Chetan, 2016); and
- Reduction in the breakdown, down-time and maintenance cost by more than 50% (Jain, Singh, & Bhatti, 2016).

Six big loss, OEE, and TPM concentrate on equipment maintenance. Likewise, organisation upholding and effectiveness depend on policies adopted.

2.2.4. Policy

Lean adopts a set of tools that aid management to focus on policy, goals and its monitoring. The primary tool, ***Hoshin-Kanri,*** focuses on an achievable, transparent, and clearly communicated policy on the desired goals through integrated and scientifically deployed objectives and strategies from all functions (Melander et al., 2016; Nicholas, 2016). The process starts with the assessment of previous years' performance and, based on previous the position's policy, the plans, targets, controls, and areas of improvement for individuals are proposed followed by a catch ball process until the parameters are frozen (Barrie, David, & Ton, 2016). Thus, the method integrates internal and external customer-supplier relation strategies in the plan and result measurement (Chiarini, 2016). The Hoshin-Kanri process facilitates the identification and effective resolving of key business objectives and enhances the ability of the people involved (Dennis, 2016). The framework of Hoshin-Kanri achieves transparency in daily management and explains the change management process (Witcher & Butterworth, 2000). Various authors substantiated the uses of Hoshin-Kanri. For example:

- Objectives integration with daily management, improvements in communication and cultural change (Tennant & Roberts, 2001); and

- A century-old Kenyan organisation adopting Hoshin-Kanri returned to profitability by 2014 from its mid-2000 down trend (Ndungu, 2016).

Hosin-kanri focuses on transparency and clarity of the policy that is aided by a goal-setting management tool (Haughey, 2013; O'Neill, 2000). Lean adopts an efficient goal-setting tool, termed ***SMART Goals*** (Haughey, 2013; O'Neill, 2000). The tool focuses on setting specific goals that are Strategic, Measurable, Attainable, Results-oriented and Time-bound – or SMART (Haughey, 2013; O'Neill, 2000). Differentiating, SMART would also mean (Rubin, 2002):

S **–** Simple, specific with a stretch, sensible, and significant;

M **–** Meaningful and motivating;

A **–** Acceptable, achievable, action-oriented, accountable, as-if-now, agreed, agreed-upon, actionable, and assignable;

R **–** Realistic, reviewable, relative, rewarding, reasonable, and relevant to a mission; and

T **–** Time-stamped, tangible, timely, time-constrained, and truthful.

During the SMART process, the stakeholders first write specific, measurable, and relevant objectives, then gather relevant data, followed by fixation of the achievable and time criteria, and then the assessment of uses (Bjerke & Renger, 2017). Tichelaar, Antonini, Agtmael, Vries, and Richir (2016)'s study on case reports of patients evidences that the SMART method had 38% higher scores for setting treatment goals than normal and 12% higher scores for treatment monitoring. Setting SMART Goals drives Lean to the next phase of measuring the key performance indicators (Gabcanova, 2012).

Key performance indicators (KPI) are a set of focused performance measures that are the critical success factors for the current and the future of the organisation (Parmenter, 2015). Financial and non-financial KPIs are aligned with the strategies and objectives and targets are based on concrete, non-manipulative data (Gabcanova, 2012). KPI's are viewed as a critical element of effective communication of a company´s progress towards its goals; the measures of success (Gabcanova, 2012) and are the highlighters in providing insights on performance (Barbuio, 2007). Substantiating this, Lloyd, Singh, Barclay, Goh, and Bajorek (2016)'s survey on 68 Australian hospital pharmacists supported the claim that KPI, a valuable tool for individual and departmental performance measurement, form the critical success factors for the current and future of the organisation. KPI, Smart goals, and Hosin-

Kanri set policies that pave the way for efficient functioning of the organisation, likewise, efforts for well-organised working environment have attain significance.

2.2.5. Factory focus

Lean adopted tools that focuses on the value adder's working environment. The factory management tool, ***Visual factory***, focuses on displaying information and effective communication to all employees (Murata & Katayama, 2016). The visual factory is aided by visual process management communication tools that drive operations and processes in real time (Parry & Turner, 2006). The visual factory has effective visual information aids, such as (Saadat & Ranky, 2007):

- Signs;
- Charts;
- Pictures illustrating processes;
- Colour coding of machines and workstations with red, yellow, and green lights;
- Scoreboards;
- Real-time interactive multimedia support systems (Murata & Katayama, 2016); and
- Methods and networks that transparently display factory performance, goals, problems, work procedures, achievements and issues in real time (Murata & Katayama, 2016).

Visual factory management starts culture change and motivates the workforce to engage in the behaviours that drive productivity (Parry & Turner, 2006; Saadat & Ranky, 2007). The visual factory management tool provides solutions for various issues, such as the quick detection of an abnormal situation, continuous maintenance of the safe environment, avoiding operational misses and knowledge sharing (Murata & Katayama, 2016). Tezel, Aziz, Koskela, and Tzortzopoulos (2016) showed that visual management systems improve self-management, control, coordination, plant activity completion to 76%, and site conditions in transportation projects, and reduced internal meeting time by 70 minutes per week.

The visual factory is aided by the communication tool, ***Andon*** (Liker, 2004). Andon, the real time deficiencies communication tool, is considered the prime tool for quality and process control (Liker, 2004). Andon focuses on alerting the team to an abnormality in the process through audio or visual elements in real time (Zoroglu & Selami, 2013). The process abnormalities that Andon issues alerts for, include production delays due to machine or material shortage, operator faults, and down time delays such as tool changeover (Shook &

Marchwinski, 2014). In addition, Andon displays process and procedure details to aid the operators (Zoroglu & Selami, 2013). Andon quality alerts include defect, rework and missing process (Shook & Marchwinski, 2014). Various researchers have substantiated the benefits of using Andon. For example:

- Defects prevented from moving further in a production line (Verrier, Rose, & Caillaud, 2016);
- On-line information that identified work-place problems and resulted in a temporary solution to the problem (Tezel et al., 2016);
- Feedback to all stakeholders and displaying of operating instructions to the value-adder (Ayvarnam & Mayurappriyan, 2017);
- Construction site work interruptions from 62 occurrences to 12 occurrences per day in a span of 5 months (Biotto, Mota, Araújo, Barbosa, & Andrade, 2016); and
- Andon highlighted a breakdown problem in real time that was resolved in less than 6 minutes in the automotive industry (Zoroglu & Selami, 2013).

The visual factory is aided by ***5S*** which has been adopted as a management tool to maintain workplace cleanliness (Bullington, 2003). The tool has 5 phases of implementation, which are specified with 5 Japanese words, Seiri, Seiton, Seiso, Seiketsu, and Shitsuke, with an English translation being sort, set in order, shine, standardise and sustain (Kanamori et al., 2015 Matsuno, & Jimba, 2015). The five phases are implemented with total employee engagement where employees were guided and trained to achieve each phase within a stipulated time (S. Edwards, 2015). The 5 phases are (Bullington, 2003; Esain, Williams, & Massey, 2008; Kobayashi, Fisher, & Gapp, 2008):

- Sort, the first phase aims to segregate and eliminate anything unnecessary at the workplace. The focus of this phase is to create a safe workplace;
- Set in order or straightening, the second phase focuses on necessary items that are tagged and stored in a designated area. The aim of this phase is to avoid directionless search and quick retrieval;
- Shine, the third phase focuses on providing an environment that is free from dust, rust, and oil spills. This phase aims to maintain a clean and tidy environment that aids to reduce abnormality and improve motivation and safety;
- Standardise, the fourth phase focuses on documenting the results of the sort, straighten, and shine and create ordinary rules to practice. The aim of this phase is to motivate and set guidelines for employees that seize the urge to revert to old habits; and

- Sustain, the final phase, focuses to ensure 5S environment. The aim of this phase is to sustain the four phases through periodic audits, training, and awareness.

The implementation of the 5 phases happens through total employee engagement that provides immense work advantages (Gomes, Lopes, & de Carvalho, 2013 2013; Rojasra & Qureshi, 2013). In the previous three decades, 5S was widely adopted by various industries, such as manufacturing (Gomes et al., 2013; Rojasra & Qureshi, 2013), warehouses (S. Edwards, 2015), service sectors (Chourasia & Nema, 2016), and health care (Bahensky et al., 2005). The usefulness of 5S practices are, for example:

- Reduced waste that increased process performance from 38% to 85% (Filip & Marascu-Klein, 2015);
- Aided quick retrieval and storage of items and records, that reduced waste and improved productivity (Edwards, 2015; Filip & Marascu-Klein, 2015);
- Reduced waiting-related waste (Yusof, Hardi, Abdullah, Jumadi, & Taharuddin, 2014);
- Waiting time reduction of 15.66 and 41.90 minutes at medical records section and consultation respectively in 16 hospitals in Northern Tanzania (Ishijima, Eliakimu, & Mshana, 2016);
- 21.8% improvement in productivity at a plant in India (Rojasra & Qureshi, 2013);
- Research evidenced that after 5S implementation, 62% of people agreed on waste reduction, productivity improvement, and quality in offices and educational institutions (Yusof et al., 2014); and
- Reduced 50% on the item transaction time and 1.15 man-hours per day, and increased 30% usable floor area (A. Tezel, Koskela, & Tzortzopoulos, 2016).

Various authors linked these management tools differently. For example:

- Venkatesh (2007) linked 5S and Kaizen as a part of TPM;
- Pegels (1984) linked JIT and Kanban, Jidoka, Andon, and Poke-Yoke;
- Parry and Turner (2006) linked VSM, Kanban, and KPI; and
- Matzka, Di Mascolo, and Furmans (2012) linked Heijunka, Takt Time, and Kanban.

However, it is important to note that these tools are widely accepted and used. The last three decades have witnessed growing evidence that suggests Lean, through its tools, aids waste reduction and elimination. The past decade has seen the rapid production of literature in Lean tools' influence on environmental concerns and waste associated with them. Table 3 shows the Lean tools' impact on waste and factors influencing the tools, as evidenced by researchers. Lean tools are listed alphabetically.

Table 3: Lean tools, waste and influencing factors

Tool	**Explanation**	**Impact on Waste**	**Influencing factors**	**Reference**
5S	Work place systematising: Sort, Set In Order, Shine, Sustain and Standardise.	Reduced ➢ Defects; ➢ Movement; ➢ Waiting; and ➢ Inventory. Reduced material usage and identified spills and leaks thus reducing environmental impact.	People involvement, and investment.	(Bullington, 2003; Chourasia & Nema, 2016; Esain et al., 2008; Fliedner, 2008; Kanamori et al., 2015; Torielli, Abrahams, Smillie, & Voigt, 2011)
Andon	A Visible feedback arrangement for display of status that signals line stoppage, abnormalities or emergencies.	Reduced defects and waiting. Reduced material usage and energy thus reducing environmental impact.	People involvement and ability to analyse the situations.	(Ayvarnam & Mayurappriyan, 2017; Garza-Reyes, Kumar, Chaikittisilp, & Tan, 2018; Shook & Marchwinski, 2014; Zoroglu & Selami, 2013)
Bottleneck Analysis	A method to identify the bottleneck process, which curtails the capacity to meet customer demand.	Reduced waiting, inventory, and over processing. Reduced material usage and energy thus reducing environmental impact.	People knowledge and ability to analyse.	(De Kogel & Becker, 2016; Garza-Reyes et al., 2018; Rane et al., 2017; Roser, Nakano, & Tanaka, 2003; Shi & Yan, 2006)
Continuous Flow	A concept to run the production process smoothly with optimum or no work in process inventory.	Reduced ➢ Inventory; ➢ Waiting; ➢ Over processing; ➢ Movement; and ➢ Transport. Reduced energy consumption thus reducing environmental impact.	People ability to constantly deliver quantity and quality. Quality of incoming parts.	(Dennis, 2016; Garza-Reyes, Villarreal, Kumar, & Molina Ruiz, 2016; Rother & Harris, 2001; Womack & Jones, 2010)
Gemba	A concept of physical workplace visit and investigation.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced material usage and energy thus reducing environmental impact.	People ability to involve, accurately analyse, and solve issues.	(Castle & Harvey, 2009; Garza-Reyes et al., 2018; Imai, 1997; Shipman et al., 2016)
Heijunka	A system to schedule levelled production.	Reduced inventory, over production, and waiting Reduced production issues and fuel consumption thus reducing environmental impact.	People ability, flexibility, and training. Quality system.	(Coleman & Vaghefi, 1994; Garza-Reyes et al., 2018; Huttmeir et al., 2009; Reyner & Fleming, 2004)

Tool	**Explanation**	**Impact on Waste**	**Influencing factors**	**Reference**
Hoshin Kanri	A process of policy deployment.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing.	Policy makers assumptions, and people involvement	(Barrie et al., 2016; Chiarini, 2016; Tennant & Roberts, 2001; Witcher & Butterworth, 2000)
Jidoka	A concept of automation with human preference.	Reduced ➢ Defects; ➢ Over production; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced material usage and fuel consumption thus reducing environmental impact.	People knowledge, cost, and ability to automate, and trust in automation.	(Dibia & Onuh, 2010; Garza-Reyes et al., 2018; Pessoa & Trabasso, 2017; Shook & Marchwinski, 2014; Sugimori et al., 1977)
JIT	A process to ensure availability of required qualitative parts in time.	Reduced inventory and over processing. Reduced material usage, while small batches increased fuel consumption thus having a mixed environmental impact.	People ability to coordinate production schedule and enhance suppliers' performance.	(Chiarini, 2017; Garza-Reyes et al., 2016; Schniederjans & Cao, 2000; Sugimori et al., 1977; Venkat & Wakeland, 2006)
Kaizen	A strategy for incremental and continuous improvement.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced environmental waste such as disposal to landfill, use of water, fuel, and energy.	People participation and cohesiveness.	(Farish, 2009; Masaaki, 1986; Von Thiele Schwarz et al., 2016; Womack et al., 2007)
Kanban	A pull system that triggered the next process to feed the exact required material.	Reduced over production and inventory. Reduced material usage, while small batches increased fuel consumption thus having a mixed environmental impact.	Human interventions in deciding the prediction and accurate prediction of the pull.	(García-Alcaraz, Oropesa-Vento, & Maldonado-Macías, 2017; Garza-Reyes et al., 2016; Gaury et al., 2000; Ohno, 1988)
KPI	A systematic metric that tracks and align progress, to achieve the goal of the organisation.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced environmental impact when given as a measure.	People's ability, involvement, and motivation.	(Barbuio, 2007; Gabcanova, 2012; Lloyd et al., 2016; Mitra & Datta, 2014)

Tool	Explanation	Impact on Waste	Influencing factors	Reference
Muda	The method or practice to identify waste or anything that did not add value to the processes.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced material usage, energy, spills and leaks thus reducing environmental impact	People involvement, ability, cohesion, and knowledge.	(Garza-Reyes et al., 2018; Ohno, 1988; Rawson et al., 2016; Simpson et al., 1998; Matthias Thurer et al., 2016)
OEE	An equipment effectiveness measure, which is a function of availability, performance, and quality.	Reduced waiting for machine availability. Reduced material usage, spills, and leaks thus reducing environmental impact	People ability, motivation, and knowledge.	(Badiger & Gandhinathan, 2008; En-Nhaili et al., 2016; Fliedner, 2008; Garza-Reyes et al., 2018; Pomorski, 1997)
PDCA	An approach to implement corrections, advancements, and upgrades.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced material usage and energy thus reducing environmental impact.	People involvement, cohesion, knowledge, and ability to analyse.	(LeMahieu et al., 2017; Moen et al., 2016; Womack et al., 2007).
Poka-Yoke	Error proofing and prevention methodology.	Reduced defects. Reduced material usage and energy thus reducing environmental impact.	People knowledge, ability, and training.	(Garza-Reyes et al., 2018; Helmold & Terry, 2016; Shingo, 1986; Tague, 2005)
RCA	A problem-solving methodology to identify and eliminate the prime causes.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced material usage and energy thus reducing environmental impact.	People ability, cohesion, knowledge, analytical skills, and involvement.	(Andersen & Fagerhaug, 2006; Garza-Reyes et al., 2018; P. F. Wilson, Dell, & Anderson, 1996; Yousem, 2016)
SMED	A method to reduce changeover time to under 10 minutes.	Reduced waiting and inventory; Reduced energy consumption thus reducing environmental impact.	People knowledge, cohesion, ability and motivation	(Agustin & Santiago, 1996; Braglia et al., 2016; Garza-Reyes et al., 2018; Moxham & Greatbanks, 2001)

Tool	**Explanation**	**Impact on Waste**	**Influencing factors**	**Reference**
Six Big Losses	A method to capture losses in manufacturing due to equipment's.	Reduced waiting, inventory, and over processing. Reduced material usage and identified spills and leaks thus reducing environmental impact	People knowledge, cohesion, ability and motivation	(Chiarini, 2014; Dal, Tugwell, & Greatbanks, 2000; Fliedner, 2008; Nakajima, 1988; Sowmya & Chetan, 2016)
SMART Goals	A methodology to define specific, measurable, attainable, relevant, and time-bound goals.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced environmental impact when set as a goal.	People knowledge, cohesion, ability and motivation	(Bjerke & Renger, 2017; O'Neill, 2000; Tichelaar et al., 2016)
Standardised Work	A method to document procedures and improvements to have repeatability.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced material usage and energy thus reducing environmental impact.	People process knowledge, cohesion, ability, discipline, and motivation	(Arnheiter & Maleyeff, 2005; Pereira et al., 2016; Torielli et al., 2011; Womack et al., 2007)
Takt Time	A method to calculate the required production pace, synchronised with customer demand.	Reduced over production and over processing. Reduced energy thus reducing environmental impact.	People process knowledge, cohesion, ability, discipline, and motivation.	(Bahensky et al., 2005; Cochran et al., 2017; Garza-Reyes et al., 2018; Heinonen & Seppänen, 2016)
TPM	An approach to maintenance that is focused on delivering qualitative productivity.	Reduced defects, and waiting. Reduced material usage and identifies spills and leaks thus reducing environmental impact.	People process knowledge, cohesion, ability, discipline, and motivation.	(Agustiady & Cudney, 2016; Chiarini, 2014; Duffuaa & Raouf, 2015; Fliedner, 2008; Jasiulewicz-Kaczmarek, 2014; McKone et al., 1999; Nakajima, 1988; Tsuchiya, 1992; Venkatesh, 2007)

Tool	Explanation	Impact on Waste	Influencing factors	Reference
VSM	A tool to map the current and future state of a process from customer requirement to customer delivery.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced material usage and energy thus reducing environmental impact.	People process knowledge, cohesion, ability, discipline, and motivation.	(D. Chen et al., 2016; Chiarini, 2014; Fliedner, 2008; Gellad & Day, 2016; Lacerda et al., 2016)
Visual Factory	A visual communication approach.	Reduced ➢ Defects; ➢ Over production; ➢ transportation; ➢ Movement; ➢ Waiting; ➢ Inventory; and ➢ Over processing. Reduced material usage and energy thus reducing environmental impact.	People Involvement, Knowledge, cohesion, ability, discipline, and motivation.	(Murata & Katayama, 2016; Parry & Turner, 2006; Saadat & Ranky, 2007; A. Tezel et al., 2016)

Lean augments organisations by providing a toolbox of approaches that are used to reduce waste, increase process productivity, and escalate organisational efficiency in business processes (Fercoq et al., 2016; Kurilova-Palisaitiene, Sundin, & Poksinska, 2018). Most of the literature on Lean demonstrates waste reduction (Dawood & Abdullah, 2018; Virmani, Saha, & Sahai, 2018). However, some researchers have identified tools that increase waste. For example, Sartal et al. (2018) and Chiarini (2017) identified that Just-in-Time negatively impacts on environment-related waste. Therefore, it is important to examine the different types of waste identified in the literature.

2.3. Waste

2.3.1. Introduction to waste.

Waste is the disproportionate utilisation of resources or materials, where resources refer to human effort, energy, air, water, land, biodiversity (Cobra et al., 2015), and machines for value addition (Prasad, Khanduja, & Sharma, 2016). Material waste managers focus on reduce, reuse, recycle (Afrika, Oelofse, Strydom, Mvuma, & John, 2010), rethink (Laseter, Ovchinnikov, & Raz, 2010), and recover (X. Ma et al., 2003), while resource waste managers at the organisational level focus on reduction and elimination (Ohno, 1988; Womack & Jones, 2010). Waste elimination through Lean adds organisational profitability (Dennis, 2016) that emphasises respect for people (DeBusk, 2012). However, some efforts have resulted in non-productive labour reduction (Acharyaa, 2011). In contrast, DeBusk (2015) argues that waste elimination does not purposefully concentrate on labour reduction. Talking an alternative position, Ohno (1988) shows that Toyota's waste reduction program released labour and moved them to fresh areas, which stopped hiring in demand and reducing labour in a downturn. Irrespective of downsizing concerns, from an organisational perspective, waste elimination has attained significance (Womack & Jones, 2010). Waste materialises at all stages of the lifecycle, including during design, extraction, production, distribution, consumption, and end-of-life (Corvellec, 2016; M. Osmani, J. Glass, & A. Price, 2008). Further contributors to waste are shown in Table 4 below.

Table 4: Contributors to Waste

Contributors to Waste	**Authors**
Underutilised skill, knowledge, experience, talent or innovation.	(Alor-Hernández, 2016; LeMahieu et al., 2017)
Individuals, teams and organisational factors influenced the work and productivity of a process.	(Thevendran & Mawdesley, 2004)
Manufacturing and storage methods, human error and technical problems.	(Durdyev & Mbachu, 2011; Mokhtar, Mahmood, Che Hassan, Masudi, & Sulaiman, 2011)
Decision-making deficiencies.	(Sajedeh, Fleming, Talebi, & Underwood, 2016)
Excessive use or underutilisation of anything like personnel, machine, method, measurement, and material for adding value to the product.	(Prasad et al., 2016)

Organisations adopting Lean and other manufacturing systems focus on eliminating waste that primarily occurs in the manufacturing process (Womack & Jones, 2010). Waste in Lean manufacturing means that human involvement utilises resources and adds no value (Womack & Jones, 2010), eliminating waste contributes to operational efficiency improvement (Ohno, 1988).

As the preliminary step, Ohno (1988) classified seven kinds of production waste based on manufacturing activity (refer to sub-section 2.2.1, in this chapter). Subsequently, various researchers' efforts supplemented the waste category, grading and correlating with Ohno's seven types of waste. For example:

- The service industry waste associated with Ohno's seven types, information or material abundance as over-production, yet to receive information or material as inventory, complex and obsolete processing as over-processing, and in-transit as transportation (Dinis-Carvalho, Lima, Menezes, & Amorim, 2017);

- Decision-making deficiencies to waiting, defect, motion, and inventory (Sajedeh et al., 2016);
- Every stage of the construction business process contributes to waste, and a prime origin of waste is associated with design and its modification (Faniran & Caban, 1998; M Osmani et al., 2008; M. Osmani, J. Glass, & A. D. Price, 2008; Sajedeh et al., 2016), design waste is related to Ohno's seven types (Sajedeh et al., 2016); and
- Majerus, Morgan, and Sobek (2016) ascertained more types of waste present in research and development actions, as listed below:

  - Foregoing advantage of Lean product development;
  - Believing Lean is not a continuous process, or it has failed;
  - Designing an unwanted product;
  - Favouring functional optimisation over value stream profitability;
  - Random versus value stream improvement; and
  - Design error.

In addition, various researchers have added to Ohno's seven types, including types such as: underutilisation of intellect, human resources, skill, knowledge, talent (Alor-Hernández, 2016; Duffy & Wong, 2016; LeMahieu et al., 2017), information (Dinis-Carvalho et al., 2017), logistics (D. T. Jones, Hines, & Rich, 1997), product development (Oehmen & Rebentisch, 2010), data and decisions (Zakaria et al., 2017), space (B. Shah & Khanzode, 2017), goods and services (Womack & Jones, 2010), and discharge to the environment (Bianciardi, Credi, Levi, Rosa, & Zecca, 2017; Murphy & Pincetl, 2013; Matthias Thurer et al., 2016). However, waste generated by information technology functions, the individual's activities, limitations of department boundaries and the hierarchical system are not well-defined. Each of these types of waste is discussed in section 2.3.1.1 to 2.3.1.10 below.

2.3.1.1. Manufacturing waste

Waste generated by manufacturing activities is classed as manufacturing waste (Womack et al., 2007). Lean defines seven types of waste based on the manufacturing process or system as referred in sub-section 2.2.1 in this chapter. In addition, people's health and space waste that are critical to a production process add to the manufacturing waste (Sriprasert & Dawood, 2003). Across continents, health has attained greater attention and importance. Human beings constitute the centre of concerns related to sustainable development, and they have the right to a healthy and productive life in harmony with nature

(Stavroula, Amanda, & Tom, 2003). In addition, former Secretary-General of United Nations, Kofi A. Annan affirmed that occupational safety and health is a crucial means to look to the future (Stavroula et al., 2003). Various authors have pointed out health risks in the manufacturing environment. For example:

- Air pollution risks in Middle-East automobile workshops that affect people's health (Ahmad et al., 2016);
- The risk of exposure to toxic chemicals, heavy equipment, electrocution, and gender-related stressors affecting women's health risk in construction that resulted in fewer women taking up this profession in the United States of America (Curtis, Meischke, Simcox, Laslett, & Seixas, 2016);
- Workplace safety, injuries, abuse, and prolonged work hours related to health risks (Pocock, Kiss, Oram, & Zimmerman, 2016);
- Work-related injuries and diseases in an Indian coal mine that affected the health of people and productivity (Samantra, Datta, & Mahapatra, 2016);
- Health risks in the Netherlands and Belgium that created legislative awareness (Lenderink, 2016);
- Prolonged workplace sitting inducing multiple health risks, including musculoskeletal issues, cardiovascular diseases, and increased mortality in the USA (Crandall, Zagdsuren, Schafer, & Lyons, 2016); and
- Exposures to physical, chemical, and biological stressors in the workplace in Ghana Tulashie, Addai, and Annan that resulted in fatalities and longterm illness to people (Tulashie, Addai, & Annan, 2016).

Absenteeism, loss of productivity and cost due to health have influenced well-managed companies to invest in workforce healthcare (Org et al., 2016). Health hazards in the workplace deteriorate health and opportunities exist to identify and integrate health and safety with methodologies of process improvement and analysis (Dos Santos & Dos Santos Nunes, 2017). In order to identify opportunities for improvement, deficiencies in manufacturing activities that harm the health of employees are termed as health waste (Org et al., 2016). Health and safety are often associated with the workplace and space. However, space utilisation had been a concern for industries (Sriprasert & Dawood, 2003).

Space is limited for on-site operations, and excess space is often expensive (Sriprasert & Dawood, 2003). Hence, space waste due to more than the optimal space occupied by materials, machines, men, and motion is critical (Sriprasert & Dawood, 2003). In addition, storage space for unwanted material, scrap, and excess inventory increase handling and storage costs, and reduces performance levels (B. Shah & Khanzode, 2017). Further, space waste includes inefficient use of a warehouse's three-dimensional space, not storing parts to full bin (Sutherland & Bennett, 2007), and surfeit space for part production, which, when squashed drive down the requisite for factory facilities (Madan & Jain, 2016).

In summary, manufacturing-related waste, including the primary seven waste types of Lean, as discussed in this chapter in sub-section 2.2.1, and grouped as manufacturing waste which affects customers, employees and organisations are:

- Waiting;
- Over-production;
- Over-processing;
- Defects;
- Motion or Movement;
- Inventory;
- Transport;
- Health; and
- Space.

Further, other waste types are classified separately to attain focus and discussed in separate sub-sections 2.3.1.2 to 2.3.1.10 in this chapter.

2.3.1.2. Environment waste:

Supporting environmental concerns, environmental waste is defined as unnecessary or excess utilisation of resources or the material constituent disposed to air, water, or land that could harm the environment (Alotaibi & Alotaibi, 2016; Cobra et al., 2015). The industry views waste as an unavoidable by-product (Teo & Loosemore, 2001). However, the reduction of waste is important for the environment as well as organisations (Teo & Loosemore, 2001). Thus, an organisation's exercise in reducing waste lessens environmental concerns (Alotaibi & Alotaibi, 2016; King & Lenox, 2001). Lean organisations strive to ascertain their logical compatibility with the green paradigm and environmental sustainability (Garza-Reyes, Kumar, Chen, & Wang, 2017; Powell, Lundeby, Chabada, & Dreyer, 2017). On the contrary, emerging electronic solid waste, such as disposed industrial and personal used and unusable electronic and electrical equipment containing toxic substances that affect the environment are fast growing (Aderoju, Dias, & Guimaraes, 2016). Though recycling is being widely adopted (Garlapati, 2016; Yoshida et al., 2016), containment at the source and resource conservation needs to be achieved through waste prevention or recovery (Murphy & Pincetl, 2013). Hence, it is of fundamental importance to measure, keep track and solve spills and waste (Bianciardi et al., 2017). Organisations monitor their environmental discharges through Information Technology (IT) that also generates waste.

2.3.1.3. *Information technology waste*

As the digital era had its impact on industries, IT has attained more significance and is now a critical and indispensable tool for organisations (Cherian & Kumaran, 2016; Maguire, 2016). Further, the current manufacturing environment is connected internally to information technology, through software systems (Khanam, Siddiqui, & Talib, 2016) and externally through online portals (Yamazaki, Takata, Onari, Kojima, & Kato, 2016). IT waste due to programming, training, documentation, and storage are equated to Ohno's Lean waste terminology, such as (Plenert, 2011):

- Over-production: Coding, non-usable documents, and inappropriate code;
- Waiting: Program delay or time lag between activities and processing;
- Transportation: Unnecessary series of IT applications navigated to complete repetitive tasks;
- Over Processing: Lack of standard design in programs or more than requested data provided;
- Inventory: Data processing backlog and unwanted data storage like temporary files;
- Movement: Unnecessary series of IT applications navigated by individuals to find files and documents; and
- Defects: Wrong code, in adequate training and documentation.

In addition, IT functions have defects, such as security threats (Ur Rahman & Williams, 2016; Zhang, Song, & Yan, 2015), hardware defects, software bugs (Bhattacharya & Fiondella, 2016), connectivity defects (McFarlane, Troutman, Noble, & Allen, 2016), and inadequate or irrelevant licences for operating the systems (Shanahan, 2016), which caused delay or issues to the customer and stakeholders. Deficiencies due to IT-related activities are categorised as IT waste.

2.3.1.4. *Decision-making individual waste*

Growing connectivity through IT has prompted customers' demand for quick decisions. Decision-making, therefore, is an important aspect in every phase of a project (Ning, Lam,

& Lam, 2011) and the project's success depends on the leader's decision-making ability (A. P. Chan, Scott, & Chan, 2004). However, while making decisions, the individual's doubt and ambiguity on situations, and facts influences the decision (Sanayei, Mousavi, & Yazdankhah, 2010). Notably, self, situation, and the probable solution influence decision-making, and individual is influenced by factors like perception, intuition, feelings, and mind-sets, which cause errors (Saaty, 2012). Human decision-making have bias and heuristic influences that simplify, distort, and reason judgement (Toet, Brouwer, van den Bosch, & Korteling, 2016). Guy, Karny, and Wolpert (2015) state that imperfection and selfishness in decision-making are associated with cost and, though not stated explicitly, this implies waste. The self, situation, and the probable solution factors that influence decision-making to generate waste are shown in Table 5.

Table 5: Decision-making factors

Factors	**Sub factors**	**Reference**
Self	Intuition, doubt, feeling, experience, procrastination, bias, fear, carefulness, perception, experience, motivation, and ignorance.	(Busenitz & Barney, 1997; D. Chen et al., 2016; Fiedler & Kutzner, 2016; H. Han, Chen, Jeong, & Glover, 2016; Karni & Vierø, 2017; L. Mann, Burnett, Radford, & Ford, 1997; Saaty, 2012; Tonetti et al., 2016).
Situation	Gravity of the problem, doubt on fact, the uncertainty of the situation, goal clarity, supervisor support, autonomy, and team support.	(Guy et al., 2015; Lingens, Winterhalter, Krieg, & Gassmann, 2016; Patanakul, Pinto, & Pinto, 2016; Sanayei et al., 2010)
Solution	Focus on the outcome, mind-sets, buck-passing, being adamant, personal judgement, emotion, and confusion on others' perspective.	(Bernal, 2017 2016; J. R. Brown, Farrell, & Weisbenner, 2016; Kaufmann, Wagner, & Carter, 2016; Kwakkel, Walker, & Haasnoot, 2016; Noval, 2016).

Hence, the inadequacies caused by delayed, lack of and/or wrong decisions in individual decision-making that arise due to self, situation, and solution factors, which affect the organisational process result in waste, deficiencies due to individual's activity is termed decision-making-individual waste.

2.3.1.5. Department or Function Waste

The decision-making process is also constrained by well-established boundaries and hierarchies (Samli, 2016). However, organisations establish boundaries to achieve fast and positive results (Micevski, Dewsnap, Cadogan, Kadić-Maglajlić & Boso, 2016). Departmental policies and procedures help to identify gaps, provide improvement opportunities and logically implant the right controls (Amadei, 2016). A hierarchy focuses on accountability within a department (Hennart, 2016). Conversely, process procedures are generated with a set of assumptions, frequently fail in practice, and commonly the bottom level staff follow while levels above ignore it (Floyd, 2017). Likewise, organisations adopt hierarchy, bureaucracy, and inflexible procedures, which at times result in negative decisions, thus increasing waste (Samli, 2016). The hierarchy blocks communication, induces delay or initiates defects (Pheng Low & Faizathy Omar, 1997; Wilensky, 2015). Obviously, the waste generated by adopting boundaries, procedures, policies, and hierarchies needs to be monitored for quick and effective mitigation. Deficiencies due to a department or function's activity are classified as department or function waste.

2.3.1.6. Decision-making cross-functional team waste

Department boundaries are crossed when complex situations arise or innovative solutions need to be delivered (Bossink, 2004; R. Scott & Boyd, 2016; Shulzhenko, 2016). Lean production focuses on professional skill and creativity as a team instead of the rigid departmental hierarchy to deliver results (Womack et al., 2007). The coordination between members of cross-functional teams is essential to success and coordination training is an investment for organisations (Littlepage, Hein, Moffett, Craig, & Georgiou, 2016). Conversely, cross-functional teams at times show negative results due to lack of trust, leadership (Simsarian Webber, 2002), a lack of uniqueness, and acceptance of workable arguments that result in unreliable decisions to add waste (Saaty, 1990). Further, inaccurate decisions (P. E. Jones & Roelofsma, 2000) and group politics within the cross-functional teams produce negative outcomes (Mintz & Wayne, 2016). Thus, decision-making cross-functional team waste is generated by the teams' delay, lack of decisions, or wrong decisions.

2.3.1.7. Human resources waste

Naturally, people are an important factor in the decision-making process. The human resources department play an important role in organisational progress (Sela, Jacobs, Michel, Klai, & Steinicke, 2016). Nevertheless, underutilisation of people where their skills, talents, and intellectual abilities are not utilised, is a waste to an organisation (Womack & Jones, 2010). People with limited communication, interaction, clarity, authority, and responsibility produce defects (Biazzo, Panizzolo, & de Crescenzo, 2016). To overcome human deficiencies, organisations incur considerable costs in training to upskill (Ong & Jambulingam, 2016). However, incorrect training, underutilisation, absenteeism, and over-staffing are indicators of workplace productivity (Magee, Caputi, & Lee, 2016). To reduce absenteeism, human resources teams often offer incentives and gifts (Kocakulah, Kelley, Mitchell, & Ruggieri, 2016). Instead, they need to develop strategies to eliminate the indicators and recapture wasted revenues (Kocakulah et al., 2016). Therefore, deficiencies due to the human resources department functional activity where talent is underutilised, incorrect training being imparted, absenteeism, and overstaffing are a form of waste.

2.3.1.8. Enterprise engagement waste

Human resource teams serve internal people, whereas organisations engage with external people and agencies. Deficiencies by external experts, consultants, and auditors are termed enterprise engagement waste. Notably, organisations face issues when allied external agencies do not resolve their issues on time, which impacts the system (Kumaar, Deventhiran, Kumar, Kumar, & Suresh, 2016). Similarly, organisations face conflict due to the engagement of consultants (Brandon-Jones, Lewis, Verma, & Walsman, 2016), audit firms (Ayres, Neal, Reid, & Shipman, 2016), and external certifiers (Dranove & Jin, 2010). Organisations tend to look at external agencies' success factors and ignore the delay or failure caused (Dranove & Jin, 2010). Further, the factors that produce deficiencies in external guided work are bias (M. Ma, Weber, & van den Berg, 2016), data error, interpretation, judgement (Kallunki, Niemi, & Nilsson, 2016; Moroney, 2016; Nelson, Proell, & Randel, 2016), usefulness, and audit quality (Bosch et al., 2016), which induced considerable stress to the operations and people.

2.3.1.9. Stress Waste

An organisation's senior management deals with the stress from external agencies. However, internal job stress remains a challenge, as working methods continue to change (Jahanian, Tabatabaei, & Behdad, 2012). The consequences of work-related stress are emotional exhaustion, dwindled enthusiasm, demotivation, and lower productivity (Hobfoll & Shirom, 2001). Work stress is a global health challenge that affects the competitiveness of organisations (Stavroula et al., 2003). Lean offers a creative tension, by objectively pushing the responsibility to workers deep down the organisational ranking (Womack et al., 2007). This encouragingly provides work autonomy and undesirably raises anxiety about mistakes being expensive and creates a stressful atmosphere (Womack et al., 2007). Similarly, stress generated by the pressure from superiors and peers impact employees' decision-making ability and causes inappropriate behaviours (Samat, Ishak, & Nasurdin, 2016). Additionally, feeling overloaded and fear related to job loss are common organisational biases that create stress and attitude-related waste (Avery, 2016).

The health sector recognises stress as a significant factor that impacts long-term health (Mustafa, Kamaruddin, Othman, & Mokhtar, 2009 & Mokhtar, 2009 & Mokhtar, 2009), the work stress may cause downtime, defect, delay, and even disaster (Domingo, 2016). While themes for effective workplace pressure management are available for employees (Holton, Barry, & Chaney, 2016), the waste caused by stress are to be eliminated by addressing its root cause (Quirke, 2001). Hence, deficiencies due to stress in an organisation are categorised as stress waste. The stress waste in an industry is associated with the methods of operations that ease work or induce deficiencies.

2.3.1.10. Methods waste

Waste generated due to methods of performing an activity is referred as methods waste. Methods include design methods (Tauriainen, Marttinen, Dave, & Koskela, 2016), overheads (Chipeta, Bradley, Chimwaza-Manda, & McAuliffe, 2016), and eagerness to conduct experiments (Nezam, Ataffar, Isfahani, & Shahin, 2016).

Design is a pivotal process to achieve waste reduction at the source (Llatas & Osmani, 2016). Design is a critical factor for waste reduction that aids cost savings and on-time project completion (Bolviken & Koskela, 2016; Whang, Flanagan, Kim, & Kim, 2016). However, the deficiencies include vague task allocation, lack of expertise and poor communication (Bolviken & Koskela, 2016; Whang et al., 2016). The key problems in large projects are deficient synchronisation within the design team, the lack of proficiency, and faulty drawings or specifications (Shaar, Assaf, Bambang, Babsail, & Fattah, 2016) which result in defects (Dhillon, 2013). With the advent of globalisation, design factors for safety calculations differ between organisations, methods and countries (McGuire et al., 2016; G. Zhou, Esaki, Mitani, Xie, & Mori, 2003) to create waste. Not only does design waste generate refuse, but this adds cost. However, design, like any other process, is optimised through trials and experiments.

Organisations often do not limit eager experiments and their subsequent errors (Nezam et al., 2016). The eagerness to know how things work, carrying out changes in the work process to find the solution, or to give faster results involves risks, uncertainty, and error (Nezam et al., 2016). However, risk-taking may be positive in attitude, but generates waste (Nezam et al., 2016). The waste generated due to eagerness and its subsequent errors need to be tracked and regulated. Organisations aim to limit eagerness and experimental waste by adding management staff or indirect labour. Indirect labour, which are overheads to an organisation over a period, find faults, criticise processes (Chipeta et al., 2016), plunge into organisational politics (Swatuk & Vale, 2016), drive job dissatisfaction (Chinomona & Mofokeng, 2016), and produce deficiencies and waste (Drory & Meisler, 2016). The defects produced by such functionaries are overhead waste.

2.3.2. Waste summary.

Waste in any form consumes time, resources and effort, which influences cost, delivery, and value. Continuous efforts reduce or eliminate waste to attain optimum efficiency induce considerable stress in the system that tends to affect the people associated with the organisation. In order to attain focus on the waste, the waste needs to be categorised. From an organisational perspective, manufacturing and its related functions are important, and from the human perspective, stress has attained significance. Considering these significant factors, organisational waste is grouped into core manufacturing, non-manufacturing, and stress waste, as shown in Table 6.

Table 6: Waste Groups

Group	**Organisational waste associated**
Core-Manufacturing	Manufacturing and environmental
Non-manufacturing	Decision making individual, department or function, decision making cross functional team, human resource, enterprise engagement, information technology, and methods.
Well-being	Stress

Notably, many authors have considered Lean tools to compare the core manufacturing waste types, as shown in Table 3 in section 2.2, while non-core manufacturing and well-being waste are yet to be compared. Further, researchers have treated waste in much detail to date. However, there has been little agreement on what types of waste an organisation needs to focus on. The literature reveals that decision-making and stress-related waste are prevalent in industries, but researchers have not classified, studied, and treated this in much detail prior to this research. Decision-making and stress are influenced by individual cognitive limitations and biases that waste time and resources (P. E. Jones & Roelofsma, 2000). Further, the human factors, especially the cognitive influence on the waste groups, have not been dealt with in previous studies, and a gap exists in the current litrature.

2.4. Cognitive bias

Organisations engage people to perform activities that enhance, create or add value (Charlwood & Hoque, 2017). The activity is a result of physical and mental actions and reactions (Wrzesniewski & Dutton, 2001) that enhances value (Cook, 2016) and/or induces drawbacks (Charlwood & Hoque, 2017). Mental actions and reactions are subjected to cognitive biases that impact decision-making (Busenitz & Barney, 1997). The cognitive biases are anomalies in the thought process that result in doubtful decisions (Dvorsky, 2013). Biases influence the decision-making process where negativity is more than positivity (Wells et al., 2016; Weyman & Barnett, 2016; Whiting et al., 2016). Wrong decisions due to biases adversely affect a decision-maker and the allied organisation (Hammond, Keeney, & Raiffa, 1998). Deficiencies due to decision-making biases influence an organisation, and inherent biases induces stress for the individual (Kahneman & Tversky, 1977). Cognitive bias distorts the decision-making process (Baron, 2008; Hama, 2010; Kahneman & Tversky, 1982) and reduces judgement ability (Moen et al., 2016). However, some biases enable faster decisions (Baron, 2008; Hama, 2010; Kahneman & Tversky, 1982).

In organisations, decision-making is of an intuitive type where the individual accumulates biased information and delivers a decision that produces negative outcomes (Saaty, 2000). Cognitive bias is the tendency of people to lean on a subject, based on perception, prejudice, interpretation, temperament, and outlook, and concluding with inclined understanding or without understanding it (Kahneman & Tversky, 1982). The literature review revealed various cognitive biases as shown in Table 7 below.

Table 7: List of biases

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
1	Absent-mindedness	A tendency to forget events, situations, or facts	(S. Fisher & Hood, 1987; Reason & Lucas, 1984; Tornas, Lovstad, Solbakk, Schanke, & Stubberud, 2016)	People	Recollect	Forgot, fail to recall, be unable to remember, erase from the mind, overlooked, not remember, and not recalled
2	Actor and the observer	The tendency to credit those behaviours and temperaments to others, which one would not attribute to himself.	(Funder, 1980; E. E. Jones & Nisbett, 1987; Watson, 1982)	People	Correlation	Bad about others behaviour and temperament
3	Affective forecasting/ Variation of durability/ Hedonic forecasting	The tendency to overestimate time and value of the future events.	(Gilbert, Pinel, Wilson, Blumberg, & Wheatley, 1998) (T. D. Wilson & Gilbert, 2003)	Cost, time and/ or energy	Valuate	Over estimating/ appraising time
4	Age	The tendency to consciously or unconsciously avoid equal opportunity based on the age of a person	(Finkelstein & Farrell, 2007; Rupp, Vodanovich, & Crede, 2006)	People	Preference	Preference based on age
5	Agreement / Collective consciousness	The tendency to possess collective consciences for achieving a common goal.	(Meek, 1988)	Group	Preference	Agreeing, supportive, approving, like-minded, harmonising, in agreement, in favour, reach an agreement, come to an understanding, supplementing, concurring, consenting, or go along with team.
6	Alternatives	The tendency to choose a particular practiced or known option more often when there are additional alternatives.	(Bornstein & Emler, 2001)	Decision	Inclination	Known alternative/substitute process

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
7	Ambiguity effect	The tendency to decide with uncertainty or insufficient information.	(Croskerry, Cosby, Schenkel, & Wears, 2009)	Decision	Ability	Decide with limited, incomplete, imperfect, partial, inadequate, restricted, or insufficient information.
8	An appeal to probability or possibility	The tendency to take things for granted and assume that it would be a particular situation or case.	(Bennett, 2016)	Decision	Belief	Assuming its only for a particular case
9	Anchoring and adjustment	The tendency to relate facts to a prominent person's view, prominent situation, or first information and later adjust to it while talking decisions.	(Cristofaro, 2017; Tversky & Kahneman, 1992)	People	Influence	Relevantly relate to superior, well-known, important, high-up, or top person views.
10	Anchoring or focalise	The tendency to incline on the first information while taking decisions.	(Schwenk, 1984)	People	Correlation	Believe first information
11	Anecdotal	The tendency to judge based on own experience or rare happenings instead of facts, data, or evidence.	(Whiten & Byrne, 1988)	People	Inclination	Trusting experience/ rare happening.
12	Anthropomorphism	The tendency to relate human feelings to non-human beings or objects	(Hutson, 2012)	Relate	Correlation	Machine issues related to human feeling.
13	Anti-trust	A tendency to suspect everything.	(Joachims, Granka, Pan, Hembrooke, & Gay, 2005; Yamagishi & Yamagishi, 1994)	People	Belief	Suspect, doubtful suspicious, distrust, mistrust, disbelieve, and be wary of trust
14	Appeal to novelty	The tendency to claim or believe a new modern approach is superior.	(Ryan & Deci, 2000; Schummer, 2014)	Relate	Belief	New approach, way, process, or methodology, are superior, exceptional, outstanding, notable, best quality, better, greater, advanced, improved or enhanced.
15	Argument from fallacy	The tendency to believe that since the view or fact has a mistaken	(Burkle-Young & Maley, 1997; D. H.	Decision	Belief	Results are wrong because of misconception, a mistaken belief or erroneous belief.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
		belief its result or conclusion is wrong.	Fischer, 1971; Sapio & Fischer, 1970)			
16	Asymmetric dominance effect / The decoy effect	The tendency to prefer an advantageous situation, thing, or person between the two choices after presented with lesser advantage third choice.	(Huber, Payne, & Puto, 1982; Pettibone & Wedell, 2000)	Decision	Correlation	A decision on advantageous initial choices.
17	Attentional	The tendency to judge based on selective attention to negative, positive aspects, data, or facts, specifically to pay greater attention to sources of threat.	(Bechara, 2005; M. W. Chan, Ho, Tedeschi, & Leung, 2011; C. MacLeod, Mathews, & Tata, 1986; Nielen, Mol, Sikkema-de Jong, & Bus, 2016)	Cost, time and/ or energy	Correlation	Judgement based on positivity, negativity, threat, danger, risk, hazard, or warning
18	Authorisation	A tendency to overestimate the risk of unauthorized actions.	(Alfawaz, Nelson, & Mohannak, 2010; Clarke & Ness, 2000; Palmer, 2000)	People	Valuate	Unauthorised action risk, danger, hazard or threat
19	Autocratic	The tendency to assume having complete knowledge on the subject and irrespective of the requirement dominating the judgment, process, and directing others.	(Partridge, 1999; Pierro, Mannetti, De Grada, Livi, & Kruglanski, 2003)	People	Belief	Control, direct, manage supervise, or regulate every process step.
20	Automation	The tendency to rely on automation and ignore differing facts presented without automation.	(Alberdi, Strigini, Povyakalo, & Ayton, 2009; Cummings, 2004; Dutilh & Rieskamp, 2016; Goddard, Roudsari, & Wyatt, 2012; Skitka, Mosier, & Burdick, 1999)	Automation	Valuate	Automation, computerisation, robotics or mechanisation focus to get data and facts.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
21	Automation adherence	The tendency to adhere to automation though better alternatives are available.	(Skitka et al., 1999)	Automation	Preference	Automation, computerisation, robotics or mechanisation focus for process step though other options are available
22	Automation omission	The tendency to miss information, events, data, facts when not prompted by automation.	(Skitka et al., 1999)	Automation	Omit	Miss, neglect, forget, overlook, ignore, skip, exclude, or leave out data and facts when not prompted/ notified by automation, computerisation, robotics or mechanisation.
23	Availability heuristic	The tendency to make decisions based on recalled experience or examples.	(Bornstein & Emler, 2001; Groome & Eysenck, 2016; Schroeder et al., 2004; Tversky & Kahneman, 1975)	Decision	Decision	Based on experience, knowledge skill, practise, or familiarity examples
24	Bandwagon effect	The tendency to believe in data, facts, or situations to align themselves to majority people belief in a particular way and follow them, irrespective of their own beliefs or the tendency to follow methods of previous success irrespective of their own beliefs.	(Asch, 1955; Sherif, 1936; Simon, 1954; VandenBos, 2007)	People	Believe	Believe and follow the way that others believe as successful, fruitful, positive, effective, profitable, or productive
25	Barnum / Forer effect	The tendency to accept vague universal data or facts as correct and/ or relate universal vague descriptions to oneself.	(Carroll, 2005; Forer, 1949; D. F. Marks, 2000; Snyder, Shenkel, & Lowery, 1977)	Relate	Relate	Trust vague, unclear, imprecise, or ambiguous universal data
26	Base rate fallacy	A tendency to consider specific information and ignore base or general information in decision-making.	(Bar-Hillel, 1983; Christensen-Szalanski & Beach, 1982; Lavigne, Feldman, &	Decision	Decision	Considering specific info

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
			Meyers, 2016; Nguyen, 2017)			
27	Belief /prior hypothesis	A tendency to accept the method, solution, procedure or process that match their belief.	(Jonathan & Feeney, 2004; Schwenk, 1984)	People	Belief	Accept the method, solution, procedure or process when belief/ faith match.
28	Bizarreness effect	The tendency to remember odd situations more than normal situations, while making decisions.	(Bäckman & Nyberg, 2009; Schmidt, 2012)	Decision	Decision	Remembering/recalling odd, abnormal, unusual, peculiar, weird, or uncommon situation/ examples while making decisions.
29	Blind spot	The tendency to understand other people bias and fail to recognise own biases.	(Pronin, Lin, & Ross, 2002; Scopelliti et al., 2015)	People	Belief	Identify other's bias and miss their own
30	Bounded awareness	The tendency of failing to notice the crucial information, options, roles, and parties involved.	(M. Bazerman, 2014; Chugh, Bazerman, & Banaji, 2005)	People	Omit	Missing crucial information, options, roles, and parties involved.
31	Chain of command	The tendency to follow the rules, policy, procedure, methods or technology after direction or approval from the management.	(Dent, 1991)	Management	Preference	Follow the rules, policy, procedure, methods or technology after direction or approval from the management.
32	Change blindness	The tendency to overlook or not noticing changes.	(Simons, 2000; Simons & Rensink, 2005)	People	Omit	Not noticing changes, modifications, transformations, or amendments.
33	Change dilution	The tendency to continue the existing process, procedure, or method and simultaneously implementing the required changes for correcting the issues or the tendency to believe in not diluting the current status when change is happening.	(Aderoju et al., 2016; Cameron & Green, 2015; Paton & McCalman, 2008; Todnem By, 2005)	Management	Preference	Prefer to undertake changes, modifications, transformations, or amendments while the process is live.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
34	Change of job	The tendency to have anxiety on the known or unknown job change.	(Jane E Ferrie, Shipley, Marmot, Stansfeld, & Smith, 1998)	People	Believe	Concerned on job change, alteration, modification, amendment, exchange, or swap
35	Cheerleader effect	The tendency to believe that people as a group are more attractive or effective.	(van Osch, Blanken, Meijs, & van Wolferen, 2015; D. Walker & Vul, 2014)	Group	Believe	State attractive as a group
36	Choice-supportive	The tendency to attribute success to the decision made by oneself.	(Mather & Johnson, 2000; Mather, Shafir, & Johnson, 2000)	People	Believe	Self-praising/ attribute success to the decision made by oneself
37	Clustering illusion	The tendency to see imaginary patterns or erroneously interpret patterns from random samples as non-random.	(Forrest, 1993; Iverson, Brooks, & Holdnack, 2008)	People	Imagine	Imagine or incorrect interpretation of patterns.
38	Confabulation	The tendency to fabricate or modify own memory unintentionally.	(Fotopoulou, Conway, & Solms, 2007; Hirstein, 2011)	People	Recollect	Memory modification
39	Confidence	The tendency to overestimate own skill, ability to control oneself or environment.	(Nurminen, Suominen, Ayramo, & Karkkainen, 2009)	People	Overestimate	Overestimate one’s skill and ability.
40	Confirmation	The tendency to interpret facts or data's as per self-beliefs.	(Bornstein & Emler, 2001; R. S. Nickerson, 1998; Oswald & Grosjean, 2004; Plous, 1993; Pohl, 2004)	People	Belief	Interpret data/ fact based on self-belief/faith
41	Confirmation evidence trap	The tendency to explore information, data, events, or facts that confirm the initial choice.	(Cristofaro, 2017)	People	Explore	Find information, data, events, or facts that confirm the initial choice
42	Confirmatory	The tendency to search or interpret information in a way that confirms own preconceptions.	(Bornstein & Emler, 2001; R. S. Nickerson, 1998; Oswald &	People	Search	Search information, data, events, or facts that confirm

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
			Grosjean, 2004; Plous, 1993; Pohl, 2004)			the preconceptions/ predeterminations.
43	Congruence	The tendency to rely on direct data and fact rather than derived data or the tendency to adopt direct hypotheses test instead of possible alternative hypotheses tests.	(Baron, 2008; Iverson et al., 2008)	Automation	Belief	Relying on direct data, information, facts, records or statistics.
44	Conjunction fallacy	The tendency to assume that specific conditions are more probable than general ones.	(Fisk, 2016; Pohl, 2004; Tvcrsky & Kahneman, 1982)	People	Belief	Specific conditions are more likely, possible, apparent, evident or noticeable
45	Conservatism	The tendency of not grasping negative facts to one's beliefs.	(W. Edwards, 1968; Tversky & Kahneman, 1975)	People	Omit	Dose not obtain, collect, accept, or gather negative facts.
46	Context-dependent cues	The tendency to recollect in any situation after nurtured with past examples or situation.	(Godden & Baddeley, 1975)	Examples	Recollect	Recollect after giving examples
47	Cross-race effect/Own-race	The tendency to recognise persons of the same origin.	(Behrman & Davey, 2001)	Group	Preference	Recognising person of the same origin
48	Cryptomnesia	The tendency to believe recalled memory as new and original.	(F. K. Taylor, 1965)	People	Recollect	Past incidence as new.
49	Cue-dependent forgetting	The tendency to recollect after served with past examples or situation.	(Pastorino & Doyle-Portillo, 2012)	Examples	Recollect	Remembering after providing an example of the situation.
50	Curse of knowledge	The tendency to predict with the knowledge one possesses instead of predicting from others view or fact presented.	(Kennedy, 1995)	People	Predict	Relying on self to judge based on knowledge/ experience without considering others views fact or data
51	Declinism	The tendency to value the past positively and future negatively	(F. K. Taylor, 1965)	Relate	Valuate	Past work/ job environment/opportunity good and future is bad.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
52	Default	The tendency to choose pre-determined options negating superior options	(Samuelson & Zeckhauser, 1988)	Decision	Decision	Pre-determined choice.
53	Defensive attribution	The tendency to defend one's self-esteem in any situation.	(Shaver, 1970; Stroebe, Postmes, Täuber, Stegeman, & John, 2015)	Performance	Defend	Defend self-decision, performance, routine, or functioning.
54	Denomination effect	The tendency to prefer spending large sum rather than its equivalent small sums.	(Raghubir & Srivastava, 2009)	Relate	Preference	Spending a large amount verses small equivalent.
55	Denying value trade-offs.	The tendency to over-value favoured alternative by denying value trade-offs.	(Schwenk, 1984)	Decision	Valuate	Over value their option
56	Devaluation	The tendency to de-value alternatives.	(Schwenk, 1984)	Relate	Valuate	Devalue alternatives.
57	Diffusion of innovation theory / Pro-innovation	The tendency to ignore limitations or weakness of own innovation.	(Palacios Fenech & Longford, 2014; E. M. Rogers, 2010)	Decision	Omit	Ignoring one's own innovation weakness or limitations
58	Digital amnesia	The tendency to not remember information that is readily available in digital mode.	(Carr, 2010; Sparrow, Liu, & Wegner, 2011)	Automation	Recollect	Not remember information, data, statistics, facts, figures, or report when available digitally.
59	Disagreement	The tendency of not stating disagreements in a forum.	(Kotlyar & Karakowsky, 2007; Levine & Thompson, 1998; Levine, Thompson, & Messick, 2013)	People	Disagreement	Not disagreeing in form/group.
60	Disaster neglect	The tendency of constructing negative scenarios that do not reflect the correct magnitude of the disaster.	(Kahneman, Lovallo, & Sibony, 2011)	Relate	Construct	Constructing fallacious, misleading, erroneous, deceptive, false, wrong, or untrue negative scenarios.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
61	Disposition effect	The tendency to dispose of the value appreciated things and retaining the depreciated things.	(Ferris, Haugen, & Makhija, 1988; Frydman & Camerer, 2016; Shefrin & Statman, 1985)	Decision	Dispose	Positive value things passed and negative held
62	Distinction	The tendency to distinct two opinions while considering at the same time or relating closely when viewed at different time.	(Hsee & Leclerc, 1998; Hsee & Zhang, 2004)	Relate	Time	Distinct two different options of the same time or relating two different options of different time.
63	Dunning–kruger effect	The tendency to overestimate one's ability based on illusion.	(Kruger & Dunning, 1999, 2009)	People	Ability	Imaginary overestimation of one's ability
64	Durability	The tendency to overestimate the duration of the emotional impact.	(Noval, 2016)	People	Valuate	Overestimating emotion
65	Duration neglect	The tendency to judge on positivity or negativity ignoring their duration.	(Czyzewska, RGraham, & Ceballos, 2011; Daniel & Shane, 2005; Fredrickson & Kahneman, 1993)	People	Time	Judgement on situation, problem, process, procedure, method, practice, or activity ignoring time.
66	Easy study	The tendency to take the easy and unproblematic area/time for a study to prove the subject worthiness.	(Bodek, 2002)	Management	Consider	Easy, stress-free, comfortable, simple, unproblematic, or painless area/ time for a study
67	Effort justification	The tendency to overvalue the results while involving self-effort or contribution.	(Festinger, 1962)	Relate	Valuate	Overvaluing self-results.
68	Egocentric	The tendency to overemphasises, unduly trust, or overestimate one's belief as reality.	(Fiedler & Krüger, 2014; klaus & Tobias, 2014; M. Ross & Sicoly, 1979)	People	Belief	Overemphasise ones idea/ belief as reality
69	Empathy gap	The tendency to underestimate own or others emotions while taking decisions.	(Bowen, Loewenstein, & Dunning, 2014; Loewenstein, 2005;	Decision	Underestimate	Emotions during the decision process.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
			Nordgren, Banas, & MacDonald, 2011)			
70	Endogeneity.	The tendency to omit erred variables.	(Antonakis, Bendahan, Jacquart, & Lalive, 2014)	Decision	Omit	Omitting erred variables, information, statistics, facts, figures, numbers, records, documents, or files.
71	Endowment effect / Divestiture aversion / Mere ownership effect	The tendency to over valuate own creations or things	(Beggan, 1992; Kahneman, Knetsch, & Thaler, 1991; Kahneman & Tversky, 1984; Morewedge & Giblin, 2015; Roeckelein, 2006; Thaler, 1980)	Relate	Valuate	Over valuate, appreciate, respect, cherish, or assess ones idea/creation.
72	Escalation of commitment	The tendency to be more committed when the outcome is negative.	(Schwenk, 1984; Staw, 2002)	Negativity	Committed	Working intensely, vigorously, rigorously, relentlessly or fast when results are negative.
73	Ethnic	The tendency to have a positive or negative outlook because of the ethnicity.	(Harris et al., 2016)	Group	Outlook	Based on ethnicity.
74	Expectancy	The tendency to distort to achieve one's expectations.	(Rosnow & Rosenthal, 1997)	Decision	Distort	Distorting facts for ones benefit, prospects, opportunities, anticipations, or expectancies.
75	Experimenter	The tendency to consciously or unconsciously influence participants to achieve the believed data's or results.	(E. Goldstein, 2010; Sackett, 1979)	Decision	Influence	Researcher influencing others for achieving ones believed data's, results, benefit, prospects, opportunities, anticipations, or expectancies.
76	External influence	The tendency of being influenced by external agencies.	(M.-D. P. Lee, 2011)	External	Influence	Influenced by auditors, consultants, government and legal authority, or other external agencies.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
77	Extrinsic incentives	The tendency to believe that others motive is more coinage than to gain skill or knowledge.	(C. Heath, 1999; L. Ross, Greene, & House, 1977)	Relate	Belief	The motivation of others is money, income, funds, assets, cash, or currency.
78	Fading affect	The tendency to forget negative events faster than positive events.	(W. R. Walker, Skowronski, Gibbons, Vogl, & Thompson, 2003)	People	Negativity	Forgetting negatives
79	False-consensus	The tendency to believe that their belief is normal and similar to others.	(L. Ross et al., 1977; Suls, Wan, & Sanders, 1988)	People	Belief	All think alike/ agrees with their belief and it is normal.
80	Fear of failure	The tendency to minimise the risk of failure at the cost of success.	(Rothblum, 1990)	Negativity	Avoid	Minimise risk always.
81	Fear of job loss	The tendency to fear job loss.	(Chou, 2014; Jane Elizabeth Ferrie, Shipley, Stansfeld, & Marmot, 2002; Greenhalgh & Rosenblatt, 1984; Vujičić, Jovičić, Lalić, Gagić, & Cvejanov, 2015)	Negativity	Fear	Fear to loose job
82	Fix it fallacy	A tendency to hurriedly solve the problem with naive solutions.	(Hirshleifer & Hirshleifer, 2017)	People	Resolve	Quickly solve problem/ issues
83	Focusing illusion	The tendency to attach importance to a single factor, information, or event while neglecting unavailable information or other important events.	(Gilbert & Wilson, 2000; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2006; Schkade & Kahneman, 1998; Vass, 2012)	Relate	Importance	Attach importance to single factor, information or event while neglecting unavailable information or other important events.
84	Framing effect	The tendency to frame an opinion based on the presentation method.	(Bornstein & Emler, 2001; Druckman, 2001; Plous, 1993; Tversky & Kahneman, 1985)	Relate	Presentation	Importance to presentation method.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
85	Frequency illusion	The tendency to notice things or their similarities, which come into own thoughts.	(Newell, Mitchell, & Hayes, 2005)	People	Notice	Similarity observing, or people repeat the same answer for different questions.
86	Functional fixedness	The tendency to believe that the data, fact, or view is to be used only in a traditional way, as previously used, or as per the original intended purpose.	(Duncker, L. S. Lees/1945; German & Defeyter, 2000)	Decision	Belief	Using data only to the purpose intended / not using data for other solutions/ideas.
87	Fundamental attribution	The tendency to value internal factors or characteristics more than external factors.	(L. Ross, 1977)	People	Valuate	Estimating internal factors more than external.
88	Gambler's fallacy/ Monte carlo fallacy/ The fallacy of the maturity of chances	The tendency to believe frequent occurrences indicate that it would occur less in the future and vice versa.	(R. Atkinson, Oxford University Press on behalf of The Analysis Committee /1956; Clotfelter & Cook, 1993; J. L. Cowan, 1969; Lehrer, 2009; Swijtink, 1986)	Decision	Belief	Predicting future occurrences based on the frequency
89	Gender	A tendency to impart unequal treatment based on gender of an employee or group of employees	(McCaffery, 1992)	People	Preference	Discriminating, distinguishing, differentiating, favouring, or victimising based on gender
90	Generation effect	The tendency to remember own generated ideas more than acquired.	(Jacoby, 1978)	People	Recollect	Remembering own idea more than acquired.
91	Group attribution error	The tendency to believe or relate an individual’s view or behaviour to the group.	(Allison & Messick, 1985; Hamill, Wilson, & Nisbett, 1980)	Group	Relate	Relate, connect, or associate individual views or behaviour to his group.
92	Group escalation of commitment	The tendency to continue support to the group during a negative outcome.	(P. E. Jones & Roelofsma, 2000)	Group	Support	Support group during a negative outcome.

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93	Group formation	The tendency to form small groups within a team and discuss an issue on side-line.	(K. Y. Williams & O'Reilly III, 1998)	Group	Form	Forming small groups
94	Group polarization Majority	The tendency to incline to the majority view, irrespective of fact and data.	(Kotlyar & Karakowsky, 2007; Lamm, 1988; Pech, 2001)	Group	Incline	Incline to the majority view.
95	Group think	The tendency of inclining to garner the support of a group.	(Janis & Mann, 1977; Kahneman et al., 2011)	Group	Incline	Incline and get group support.
96	Guidance	The tendency to seek guidance from management, people, or consultants in ambiguous situations.	(H. Arrow & McGrath, 1993; Kotlyar & Karakowsky, 2007)	Management	Guidance	Seeking guidance or approval from superiors or management
97	Halo effect	The tendency to have an opinion on view, situation, or people as an observer and later use appropriately. The decision maker sees a story as more emotionally consistent than it really is.	(Long-Crowell, 2015; Nisbett & Wilson, 1977) (Kahneman et al., 2011)	Decision	Opinion	Stay as an observer of a problem and use it at an appropriate time/ else ware.
98	Herd instinct	The tendency to adopt the opinions and follow the behaviours of the majority to avoid conflict or be secure.	(Braha, 2012; Burke, Tobler, Schultz, & Baddeley, 2010; Raafat, Chater, & Frith, 2009)	Group	Opinion	Inclining to a majority to be safe or avoid conflict/ disagreement.
99	Hindsight	The tendency to relate one's non-factual prediction to its prior predictability or believe the result all along the process.	(Arkes, Wortmann, Saville, & Harkness, 1981; Bornstein & Emler, 2001; J. D. Campbell & Tesser, 1983)	Relate	Believe	The result is based on non-factual prediction.
100	Hot-hand fallacy or phenomenon	The tendency to believe that random success has subsequent success with more attempts.	(Green & Zwiebel, 2015)	Relate	Believe	Random success has subsequent success with more attempts.

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101	Hyperbolic discounting	The tendency to inconsistently discount, the fact, or evidence based on the duration of time. The tendency to have a stronger preference for immediate payoffs rather than later payoffs.	(Frederick, Loewenstein, & O'donoghue, 2002) (Laibson, 1997)	Cost, time, and/ or energy	Time	Inconsistently discount, the fact, or evidence based on the duration of time, emphasising its applicable only to past or future
102	Identifiable victim effect	The tendency to compensate individual higher than the group in a similar situation.	(Collins, Taylor, Wood, & Thompson, 1988; T. Kogut & Ritov, 2005; Small, Loewenstein, & Strnad, 2006)	People	Inclination	Individual compensation higher than group
103	Illusion of asymmetric insight	The tendency to influence people or situation with knowledge, to gain an advantage.	(Pronin, Fleming, & Steffel, 2008; Pronin, Kruger, Savtisky, & Ross, 2001)	People	Influence	Influencing others with knowledge, skill, expertise, or familiarity on the subject.
104	Illusion of control	The tendency to overestimate one's ability to control or influence outcomes that they clearly cannot	(Plous, 1993; Thompson, 1999; Vyse, 2013)	People	Ability	Overestimating one's ability to control or influence outcomes.
105	Illusion of external agency	The tendency of being influenced by an external or unfamiliar participant or situation.	(Gilbert, Brown, Pinel, & Wilson, 2000)	External	Influence	External influence.
106	Illusion of transparency	The tendency to overestimate others' ability to know them and their ability to know others.	(Gilovich & Savitsky, 1999; Gilovich, Savitsky, & Medvec, 1998; McRaney, 2011)	People	Ability	Ability to judge others
107	Illusion of validity	The tendency to overestimate own ability to judge outcomes based on a steady pattern.	(Tversky & Kahneman, 1975)	People	Ability	Ability judge outcome based on a steady pattern.
108	Illusory correlation	The tendency to believe in the fallacious correlation among facts, people, or situations.	(Mullen & Johnson, 1990; V. E. Peeters, 1983; Pelham & Blanton, 2012;	People	Believe	Believing a false correlation of facts, people, or situations.

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			Stroessner & Plaks, 2001)			
109	Illusory superiority/Leniency error/Sense of relative superiority/The primus inter pares effect	The tendency to overestimate one's ability based on illusion, relatively to others.	(Hoorens, 1993; Pinker, 2011)	People	Overestimate	Ability to understand the illusion.
110	Illusory truth effect	The tendency to trust data after considerable experience or continuous disclosure.	(Hasher, Goldstein, & Toppino, 1977)	People	Trust	Trusting data after experiencing or continuous display.
111	Immune neglect	The tendency of being unaware of one ability to adapt to negativity.	(Gilbert et al., 1998)	Negativity	Ability	Ability to adopt negativity or negative situation
112	Impact	The tendency to predict others future emotional state or behaviour and overestimate the emotional impact	(Noval, 2016; T. D. Wilson & Gilbert, 2003)	People	Predict	Predict/overestimate another person's emotional impact.
113	Implicit stereotype	The tendency to point certain characteristics or situation to a person of a specific unit.	(Dovidio, Hewstone, Glick, & Esses, 2010; Greenwald & Banaji, 1995; Lieberman, 1998)	Relate	Relate	Relate characteristics or situation to a particular person
114	Impossibility	The tendency to spend the effort to identify negative fact to convince oneself that it is impossible to achieve desired outcome.	(Schwenk, 1984)	Negativity	Effort	Finding/ providing negative facts, evidence, particulars, specifics, statistics, data, or circumstances to convince it is impossible.
115	In attentional blindness	The tendency to miss obvious or visual information when focusing on a particular task.	(Simons, 2000)	People	Omit	Missing visual information.
116	Information	The tendency to seek more information though it is irrelevant.	(Baron, 2008; Vaughan, 2013)	Relate	Correlation	Seeking irrelevant information, data, evidence, report, statistics, or facts.

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117	In-group favouritism/In-group–out-group	The tendency to favour members of the liked group.	(Aronson, Wilson, & Akert, 2013; Brewer, 1979; Kavaliers & Choleris, 2017; D. M. Taylor & Doria, 1981)	Group	Correlation	Group favour.
118	Insensitivity to sample size	The tendency to judge without considering sample size.	(Tversky & Kahneman, 1975)	Decision	Decision	Decision without sample size consideration
119	Intensity	The tendency to overestimate the initial intensity of the emotional impact.	(T. D. Wilson & Gilbert, 2003)	Relate	Overestimate	Overestimate emotional impact.
120	Irrational escalation	The tendency to decide irrationally, based upon previous rational decisions or to justify actions already taken.	(Drummond, 1998)	People	Decision	Justifying actions already taken.
121	Just-world hypothesis	The tendency to believe in fate for positives and negatives.	(Furnham, 2003; Lerner & Montada, 1998)	Relate	Belief	Believe in fate.
122	Lack of control	The tendency of not focussing effort to control events, person, or situation.	(Jensen & Meckling, 1976)	Management	Focus	Not controlling events, events, person, or situation.
123	Lack of systemicity	The tendency to overestimate own ability to retain all the pieces of information collected.	(Cristofaro, 2017)	People	Overestimate	Overestimating one's ability to store all info with him
124	Lack of trust	The tendency of not trusting the stakeholders.	(J. A. Brown, Buchholtz, & Dunn, 2016; Greenwood & Van Buren III, 2010; Swift, 2001)	Trust	Trust	Lack of trust.
125	Lake wobegon effect	The tendency to believe that all subjects and situations are above average.	(Harrison & Shaffer, 1994; Moran & Morgan, 2003; Phillips, 1990)	Group	Believe	All people/situations are above performing above average.

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126	Lead	The tendency to not take the lead to expose a complicated issue for discussion.	(Lynskey, 1955)	People	Challenges	Who will tell the management, superior or the group?
127	Less-is-better	The tendency to prefer smaller alternative when evaluated separately instead of collective evaluation that yields a larger alternative.	(Hsee, 1998)	People	Preference	Smaller alternatives preferred instead of major changes.
128	Levelling and sharpening	The tendency to recollect the smallest details and omit certain details to convenience.	(Gordon W Allport & Postman, 1945)	People	Omit	Leave out details for convenience.
129	Levels-of-processing effect	The tendency to recollect or store in memory more details post in-depth analysis.	(Eysenck, 2006)	People	Recollect	The memory of in-depth analysis details.
130	Long work	The tendency to work long hours for productivity, quality, earnings, promotions, and job security.	(Kodz et al., 2003)	People	Belief	Working long hours.
131	Loop hole	The tendency to identify loopholes and pass the blame.	(Leun, 2003; Sterman, 2006)	People	Correlation	Blame others/ weak link
132	Loss aversion	The tendency to avoid the loss or the disutility of giving up an object is greater than the utility associated with acquiring it.	(Kahneman et al., 2011; Kahneman & Tversky, 1984; Tversky & Kahneman, 1992, 2016)	Cost, time, and/ or energy	Inclination	Avoiding loss while making decisions or operating.
133	Magical number seven, plus or minus two	The tendency to believe that the average number of items that comes to the memory of average human is 7 ± 2	(G. A. Miller, 1956, 1994)	People	Ability	Quoting about 7 instances
134	Masked-man fallacy Intentional fallacy Epistemic fallacy	The tendency of unlawfully arguing or judging a phenomenon or people with different qualities and properties as equal.	(Bowell & Kemp, 2014)	Performance	Unlawful	People are equal

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135	Memory inhibition	The tendency of not remembering irrelevant facts or situation	(C. M. MacLeod, 2007; Neumann, Cherau, Hood, & Steinnagel, 1993; Wade, Tavris, & Garry, 2012)	People	Recollect	Not remembering irrelevant facts.
136	Mental accounting	The tendency to mentally bifurcate and categorise economic factors.	(C. Heath & Soll, 1996)	Cost, time, and/ or energy	Calculation	Mentally bifurcate economic factors.
137	Mere-exposure effect	The tendency to positively judge based on familiarity.	(Pliner, 1982; Zajonc, 1968, 2001)	People	Relate	Familiar things positive
138	Misattribution of memory	The tendency to attribute facts or situations to the wrong source.	(Baddeley, Conway, Aggleton, Schacter, & Dodson, 2001; Payne, Cheng, Govorun, & Stewart, 2005; Schacter, 2002; Zaragoza & Lane, 1994)	Relate	Relate	Facts to the wrong source.
139	Misinformation effect	The tendency to recollect less accurate information on a situation based on post event facts or information.	(Robinson-Riegler & Robinson-Riegler, 2016; Saunders & MacLeod, 2002; Weingardt, Toland, & Loftus, 1994; Weiten, 2007)	Example	Recollect	Memory recall of less accurate information of a situation based on post event facts or information
140	Modality effect	The tendency to understand clearly based on the presentation method.	(Leahy & Sweller, 2011; M. J. Watkins, Watkins, & Crowder, 1974; O. C. Watkins & Watkins, 1977, 1980)	People	Presentation	Understand based on presentation method.
141	Money illusion	The tendency to provide or evaluate nominal financial value instead of real value in the decision process.	(Benartzi & Thaler, 1995; Bertrand, Mullainathan, & Shafir, 2004; I. Fisher, 1928;	Relate	Valuate	The nominal value provided instead of a real one.

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			Patinkin, 1969; Shafir, Diamond, & Tversky, 1997)			
142	Moral credential effect	The tendency to establish oneself as a person to decide based on consensus but later prove otherwise.	(Kouchaki, 2011; Monin & Miller, 2001)	Management	Belief	Not being a decision maker based on consensus against the associated people belief.
143	Moral luck	The tendency to relate moral connection to an outcome.	(J. M. Fischer, 2011; B. Williams, 1981; B. A. Williams & Nagel, 1976)	Relate	Relate	Moral connection to outcomes
144	Motivated blindness	The tendency to ignore readily available information that contradicts their preferences, when motivated.	(M. H. Bazerman & Sezer, 2016)	Decision	Omit	Ignore available information if contradicts preference
145	Murphy's law	The tendency to believe that things, which can go wrong, will eventually go wrong.	(J. Chen, 2017; Chew, Leonard-Barton, & Bohn, 1991; Dimson & Marsh, 1999; Matthews, 1995)	People	Belief	If it is, things will go wrong.
146	Myside Diagnostic	The tendency to selectively gather and interpret evidence that confirms own diagnosis and ignoring evidence that might disconfirm it.	(Bornstein & Emler, 2001; R. S. Nickerson, 1998; Oswald & Grosjean, 2004; Plous, 1993; Pohl, 2004)	People	Belief	Selectively gathering and interpreting data, information, statistics, facts, records, or documents based on self-belief.
147	Naive cynicism	The tendency to predict others to be more selfish than actual.	(J. Heath, 2006; Kruger & Gilovich, 1999; Tsay, Shu, & Bazerman, 2011)	Relate	Predict	Others are selfish.
148	Naive realism	The tendency to believe demonstrable things around us, and judge those with disagreement as mind-set person or ignorant.	(T. Brown, Reed, & Turiel, 1996; D. W. Griffin & Ross, 1991; Hergenhahn & Henley,	Relate	Judging	Judging that others who disagree have mind set, ignorant, uninformed,

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			2013; Lewicka, Czapinski, & Peeters, 1992; Nuttall, 2013; L. Ross, Lepper, & Ward, 2010)			unfamiliar, inexperienced, or illiterate.
149	Negativity	The tendency to incline towards negativity when both positive and negative have the same weightage.	(Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; E. E. Jones et al., 1972; Kanouse & Hanson Jr, 1987; Lewicka et al., 1992)	Negativity	Incline	Incline to negativity.
150	Neglect of probability	The tendency to judge without considering probability.	(Kahneman, 2011)	Decision	Omit	Not considering probability
151	Next-in-line effect	"When subjects are next in line they may ignore cues not related to performing"	(Brenner, 1973)	People	Ability	Ignoring unwanted cues.
152	No response	The tendency of waiting, watching and being unresponsive.	(Dutilh & Rieskamp, 2016)	People	Response	Not responding to change or improvement.
153	No time and energy	The tendency to overestimate or believe non-availability of time and/or energy for performing a process or activity.	(Barrouillet, Bernardin, & Camos, 2004)	Cost, time, and/ or energy	Time	No time and energy
154	Non-rational escalation of commitment	The tendency to escalate the non-rational support or commitment to the decision.	(M. H. Bazerman & Moore, 2009)	People	Support	Support for a decision.
155	Normalcy/ Normality	The mental state of people in a disaster situation or tendency to fail to prepare for disaster.	(Evans, 2012)	People	Negativity	Not preparing, planning, training, or coaching for a negative situation.
156	Not invented here	The tendency to ignore views and/or facts that come from an external origin.	(Webb, 2010)	External	Omit	External views omitted.

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157	Occam's /Ockham's razor	The tendency to select a solution with fewer assumptions.	(Blumer, Ehrenfeucht, Haussler, & Warmuth, 1987; Domingos, 1999)	Decision	Preference	Selecting option with fewer assumption.
158	Occupational	The tendency to incline or distance based on people occupation.	(Blau, 1957)	People	Inclination	Considering the profession of suggestion maker.
159	Omission/ Opportunity	A tendency to unconsciously avoid equal opportunity	(Pollard, 1999)	Group	Preference	Not providing equal opportunity.
160	Optimism	The tendency to believe that one is at comparably at reduced risk or overconfident in own ability to avoid or avert a negative situation.	(DeJoy, 1989; O'sullivan, 2015; Sharot, 2011; Weyman & Barnett, 2016)	Negativity	Negativity	Thinking, judgement, belief, reasoning, or deliberating that risk in a negative situation is low.
161	Ostrich effect	The tendency to avoid presenting negative financial information.	(Galai & Sade, 2006)	Negativity	Omit	Not giving negative financial information
162	Out group	The tendency to avoid or misalign with non-familiar or non-genetically related individuals.	(Kavaliers & Choleris, 2017)	Relate	Avoid	Avoiding no familiar person
163	Outcome	The tendency to err in evaluating the known outcome or blame others for unfavourable outcomes and ethical violations and gain credit for the positive outcome or be influenced by an expected outcome while evaluating probabilities.	(Baron & Hershey, 1988; Bornstein & Emler, 2001; Gino, Moore, & Bazerman, 2009; Gruppen, Margolin, Wisdom, & Grum, 1994; Sezer, Zhang, Gino, & Bazerman, 2016; Xiang et al., 2013)	Cost, time, and/ or energy	Decision/ blame	Err outcomes, blame others for an outcome, taking more credit from positive outcome, being influenced by expected outcome.
164	Out-group homogeneity effect	The tendency to believe that members of the disliked group are similar and liked group members are diverse.	(Haslam, Oakes, & Turner, 1996; Quattrone & Jones, 1980; Richard & Judith-Ann, 1986)	Group	Believe	Believe disliked group are alike and disliked group members are diverse.

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165	Overdo	The tendency to overdo process, procedure, method, system, or technique.	(Kaiser & Overfield, 2011; Kaplan & Kaiser, 2009; Pither & Nicholas, 1991)	People	Valuate	Over doing process, procedure, method, system, or technique
166	Overconfidence effect	The tendency to overestimate, over emphasise, or over precise on subjective factors like the probability of correctness of actions, beliefs, and experience than objective factors while giving a decision.	(Busenitz & Barney, 1997; Kahneman et al., 2011; Moore & Healy, 2008; Pallier et al., 2002)	Management	Valuate	Overestimate, over emphasising, or over precise on subjective factors or the probability of correctness of actions, beliefs, and experience.
167	Pareidolia	The tendency to believe non-existing familiar pattern when prompted by a situation, image or sound.	(Takahashi & Watanabe, 2013)	People	Recollect	Believe non-existing familiar pattern by situation, image, or examples.
168	Parkinson's law	The tendency to believe that effort is adjusted to the difficulty of the task.	(Latham & Locke, 1975)	People	Belief	The effort needed depends on the task
169	Parkinson's law of triviality	The tendency of the organisation to give over value to trivial issues.	(C. Parkinson, 1958; C. N. Parkinson & Osborn, 1957)	Cost, time, and/ or energy	Concentrate	Organisation to devote time and effort to trivial issues greater than needed.
170	Part-set cuing effect	The tendency to remember the highlighted facts or events while making a decision.	(Marsh, Dolan, Balota, & Roediger, 2004; Nairne, 2014; Slamecka, 1968; Stone, Hunkin, & Hornby, 2001)	Decision	Decision	Remember the highlighted, emphasised, or stressed facts or events while making a decision.
171	Patenting	The tendency to believe that patents are unnecessary to gain returns.	(Levin et al., 1987)	Automation	Patent	Focus on exclusive technology that needs to be patented for future business.
172	Peak–end rule	The tendency to form an opinion based on experience with extreme results.	(Fredrickson & Kahneman, 1993;	Decision	Opinion	Opinion based on experience with extreme results

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			Kahneman & Tversky, 2000)			
173	Person -environment fit	The tendency to believe people-environment fit has consequences and change the person if a process in not working.	(Rounds & Tracey, 1990)	Management	People change	Change the person if a process in not working.
174	Person identification	The tendency to identify a person to appreciate or blame	(Coates & Tognazzini, 2013)	People	Identify	Blame or appreciate others
175	Picture superiority effect	The tendency to remember pictures or images better than words.	(Ally, Gold, & Budson, 2009; Curran & Doyle, 2011; Defeyter, Russo, & McPartlin, 2009; McBride & Dosher, 2002; Shepard, 1967; Whitehouse, Maybery, & Durkin, 2006)	People	Recollect	Remember pictures/images better than words
176	Placebo	The tendency to believe successful methods as incompetent.	(Gensini, Conti, & Conti, 2005; Lanotte et al., 2005)	People	Belief	Believe successful methods/ technology as incompetent
177	Planning fallacy Hofstadter's law	The tendency to underestimate task-completion times. The tendency to predict the optimistic time required for task completion.	(Sanna & Schwarz, 2004) (Kahneman & Tversky, 1977; Pezzo, Litman, & Pezzo, 2006)	Cost, time, and/ or energy	Time	Underestimate / optimistic task-completion times
178	Positivity effect	The tendency to value positively negative situations, failures or errors created by oneself, own group or the people of own choice.	(Hallahan, Lee, & Herzog, 1997; Klar & Giladi, 1997; G. Peeters, 1971)	Relate	Valuate	Project/ argue positively the negative situations of own or own group.
179	Prejudice	The tendency to form an opinion ahead of analysing or receiving information about a person or situation.	(Gordon W Allport, Perseus Books Publishers, 1954/1979; Rosnow, 1972)	Decision	Opinion	Form an opinion ahead of analysing.

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180	Primacy effect	The tendency to remember the beginning of a situation better than the middle events.	(Gordon Willard Allport, 1937; Craik & Lockhart, 1972)	People	Recollect	Remembering the situation beginning better than in middle events.
181	Priority	The tendency to work based on priority, favour one of the response options or perceived urgent options.	(Dutilh & Rieskamp, 2016; Vepsalainen & Morton, 1987)	People	Preference	Working based on priority, not on first in first out or a set pattern.
182	Problem set	The tendency to repeat one tactic and restrict developing alternative tactics.	(Schwenk, 1984)	Management	Preference	Using the same tactics, strategies, policies, procedures, schemes, methods, approaches, or ways repeatedly
183	Project success project short comings	The tendency to accept the success of a project when it achieves base requirements rather than the predicted level.	(Kerzner, 2013; Munns & Bjeirmi, 1996)	People	Accept	Accepting base results than the predicted level
184	Pseudo certainty effect	The tendency to make risk-averse choices if the expected outcome is positive, but make risk-seeking choices to avoid negative outcomes. The tendency to keep outlook positive under uncertainty.	(Hardman & Hardman, 2009) (Tversky & Kahneman, 1985, 1986)	Decision	Negativity	Outlook positive under uncertainty
185	Reactance	The tendency to enthusiastically react in self's unfavourable situation.	(Brehm, 1966)	Negativity	Negativity	Enthusiastically, actively, willingly, devotedly, strongly, readily, or whole-heartedly react in self's unfavourable situation.
186	Reactive devaluation	The tendency to devalue facts and views of contender or competitor.	(K. Arrow, Mnookin, Ross, Tversky, & Wilson, 1995; L. Ross, Stanford Center on Conflict and	Relate	Valuate	Devaluate, undervalue, degrade, or fail to recognize not considering competitors/ contender views.

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			Negotiation, Stanford University/1995; L. Ross & Stillinger, 1991)			
187	Reasoning by analogy	The tendency to apply simple analogies and images to guide problem definition.	(Schwenk, 1984)	Relate	Problem definition	Using an analogy, comparisons, resemblances, and visual aids
188	Recency illusion	The tendency to believe a long-standing concept, fact, or data as a recent one.	(Rickford, Wasow, Zwicky, & Buchstaller, 2007)	Relate	Beleive	State old concept as a new one.
189	Recollection	The tendency to recollect information from the past for any situation.	(Botvinick et al., 2009)	People	Recollect	Recollect information from the past for any situation
190	Regret	The tendency to be suspicious of omitting certain diagnosis and thereby overestimating the negative probability of analysis to avoid regret.	(Bornstein & Emler, 2001)	Negativity	Avoid	Avoid regret overestimating the negative probability
191	Representativeness	The tendency to overgeneralise certain characteristics or observation or overemphasise evidence that resembles and represents a particular range of events.	(Bornstein & Emler, 2001; Busenitz & Barney, 1997)	Relate	Emphasise	Overemphasise evidence
192	Restraint	The tendency to overestimate one's self-control to irresponsible actions	(T. Mann & Ward, 2007; Nordgren, Van Harreveld, & Van der Pligt, 2009)	People	Overestimate	Overestimate one's self-control to irresponsible actions
193	Reverse psychology	The tendency to project negative factors to a situation to obtain desired results.	(Sinha & Foscht, 2006)	Performance	Projecting	Projecting or focused stating of negative factors
194	Risk compensation	The tendency to adjust their belief or situation based on the level of risk.	(Feng, Wu, Ye, & Zhao, 2017; Hedlund, 2000; Streff & Geller, 1988)	Relate	Belief	Adjust based on the level of risk

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195	Rosy retrospection	The tendency to enhance the value of past events.	(Mitchell, Thompson, Peterson, & Cronk, 1997)	Relate	Valuate	Enhancing value to the past situation
196	Saliency	The tendency to find confirming data and elaborate a single alternate.	(Cristofaro, 2017)	Relate	Belief	Finding confirming data for particular alternate.
197	Selection	The tendency to incline to particular participants in a selection process.	(N. Pearce, Checkoway, & Kriebel, 2007)	Group	Inclination	Inclining towards a choice of people.
198	Selective perception	The tendency to ignore or not notice views, data, or facts contradicting one's belief.	(R. W. Griffin, 2013)	People	Omit	Ignoring contradicting data, information, statistics, facts, figures, records, or documents contradicting one's belief.
199	Self-consistency	The tendency to overestimate consistency in outlook and belief, and rejecting ideas inconsistent with their experience, belief or outlook.	(Jussim, Yen, & Aiello, 1995; Koriat, 2012)	People	Overestimate	Overestimating consistency in outlook, viewpoint, stance, and belief
200	Self-integrity preserving moral integrity	The tendency to preserve moral integrity in all situations	(Fein & Spencer, 1997; Kelly, 1998; Kroon, 2008)	People	Integrity	Preserve moral integrity in any situation or the fear that one’s integrity is under questioning when he performs his duties or process.
201	Self-perceived job insecurity	The tendency to fear job loss due to innovation, improvement, or an alternate process.	(Jane Elizabeth Ferrie et al., 2002)	People	Fear	Fear of technology, innovation, improvement, or alternate process related job loss.
202	Self-reference effect	The tendency to understand the information in relation to self.	(T. B. Rogers, Kuiper, & Kirker, 1977)	People	Understand	Understand information, data, information, statistics, facts, figures, records, or documents in relation to self.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
203	Self-serving/ Self – interest	The tendency to favour oneself or enhance self-esteem or engage in self-enhancing attributions in successful situations, and engage in self-protective attributions in negative situations.	(Babcock & Loewenstein, 1997; Blaine & Crocker, 1993; W. K. Campbell & Sedikides, 1999; Kahneman et al., 2011; Kashima & Triandis, 1986; D. T. Miller & Ross, 1975; Myers, 2012)	People	Belief	State self interest
204	Semmelweis reflex or effect	The tendency to reject new evidence that contradicts one's belief.	(Leary & Wilson, 1993; Leavitt & Dubner, 2010)	People	Belief	Reject new evidence, information, data, information, statistics, facts, figures, records, or documents that contradict one's belief.
205	Serial position effect	The tendency to recollect start and end in a situation better than the middle sequence.	(Colman, 2015; Deese & Kaufman, 1957; Ebbinghaus, 1913/H. A. Ruger & C. E. Bussenius/2015; Murdock Jr, 1962)	People	Recollect	Recollecting start and end of the situation better than the middle sequence.
206	Social comparison	The tendency to believe disliked and dejected after facing a stronger situation or contender.	(Garcia et al., 2010)	Relate	Challenges	Lowness during negativity
207	Social desirability	The tendency to answer in a manner that is advantageously viewed by others rather than reflecting their real opinion.	(R. J. Fisher, 1993; Grimm, 2010; Nederhof, 1985)	People	Answer	Answer advantageously or favourably viewed by others
208	Spacing effect	The tendency to understand a situation clearer when it is accessed over a period.	(Shaughnessy, 1977)	Relate	Time	Understanding a situation, issue, problem or difficulty after considerable experience or over a period.

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
209	Spotlight effect	The tendency to overestimate the level of attention one gets.	(Gilovich, Medvec, & Savitsky, 2000; Gilovich & Savitsky, 1999; McRaney, 2012)	People	Valuate	Overestimate the level of one's attention
210	Standardisation	The tendency adopts to same way of operations.	(Ungan, 2006)	Standardisation	Actions	Work in the same way as followed by others.
211	Status quo / Situation	The tendency to hold on to the current situation or method.	(Arnott, 2006; Kahneman et al., 1991; B. H. Martin, 2017; Samuelson & Zeckhauser, 1988)	People	Embrace	Hold on to a current situation
212	Stereotype	The tendency to follow certain beliefs and ways of execution.	(Cox, Abramson, Devine, & Hollon, 2012; Judd & Park, 1993; McGarty, Yzerbyt, & Spears, 2002)	People	Embrace	Follow certain beliefs and ways of execution.
213	Subadditivity effect	The tendency to believe the collective probability of occurrence is less than the sum of individual probabilities.	(Baron, 2008)	Relate	Belief	Believe the collective probability of occurrence is less than the sum of individual probabilities
214	Subjective validation/ Personal validation effect	The tendency to agree with a fact or data if it match personal belief.	(Forer, 1949; D. Marks, 1988; S. W. Russell, 1986)	People	Belief	Agree with a fact, data, information, statistics, if it match personal belief.
215	Suffix effect	The tendency to get distracted when irrelevant information is presented.	(N. Cowan, 1984; Morton & Holloway, 1970; Spoehr & Corin, 1978)	People	Distracted	Distracted by irrelevant information
216	Suggestibility	The tendency to accept untruthful believable facts or data from others while recollecting a situation or incident.	(Ceci, Ross, & Toglia, 1987; Gudjonsson, 1997; Kelman, 1950)	External	Accept	Accept untruthful believable facts

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
217	Sunk cost	The tendency to consider invested cost while making decisions or invested cost irrationally influence on future decisions.	(Bornstein, Emler, & Chapman, 1999; Sherman, 2008)	Cost, time, and/ or energy	Decision	Consider invested cost
218	Survivorship/survival	The tendency to believe in mechanisms that gave success in past and neglecting other options.	(Elton, Gruber, & Blake, 1996; Shermer, 2014)	Management	Belief	Believe on the process, procedure, and methods that gave success in past.
219	System- human	The tendency not acknowledging system and /or human influences	(Arthur, 1994; Merchant, 1981)	Automation	Influence	Not acknowledging system and /or human influences
220	System justification theory	The tendency to have favourable value to oneself, own group and own social system.	(Jost & Banaji, 1994; Jost, Banaji, & Nosek, 2004)	Relate	Valuate	Have favourable value to oneself one's team.
221	Talent misjudgement	The tendency to misjudge talent and expect extraordinary results in their function.	(Bjorkman, Ehrnrooth, Makela, Smale, & Sumelius, 2013; Scullion & Collings, 2011; Thornton, 1982)	Management	Talent	Expect extraordinary results from all people.
222	Technology aversion	The tendency of aversion to using technology without understanding what the technology offers.	(Howard, 2013; C. R. Scott & Rockwell, 1997; Wheeless, Eddleman-Spears, Magness, & Preiss, 2005)	Automation	Aversion	Aversion to using technology
223	Telescoping effect	The tendency to believe the recent event occurred in distant past and vice versa.	(S. M. Janssen, Chessa, & Murre, 2006)	Relate	Believe	State recent event occurred in distant past and vice versa.
224	Testing effect	The tendency to devote time to recollect events or situation to enhance knowledge.	(E. B. Goldstein, 2014; Roediger & Butler, 2011)	People	Recollect	Devote time to recollect events or situation to enhance knowledge
225	The IKEA	The tendency to overvalue one’s partially created things.	(Norton, Mochon, & Ariely, 2012)	Relate	Valuate	Overvalue one’s partially created things

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
226	Third-person effect	The tendency to believe that publicised messages impact or effect more on others.	(Davison, 1983)	External	Believe	Believe that publicised messages impact or effect more on others
227	Thyme-as-reason effect/ Eaton-rosen phenomenon	The tendency to believe things more accurate when it is rhymed.	(Kahneman, 2011; McGlone & Tofighbakhsh, 1999, 2000)	People	Presentation	Things more accurate when it is rhymed
228	Tip of the tongue	The tendency to fail to recollect familiar events or situation.	(Beattie & Coughlan, 1999; A. S. Brown, 1991; R. Brown & McNeill, 1966; Rastle & Burke, 1996; Schwartz, 1999; Schwartz & Metcalfe, 2011)	People	Recollect	Fail to recollect events or situation in work place.
229	Trait ascription	The tendency to estimate one as predictable more than others in different situations.	(Funder, 1980)	Relate	Valuate	Estimate one as predictable more than others in different situations
230	Ultimate attribution error	The tendency to believe that group positivity is due to people character and negativity is due to the situation.	(Hewstone, 1989; Pettigrew, 1979, 2001)	Relate	Belief	Group positivity is due to people character and negativity is due to the situation.
231	Unacceptability	The tendency to refuse or evade questions that may embarrass or invade privacy.	(Baron, 2008; Bishop & Trout, 2004; Forrest, 1993; Gilovich, Griffin, & Kahneman, 2002; Greenwald, 1980)	People	Refuse	Refuse or evade questions that may embarrass or invade privacy
232	Underreporting	The tendency to underreport situations or facts.	(Drakos & Gofas, 2006)	People	Report	Underreport situations or facts
233	Weber–fechner law	The tendency to recall odd situations more than normal situations while making decisions.	(Fechner, 1966)	Decision	Recollect	Recall odd situations more while taking a decision
234	Well-travelled road effect	The tendency to estimate time, based on one's familiarity.	(L. Allan, 1979; Jackson & Jucker,	Cost, time, and/ or energy	Time	Estimate time, based on one's familiarity

Sl. No.	Bias	Description	References	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
			1982; Rubia & Smith, 2004; Zakay & Block, 2004; Zakay & Fallach, 1984)			
235	Wishful thinking	The tendency to underestimate the impact or consequences based on the analysis.	(Poses & Anthony, 1991)	Decision	Underestimate	Underestimate risk, impact, or consequences
236	Wrong information	The tendency to provide wrong information or wrong classification.	(N. Pearce et al., 2007)	People	Information	Provide wrong information, data, evidence, facts, or report
237	Zero defect	The tendency to assume or insist on zero defects in a process.	(Calvin, 1983; Florida, 1996; Ghosh, Mukhopadhyay, & Lu, 2006)	Zero (risk or defect)	Insist	Insist on zero defects in a process.
238	Zero-risk	The tendency to avoid complete risk or the preference for reducing a small risk to zero over a greater reduction in a larger risk.	(Baron, Gowda, & Kunreuther, 1993; Viscusi, Magat, & Huber, 1987)	Zero (risk or defect)	Avoid	Avoid complete risk
239	Zero-sum	The tendency to believe the effect of positivity and negativity equals zero.	(Meegan, 2010)	Zero (risk or defect)	Believe	Believe the effect of positivity and negativity equals zero

Table 7 forms the basis of this research and aids in an understand the biases prevalent in the industry. A total of 239 biases and their descriptions were identified from the literature. The important and connected words, actions, and behaviour are referred in Table 7, which was derived from the description of the bias obtained from the literature. The important word denotes the prime tendency and connected words are the different possible terms that a person uses to indicate the bias. The respective literature that provided the bias description is given in the reference column. The primary codes were the key issues, concepts, and themes identified during the analysis phase of this research that was linked back to the biases. The biases were identified mostly in areas other than operations. However, a few researchers attribute operational outcomes to biases.

2.4.1. Bias summary and research questions

Psychological researchers have recorded the cognitive biases that ascribe success or challenge to the practice of operation management tools (Worren, Moore, & Elliott, 2002). For example:

- Status quo bias and people's resistance to change (Samuelson & Zeckhauser, 1988);
- Status quo bias in information system implementation (H.-W. Kim & Kankanhalli, 2009);
- Planning fallacy and lead time performance improvement (De Treville, Hoffrage, & Petty, 2009); and
- Cognitive biases' influence on IT system execution (Iris & Cebeci, 2014).

However, psychologists have researched the influences of biases, but too little operations research focuses on biases' influence on management tools (De Treville et al., 2009; Gino & Pisano, 2008; McNamara, 2014).

Over the last two decades, a few researchers have identified bias' influence on Lean tools. For example:

- Lean practitioners exhibit a hurried bias to encounter problems, try incomplete solutions to obtain expertise, and leadership use the emotional and practical anti-meeting room bias to pull people for a Gemba (Ballé, 2005); and
- Self-serving bias and fundamental attribution error were barriers to effective implementation of 5S in an Irish case study (McNamara, 2014).

Essential to sustaining a Lean system, management needs to find worker perceptions and identify cognitive biases which are obstructing potential solutions (Morley, Moore, Heraty, & MacCurtain, 2013). Some researchers have attempted to identify solutions. For example, Nickerson, Silverman, and Zenger (2007) proposed synthetic process methods to overcome cognitive, motivational and informational biases. Many operational analytical models assume that the people are tempted to behave rationally without cognitive influence, while researchers in economics, finance, and marketing incorporate people's influence into their models, unlike operations (Gino & Pisano, 2008). This literature review substantiated De Treville et al. (2009), McNamara (2014), and Gino and Pisano (2008) 's claim and established that a gap exists in understanding the interaction of biases in an operation process, its influence on the tools used, and waste. This gap is addressed in the basic research question:

What are the interactions between cognitive biases' interventions, Lean tools, and waste types in organisational processes?

The research question seeks to investigate the interaction between the three primary factors noted above. Therefore, it is important to investigate the three primary factors of this study and to ascertain their interactions. A primary factor is the biases that could be specific to the stressors in the process and the organisation. Hence, it is important to understand:

- *How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?*

Further, to understand the process, it is important to involve all system-wide stakeholders in the process that include both internal and external, which could unfold the set of biases a system possesses. Hence, it is important to understand:

- *What are the system-wide cognitive bias interventions in workplaces that interact and influence waste and Lean tools in organisational processes?*

Similarly, the process would be adopting Lean tools and incurring waste that needs to be identified along with the interaction between Lean tools and waste. Hence, it is important to understand:

- *What are the different types of waste prevalent in organisations?*
- *What is the interaction between Lean tools and waste types?*

2.5. Chapter Summary

The chapter discussed manufacturing philosophies and Lean, and drew attention to 25 Lean tools commonly used. The literature review identified various types of waste generated in an organisation. In addition, the chapter analysed waste induced by deficiencies of information technology functions, the individual's activities, department boundaries, human resources, and methods that were previously not well-defined. The waste types were subdivided into ten categories and pooled in three groups. The chapter further highlighted the 239 cognitive biases from various previous studies. The literature review underpinned the research gap that exists in operations related to the understanding of the system-wide interactions of cognitive biases, Lean tools, and waste in an organisation process. The identified gap was set out to the basic research question and sub-questions. The chapter is concluded with this chapter summary.

3. Methods

3.1. Introduction

This chapter outlines and justifies the approach to find answers to the research questions. The research seeks to add to the knowledge on system-wide cognitive bias influence on Lean methodologies and the resultant waste. The study focuses on understanding system-wide interactions between cognitive biases, Lean tools, and waste in an organisational process and works on the following research question and sub-questions:

RQ: What are the interactions between cognitive biases' interventions, Lean tools, and waste types in organisational processes?

Sub-questions:

- How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?
- What are the system-wide cognitive bias interventions in workplaces that interact and influence waste and Lean tools in organisational processes?
- What are the different types of waste prevalent in organisations?
- What is the interaction between Lean tools and waste types?

In order to explore the research questions, this research adopts a qualitative narrative inquiry methodology that leans heavily on an interpretivist theoretical framework and constructivist epistemology. The research was conducted at five organisations which implement Lean practices or demonstrate a willingness to take up Lean, involving seven different operating processes. This chapter discusses the choices of epistemological position, theoretical framework and methodology, justifying the choice adopted for this research in sections 3.2 to 3.6. This is followed by section 3.7 and 3.8 that discuss data collection and analysis methods adopted along with the administrative aspects of collecting the data. Quality criteria such as reliability and validity are discussed in section 3.9, and the chapter is concluded with a research strategy summary in section 3.10.

3.2. Philosophical position of the researcher

Researchers explore underpinning research philosophies and frameworks to evaluate different methodologies and methods for their research. Crotty (1998) suggests four elements as part of the framework for the research process that includes an epistemology, theoretical framework, methodology, and methods. The epistemology proposes how the reality is known and the relationship which the researcher or knower has with the known (Love, Holt, & Li, 2002). The theoretical framework discusses the approaches used to get the knowledge while the methodology addresses the procedure adopted to acquire the knowledge (Guba, 1990). The methods are the tools used to collect and analyse data to acquire the said knowledge (Morgan, 1996). The four research framework elements are discussed in sections 3.3, 3.4, 3.5, and 3.6 to highlight the choice of methodology and method adopted in this research.

3.3. Epistemology

Epistemology is the branch of philosophy concerned with how to understand reality and the nature of knowledge (Crotty, 1998; Grant & Giddings, 2002). To know the reality, it is essential to determine what a reality is; the ontological position, which is a precursor for epistemological assumptions, facilitates understanding of what reality is (Cohen, Manion, & Morrison, 2002).

3.3.1. Ontological position

Ontology is understanding what reality is (Guba, 1990) or what the nature of reality is (Crotty, 1998). Burrel and Morgan (1979) suggest two possibilities: realism and idealism. Realism assumes that there is one reality and that it is observable without the impact of an object that is observed while idealism assumes reality has cognitive influence and engagement influences the observer and object (Burrel & Morgan, 1979). Ontologically, the relationships among cognitive biases, Lean tools, and waste are subjective and deal with cognitive factors that require the engagement of participants which influences the observer and the participant. Therefore, idealism was chosen as the ontological position of the researcher and the research.

3.3.2. Epistemological position

Epistemology is about methods of knowing reality and is a philosophical grounding for the knowledge being acquired, its kinds, its basis, and the nature of the relationship between the researcher and what is known (Crotty, 1998; Grant & Giddings, 2002). Researchers have identified objectivism, constructivism, and subjectivism as the three dimensions of epistemology.

3.3.3. Dimensions of epistemology

3.3.3.1. Objectivism

Objectivism revolves around the theory that reality exists as such, and is separate from any human consciousness and methods that lead to discovering the objective truth (Crotty, 1998).

In objectivism, the researcher assumes the participant to be an object (Grant & Giddings, 2002) and the researcher is independent with no influence on the outcome (Polit & Hungler, 1999). The knowledge is obtained by verifying the researcher's hunches through generalisations, employing fixed design deductive process that emphasises discrete and specific concepts and have tight control over the context of research with an emphasis on measured, quantitative information and statistical analysis (Polit & Hungler, 1999).

3.3.3.2. Constructivism

Constructivism revolved around the theory that cognitive meaning is constructed rather than discovered and different researchers construct different meanings for the same phenomenon based on the knowledge they inherited (Crotty, 1998). In constructivism, the researcher engages participants' intersubjectivity (Grant & Giddings, 2002) and the researcher interacts with participants and knowledge is gained from the interactive process (Polit & Hungler, 1999). The knowledge is obtained by seeking patterns emerging from interpretations grounded in participants' experiences through flexible design and inductive processes, which emphasises the entirety of the holistic phenomenon that recognises context from narrative information and qualitative analysis (Polit & Hungler, 1999).

3.3.3.3. Subjectivism

Subjectivism revolves around the theory that our experience is a reality rather than shared or external objective truth (Richardson & Bowden, 1983). Subjectivism holds two pathways, the radical researcher/researched relationship and post-structuralist researcher/researched relationship (Grant & Giddings, 2002).

In a radical pathway, participants are treated as co-researchers and it revolves around (Grant & Giddings, 2002):

- Reciprocity; and
- Participation and power-sharing.

In a post-structuralist pathway, the researcher traces certain discourses in the way the participants talk and act towards themselves and others. In post-structuralist textual analysis, there exists a distinct possibility that participants will not recognise, or agree with and no longer guarantee their own truth (Grant & Giddings, 2002).

3.3.4. Epistemology requirement for the research

The research seeks knowledge on the cognitive bias influence on Lean tools and the waste in a process. The understanding of cognitive factor influences needs an interactive approach where the participants, being the subject matter experts, are required to share their experience. Further, the interactive participation must be system-wide, including the internal and external customers and suppliers, for understanding of the happenings in the chosen process. Furthermore, the suppliers and customers may not be the actual value adders in the process, but their requirements and limitations influence the way the process operates. Therefore, the participation must be interactive for exploring the knowledge sought.

Objectivism distances the researcher and the participant, and being a non-interactive dimension, wherein the customers' and suppliers' expressions may not be captured in full; it was not an appropriate position for this research. Similarly, subjectivism treats participants as co-researchers, who may distance themselves from the disclosures and also since the suppliers and customers have a limited role in the value-adding process, it was not the appropriate position for this research. Alternately, constructivism emphasises the fact that knowledge is dynamically ‘constructed’ by participants, instead of passively received from them and the researcher acquires it through a systematic approach (Ormston, Spencer, Barnard, & Snape, 2014), which is suited for cognitive responses understanding. Hence, this research is positioned in the constructive dimension which provides interactive knowledge acquiring through flexible design and qualitative analysis.

3.4. Theoretical framework position

The theoretical framework is the approach to acquiring knowledge (Guba, 1990). Quentin (2017) tabulated the three elements of the research process: epistemology, theoretical framework, and methodology (refer to Table 8).

Table 8: Theoretical framework

Epistemology	**Objectivism**		**Constructivism**	**Subjectivism**	
Theoretical Framework	Positivism	Post-positivism	Interpretivism	Radical/ critical	Post-structural
Methodology	➢ Scientific method ➢ Control ➢ Prediction ➢ Extraneous variables ➢ Reliability ➢ Validity ➢ Generalisability ➢ Representative sample	➢ Scientific method ➢ Mixed-methods	➢ Phenomenology ➢ Hermeneutics ➢ Grounded theory ➢ Narrative inquiry ➢ Ethnography ➢ Interpretive Description	➢ Critical social theory ➢ Feminist theories ➢ Post-colonial approaches	Key ideas: ➢ Discourse ➢ Power ➢ Subject ➢ Deconstruction ➢ Post-critical discourse analysis

Meredith (1998) linked the constructivist epistemological position to interpretivism. The phenomenon that underlines the value of interpretation and observation in seeking the knowledge is known as 'interpretivism' while the related 'constructionism' emphasises that knowledge is dynamically 'constructed' by participants, instead of passively received from them and researcher is focused on acquiring the knowledge from participants' experience through their points of view (Ritchie, Lewis, Nicholls, & Ormston, 2013).

The interpretivism framework acquires knowledge on human beliefs, tendencies and social phenomena by focusing on human activities (Kim, 2003), and encourages researcher interaction with participants to reflect their biases (Kock, Gallivan, & DeLuca, 2008). The interpretivist approach allows the researcher to capture reasons for the effects (Meredith, 1998) and has been popular since the 1990s in social science research (Orlikowski & Baroudi, 1991). Critiques have included that researchers' interests influence interaction, which impacts the research (Orlikowski & Baroudi, 1991) and such interests reduce their generalisability (Mangan, Lalwani, & Gardner, 2004). However, given the positives of an interpretivism approach and interactive requirements to understand the cognitive biases, this research is positioned in the interpretivism theoretical framework. The assumptions, emphasis, knowledge paradigm, assessing criteria and characteristics of an interpretivist theoretical framework for the current research are:

- Assumptions: The reality is sought with human interests, the researcher is a part of the research, and the interactive dimension is constructive and represents knowledge sought after;
- Emphasis: Understanding the context, interact and interpret through known common language to acquire the knowledge of cognitive biases, Lean tools, and waste;
- Knowledge paradigm: Non-falsified facts described through meanings and situations from examining interactive and observation realities;
- Criteria: Assessing criteria are reliability and validity; and
- Characteristics: The characteristics included reasonable sample size, use of multiple methods and in-depth qualitative analysis.

3.5. Methodology

Creswell and Creswell (2017) compared epistemological positions, wherein they identified the constructivism-based methodology as inductive, where researchers rely on participants' view to construct a theory. The current research focuses on cognitive biases, which are subjective and possible to obtain by close interaction. Quentin (2017), tabulated the associated methodologies with constructivism and interpretivism (refer to Table 8, section 3.4). The current section discusses the different methodologies related to interpretivism in sub-sections

3.5.1 to 3.5.6, followed by sub-section 3.5.7 that affirms the research methodology requirement and choice for this research.

3.5.1. Phenomenology

Phenomenology is a combination of the words phenomenon (“to appear”) and logos (“discourse”) (Reason & Lucas, 1984), which appears in concrete experiences and nothing comes without those familiarities (Pivcevic, 2013). Phenomenology is the study of structures of familiarities, consciousness, and appearances of things in our encounters or the ways we live through things, which underline the meanings of things we have in our experience (Patocka, 2018). The study of phenomenology focuses conscious experience from the first-person point of view to obtain the sought knowledge (Patocka, 2018). Husserl (1970) argued that since we exist in the world and encounter it, which is the only certainty, the foundation for all knowledge is to be understood through our experience of our world. However, one of the limitations of this view is the influence of moods and emotion and its connections according to Husserl’s Philosophy of Phenomenology (Quepons Ramírez, 2015).

3.5.2. Hermeneutic Phenomenology

Hermeneutic phenomenology closely is tied to phenomenological philosophy, which underpins that fundamentally the world is already full of meaning and lived meaning forms basic experience, which gives the foundation for knowledge (Merleau-Ponty, 1945; Landes, 2013). Hermeneutic phenomenology implies that knowledge appears in daily life before it has been hypothesised, interpreted, clarified, and otherwise extracted while any attempt to gain knowledge is always tentative, conditional, and incomplete (Goble & Yin, 2014; Sloan & Bowe, 2014). Annells (1999) affirmed that hermeneutic phenomenological research is about understanding the individual’s perception and sense of their lived experience. However, limitations include power dynamics, agendas, the roles of researcher and participant (Briggs, 2003), fear of being placed in a disadvantageous position by giving their experience, recalling events correctly, disparity on their claims (Atkinson & Coffey, 2002) and authenticity of the inter-subjective understanding (Standing, 2009).

3.5.3. Ethnography

Ethnography advocates acquiring the sought knowledge by understanding the experiences of people being studied through participation and immersion in their activities to construct comprehensive descriptions of their values and beliefs (Rachel, Liz, Mat & Dawn, 2013). In ethnography, the researcher becomes immersed in the research as an active participant through personal engagement and records all-encompassing study notes through participant observation, interviews, conversational and discourse analysis, documentary analysis, film, and photography, and life histories (Dick, 2006). Further, Ethnography uses behaviour examination in specific social conditions as a method of data collection and then interprets and understands behaviour (Dewan, 2018). However, limitations include (Savage, 2000):

- Unintended generalisation;
- The approaches of ethnographic research foster ethical issues;
- Required skilled supervision; and
- Useful in a predesign phase of research to generate questions to be investigated by other methodologies.

3.5.4. Narrative inquiry

Narrative Inquiry, a ubiquitous practice in which humans narrate the experiences they live out, was interweaved to construct a phenomenon (Clandinin, 2016). Narrative inquiry is widely used in experience-based studies (Connelly & Clandinin, 1990). Clandinin and Connelly (2000) affirmed that narrative inquiry allows the intimate study of experiences over time and in context. Acquiring the sought knowledge by enquiring, studying and analysing the narrative reveals information about the people and their domain (Ritchie et al., 2013). Each narrative inquiry is made out of short or long personal and social stories, which is the reflection of the world we live in that includes but is not limited to autobiography, life history, personal narration, art-based narrative such as novels, biography, and performance narrative (Kim, 2015). Small stories bring out big thinking in the narrative inquiry (Connelly & Clandinin, 1990). However, Denzin (1995) argued that this study examined lived textuality rather than experiences. Elbaz-Luwisch (2005) corroborates the claim by arguing that electronic media influence can no longer give a pure experience. Conversely, Elbaz-Luwisch (2005) supported textuality to be viewed as an essential part of the experience. The two pathways of narrative analysis are (Polkinghorne, 1995):

- Experimental data are collected and a narrative plot is created suitable to the research aim, and the created plot is the phenomenon of the research study; and
- Stories are collected from participants and analysed for common themes related to the research aim and the phenomenon of the research study.

As narrative inquiry is an extensive form of survey, ethics play an important role and aspects that cause discomfort to researchers and participants need to be analysed carefully (Clandinin, 2006).

3.5.5. Grounded Theory

The grounded theory emphasises systematic gathering and analysis of data that are grounded to construct a theory (Faggiolani, 2011; Strauss & Corbin, 1994). Sources of data include interviews, field observations and all kinds of documents which are reviewed for finding repeated ideas, concepts or elements that are tagged with codes that have been extracted from the data (Martin & Turner, 1986). The codes are grouped into concepts, and then into categories which become the base of the theory (Allan, 2003). The coding requires micro word-by-word analysis of data and, considering the mass of data, the process is time-consuming (Allan, 2003). Further, the grounded theory uses and develops inductive knowledge (Thomas & James, 2006). This approach changes as the researcher moves away from choosing an existing theoretical framework, and then collects data to obtain knowledge (Allan, 2003). The grounded theory uses the complicated methodology and unclear terminology to traverse, instead of a practical alignment to research and data analysis (Tolhurst, 2012). Furthermore, Thomas and James (2006) concluded that the procedures undeniably provide indications for researchers, but the significance of interpretation, narrative, and reflection could be destabilised by the procedures of grounded theory.

3.5.6. Interpretive description

The interpretive description is aligned to a constructivist and naturalistic orientation to the inquiry and is a non-categorical methodological approach to develop a clinical understanding (Hunt, 2009). An interpretive description methodology acknowledges a researcher's theoretical and practical knowledge incorporated in the study, and this foreknowledge of the phenomenon under study is the platform on which the project is designed that aids in determining its predicted boundaries (Hunt, 2009). Moreover, an interpretive description uses inductive analytic approaches to pursue knowledge of clinical phenomena that clarify their features, patterns, and structure (Thorne, Kirkham, & O'Flynn-Magee, 2004). Nonetheless, the expertise of the researcher is an eminent part of the research, and explaining the depth of familiarity one possesses to obtain new knowledge is difficult (Hunt, 2009). Similarly, Sandelowski and Barroso (2003) argued that the likely peril in the interpretive description is that researchers fail to develop an adequate interpretation, limiting the practicality of knowledge obtained. In addition, the researcher and participant co-construct, interact and influence such that prior theoretical knowledge cannot be adequately accounted for in the study (Hunt, 2009).

3.5.7. Research methodology requirement and choice for this research

The research focuses on obtaining knowledge on the cognitive biases with respect to Lean tools and waste in work practices, which is sought from the system-wide participants through understanding their experiences of a particular process. The moods and emotions should not be at the forefront of the participant response as in a phenomenology methodology. Similarly, limitation elements of hermeneutic phenomenology, such as power dynamics, agendas, and the roles of the researcher and participant, fear of being in a disadvantageous position by giving their experience, memory inhabitation, the disparity of their claims and authenticity for response could not be compromised to obtain cognitive biases.

The research aims at a degree of generalisation as the focus is on relating three factors, namely, bias, Lean tools, and waste. In addition, the research aims to keep away from ethical issues and the researcher is not to be immersed in the research as an active participant as required in ethnography methodology. Further, the current research uses the preceding theories and aims to address practical issues, which would be understandable to academics and industry professionals, and adopts methods with fewer complications compared to grounded theory. The researcher's knowledge gained through years of practice in Lean and waste are adequate. Nevertheless, the adequacy of knowledge on biases will be obtained by the end of the research, which discounts the interpretive description methodology.

The current research revolves around the cognitive biases with respect to Lean tools and waste in workplaces, which are sought from the participants by interaction and construction of their experiences. Hence, it was appropriate to choose the narrative inquiry methodological position for the current research.

3.6. Research methods approach

In the narrative inquiry approach, the researcher interacts with participants and knowledge is obtained through the creation of an interactive process. Knowledge is obtained by (Polit & Hungler, 1999):

- Inductive processes;
- Emphasis on the entirety of holistic phenomena;
- Emerging interpretations grounded in participants' experiences;
- Flexible design;
- Recognising context;
- Emphasis on narrative information and qualitative analysis; and
- Seeking patterns.

For the current research, the narrative inquiry methodology is substantiated with the method of data collection through a multiple system-wide case study approach that emphasises in-depth qualitative focus through process observation, participant observation, and semi-structured interviews with open-ended questions.

The basis of the respectable case study is to use multiple sources to collect data (Yin, 1994). The current study employs a multi-case study design since data from multiple sources reflect more convincing and persuasive evidence when compared to a single example (Flick, 2002). The repetition logic can be applied to multiple cases which provide basics for comparison (Noor, 2008; Nordin, Ismail & Saad, 2014). By investigating the distinguishing characteristics of two or more cases, the contrast and similar findings potentially provide rich information on the research focus (Noor, 2008; Nordin et al., 2014). The advantages of multiple source data collections are (Yin, 1994):

- It addresses a wide range of observational concerns;
- The enhancement of converging knowledge; and
- A process of triangulation, which substantiates the finding or conclusion that is more convincing and accurate.

Triangulation (a term that emerged from the navigation and military field, where multiple references are converged to find the position of the object) is a combination of techniques which are used to increase accuracy, improve judgments and validate data through cross-verification from multiple sources (Smith, 1975). Patton (1999) stated that the triangulation term comes from the land survey field. The types of triangulation are (Denzin, 1978; Patton, 1999; Schwandt, 1997):

- Data triangulation: Uses multiple sources of data, involving time and effort;
- Investigator triangulation: Employs multiple researchers in data collection and interpretation;
- Theory triangulation: Employs multiple theories to interpret a phenomenon;
- Methodological triangulation: Employs more than one method to collect data, for example, interviews, observations, questionnaires, and documents; and
- Environmental Triangulation: Employs different locations, settings, and other critical environmental factors (time, day, or season) in which the research is conducted.

Triangulation enhances knowledge, yet in multiple-source actual data collection, depending on the purpose of the study, qualitative researchers researching human experiences conduct interviews with individuals or focus groups (Carter, Bryant-Lukosius, DiCenso, Blythe, & Neville, 2014). One-on-one in-depth interviews are the most desirable tool for understanding and gaining knowledge on human experiences and cognitive topics (Fontana & Frey, 2000). In-depth interviews, both structured and semi-structured, stimulate valuable information about participant experiences and perspectives (Russell et al., 2005). In-depth interviews allow for naturalness, spontaneity, plasticity, and responsiveness from participants (Carter et al., 2014). In contrast, time and effort constraints for conducting the interviews and analysis are a drawback, and focus group interviews prompt source data from participant groups (Carter et al., 2014). During the focus group interview, participants hear each other's replies and either align to prominence or offer supplementary comments which may not be their own experience (Carter et al., 2014). The following section 3.7, describes the methods used in this research.

3.7. Data collection for this study

The research was focused on acquiring responses on the cognitive biases influence on Lean tools and waste in a process through a system-wide approach. The multiple source data collection was done through:

- In-depth semi-structured open-ended question interactive one-on-one interviews;
- Process observation and participant observation to understand the consistency in performance to achieve the desired result rather than repeatability or precisely doing the same way; and
- Documents: Review of objective and subjective archival data (productivity and waste related files), and display review.

The data collection included the position of participant and experience apart from the research theme related questions; refer to Appendix 8 for the interview questionnaire.

The data were stored in the form of:

- Interview recordings (mp 4 files);
- Interview notes;
- Process Observation / discussion notes;
- Participant observation / discussion notes;
- Documents/display review notes.

The research used four types of triangulation:

- Data Triangulation: Data collected from system-wide multiple case studies;

- Theory Triangulation: Combination of cognitive bias, Lean tools, and waste theories;
- Methodological triangulation: Used in-depth interviews and observation of process and participants; and
- Environmental Triangulation: System-wide case studies involving multiple locations and seasons.

The sample size is based on the snowballing principle, and the participants were recruited based on the process requirement, which varied in numbers for each case study (Biernacki & Waldorf, 1981; Noy, 2008).

3.7.1. Criteria for selecting the source for data collection (participants):

The participants included workers, production workers, skilled trades' workers, team leaders, group leaders, staff, managers, and senior executives. The following two criteria were used to choose participants:

A) People working for the following types of organisations:

- Organisations that are engaged in producing products or processing a service;
- Lean practising, willingness to do a Lean exercise or willingness to eliminate waste in the processes; and
- An organisation that had systems or willingness to implement the systematic approach.

B) The participant should communicate in English.

3.7.2. Data collection administration

To understand the methodological requirements and model the outcomes, an exercise in India in 2014-15 to improve productivity and reduce work stress in which the researcher collected data involved in the study was revisited. The case study revisit was presented at conferences; the poster and papers at conferences helped to obtain industry contacts and discussions with them aided in designing the methodology and refining our ethics approach. The conferences attended are listed on page VI. Further, personal contacts and university contacts were used to obtain potential organisations to approach for the case study. Figure 2 explains the details of the data collection approach.

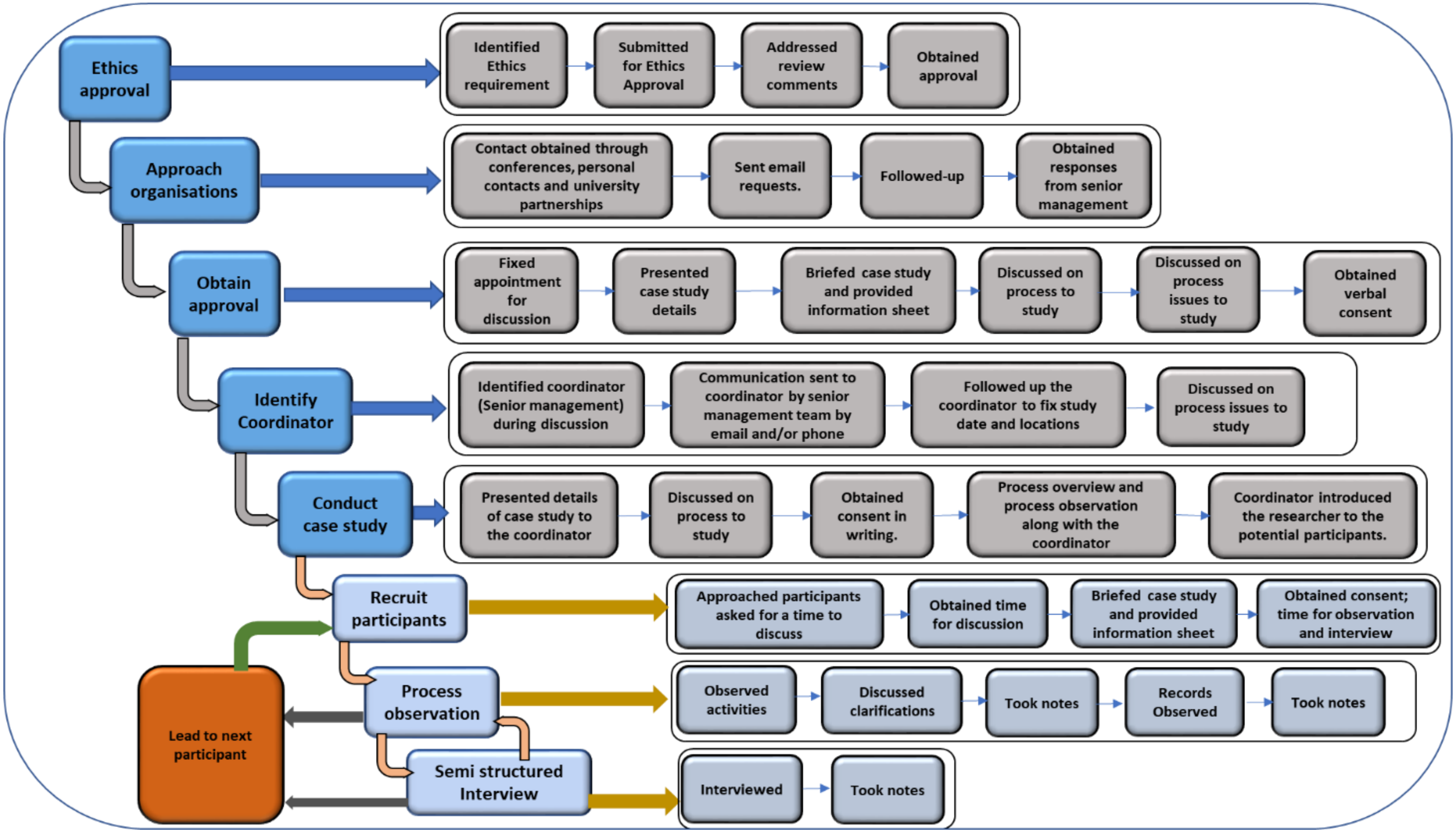

Figure 2: Approach to collect data

The process started with ethics approval at AUT to conduct case studies at organisations in New Zealand. The ethics requirements as per the AUT Ethics Committee (AUTEC) form EA1, were identified, drafted and submitted. The ethics application included:

- Consent forms for organisation, participants and participant groups;
- Information sheets for organisations and participants;
- Safety protocol;
- Questioner; and
- Questions and research question linkage.

The next phase was the identification of organisations for the case study. Contacts were obtained through conferences attended, personal contacts and university contacts. Emails were sent to potential organisations who were practising Lean or intending to practice Lean. Follow up emails were sent to organisations. A total of five organisations' senior management responded, four through personal contacts and one through a University contact.

In the next phase, appointments were obtained with the senior management of the organisations, case study details were presented, and the potential process for the study was discussed with them.

Key points made to the senior management included:

- No comparison study between employees would be done;
- A report would be presented to them on potential process improvement;
- The thesis would be available to them electronically;
- They could withdraw from the study prior to the presentation of the report to them or any publication by the researcher;
- Being bound by ethics;
- Participants' given and obtained data would be confidential; and
- The organisation would be kept anonymous.

During the discussions, a coordinator for each study was identified by senior management, and they communicated with the coordinator regarding the proposed study. Next, the coordinators were contacted, and timelines for the project were discussed and agreed upon. The process overview was done with the coordinator, who introduced the researcher to the potential participants in one of their meetings or in person. The potential participants were approached and a time for discussion was obtained during which the details of the study were discussed, a participant information sheet (Appendix 4 and 5) was given to participants, and their consent was obtained.

A time was fixed with each participant for their interview and to observe their activity. In most cases, the time shifted depending on the nature of their work, which had been anticipated. During observation, the individual's activities were observed from a safe distance, and a brief discussion and clarifications were sought and noted. In addition, the relevant data from their records, and visual displays were sought from the participant and noted. The next phase was the interview with the participants. A set of open-ended questions were asked (Appendix 8) which was substantiated with connecting relevant questions and feedback was obtained. The entire interview process was noted and recorded with their consent. A total of 106 participants were recruited from five organisations for seven process studies, out of which 99 participated in the study, seven participants participated in a trial, one participant agreed to give an interview but refused consent to record, one participant communicated in English but had speech issues and declined to record, and one participant's recording was not clear.

The system-wide study was conducted on seven different processes in five organisations. Since each of the processes was studied system-wide, involving all stake holders such as management, staff, operators, contractors, and allied department people, the studies are referred as "case studies". Each case study (and its participants) was assigned with an identification code.

The case studies were identified as:

- Alpha;
- Beta;
- Gamma;
- Delta;
- Epsilon;
- Zeta; and
- Eta.

Participants were coded with respect to their project and order of observation/ interview. For example, the first participant of the first study was coded as Alpha 1.1 and the second participant was coded Alpha 1.2. Similarly, the first participant of the second study was coded Beta 2.1, and so on.

The process observation started with a brief on the process by the coordinator, which was noted by the researcher. Then the actual workplace was visited, and the process step of each consenting participant was observed and noted. Further, the process observation and participant observation included a short and relevant question/discussion session, both the observation and discussion were noted. Additionally, the documents in the system and physically given by the participant were studied, and relevant contents were noted. Similarly, the relevant details from graphs, productivity data, and policy displays were noted. No sensitive human resource records or financial data were sought or viewed. The process observation was followed by a participant interview. Based on Nicky (2006), the key elements of interviews that were focused on were location, consent, adopting open and emotionally neutral body language and a recording device.

Prior to a one-on-one meeting with a participant, a meeting room was arranged in the workplace that was reasonably quiet. Some participants' chose to give the interview at their workplace, and one participant preferred a restaurant. Mostly, the researcher and participant were uninterrupted during the interview. However, interruptions were experienced on occasion, especially when the participants chose their workplace to give the interview. On such occasions, people disturbance and phone calls interrupted the interviews.

Before the start of the interview, participants were informed about the study details and given assurance about ethical principles. It was communicated to the participant that their details and discussion would be kept confidential and will not be shared with their management. However, since the recruitment was done for the process study, participants may be identified by the organisation, and hence they were free to refuse to answer any question which they felt was inappropriate or would affect them in any way. In addition, it was communicated that participation was entirely voluntary and they could even withdraw after they gave the interview if they were not comfortable, and entire recordings/notes would be deleted in front of them, but that withdrawal should be before reports were submitted to the organisation or published. The participants were given the opportunity to raise questions on the research aim, process, and ethics, and were responded to appropriately. This gained their confidence and it was also observed that the first participant from the process recruited for the case study spread the details of research to fellow employees and was aiding in recruiting others.

The semi-structured questions previously formed for the research was printed and used for the questioning at the interview. The participants were encouraged to talk by nodding, smiling, looking interested and making encouraging noises. The silence, reflecting remarks and probing remarks were used appropriately, and semi-structured open-ended questions were used to gain specific responses. During the interview, the researcher had genuine care, concern, and interest for the participant that was reflected in the researcher's body language (concerned look, happy, and laughing).

The interviews were recorded using a mobile phone, and during the interview, notes were taken as the narration was in progress. The narrations were not interrupted for taking notes mostly, and the participants were allowed to continue freely. For the comfort of participants, the recording was done using a mobile phone, which caused them minimal distraction. However, there were occasions when the researcher received calls that distracted the flow. On such occasions, an apology was made to the participant and the interview was continued. Notes were taken in front of the participant, which were short and brief and mostly allowed eye contact with the participant.

3.7.3. Brief on case studies

The case study involved four large-scale organisations and one small-scale organisation for seven different process case studies. The case studies were coded in Greek numeric to avoid confusion on numbers and alphabets used elsewhere in this research.

3.7.3.1. Alpha

The case study Alpha was conducted at a small-scale printing press. The organisation had one chief executive officer, one production staff member, one administration staff member, and four operators and had an annual turnover of $5 million. During the case study, the production staff member was on leave, and the chief executive officer assumed his responsibilities. The chief executive officer himself was the coordinator. All six of the available participants volunteered to participate.

3.7.3.2. Beta and Gamma

The case studies Beta and Gamma were conducted at an electrical organisation. The company was established in 1955 in New Zealand had 1,000 employees with $350 million revenue and is a part of a French multinational with a turnover of 10.2 billion euro employing 65,000 people worldwide. The initial discussion was to have a case study in risk integration, and the contact arranged a meeting with the general manager. During the meeting, the General Manager suggested the undertaking of two case studies at their distribution facility:

- Store process (Beta); and
- Fault rectification and Project process (Gamma).

Both processes involved a different set of people, interconnected in operations. During the study, an electrical power outrage (1,000 houses) due to an unpredictable storm was encountered which stretched the operations of both the processes to meet the customer commitment of restoration of the power supply within 48 hours that brought out problems and issues. The Beta process operated in two locations that involved nine people (one facility manager, one staff member, seven operators) and all volunteered to participate. The volunteering of all participants was after the facility manager gave consent and a discussion with him. However, the facility manager had minimum influence on the Gamma study, which was entirely voluntary. The Gamma case study involved three locations, and the team had 14 people involved, out of which 11 volunteered for participation and covered the entire process system-wide.

3.7.3.3. Delta and Epsilon

The case studies Delta and Epsilon were conducted at a large-scale supermarket regional distribution organisation. The organisation owned and operated over 180 supermarkets in New Zealand and had been in business for 80 years. It was New Zealand's largest private sector employer, with 18,500 New Zealanders employed in their stores, support offices, processing plants, and distribution centres. The heavily unionised organisation made a turnover of $US 6.2 billion annually. The distribution centre (DC) involved in the study had a turnover of $US 22,474 million annually. The contact for the organisation was an analyst, who had forwarded the case study details by email to the national transport manager who proposed two studies:

- Warehouse process (optimal picking, preparing, and docking); and
- Transport process (inspection, loading, sealing and transiting of orders).

The transport project had time management issues, and its objectives were:

- Decongest the DC at certain times;
- Optimal use of the carrier's trucks, trailers and drivers;
- Best routing combinations; and
- Review of existing delivery windows.

The warehouse had 440 people working in various processes, and the chosen Delta case study on warehouse process involved 41 people out of which 30 people volunteered across the system. The transport section had 280 people working in various processes and the Epsilon case study involved 15 people, including transporter and retail stores. A total of 14 people volunteered system-wide, representing each step in the entire process. The organisation had two shifts operating, one from 4.30 am to 4.30 pm and other from 4.30 pm to 4.30 am. The research covered both shifts, and the researcher extended the time beyond 4.30 pm to collect data.

3.7.3.4. Zeta

The case study Zeta was conducted at large-scale supermarket national distribution organisation that came through as a continuation of the Delta and Epsilon studies. The organisation was a parallel distribution centre under the same corporation and had similar issues:

- Warehouse process (optimal picking, preparing, and docking); and
- Transport process (inspection, loading, sealing and transiting of orders).

The study had similar operations and employees were part of the same trade union as those in Delta and Epsilon. The plant had 250 people in the workplace in two shifts, the Zeta study area involved ten people, and nine volunteered to participate. The organisation had two shifts operating, one from 4.30 am to 4.30 pm and the other from 4.30 pm to 4.30 am. The research covered both shifts. The researcher extended the time beyond 4.30 pm to collect information. The participants of the study were from the warehouse process. The organisation had the same transporter and retail stores as in the Epsilon study, therefore the inputs of Epsilon were considered for transport issues.

3.7.3.5. Eta

The case study Eta was conducted at a large-scale fruit cool store and packing organisation. The initial contact was the Managing Director. The case study was conducted in two seasons, namely, peak season and repack season. The fruit arrived from an orchard in peak season, during which it was inspected, size-segregated, placed in cold storage and retrieved to dispatch, which was at its maximum capacity. During repacking season, the fruits from cold storage were retrieved, re-inspected and dispatched at a steady phase, which is lower by 80% than peak season. The organisation employed a large number of casual labourers during peak season and a minimum number during repacking season. Established in 1971, the privately-owned company employed about 170 permanent staff and about an extra 1,650 seasonal staff between March and June each year and had a turnover of $160 million. The study focused on the process of receiving and executing suggestions from the permanent staff that aimed for continual improvement. The study area involved 21 people, and 19 long-term employees volunteered, along with one consultant. The study involved a Gemba trial which had participation from seven other people.

3.7.4. Statistics

The total number of participants in the study were 106, out of which 99 were observed and interviewed, and seven were engaged in a process improvement study. The study covered all process steps, and a high percentage of participation ensured findings were reliable largely. The case study-wise number of persons in each process, participated, and not participated data are shown in Table 9, below.

Table 9: Case study wise participant information

Study reference	Number of people in the process	Participated	Not participated	% Participation
Alpha	7	6	1	85.71
Beta	9	9	0	100.00
Gamma	14	11	3	78.57
Delta	41	30	11	73.17
Epsilon	15	14	1	93.33
Zeta	10	9	1	90.00
Eta	21	20	1	95.24
Total	**117**	**99**	**18**	**84.62**

The participants were from three levels in the organisation, namely, management, staff, and operators. The case study participant details are tabulated in Table 10 below.

Table 10: Number of participants

Study Reference	Management	Operator	Staff	Total
Alpha	1	4	1	6
Beta	2	6	1	9
Gamma	2	6	3	11
Delta	2	19	9	30
Epsilon	4	1	9	14
Zeta	1	1	7	9
Eta	5	1	14	20
Total	17	38	44	99

The participants were from mixed races, as tabulated in Table 11 below. Nevertheless, this data is to show that participants were from multiple cultures and has no further relevance to this research, as a social culture has not been considered for this research and could be taken up as future research in this field.

Table 11: Participant split

Social culture	Management	Operator	Staff	Grand Total
European	13	16	16	45
Indian	2	2	14	18
Pacific	2	20	14	36
Grand Total	17	38	44	99

The participants had varied years' experience. The mean experience was 17.95 years with a standard deviation of 10.54 years and P value of 0.00003, which implies the significance of participant experience. The experience details are shown in Table 12.

Table 12 Experience of participants

Experience in years	Number of participants
0 - 5 (Trainee)	13
6 - 10 (Adequate)	16
11 - 20 (Reasonable)	35
21 - 30 (Good)	19
31 - 50 (Superior)	16
Total	99

Standard deviation (years of experience)	= 10.54
Mean (years of experience)	= 17.95
P value (years of experience)	= 0.00003

A total time of 2114.64 minutes were spent interviewing the participants. The mean interview time was 20.65 minutes with a standard deviation of 9.11 minutes and P value of 0.0037, which implies the significance of the participant interview time. The interview time of each case study and the level wise split is tabulated in Table 13.

Table 13 Interview time in minutes

Study reference	Management	Operator	Staff	Grand Total
Alpha	12.58	43.91	33.72	90.21
Beta	46.43	105.14	24.66	176.23
Gamma	41.91	134.38	82.87	259.16
Delta	78.69	391.48	240.52	710.69
Epsilon	110.56	14.38	198.93	323.87
Zeta	22.03	47.96	123.71	193.7
Eta	143.35	6.33	211.1	360.78
Grand Total	455.55	743.58	915.51	2114.64
Standard Deviation	=			9.11
Mean	=			20.65
P value	=			0.0037

3.8. Data analysis for this study

The forms of qualitative information gathered in the non-numeric form set the platform for inductive or deductive reasoning processes to decode and construct the knowledge sought (Morse, 1994). Inductive reasoning interprets the data to construct a hypothesis, whereas deductive reasoning interprets data for hypothesis testing to confirm or contradict the hypothesis (Holloway, 1997). In the deductive approach, the pre-determined structure was used by the researcher for qualitative data analysis, whereas the inductive approach was not based on the pre-determined structure and used where the phenomenon was not known earlier (Schwandt, 1997). The current research focused on acquiring knowledge on cognitive biases' influence on Lean tools and waste in a process through a system-wide approach, which involved known factors, such as bias, Lean tools, and waste, and hence the deductive approach was undertaken.

In both approaches, researchers suggest various qualitative data analysis methods:

- Content analysis: The process of categorising data to grade, summarise and tabulate (Pope, Ziebland, & Mays, 2006);
- Narrative analysis: The process of reformulation of stories by the researcher, compiling the different experiences of all respondents, wherein the primary qualitative data was revised by tracking sequences, chronology, stories, or processes in the data (Sandelowski, 1994);

- Discourse analysis: The process of analysing natural talk and all forms of written text considering the social or ideological influences and thrust on the patterns, structures, and language used (Boutain, 1999; Coffey, Beverley, & Paul, 1996);
- Framework analysis: The process of analysis that involves familiarisation, identifying a thematic framework, coding, and interpretation which is closely aligned with pre-determined research interests to seek knowledge that allows focus on specific answers and leaving of the rest (Pope et al., 2006); and
- Grounded theory: The process of single case qualitative data analysis to formulate a theory, followed by subsequent cases for verification of the theory (Strauss & Corbin, 1990).

The current research used the content analysis, narrative analysis, and framework analysis methods of data analysis, as represented in Figure 4, below. The research did not consider the social and ideological influence. Hence, the discourse analysis method was not adopted. Also, grounded theory was not used, as the research aimed at generalising through working on multiple case studies on pre-determined factors.

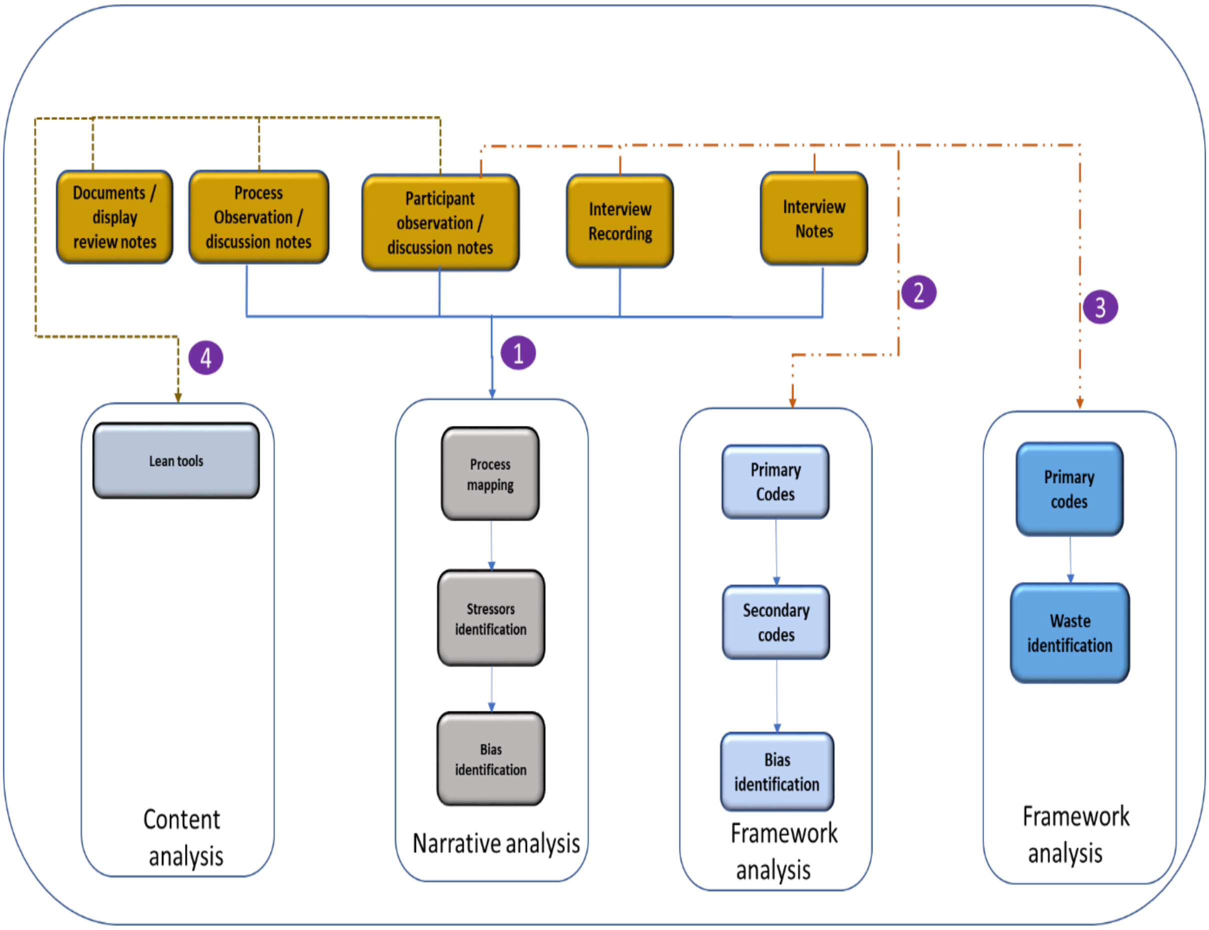

Figure 3: Data analysis methods adopted

The analysis had four pathways. The biases were constructed in two pathways and Lean and waste was obtained from one each, as shown in Figure 3. In the first pathway (1), the data gathered from process observation, participant observation, interview recordings, and interview notes were used to construct the process and identify the process-related biases through narrative analysis. In the second pathway (2), the participant observation/discussions, interview recordings, and interview notes were used to identify system-wide biases through framework analysis. Pathway 1 provided insights of biases related to the seven processes, while pathway 2 provided the insights of participant biases system-wide and provided higher sample size (99) based statistics. Similar to pathway 2, the participant observation/discussion, interview recordings, and interview notes were used to identify waste in the system (3). The documents/display notes, process observation, and participant observation were used to identify Lean tools used through content analysis (4). The research is focused on acquiring knowledge on the cognitive biases' influence on Lean tools and waste in a process through a system-wide approach. The units of analysis were determined for the research as:

- Cognitive bias
- Lean tool
- Waste

The steps involved in the analysis are discussed below.

3.8.1. Narrative analysis: Approach to analyse process bias

The data gathered from process observation, participant observation, interview recordings, and interview notes were used to construct the process and identify the related biases through narrative analysis. The process had the following steps:

- Collective Happening In the Process (CHIP): The analysis started with identifying the happenings in the process, considering the importance of having a system-wide approach to handle a problem. CHIP is the system-mapping diagram used to capture the inputs to the process, process actions, output to process and seepages to the process in complete system-wide happenings. In order to represent process activities, a CHIP mapping was done;
- Plotted pre-intervention process: In the next step, the pre-intervention process was mapped pictorially wherein all the process steps were captured and followed by a brief narration on the steps in the process;
- Stressors in the process: The third step was to identify the stressors in the process based on the observation and interview notes;

- Stressors and biases in the case study: In the next step, the stressors were used to tabulate associated biases using the important and connected words, actions, and behaviour;
- Suggested process: The next step was to analyse the process to find solutions for the stressors and associated biases, which was followed by plotting the improved process;
- Stressors and biases addressed in the suggested process: The details of the stressors and biases addressed in the suggested process were tabulated;
- Summarised the biases: The summary of process biases obtained from the case studies were consolidated and tabulated; and
- Report to the organisation: Process steps 1, 2, 3, and 5 were compiled into a Power Point presentation and presented to the management of each of the case studies to understand the correctness of process and issue capturing, the worthiness of the suggested process and obtained feedback.

3.8.2. Framework analysis: Approach to analyse system-wide bias

The framework analysis was used to analyse the interview recordings and notes to identify system-wide biases and waste. The system-wide bias data analysis followed the approach similar to Pope et al. (2006), the steps involved were:

- Familiarised the data: The data familiarisation was done by listening to interview recordings and reading the process observation, participant observation, and interview notes;
- Identified a thematic framework (the key issues, concepts, and themes): In the next step, the interview recordings and notes were used to identify the themes which participants narrated. The themes were converted into primary codes, which were used to categorise the data. The primary codes were:
    - Automation;
    - Cost, time, and/ or energy;
    - Decision;
    - Examples;
    - External;
    - Group;
    - Management;
    - Negativity;
    - Performance;
    - People;

- Relate;
- Standardisation;
- Trust; and
- Zero (risk or defect).

- Search for themes: Next, the identified primary codes were linked to the 239 biases identified in the literature review, refer to Table 7, section 2.4;
- Review themes: In the next phase, the notes and recordings were read and listened to twice to identify potential primary code, important and connected words, actions, and behaviour and correlated to respective biases. The responses were noted as yes (y) and no (N) for the influence and tabulated participant-wise in a matrix in the excel file; and
- Summary of data: The summarised matrix data were matched to the participant, their position and experience. The matrix structure was visually upfront and aided recognition of patterns in the data empty cells drew attention to differing data.

3.8.3. Framework analysis: Approach to analyse waste

A framework analysis that followed the approach similar to Pope et al. (2006) was used to identify waste data, the steps involved were:

- Familiarised the data: The data familiarisation was done by listening to interview recordings and reading the process observation, participant observation, and interview notes;
- Identified a thematic framework (the key issues, concepts, and themes): In the next step, the interview recordings and notes were used to identify the themes which participants narrated. The themes were converted into primary codes, which were used to categorise the data. The primary codes were:
    - Manufacturing;
    - Environment;
    - Information technology;
    - Decision-making individual;
    - Department or Function;
    - Decision-making cross-functional team;
    - Human resources;
    - Enterprise engagement;
    - Stress; and
    - Methods.

- Search for themes: Next, the identified primary codes that were linked to 10 types of waste, waste definitions and factors from the literature (refer to section 2.3) were familiarised;
- Review themes: In the next phase, the notes and recordings were read and listened to twice to identify potential primary code. The responses were noted as yes (y) and no (N) for the influence and tabulated participant-wise in a matrix in the excel file; and
- Summary of data: The summarised matrix data were matched to the participants, their level and experience. The matrix structure was visually upfront and aided recognition of patterns in the data; empty cells drew attention to differing data.

3.8.4. Content analysis: Approach to analyse Lean tools

The data gathered from process observation, participant observation, and document notes were used to identify the Lean tools status in organisations by following these steps:

- Familiarised the data: The data familiarisation was done by reading the process observation, participant observation, and documents/display review notes;
- Identified a thematic framework and search for themes: In the next step, the process observation, participant observation, and documents/ display review notes were used to ascertain the status of 25 lean tools identified in the literature review (refer to section 2.2, Chapter 2).
- Review themes: In the next phase, the status was noted as implemented, inadequate, not implemented and not applicable. The results were tabulated case study-wise in a matrix in the Word file; and
- Summary of data: The summarised matrix data were matched to the case study. The Lean tools effectively implemented were denoted by "+" and Lean tools that were not effective were denoted by "-". The matrix structure was visually upfront and aided recognition of patterns in the data, empty cells drew attention to differing data.

3.8.5. An interaction between cognitive biases, Lean tools, and waste

In the next phase, the interactions between cognitive biases, Lean tools, and waste were analysed using narrative analysis. The approach to analysing and plot interactions between cognitive biases, Lean tools and waste were:

- Familiarised the data: The identified cognitive biases, Lean tools, and waste data familiarisation was done by reading the results of the analysis that followed methods described in sub-sections 3.8.1, 3.8.2, 3.8.3, and 3.8.4.

- Identified a thematic framework (the key issues, concepts, and themes): The analysis of case study observation and interview revealed the process and system-wide biases, which included nine unfamiliar biases identified during this study. The biases were then analysed based on case study, level, and experience. The percentage mean for each type of analysis based on the number of responses and the number of participants was calculated. Next, the medians for the case study, level, and experience-wise data were calculated. The results were tabulated, indicating the number of participants who identified the biases. The experience, position and case study data, along with the total number of participants and percentage responses were shown in columns. The percentage responses were further subdivided into positive, negative and nil response and shown in the column. The different types of identified biases were shown in rows. The data revealed that the responses for each bias varied, and to identify the predominant biases, the data was analysed for its generalisability. In order to have a fair consideration, the biases above the median of the case study, experience, and position from the results were taken and compared. The data which appeared in all three analyses were considered prominent and referred to as generalised biases. Further, to identify the polarity, the positive, negative and nil response percentages of these generalised biases were noted.
- Search and review for themes: The literature review identified 25 Lean tools, ten types of waste and 239 biases. Out of 239, this research identified 113 prevalent in the industry and further detected nine unfamiliar biases. The results were analysed to obtain 45 generalised biases. In the next step, the process observation, participant observation, documents/display review, and interview notes were read, and interview recordings listened to. Each of the generalised bias primary code, important words, and connected words, actions, and behaviour observed during data collection, alongside the waste primary code and Lean tools, were correlated to tabulate the interaction between:
    - Lean tools and waste;
    - Biases and waste; and
    - Biases and Lean tools.

  The results of the interactions were then plotted in two stages:
    - Interaction between Lean tools and types of waste; and
    - Interaction between generalised biases, Lean tools, and waste.

In the tables that represent the interaction of lean tools and waste, to represent the polarities for the lean tools and waste interactions "-" was used to indicate negative polarity and "+" to indicate positive polarity.

In addition, for the connectivity in system mapping of lean tools and waste interactions, the red dotted arrows represented the Lean tool's influence to reduce waste and blue arrows represented the Lean tool's influence to increase waste. The green arrows represented the various Lean tools' influence to increase process productivity, and orange arrows represented the various waste types' influence to decrease process productivity.

Similarly, the interaction between the three factors, namely, bias, Lean tools, and waste were represented as follows:

- The biases were represented by name;
- Lean tools were represented in a diamond shape; each of the 25 tools was assigned a specific alphabet; for example, 5S was assigned alphabet "A". Colour codes were used to represent the interaction polarity,
  - The polarity of bias that increased the effectiveness of a specific Lean tool was represented in red A ; and
  - Bias that decreased the effectiveness of the specific Lean tool was represented in black and white A .

Wherever Lean tools were sequential, for example, if it was from A, B, C, D, E, F, and G, it was represented as A-G: A - G ;

- Waste was represented by a hexagon shape; each of the ten waste categories was assigned a specific number; for example, manufacturing waste was assigned number "1". Colour codes were used to represent the interaction polarity,
  - Biases increasing waste was colour coded blue and black 1 ; and
  - Biases reduced waste was represented as grey and red 1 .

3.9. Quality control criteria for research design

The reliability and validity of the qualitative research were intellectualised as trustworthiness and rigour in data collection and analysis (Denzin, 1978). Bryman, Becker, and Sempik (2008) affirmed the credibility of data, transferability of results, dependability on method, and auditability as quality criteria of qualitative research. This research followed Denzin (1978)'s approach.

3.9.1. Reliability/ dependability

Reliability depends on the ability to demonstrate organised data and ideas in order to promote understanding (Walliman, 2017). Walliman (2017) affirmed that ethics, large sample size, multiple sites, triangulation, data from a large organisation, careful sampling, and rigorous coding enhance reliability in qualitative research.

For this research, the following seven actions were taken to ensure reliability:

- Ethical research: The primary step to ensure reliability was to design ethical research. The current research was designed to keep the confidentiality of the participant and organisation, participation was voluntary, and people were protected from any risk;
- Large sample size: To ensure reliability, the research was conducted with large participation, 99 participants were involved in seven case studies;
- Multiple sites: To ensure reliability, the research was conducted in five organisations and multiple locations;
- Triangulation: Methods, environment, theory, and data triangulation methods were used to collect the data that assured reliability.
- Data from a large organisation: Smaller organisations or commercial companies' records are difficult to examine for reliability, large organisations were encouraged to participate, six out of seven case studies were from four large organisations;
- Careful sampling: To ensure reliability, importance was given to the quality of participants, who were the actual employees at the workplace and were able to communicate in English so that data could be examined as per the participant experience to achieve generalisability and the development of knowledge; and
- Rigorous coding: The data collection for this research employed three sources of evidence: process direct observation, recorded interviews, and documentation. The data were analysed to set themes and codes that ensured reliability.

3.9.2. Validation:

Validity in research is “the extent of the legitimate generalisability of the results of an experiment” (Walliman, 2017). The validity of research depends on the robust ethical design that used the same protocol all across and carried out in the normal life settings that provided data representativeness of influence on sought variables (Denzin, 1978). Yin (1994) stated that multiple case study evidence establishes the construct validity and reliability, while Carter et al. (2014) argued triangulation is a strategy to achieve validity. Golafshani (2003) emphasised that reliability, validity, and triangulation reflect the multiple ways of establishing the truth. The validity of the current research was ensured by:

- Ensuring the same semi-structured interview protocol was developed and was used for different participants and different case studies;
- External validity was achieved by conducting case studies at seven reliable organisations involving employees as participants;
- The robust ethical design of research aided to obtain data that genuinely reflect the influences of the variables (Cognitive bias, Lean tools, and waste);
- Methods, environment, theory, and data triangulation methods used to collect the data;
- Methods, environment, theory, and data triangulation methods used analyse the data;
- Following the same study protocol and obtaining feedback for all case studies on the reports presented to the senior management team.
- Process observation, participant observation, and document review happened at multiple actual work site;
- Confirmability: The research generalised theory through the analysis of multiple case study data and reported the process improvement to the organisation and obtained feedback on the usefulness of the study;
- Credibility: Following Patton (1999), the credibility was ensured by gathering and analysing high-quality data from mostly large reputable organisations that had implemented Lean, multiple case studies, and triangulation; and
- Transferability: The research was conducted in normal work life settings with high ethical practices to ensure transferability.

The current research adopted ethical practices and was conducted at multiple sites, with the same protocol and triangulation aided to obtain data that genuinely reflect the influences of the variables (Cognitive bias, Lean tools, and waste). The case studies were conducted in normal work life settings with high ethical practices that obtained high-quality data and feedback on the usefulness of the study in mostly large reputable organisations ensuring the reliability and validity of the current research.

3.10. Research strategy summary

For the cognitive study, there is no meaning without understanding the mind. Cognitive factors are not discovered but constructed, and different observers may identify a different set of variables in relation to the same process. The research adopted a narrative inquiry methodology to understand cognitive factors in the work environment, which typically focused on the individuals' experience through their own stories in their work environment. The research methodology choice of narrative inquiry was constituted with an interpretive theoretical paradigm which was firmly grounded with constructivism epistemology and the idealism ontological position. The research method adopted ethical practices and was conducted at multiple sites, with the same protocol and triangulation, which aided in obtaining data that genuinely reflect the influences of cognitive bias, Lean tools, and waste. This was followed by a narrative, framework and content analysis to capture cognitive biases, Lean tools, and waste and their interactions. The case studies were conducted in normal work life settings with high ethical practices that obtained high-quality data and feedback on the usefulness of the study from mostly large reputable organisations, ensuring the reliability and validity of the current research. The choice of the research framework from broader ontological position to the methods adopted for data collection and analysis, adapted from Crotty (1998), is represented in Figure 4, below.

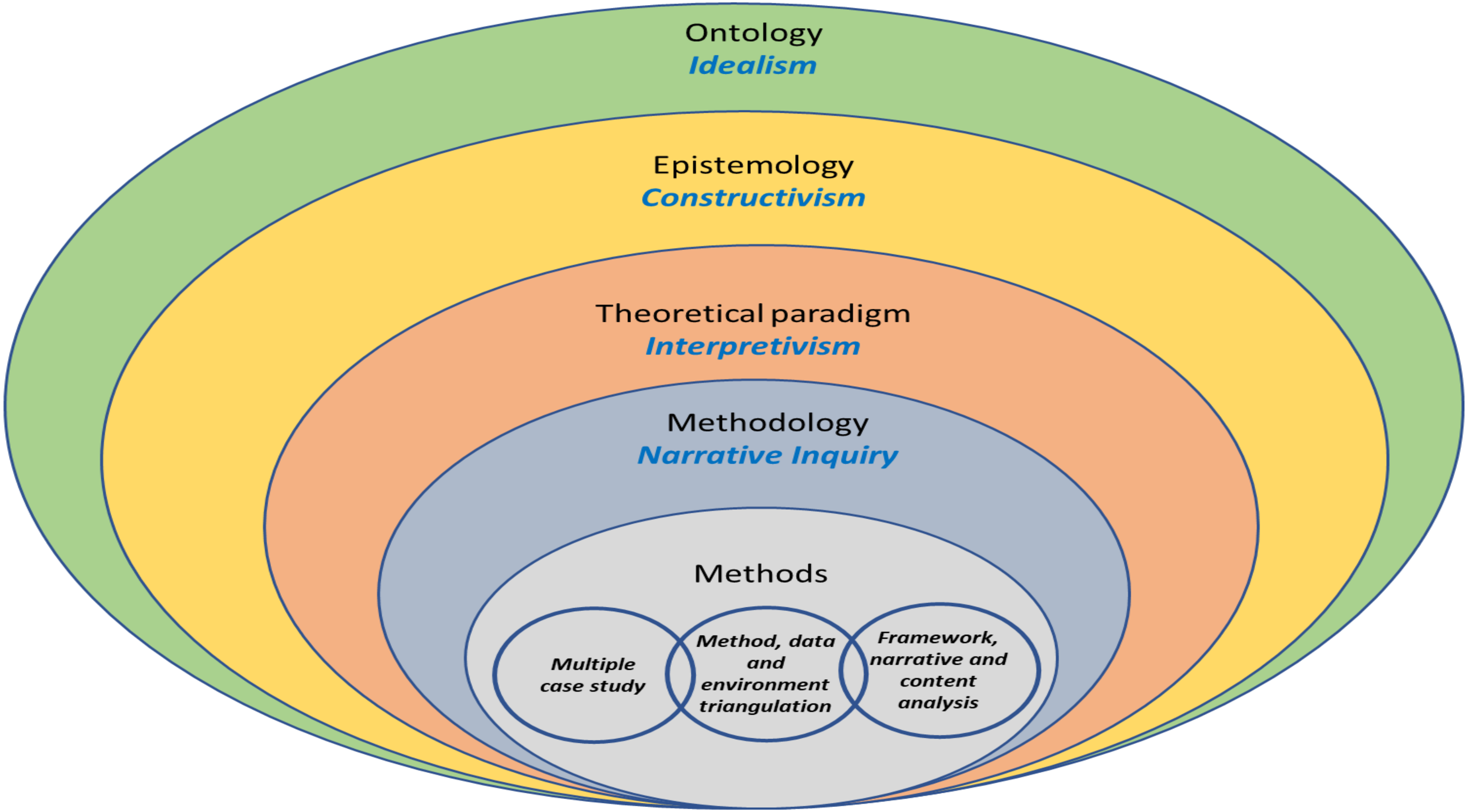

Figure 4: Research strategy

4. Results

4.1. Introduction

This chapter introduces the seven case studies that supported the addressing of the research questions. The case studies are narrated using the theoretical framework embraced in Chapter 3. The introduction and statistics on case studies are explained in section 3.7.3 and section 3.7.4. To obtain comparative data, the same data collection methods that included process observation, documents and display review, participant observation and discussion, and semi-structured interviews with the same set of questions were used. Subsequent to the introduction section, seven case studies are narrated from section 4.2 to section 4.8. The case studies are coded as Alpha, Beta, Gamma, Delta, Epsilon, Zeta, and Eta. Each case study narration is split into sub-sections as below:

- Case study introduction: This sub-section introduces the case study;
- Collective happening in the process (CHIP): It is essential to have a system-wide approach to handle a problem that maps the critical subprocess. This sub-section introduces collective happening in the process, a mapping to have a system-wide approach to handle a problem that included inputs, actions, output, and seepage sub-processes related to the process;
- Pre-intervention process mapping: The process mapped at the beginning of the case study is described in this sub-section;
- Process biases: The stressors and associated biases related to the pre-intervention process is described in this sub-section. The reasons for the stressors combined with the narrative analysis based on process observation, documents and display review, participant observation and discussion, and semi-structured interviews with the same set of questions were the basis for arriving at the associated biases;
- Improved process: This sub-section describes the suggested improved process that focused on the stressors and related bias elimination;
- Lean tool status: The Lean tool status of the process is described in this sub-section. Content analysis based on process observation, documents, display review, and participant observation was the basis to this sub-section; and
- Waste status: The waste status of the process is described in this sub-section. Framework analysis based on participant observation and semi-structured interviews with the same set of questions were the basis to this sub-section.

Additionally, in the Eta case study, a Gemba sub-study; and in Delta and Epsilon case studies, the key issues that aided better understanding of the process, are described. The case studies are followed by section 4.9 that reports the consolidated process bias data and key take away, while section 4.10 discusses the new biases identified. The descriptive statistics on Lean tools, waste, and system-wide biases are detailed in section 4.11, and the chapter concludes with a chapter summary in section 4.12.

4.2. Alpha case study:

4.2.1. Alpha Introduction

The Alpha case study focused on the effects of biases in a printing organisation. The organisation was having issues in people and material movement. The chief executive officer viewed cleanliness as a problem. During the observation process, records (such as order tracking sheet, layouts, and email from customers, customer orders, and purchase orders) were reviewed. Further, the printing, sizing, and binding operations were observed, followed by the interview of people involved in the process. The problem was defined as a cleanliness issue from a management perspective, and the CHIP and 'pre-intervention' process flows were mapped.

4.2.2. Alpha collective happening in the process

The CHIP of Alfa case study is represented in Figure 5 below.

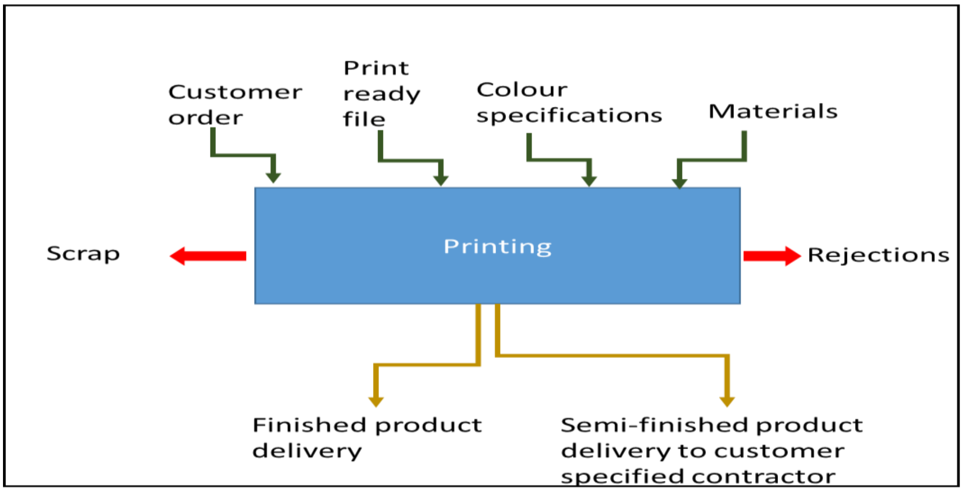

Figure 5: Alpha CHIP

The inputs included customer order, print ready file, colour specifications from customer and materials such as paper and ink. The processing operation was printing; the outputs included finished product delivery to customers and semi-finished product delivery to a customer-specified contractor. The seepages were scrap and rejections. Further to the CHIP mapping and subsequent discussion with the chief executive officer of the plant, the printing process was considered for the study, and a detailed pre-intervention process cycle was plotted.

4.2.3. Alpha Pre-intervention Process

The pre-intervention process is represented in Figure 6 below.

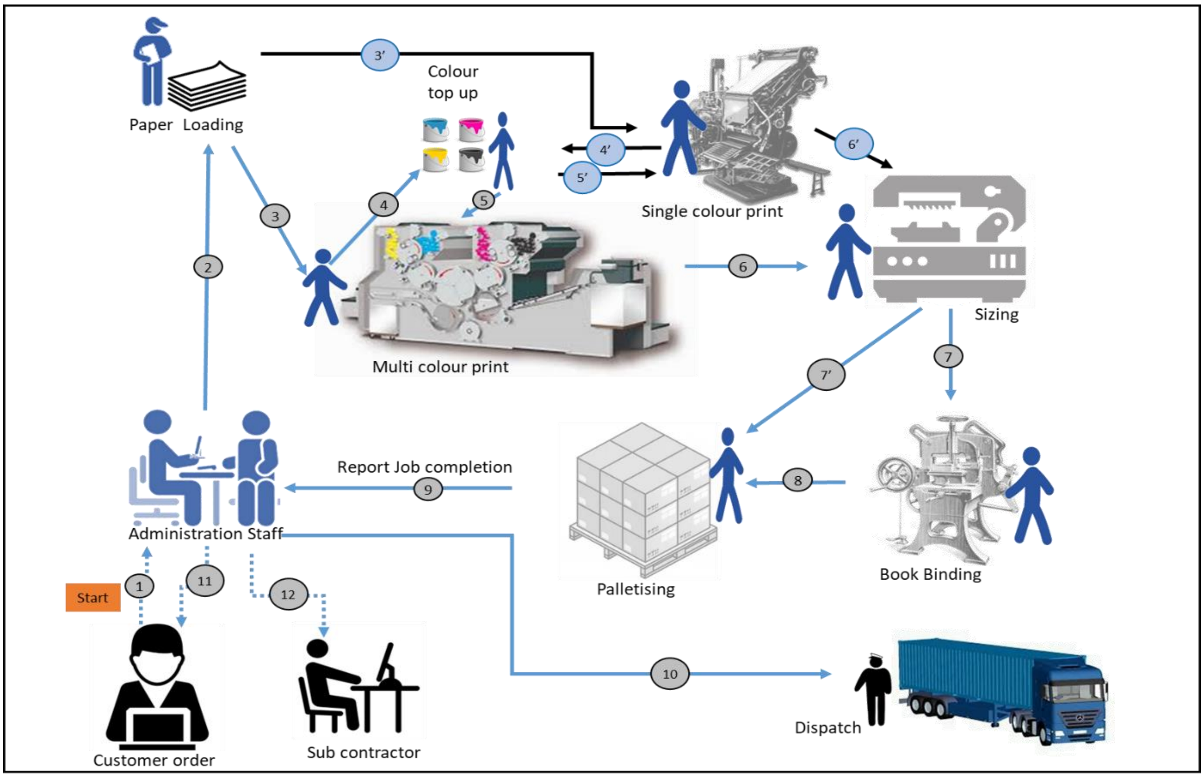

Figure 6: Alpha pre-intervention process

The process started with the receipt of order, print-ready file and colour specifications from the customer (1). The customer order was split into two types, namely, multi-colour and single colour print, which administration staff entered in a stage-wise order-tracking form, and manually handed over to the respective operator for processing (2). The operator then selected the paper according to the size and loaded it on the respective machine (3, 3'). Then the operator topped-up the specified colour ink in the machine, printed, and moved the material for sizing (4-6 / 4'-6'). After sizing, the items were then boxed and palletised (7'). Whenever the order was to be delivered as books, the materials were moved to bookbinding and trimming, and then boxed and palletised (7-8). Subsequently, the operator handed over the duly completed order-tracking sheet manually to the administration staff (9). The administration staff then filled dispatch details in the order-tracking sheet for future reference, arranged the delivery of goods to the customer or their sub-contractor, as specified in the customer order, and notified the concerned parties through email (10-12). The process had various stressors that affected the process productivity.

4.2.4. Alpha process biases

The study revealed that the process had been impacted by various stressors, as shown in Figure 7 below.

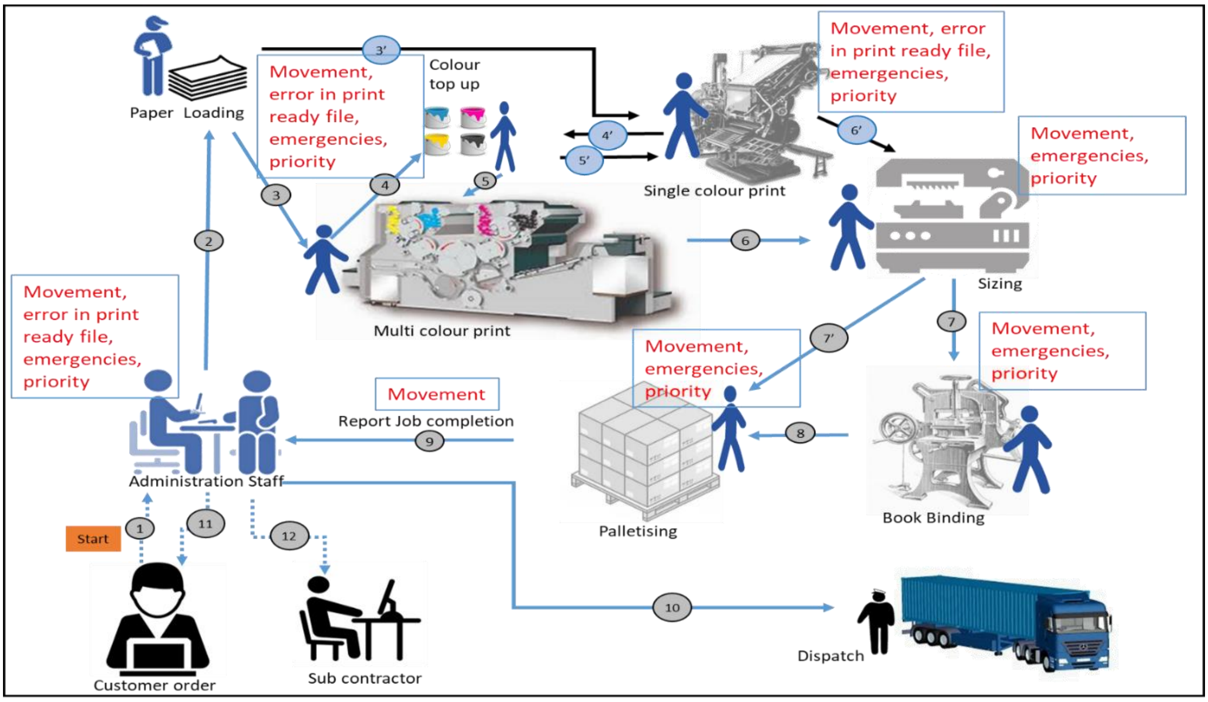

Figure 7: Alpha stressors

The process stressors and associated biases influences are shown in Table 14.

Table 14: Alpha stressors and associated biases

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Movement	Physical	Performance, health, and safety	Difficulty in material movement.	Bandwagon effect, bounded awareness, in attentional blindness, overdo, and no time and energy.
Error in print ready file	Low job control	Performance	Three out of seven customers supplied print ready files had issues, administration staff reached out to customers on phone and email, followed up and received corrected files.	Overdo, fear of job loss, fear of failure, and wrong information.
Priority and emergencies	Emergencies	Role	People were driven by customer priorities and emergencies due to print ready file and movement related delays combined with three-day delivery commitment.	Priority and long work.

Discussion with the management, staff, and operators revealed that the critical issue was difficulty in movement, which consumed their time and energy. The movement of the operators and material was observed and mapped (refer to Figure 8). The printing followed two pathways, auto print and manual print, which are denoted by red and blue lines. The congested layout and operations provided scope for improvement.

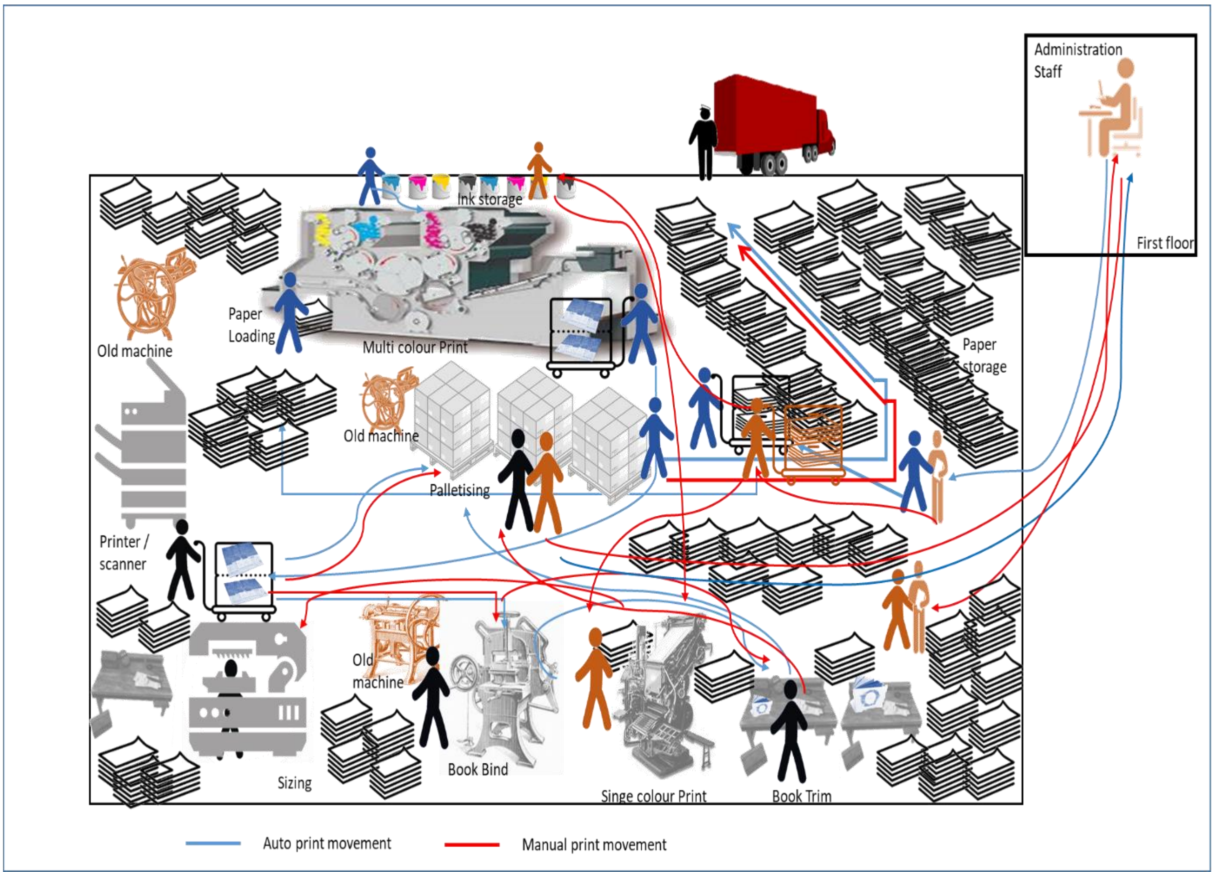

Figure 8: Alpha movement mapping

4.2.5. Alpha suggested process improvements:

The case study analysis revealed that a change in layout would ease movement and reduce the stressors and biases in the system. The changed layout recommended, was a “U shape” material flow, as shown in Figure 9, that positioned the multicolour and single colour machines next to each other. The sizing, bookbinding, book trimming and palletising are to be placed in sequence with storage space for work in progress. The working area is denoted in green and the walk area is denoted by yellow. The suggested process movement mapping indicates the improved access and uncomplicated movement. The layout could include a display area where the status of current jobs, timelines, completed jobs, delay, defects, and suggestions would be displayed.

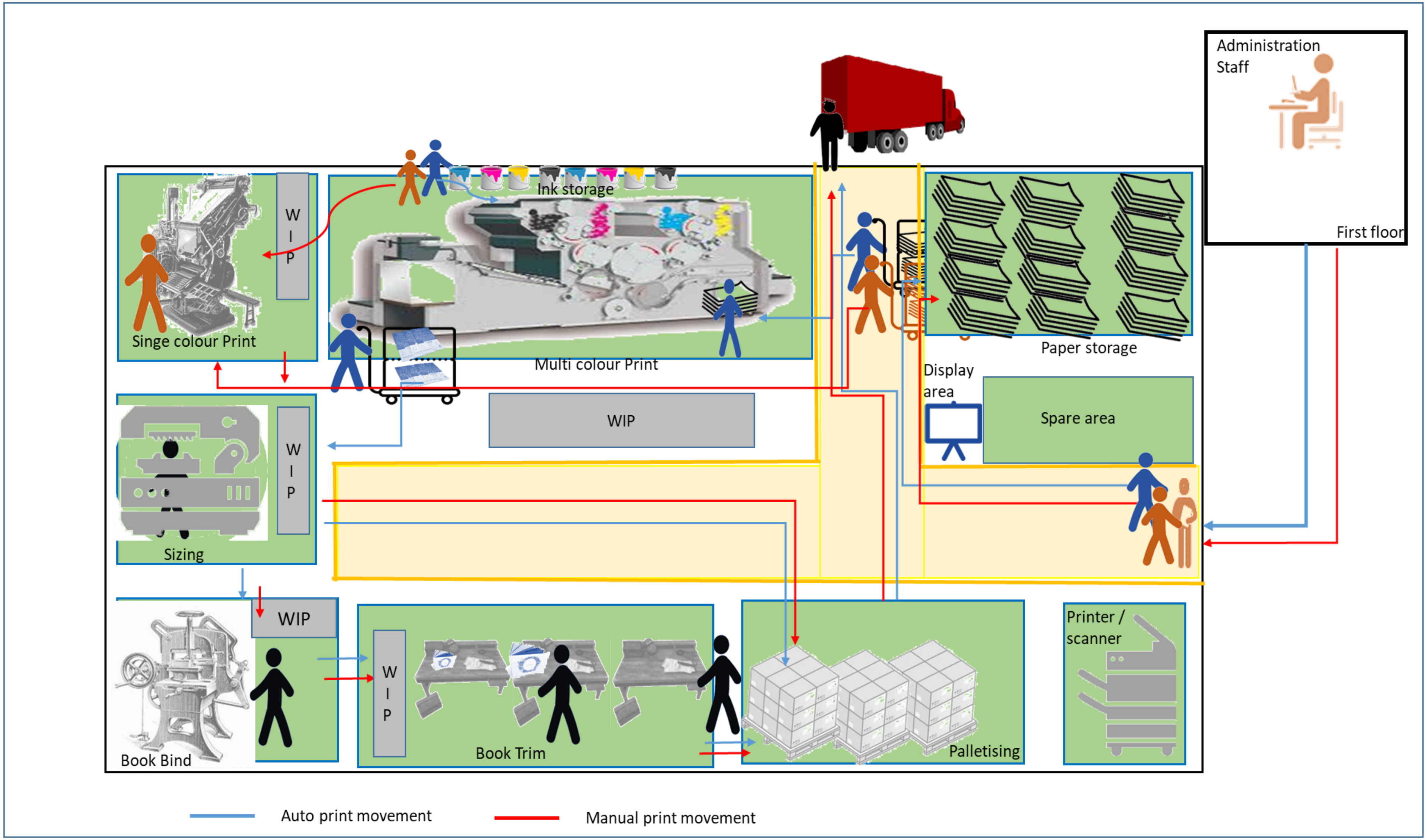

Figure 9: Alpha suggested movement mapping

The suggested process addressed the stressors and biases, which are shown in Table 15 below.

Table 15: Alpha suggested process stressors and biases predicted status

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Movement	Physical	Performance and Health and safety	The revised layout would facilitate uncomplicated material movement.	Bandwagon effect, bounded awareness, in attentional blindness, overdo, and no time and energy.
Error in print ready file	Low Job control	Performance	Three out of seven customers supplied print ready files had issues, administration staff reached out to customers on phone and email, followed up and received corrected files: the problem would exist post-intervention.	Overdo, fear of job loss, fear of failure, and wrong information.
Priority and emergencies	Emergencies	Role	Emergencies and priorities communicated through a display board. Improved layout reduces the movement and time which would aid in serving emergencies.	Priority and long work.

The layout change requirement was communicated to the chief executive officer; the verbal feedback was that the layout change needed investment and a temporary shutdown of the facility, hence they would take up improvement at an appropriate time.

4.2.6. Alpha Lean tool Status

The case study revealed the status of Lean tools used and the waste prevalent in the system. The status of the Lean tools used is shown in Table 16 below.

Table 16: Alpha Lean tools status

Tool	**Status**	**Remarks**
5S	Not maintained	Poor 5S observed that restricted movement and affected safety.
Andon	Not implemented	No displays or status board was available on the shop floor, Andon would aid productivity increase.
Bottleneck Analysis	Partially implemented	Not systematically captured as required for the operation.
Continuous Flow	Not Implemented	Layout change needed, required for the operations, eased movement, and safety.
Gemba	Implemented	Gemba for customer complaints evidenced.
Heijunka	Partially implemented	Priority-driven processes, work scheduling not evidenced. Priorities often shift, people struggle in daily routine.
Hoshin Kanri	Not implemented	Require recurring time and cost to implement.
Jidoka	Not implemented	Automation was not considered in the near future due to sunk cost and additional investment.
JIT	Partially implemented	Ordered as and when required or when the shortage was noticed.
Kaizen	Implemented	Operator and staff suggestions for small cost implemented for motivation was evidenced. However, a systematic analysis of suggestions not evidenced.
Kanban	Not implemented	Not evidenced.
KPI	Implemented	Customer KPI on quality and delivery were set as organisation KPI. However, individual KPI not evidenced.
Muda	Partially implemented	Not systematically captured.
OEE	Not implemented	Contracted maintenance, OEE measurement not evidenced.
PDCA	Implemented	For each order, a PDCA job card was used. However, for change management PDCA not evidenced.
Poka-Yoke	Not implemented	Inbuilt error deduction system in one machine evidenced. Other machines were without error proofing. For example, the sizing machine, which has sharp blades lacked fool proofing.
RCA	Implemented	Job cards were used to analyse and respond to customer complaints and internal rejections.
SMED	Not implemented	Set up change time averaged ½ hour for the auto printer and 10 minutes for the manual printing machine.
Six Big Losses	Not implemented	Not captured. Data capturing will aid to reduce cost.
SMART Goals	Not implemented	Smart goals were not evidenced.
Standardised Work	Not implemented	Standard operating procedures (SOP) not evidenced.
Takt Time	Not implemented	Not evidenced for one time orders, recurring orders fixed as three days based on customer requirement.
TPM	Not implemented	Not evidenced.
VSM	Not implemented	Not evidenced.
Visual Factory	Not implemented	Not evidenced, required for the operations.

4.2.7. Alpha waste status

The case study observation revealed various types of waste in the system, as shown in Table 17 below.

Table 17: Alpha waste status

Waste	**Participants confirmation**	**Remarks**
Manufacturing waste	6/6	All waste types were evidenced.
Environment waste	6/6	Paper, ink spill, diesel forklift, and power waste evidenced.
Information technology waste	2/6	Glitches in files and emails evidenced.
Decision-making individual waste	6/6	Procrastination evidenced.
Department or Function Waste	0/6	No established procedures or policies were available.
Decision-making cross-functional team waste	0/6	No cross-functional teams.
Human resources waste	6/6	Lack of training and knowledge sharing on Lean tools.
Enterprise engagement waste	1/6	External audit suggestions were reported as less useful.
Stress Waste	6/6	Stress evidenced in daily job routine.
Methods waste		
Design waste	0/0	Layout design had material and physical movement difficulty.
Overhead waste	0/6	No supervisory staff.
Eagerness waste	6/6	In the absence of SOP, different operators perform the same job differently based on their experience.

4.3. Beta case study:

4.3.1. Beta introduction

The Beta case study focused on the effects of biases in the material procurement ordering and receiving process at an electricity distribution networks facility. The organisation was having issues with meeting their KPIs to its customers. Management’s view was that the stores’ stock variation and periodic counting had correctness and reconciliation issues, while people struggled and were stressed, and attrition in the department was high. The manual process had variation, delays, incorrect data entries, missing process, and integrity issues, which resulted in non-adherence to customer commitment, cost overshoot, and delays in restoring the power supply.

During the observation process, records (such as stock transaction files of 2017, purchase orders, graphs, KPI, layouts, continuous improvement sheets, manual material requests, emails from allied departments, picklist, bill of materials (BOM), and human resources policy displays) were reviewed and noted. Further, the operations of stores, fault teams, and project teams were observed. It included receiving, issues, other departments picking material from stores, internal customer response, procurement coordinator interaction, project material storage, stock taking, and storage. In addition, the Workbench (IT system) workings, Tab usage, and allied data entries were observed. During the case study, a massive power outage happened due to unpredicted weather conditions that demanded the highest efficiency from people and processes. The problem was defined from a management perspective as a stock variation and stock counting issue and CHIP was mapped.

4.3.2. Beta collective happening in the process:

The CHIP inputs included material receiving, positive adjustments of stock variation, material returned from the field, and system update of unaccounted items. The processing operation was stores that performed storage and retrieval, and the outputs included material issues to a fault and projects, material transfers to other depots and negative adjustments of stock variation. The seepages were scrap and rejections, and the CHIP is shown in Figure 10 below.

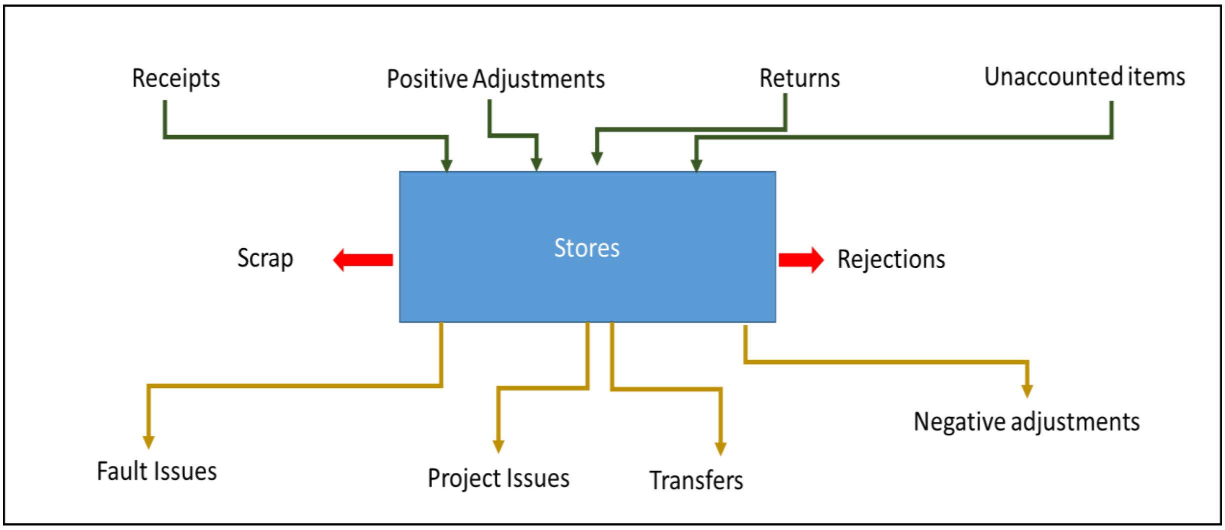

Figure 10: Beta CHIP

4.3.3. Beta pre-intervention process

For the study, the receipt, fault issues, and project issues were considered, and a detailed pre-intervention process cycle was plotted, as shown in Figure 11 below.

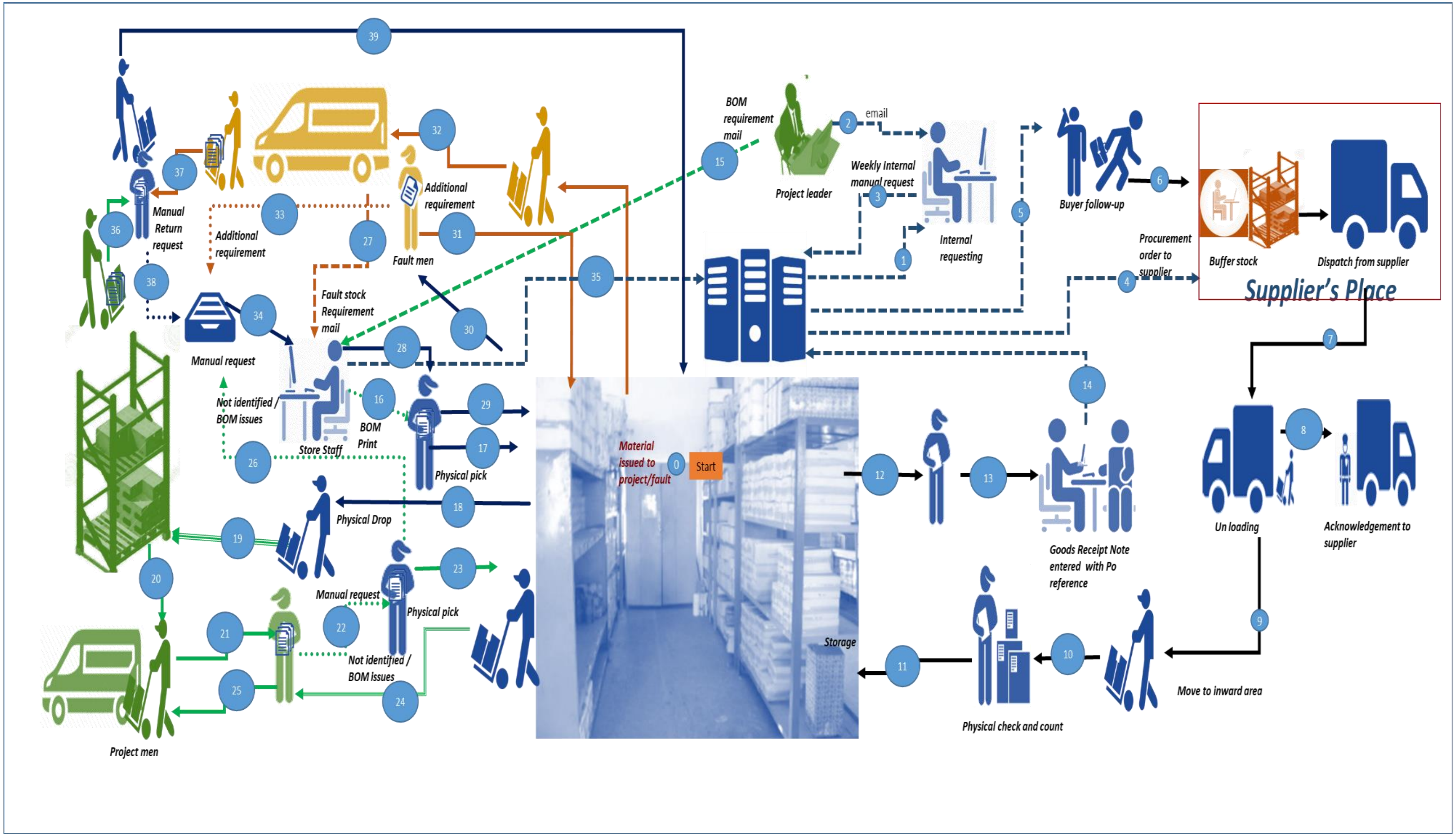

Figure 11: Beta pre-intervention process

The process started with the stores running short of components/materials and requesting more materials (1). Every Monday, the staff verified the system stock, identified shortages that were subsequently checked physically. The project leaders (2) had by then sent the new requirements by email, which the internal requesting staff used to estimate material requirements based on previously fixed minimum/ maximum order quantities, and electronically send the orders to suppliers/ buyers and thus initiated a follow-up with the supplier (3-5). On receipt of the order, the supplier would then arrange the parts within the agreed lead-time and dispatched them, giving their part number, on a pre-agreed fixed day of the week (6-7). Then the supplier vehicle reached the stores, where the physical unloading (8) was done, and a receiving acknowledgement was signed in the copy invoice or packing slip and given to the vehicle driver. The package was then opened and counted (9-10), and materials were dropped in the pre-allocated storage bin (11). Whenever the pre-allocated bin was full, the material was stored at the top row of the respective rack. Then, correlating supplier part number to the organisation part number, the goods receipt entries were updated in the information technology (IT) system using workbench software (12-14).

The issue process started when the project leader sent an email for a BOM-based requirement (15). The BOM print was then taken, and the materials were picked and dropped in the project leader's designated rack (16-19). The project staff picked the material, checked for 100% part availability and identified the BOM error to raise a manual paper request and physically handed it over to store staff, upon which the store staff picked and handed the materials to them (20-25). The manual request was then placed in a tray for updating later. Simultaneously, the fault men from the field came to stores, picked the material they needed, updated a manual paper request, and handed over to store staff, and took the material (27-33). The manual paper requests were updated the next day or later, whenever store staff found time to update (34-35). Since the transaction updating was delayed and not online, the internal requesting person had to check stock physically and adjust the quantity requirement manually in the IT system before sending the electronic weekly order to suppliers. The process was manual dependent and was influenced by human cognitive biases.

4.3.4. Beta process biases

The study revealed that the process had been impacted by various biases, which were due to the system stressors. The observation and discussion revealed the stressors in the process (refer to Figure 12), and the process stressors association to biases are shown in Table 18.

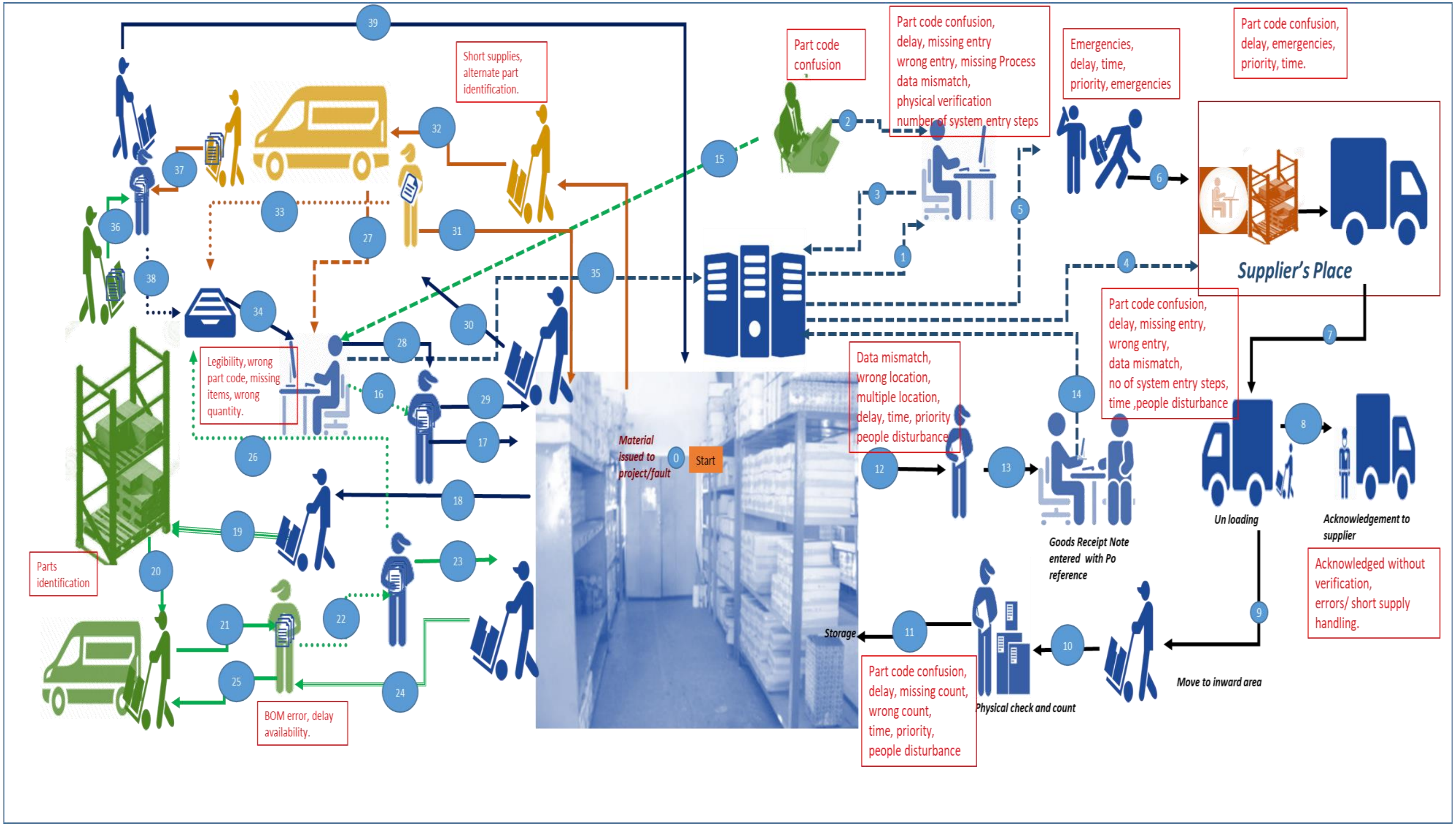

Figure 12: Beta stressors

Table 18: Beta stressors and associated biases

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Acknowledged without verification	Low job control	Role	The staff provided acknowledgement without verification to truck drivers due to lack of control, trust on supplier, and scarcity of time.	No time and energy, lack of control, and anti-trust.
Alternate part identification	Communication	Intellectual discretion	Standard alternate part code list was unavailable, and people relied on installation catalogues to identify alternates.	Standardisation and congruence.
Availability	Information	Intellectual discretion	Staff held information within the group and had little concern for problems to other departments.	In-group–out-group and bounded awareness.
BOM error	Data mismatch	Performance	Field staff relied on the IT system and missed information other than the IT system, standard BOM and alternate part codes list was unavailable, and BOM not updated periodically. However, field staff acted enthusiastically and pushed stores staff for parts ignoring stores staff difficulties.	Automation omission, standardisation, reactance, bandwagon effect, in attentional blindness, and bounded awareness.
Data mismatch	Data mismatch	Performance	Different reports (system reports) gave different outputs.	Wrong information.
Delay	Time	Role	People worked based on priority and were unaware of the consequences to others when there was a delay.	Bounded awareness, fear of failure, and priority.
Emergencies / priority / time	Emergencies	Role	People were driven by priorities and emergencies instead of the process.	Priority and escalation of commitment.
Errors/ short supply handling, missing entry, missing items, and missing process	Low job control	Role	People updated wrong details, omitted short supplies update and part physical count.	Endogeneity, and levelling and sharpening.
Multiple locations	Data mismatch	Performance	Followed old practice and inclined to superior’s views and kept multiple locations.	Bandwagon effect and herd instinct.
No of system entry steps	Data entries	Monotonous work	Too many steps in IT system entries.	Overdo
Part code confusion	Communication	Intellectual discretion	The suppliers had their part code mentioned in their invoice rather than customer part code. The store staff worked with an outdated conversion chart. The other department people were unaware of the part codes, did not have a part code list and worked with assumption while requesting the items.	Standardisation and congruence.
Part identification	Data mismatch	Performance	Parts did not have an identification that connected to the supplier or customer code.	Standardisation and congruence.

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Parts identification difficulty	Physical	Health and safety	Store staff placed items in the designated project team racks without identification, easy retrieval by project men was not considered.	Bounded awareness.
People disturbance	Priorities	Role	People frequently disturbed store staff without realising their roles and responsibilities.	Bounded awareness.
Physical verification	Physical	Health and safety	The stock was physically verified every time to ensure transactions or to highlight problems.	Overdo.
Short supply	Criticism, trust deficit, suspicion	Role	The supplier provided wrong information on the quantity supplied. Store staff trusted the suppliers and had not verified quantities at times.	Wrong information and anti-trust.
System verification	Criticism, trust deficit, suspicion	Role	The internal requestor had not trusted the system stock and requested stock verification before ordering. The staff was not provided with the system stock while stock talking due to a trust deficit.	Anti-trust.
Writing legibility	Data entries	Monotonous work	People were unaware of the issues that raise to store staff due to illegible writing in the manual request form.	Bounded awareness.
Wrong entry	Data entries	Monotonous work	Staff entered wrong information on item transactions.	Wrong information.
Wrong part code and wrong quantity	Data mismatch	Performance	Staff provided wrong part code information on item transactions without realising the effect on the system.	Bounded awareness and wrong information.

4.3.5. Beta suggested process improvements

The case study analysis revealed that the process could be improved by understanding the stressors and biases in the system. The variation in stock may be any percentage, but even if a nut of 5 cents value was not available, the fault rectification or project would be stopped/delayed. Hence the focus was process improvement based on material flow, without considering value associated. The data regarding 12 months of reactive priorities and emergencies material requirement data were downloaded and analysed. The analysis and subsequent discussion with the store team lead to maintaining a 3-day stock of 788 items exclusively for reactive emergencies. In addition, one-time stock verification and system correction were recommended, and future ordering was to be based on system stock and a multi-bin storage process. It was recommended to change the layout to have a single location for an item stored in multiple bins. Moreover, the alternate part codes catalogue was recommended to be made available to all relevant people. The suggested process is shown in Figure 13 below.

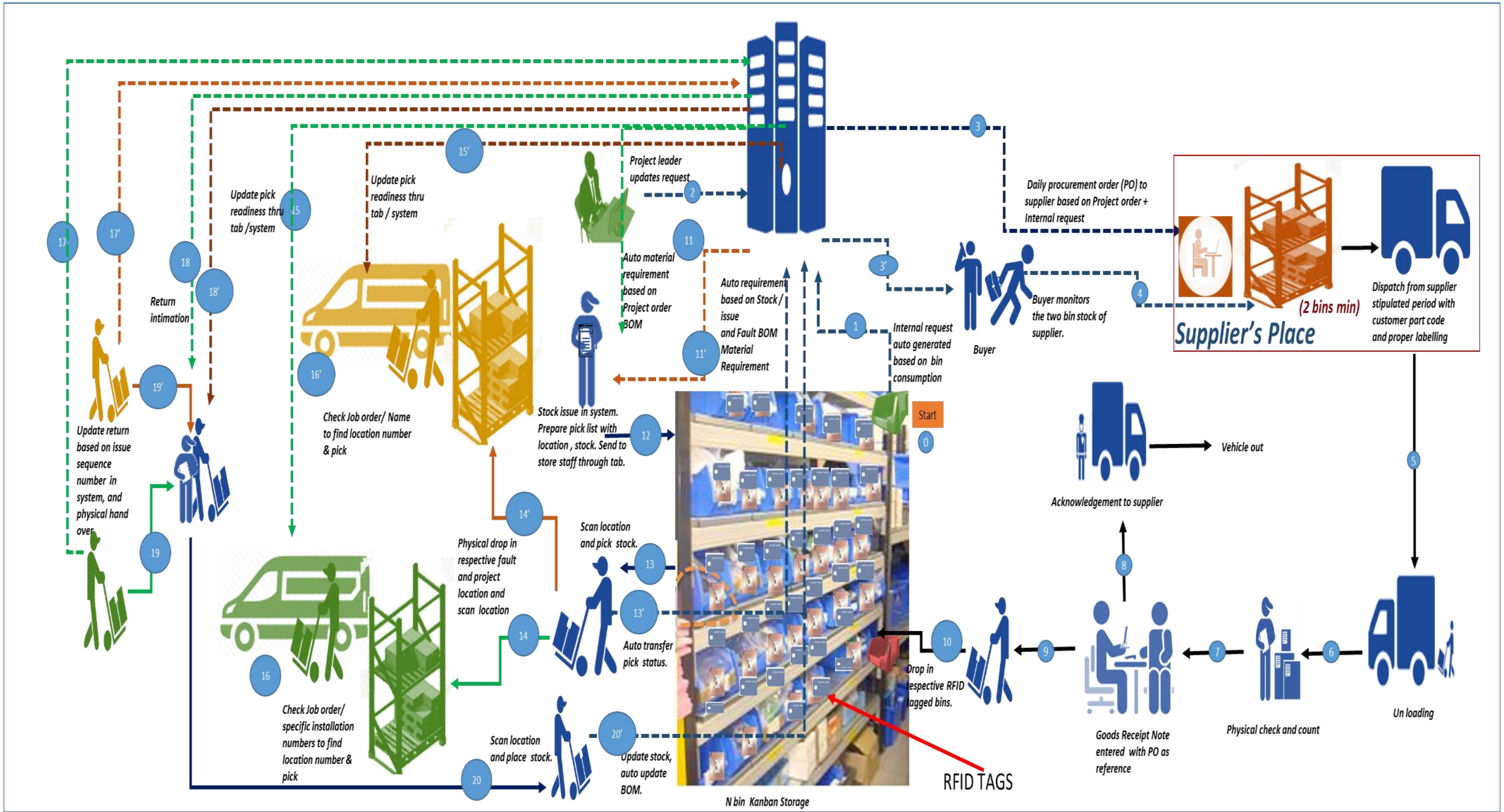

Figure 13: Beta suggested process

The suggested improved process focused on online updating of all relevant data and daily communication with all stakeholders. In the suggested process, on a daily basis, once the stock reached the predetermined level (1), the IT system would consider the new requests updated in the IT system by the project leader, to calculate the material requirement (2) and electronically send the procurement order to the supplier and buyer (3). The buyer would call or visit a supplier and monitor the stock level at the supplier to ensure continuous supplies (4). The supplier would dispatch the material through his vehicle in a stipulated period with customer part number and proper labelling (5). Once the vehicle reached the company stores, the store staff would unload, check, count, and prepare an electronic Goods Receipt Note in IT system based on the order number and give acknowledgement to the supplier representative within half an hour’s time (6-8). Then the material would be moved manually and stored in RFID tagged bins at pre-determined locations (9-10).

A daily material pick list would be auto-generated by the IT system based on both the fault men consumption and project requirement and sent to store staff (11). The store staff would update material issued the in IT system using a Tab, and the IT system would send the pick list with the location to the store picker for a physical material pick up (12). The picker would then scan the location, pick the specified quantity in a box, drop the parts in respective racks allotted for fault men or a specific project, and scan the drop location and report to store staff on shortages, if any, for a stock adjustment (13-14). The system would send the drop location information to the respective fault men or project team who would pick the material from their respective racks (15-16) and use in the field. In the next stage, whenever there was unused material in the field, the fault men or project team would update the return note based on the issue number in the IT system and physically return the material to the store. The store staff would then count, scan, and drop the material in the respective location and update the received quantity using the tab (17-20). Then, the system would auto update stock and send the material return information to the project leader for further corrections in BOM (20'), and the cycle would be repeated.

The suggested process addresses the stressors and biases, are shown in Table 19 below.

Table 19: Beta improved process stressors and biases predicted status

Process stressors	**Primary stressors**	**Resultant stressors**	**Improvement in the suggested process**	**Associated biases**
Acknowledged without verification	Low job control	Role	The staff provided acknowledgement after physical verification (refer steps 7-8).	No time and energy, lack of control, and anti-trust.
Alternate part identification	Communication	Intellectual discretion	The process operated on materials issues updated in the IT system and alternate part code list.	Standardisation and congruence.
Availability	Information	Intellectual discretion	All relevant information was made available, and the system sent the location, readiness, and stock detail to fault and project team members (refer to step 15-16).	In-group–out-group and bounded awareness.
BOM error	Data mismatch	Performance	The process operated on materials issues updated in IT system that demanded BOM accuracy.	Automation omission, standardisation, reactance, bandwagon effect, in attentional blindness, and bounded awareness.
Data mismatch (system reports)	Data mismatch	Performance	Since the internal requesting was automated, the process would not require reports for day-to-day operations.	Wrong information.
Delay	Time	Role	The process would be online and linked to subsequent steps, which ensure staff doing their job on time. Further, the process followed the first-in-first-out principle that combined with automation and online update to reduce the delays arising out of the system design.	Bounded awareness, fear of failure, and priority.
Emergencies / priority / time	Emergencies	Role	The process would follow the first-in-first-out principle that combined with automation and online update to reduce the emergencies arising out of the system design.	Priority and escalation of commitment.
Errors/ short supply handling, missing entry, missing items, and missing process	Low job control	Role	The process steps would ensure that the materials are accurately accounted and placed in a location (refer to 6-8).	Endogeneity, and levelling and sharpening.
Multiple locations	Data mismatch	Performance	The process would have predetermined, mostly single location.	Bandwagon effect and herd instinct.
No of system entry steps	Data entries	Monotonous work	The entries at each stage would be linked, and this reduced the number of update steps. For example, the goods receipt note was based on a purchase order. Once the store staff entered the purchase order number, it would	Overdo.

Process stressors	Primary stressors	Resultant stressors	Improvement in the suggested process	Associated biases
			display the item and quantity ordered and staff updated received quantity that reduced the number of steps from five to two.	
Part code confusion	Communication	Intellectual discretion	The supplier would supply the items with customer part code.	Standardisation and congruence.
Part identification	Data mismatch	Performance	The supplier would supply the items, with visible identification slip or tag at receipt stage.	Standardisation and congruence.
Parts identification difficulty	Priorities	Role	Store staff place items in the designated racks and scan the location to update in IT system. The IT system subsequently intimates the fault or project staff on readiness and location of the materials that reduce part identification difficulty (refer to step 14-16).	Bounded awareness.
People disturbance	Physical	Health and safety	The process would be online, and information sent to relevant persons through the IT system reduce disturbance to store staff.	Bounded awareness.
Physical verification	Priorities	Role	Physically verification would be reduced to annual cycle count as the system would be online, and all defects are highlighted instantly.	Overdo.
Short supply	Criticism, trust deficit, suspicion	Role	The staff provide acknowledgement after physical verification and enter the correct quantity in the IT system thus capture short supplies (refer to steps 7-8).	Wrong information and anti-trust.
System verification	Criticism, trust deficit, suspicion	Role	The internal requestor role would be eliminated as the system automatically generate request on predetermined logic.	Anti-trust.
Writing legibility	Data entries	Monotonous work	All entries would be in the IT system that eliminates manual writing.	Bounded awareness.
Wrong entry	Data entries	Monotonous work	Reduce due to system design, however, the problem may exist due to stock adjustment manual updates in process design.	Wrong information.
Wrong part code	Data mismatch	Performance	The process worked on requirement generated through the system, this eliminates part code confusion at stores. However, there exists a possibility of fault and project team updating the wrong part code in the IT system.	Bounded awareness and wrong information.
Wrong quantity	Data mismatch	Performance	Since store staff would pick and supply the items as per the material pick list generated by the IT system that would reduce the wrong quantity issued. However, physical mistakes possibility existed (refer to step 11-14).	Bounded awareness and wrong information.

The report was presented to the management team, and they confirmed the pre-intervention process and acknowledged stressors. Further, the management team, based on the recommendation, implemented a layout change and single location (evidenced by the researcher) and communicated that the store staff unloaded, checked, counted, and prepared an electronic Goods Receipt note in the IT system. Management considered and started implementing 3-day stock of 788 items exclusively for reactive emergencies (evidenced by the researcher), and other recommendations were sent to a project team for further consideration. The feedback was received during the presentation and later by an email. Management and staff acknowledged the friendly and professional manner in which the study was conducted.

4.3.6. Beta Lean tool Status

The case study revealed the status of Lean tools used. The status of Lean tools used is tabulated as shown in Table 20.

Table 20: Beta Lean tool status

Tool	Status	Remarks
5S	Partially implemented	Difficulties noticed in stores operation due to poor 5S.
Andon	Partially implemented	Process details were not online, policy and health and safety data were continuously displayed.
Bottleneck Analysis	Partially implemented	The team needed to analyse bottlenecks in the process and resolve.
Continuous Flow	Partially implemented	Layout change needed that involved cost, resources, and energy.
Gemba	Implemented	Gemba practised when internal/external customer complaints were received, but details were not recorded systematically.
Heijunka	Partially implemented	Levelled scheduling would reduce process strains.
Hoshin Kanri	Implemented.	Policy deployment at a higher level was evidenced. However, individual departmental policy and breakdown to a finite level not evidenced.
Jidoka	Partially implemented	Inadequately IT automated procurement order and material pickup process.
JIT	Partially implemented	Despite IT and bin-based system at stores, materials were ordered manually based on email request and physical stock.
Kaizen	Implemented	Selective but systematically implemented. However, in most cases, the feedback was deficient. Workers and staff suggestions on the small cost were implemented to motivate them.
Kanban	Partially implemented	Manual requesting and min/max quantity-based system was used.
KPI	Implemented	Departmental KPI and customer KPI on quality and delivery were well understood across all positions. However, KPI for individuals, catch ball concept to set targets was not evidenced.
Muda	Partially implemented	Not systematically captured. However, people work to reduce based on their belief.
OEE	Partially implemented	Forklifts OEE not calculated.
PDCA	Partially implemented	Just do it culture, actions were mostly top-down approach, and open discussions were not evidenced.
Poka-Yoke	Not implemented	Error proofing in the process not evidenced.
RCA	Implemented	Root causes for customer complaint evidenced, however, internal issues analysis not evidenced.
SMED	Not applicable	No setup changes in the process.
Six Big Losses	Not applicable	Only three equipment were available (two hand pallet truck and one forklift).
SMART Goals	Partially implemented	Organisational goals evidenced. Individual and department or function level not systematically passed to individuals.
Standardised Work	Implemented	SOP available, however not followed, revisited, and updated periodically.
Takt Time	Not implemented	Capturing TAKT time requirement from internal stakeholders would improve the performance of stores and organisation.
TPM	Not implemented	Not evidenced.
VSM	Not implemented	VSM not evidenced. VSM would enhance productivity.
Visual Factory	Partially implemented	Evidenced area markings, safety, and policy display; adopting a complete visual factory approach would solve existing issues.

4.3.7. Beta waste status

The case study observation revealed various types of waste in the system, as shown in Table 21 below.

Table 21: Beta waste status

Waste	**Participants confirmation**	**Remarks**
Manufacturing waste	9/9	All types of waste were evidenced.
Environment waste	9/9	Reusable corrugated boxes sent to landfill, diesel forklift polluted the air and power waste such as excess lightings.
Information technology waste	9/9	Tab issues such as slow, poor Wi-Fi and data coverage, not user-friendly, and inadequate training reported. Too many update steps were required for updating a transaction, and reports did not provide all required information.
Decision-making individual waste	9/9	Relaxed working in the absence of priorities and emergencies, and transactions not updated in time.
Department or Function Waste	9/9	Policy and procedure were reported as elaborate or inadequate. Approval procedures were lengthy and passed through positions induced delay. The weekly stock check was mandatory which consumed time and energy.
Decision-making cross-functional team waste	3/9	Delay in an agreement between departments and implementation of suggestions was reported.
Human resources waste	9/9	People reported a lack of training in IT and Lean skills. Attrition issue reported at stores.
Enterprise engagement waste	2/9	Audits were reported as formalities and at times blame focused.
Stress Waste	9/9	Stress evidenced to complete the priorities and emergencies, after fixing an issue, people remained idle to get over the stress. Attrition reported due to stress.
Methods waste		
Design waste	0/9	Inefficient process design and process steps evidenced.
Overhead waste	6/9	The hierarchy was evident, the supervisors and managers did not focus on eliminating the root cause of the problem.
Eagerness waste	6/9	In order to solve emergencies, people deviated from SOP, missed entries and transactions.

4.4. Gamma case study

4.4.1. Gamma introduction

The Gamma case study focused on the effects of biases in fault rectification of an electricity distribution networks company. The organisation was having issues with meeting their KPI to its customers. Management's view was that the fault processes had issues, while people were struggling and stressed. During the case study, GIS fault monitoring system, workbench (IT system), and operations of fault men (from customer call to work completion) were observed and noted. Further, KPI records, graphs, continuous improvement sheets, tab usage, vehicle monitoring, picklist, BOM details, fault process, van stock talking, van stock, and depots functioning were observed. The problem was defined from a management perspective as issues in fault process. The process had emergencies, missing process, missing entries, traffic regulations, traffic density, and material availability issues, which resulted in non-adherence to two-hour power safety/restoration commitment to the customer.

4.4.2. Gamma collective happening in the process:

The CHIP is represented in Figure 14 below. The inputs to the process were customer intimation through emails or phone calls, fault men work allocation and material transfer from stores. The processing operation was fault response, and the outputs included fault material update, fault job closing, BOM error correction/ alternate material update, material return to stores and invoice to the customer. The seepages were scrap and rework. The sub-processes considered for the study are discussed in the next section.

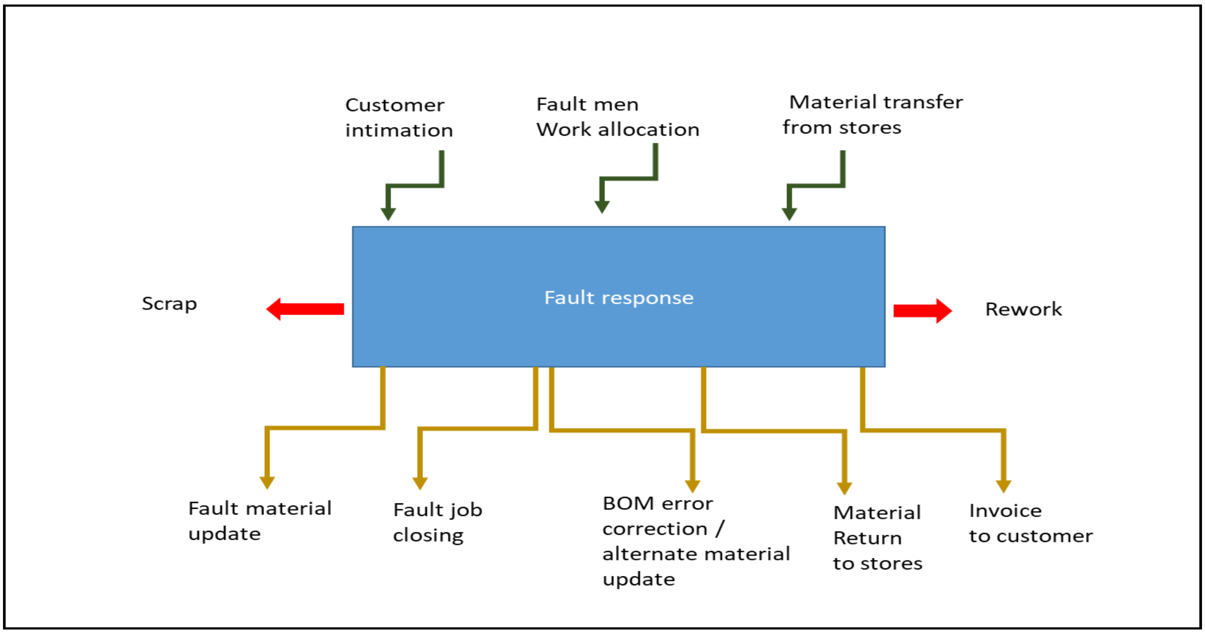

Figure 14: Gamma CHIP

4.4.3. Gamma pre-intervention process

For the study, processes such as the fault men work allocation, fault response, fault material update, fault job closing, and BOM error correction/ alternate material update were considered, and the pre-intervention process is represented in Figure 15 below.

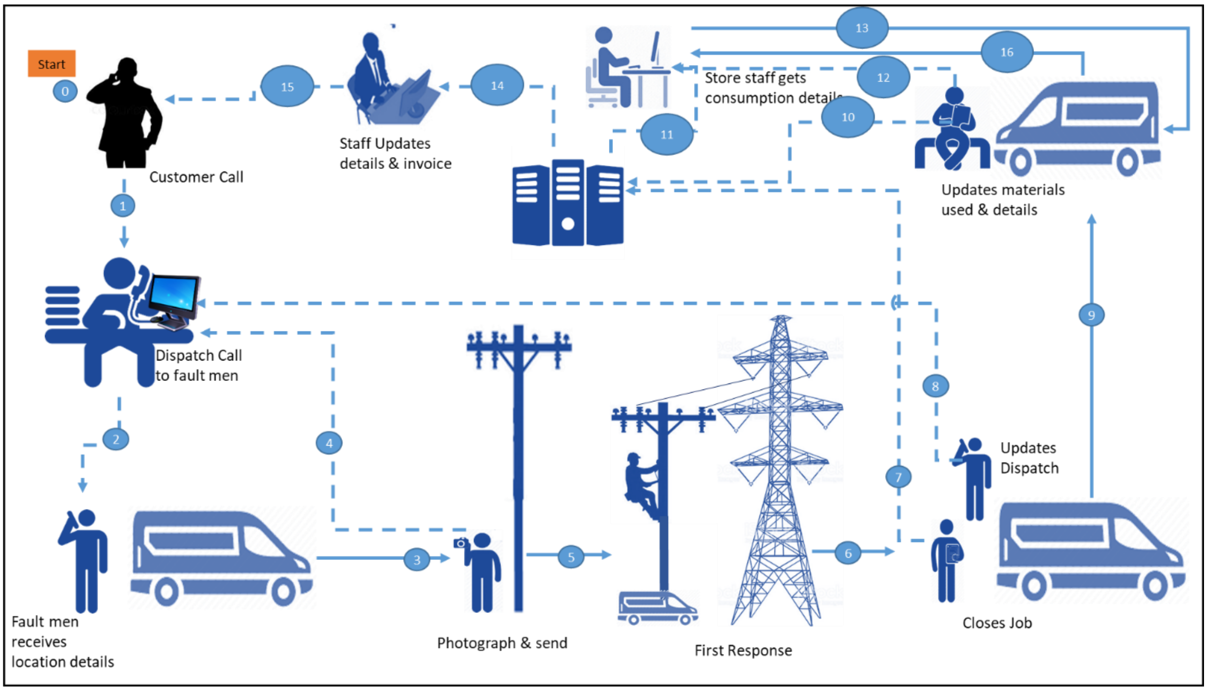

Figure 15: Gamma pre-intervention process

The process started with the customer intimation of a fault to dispatch staff. The dispatch staff verified previous allocations and then called the unallocated fault men on their mobile phone to check their status and allocated fault men for the job (1-2). Then, the fault men, with a van that held allocated stock and equipment, upon reaching the site took a photograph and sent to the dispatch office (3-4), analysed the problem, rectified the problem using their van stock (5). Whenever fault men had issues in rectification, they put the installation into safety mode. Subsequently, fault men moved back to the depot or nearby restaurants, and closed the job using the tab, and updated the dispatch staff on job completion (6-8). Then the fault men updated details of material used or in cases where there was another call the fault men updated the details at the next available time (9-10). Based on the update, the IT system calculated the material requirement compared to allowed van stock. The fault men periodically requested material, mostly monthly, from the stores by email, and the store staff replenished the van stock based on the IT system calculation (11-13). The dispatch staff then updated details of time and completion of the job and sent the invoice to the customer (14-15). In the final step, the fault men checked the van stock periodically and returned unwanted and excess van stock that accumulated, whenever they visited stores (16). The process had various stressors that affected the process productivity.

4.4.4. Gamma process biases

The observation and discussion revealed the stressors in the process as shown in Figure 16, and the process stressors' association with biases are shown in Table 22.

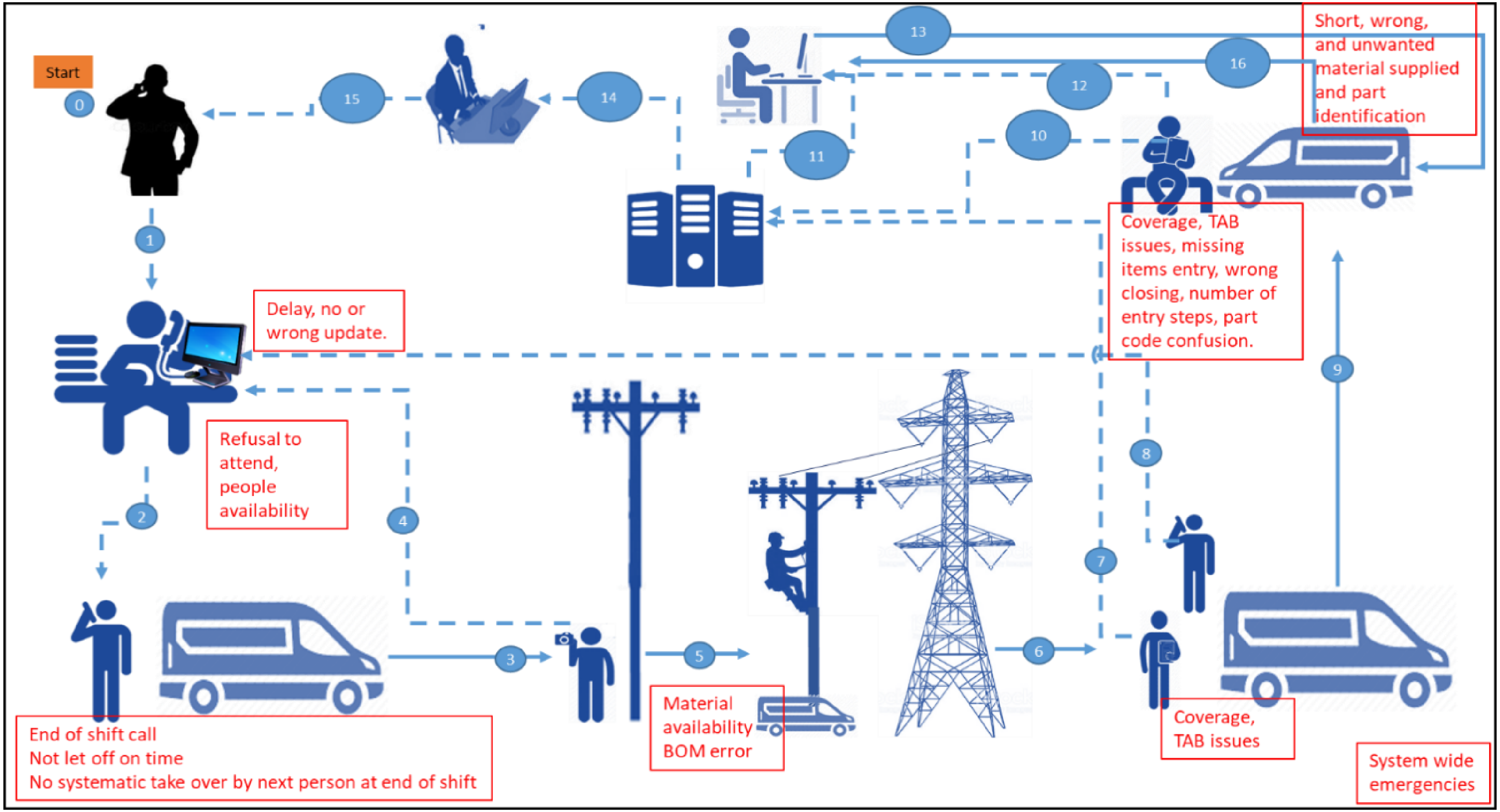

Figure 16: Gamma stressors

Table 22: Gamma stressors and associated biases

Process stressors	Primary stressors	Resultant stressors	Remarks	Associated biases
Delay, no or wrong update	Low job control	Role	Fault men delayed, held and erred job completion update.	No time and energy and lack of control.
Refusal to attend	Low job control	Role	Fault men refused to take jobs citing the end of shift time.	No time and energy and lack of control.
People availability	Information	Intellectual discretion	Fault men did not voluntarily share availability or presence to work.	Bounded awareness.
Material availability	Information	Intellectual discretion	Store staff did not share information on material shortage.	In-group–out-group and bounded awareness.
BOM error	Data mismatch	Performance	Fault men missed information that was not in the system, followed old BOM and did not have an alternate part code list. Further, fault men were unaware of problems that were created by BOM error to buyers and store team.	Automation omission, in attentional blindness, standardisation, reactance, bandwagon effect, and bounded awareness.
Emergencies	Emergencies	Role	People were driven by priorities and emergencies instead of the process.	Priority, escalation of commitment, and fear of failure.
Short, wrong and unwanted material supplied	Low job control	Role	Store staff replenishes unwanted material, wrong item and at times short supplied.	Bounded awareness, wrong information, and anti-trust.
Missing items entry	Data mismatch	Performance	Fault men missed material update due to part code confusion.	Endogeneity, and levelling and sharpening.
Wrong closing	Data mismatch	Performance	Fault men omitted or wrongly updated item transactions, time and work content to close fault calls without realising the effect on the system.	Endogeneity, levelling and sharpening, bounded awareness, and wrong information.
Tab issues	Data mismatch	Performance	Slow processing of information, unfriendly to a user and multiple options to update the same data. Fault men reported that the IT department had not focused on solving the issues.	No time and energy, lack of control, and bounded awareness.
No. of system entry steps	Data entries	Monotonous work	Multiple steps to update job closing.	Overdo.
Coverage	Communication	Role	The data connectivity was reported poor, and fault men had to move to the location that had data connectivity and update the job closure, and hence they preferred manual update.	Absent-mindedness and technology aversion.
Part code confusion	Priorities	Role	Fault men missed entry due to part code confusion.	Endogeneity, standardisation,

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
				congruence, and levelling and sharpening.
End of shift call	Physical	Health and safety	Calls were allocated to fault men towards the end of the shift.	Long work and no time and energy.
Not let off on time	Priorities	Role	Dispatch staff allocated end of shift calls to fault men citing priorities and extended working hours.	Priority and long work.
No systematic take over	Priorities	Role	Systematic take over during end of fault men shift was not planned.	Long work

4.4.5. Gamma suggested process improvements:

The case study analysis revealed that the primary stressors in the process were traffic delay, emergencies, priorities, BOM error, availability of men and material, and end of shift calls. The analysis and subsequent discussion with fault team led to suggesting a vehicle tracking system and positioning the fault men at geographically sensitive locations that enabled the fault men to cover a radius within a one-hour reach. It was suggested that, based on 12-month usage, the material requirement list had to be updated and a two-bin system was to be adapted to store material in the van. Each bin was to be identified with the respective part code. Further, the BOM was to be used for the specific allocated job serial number to be provided to the fault men in the Tab. Subsequently, the job closure update had to be done after actual material consumption, in a single program, with a provision to update materials used other than in the BOM. The system would then calculate the discrepancies and intimate to the fault team staff to update the BOM accordingly after verification. The suggested improved process is represented in Figure 17 below.

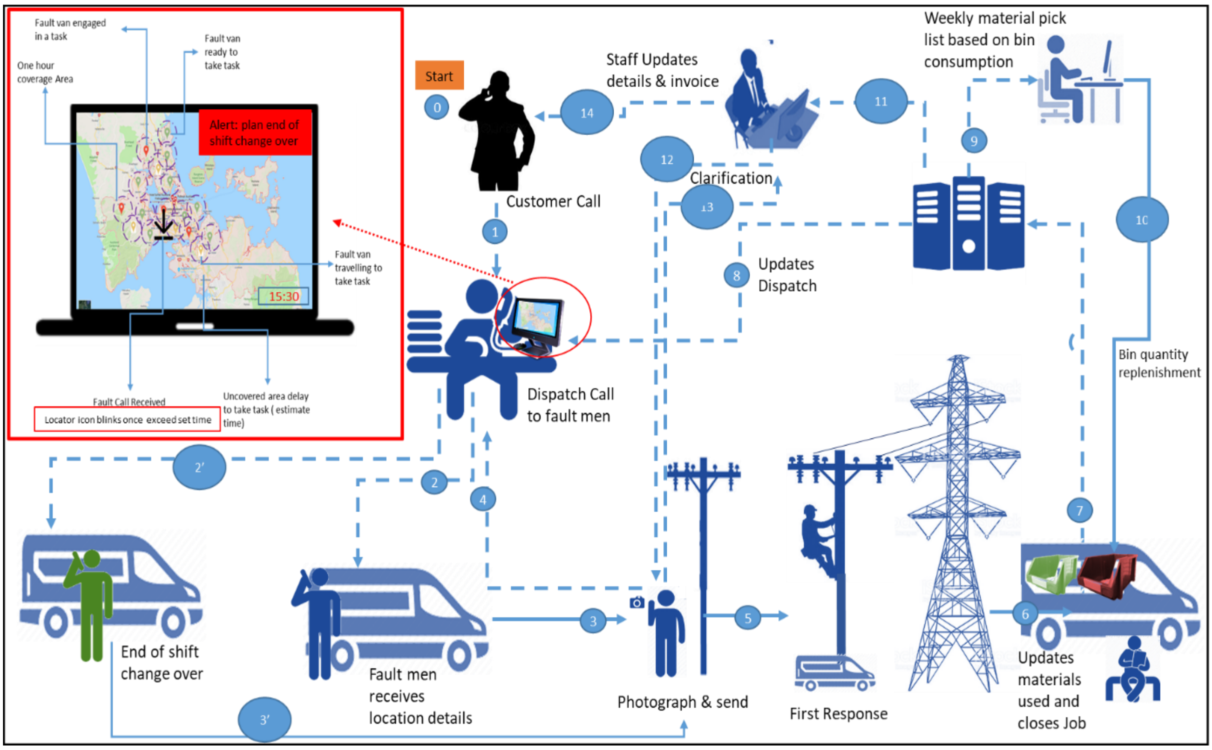

Figure 17: Gamma suggested process

The process would start when a call by the customer was logged (1). The dispatch staff would refer to the tracking screen, which highlights the status of prepositioned fault men, who could cover a range of 1-hour drive time area and intimate the respective fault men to proceed to the site (2-3). Whenever the call was towards the end of the shift, in this case if it was after 3.30 pm, the next incoming shift fault men would be allocated for a systematic take over (2'-3'). The fault men, on reaching the site, would photograph the installation, send to dispatch staff and engage in fixing the issue (4-5). On completion of the job, the fault men would refer to the pre-allocated job number, update the material details, and close the job using the Tab connected to a 4G data card, either at the site or upon moving to coverage location, which would be sent to the dispatcher by the system (7-8). The job completion and availability of fault men would be displayed in the tracking system after the system update. Whenever the fault men exceeded the stipulated set time, the tracking screen would highlight the location by blink, and the dispatcher would check their status by calling the fault men. The materials used would be tracked by the system to estimate BOM variation and consumption of the two-bin storage in the van and stores would replenish the empty bins weekly (9-10). The fault team staff would use a BOM variation list to identify reused materials and BOM error and update the BOM appropriately (11-13). From the job closing status of fault men, the fault staff would prepare the invoice and send to the customer (14).

The suggested process addresses the issues, stressors and the resulting biases as shown in Table 23.

Table 23: Gamma suggested process stressors and biases predicted status

Process stressors	**System stressors**	**People stressors**	**Remarks**	**Associated biases**
Delay, no or wrong update	Low job control	Role	Online update monitored through system tracking and pre-determined time limit.	No time and energy, and lack of control.
Refusal to attend	Low job control	Role	Systematic take over for the end of shift calls, online status, monitored through system tracking and pre-determined time limit reduced the issue.	No time and energy, and lack of control.
People availability	Information	Intellectual discretion	Availability monitored through system tracking and pre-determined time limit.	Bounded awareness.
Material availability	Information	Intellectual discretion	Two bin system and weekly replenishment of used material reduce the issues related to material availability.	In-group–out-group, and bounded awareness.
BOM error	Data mismatch	Performance	The process designed to capture and update BOM.	Automation omission, in attentional blindness, standardisation, reactance, bandwagon effect, and bounded awareness.
Emergencies	Emergencies	Role	The process designed to cater emergencies while a systematic end of shift take over reduced strain on fault men	Priority, escalation of commitment, and fear of failure.
Short, wrong and unwanted material supplied	Low job control	Role	Two bin system based on 12-month consumption in the field and weekly replenishment of used material reduce these issues.	Bounded awareness, wrong information, and anti-trust.
Missing items entry	Data mismatch	Performance	Part code confusion reduces as the system displayed the material to be used. Whenever the materials other than BOM were used, the bin-part identification would aid fault men to use a correct part number.	Endogeneity, and levelling and sharpening.
Wrong closing	Data mismatch	Performance	The system monitored the wrong update or BOM discrepancy of item transactions that would be intimated to fault men and staff to correct.	Endogeneity, levelling and sharpening, bounded awareness, and wrong information.
Tab issues	Data mismatch	Performance	Tab with 4G connectivity and a single program to update material consumption and job closure reduce the issues.	No time and energy, lack of control, and bounded awareness.

Process stressors	**System stressors**	**People stressors**	**Remarks**	**Associated biases**
No. of system entry steps	Data entries	Monotonous work	A single program to update material and job closing reduces the number of entry steps.	Overdo.
Coverage	Communication	Role	Tab with 4G connectivity reduces coverage issues.	Absent-mindedness, and technology aversion.
Part code confusion	Priorities	Role	Part code identification provided in the bin reduces confusion.	Endogeneity, standardisation, congruence, and levelling and sharpening.
End of shift call	Physical	Health and safety	Systematic take over for an end of shift calls and online status monitored through system tracking and pre-determined time limit reduce the issue.	Long work, and no time and energy.
Not let off on time and no systematic takeover	Priorities	Role	Systematic take over for an end of shift calls and online status monitored through system tracking and pre-determined time limit reduce the issue.	Priority, and long work.

The report was presented to the management, and the management team confirmed the pre-intervention process and acknowledged the stressors. Further, the management communicated by email that the two-bin van stock would be considered in the near future and other recommendations were sent to a project team for further consideration. The management and staff acknowledged the friendly and professional manner in which the study was conducted.

4.4.6. Gamma Lean tool Status

The status of Lean tools used is tabulated (refer to Table 24) below.

Table 24: Gamma Lean tool status

Tool	Status	Remarks
5S	Partially implemented	The depots and van stock lacked in 5S, location identification not evidenced, used, and salvaged items were unidentified.
Andon	Partially implemented	The organisation, health, and safety policy displayed, key productivity figures and process related data not displayed.
Bottleneck Analysis	Partially implemented	The team needed to analyse bottlenecks in the process and resolve.
Continuous Flow	Partially implemented	Dispatch process for fault rectification did not have systematic take over at the end of the shift.
Gemba	Implemented	Gemba practised when internal/external customer complaints were received, but details were not recorded systematically.
Heijunka	Partially implemented	Levelled scheduling would reduce process strains and long work hours.
Hoshin Kanri	Implemented	Policy deployment at a higher level was evidenced. However, individual departmental policy and breakdown to a finite level not evidenced.
Jidoka	Partially implemented	Automated tracking of fault men not implemented due to resistance and fear of exposure.
JIT	Partially implemented	Van stock not replaced based on JIT.
Kaizen	Implemented	Selective but systematically implemented. However, in most cases, the feedback was deficient. Workers and staff suggestions of the small cost were implemented to motivate them.
Kanban	Partially implemented	Two-bin system for the van stock not implemented.
KPI	Implemented	Departmental KPI and customer KPI on quality and delivery were well understood across all positions. However, KPI for individuals, catch ball concept to set targets was not evidenced.
Muda	Partially implemented	Not systematically captured, however, people work to reduce based on their belief.
OEE	Implemented	Van OEE not calculated. However, van maintenance was contracted, and contractors support was reported efficient. Fault men engaged in daily maintenance and cleaning. Scheduled maintenance completion on time was evidenced. Fault men were aware that customer KPI would not be meet if vans were not maintained.
PDCA	Partially implemented	Just do it culture, actions were mostly top-down approach, and open discussions were not evidenced.
Poka-Yoke	Not implemented	Error proofing in the process not evidenced.
RCA	Implemented	Root causes for customer complaint evidenced, however, internal issues analysis not evidenced.
SMED	Not applicable	Not applicable.
Six Big Losses	Not applicable.	Not applicable.
SMART Goals	Partially implemented	Organisational goals evidenced. Individual and department or function level not systematically passed to individuals.
Standardised Work	Implemented	SOP available. However not followed, revisited, and updated periodically.
Takt Time	Not implemented	Capturing TAKT time requirement geographically would improve the dispatch process performance.
TPM	Not implemented	Not evidenced.

Tool	Status	Remarks
VSM	Not implemented	Value stream mapping not evidenced. VSM would enhance productivity. The team lacked awareness and training.
Visual Factory	Partially implemented	Depots had visible floor markings and safety displays, no process related displays evidenced, adopting a visual factory approach at dispatch station and depots would enhance productivity.

4.4.7. Gamma waste status

The types of waste in the process are tabulated in Table 25 below.

Table 25: Gamma waste status

Waste	Participants confirmation	Remarks
Manufacturing waste	11/11	All waste were evidenced.
Environment waste	11/11	Van and trucks operations efficiency data, carbon neutrality not evidenced.
Information technology waste	11/11	Tab issues such as slow, poor Wi-Fi and data coverage, not user-friendly, and inadequate training reported. Two different programs and multiple options were used to update job closure and material issues.
Decision-making individual waste	11/11	Relaxed working in the absence of priorities and emergencies, and transactions not updated in time.
Department or Function Waste	10/11	Policy and procedure were reported as elaborate or inadequate.
Decision-making cross-functional team waste	5/11	Delay in an agreement between departments and implementation of suggestions was reported.
Human resources waste	11/11	People reported a lack of training in IT and Lean skills.
Enterprise engagement waste	0/11	Audits were reported as formalities and at times blame focused.
Stress Waste	11/11	Stress evidenced to complete the priorities and emergencies, after fixing an issue, people remained idle to get over the stress.
Methods waste		
Design Waste	0/11	Inefficient process design and process steps evidenced.
Overhead Waste	11/11	The hierarchy was evident, the supervisors and managers did not focus on eliminating the root cause of the problem.
Eagerness and Error Waste	10/11	In order to solve emergencies, people deviate from SOP.

4.5. Delta Case Study

4.5.1. Introduction

The Delta case study focused on the effects of biases on a large-scale supermarket regional distribution centre and was conducted during a peak distribution season that covered Good

Friday to Easter Monday holiday sales. The regional distribution centre, during this period, dispatched materials for an additional four days requirement owing to holiday period closure. The organisation was having issues with meeting their KPI to its customers, attrition, individual performance issues and performance. There were levels of hierarchy, such as plant manager, shift manager, assistant shift managers, supervisors, team leaders, assistant team leaders, and operators to manage the workforce and process the incoming orders.

During the observation process, records, such as graphs, KPI, layouts, continuous improvement sheets, emails from allied departments, the safety policy, and HR policy displays were reviewed. Further, system related transactions such as dispatch list, allocated pick list, data entries, inventory transactions, error rectification, storage allocation procedures, and fault correction were reviewed. The operations of shift manager, assistant shift managers, safety officer, supervisors, team leaders, assistant team leaders, and operators, which included receiving, picking material from storage, drop off at dock area, communication to job changeover, equipment handling, maintenance, packaging rework and shift changeover were observed. The problem was defined from a management perspective as attrition and performance issues.

4.5.2. Delta collective happening in the process

The collective CHIP was mapped, and the inputs to the process included receiving, transfers, and positive adjustments, material returned from the field/rework, and system update of unaccounted items. The processing operation was warehouse picking: palletising to order, outputs included material issues to a store consumption, transfers to other depots, internal consumption, rework, exports and negative adjustments of stock variation. Further, the seepages were scrap and rejections. The CHIP is represented in Figure 18, and the sub-processes considered for the study are discussed in the next section.

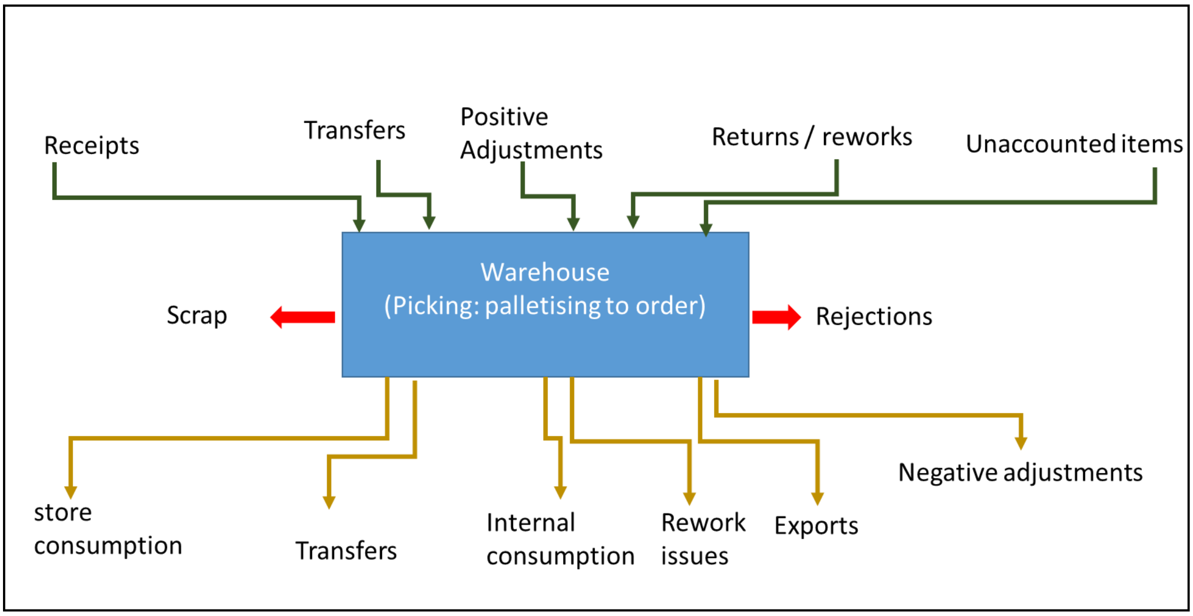

Figure 18: Delta CHIP

4.5.3. Delta pre- intervention process

For the study, the receipt and warehouse picking processes were considered and a detailed pre-intervention process was plotted, as shown in Figure 19 below.

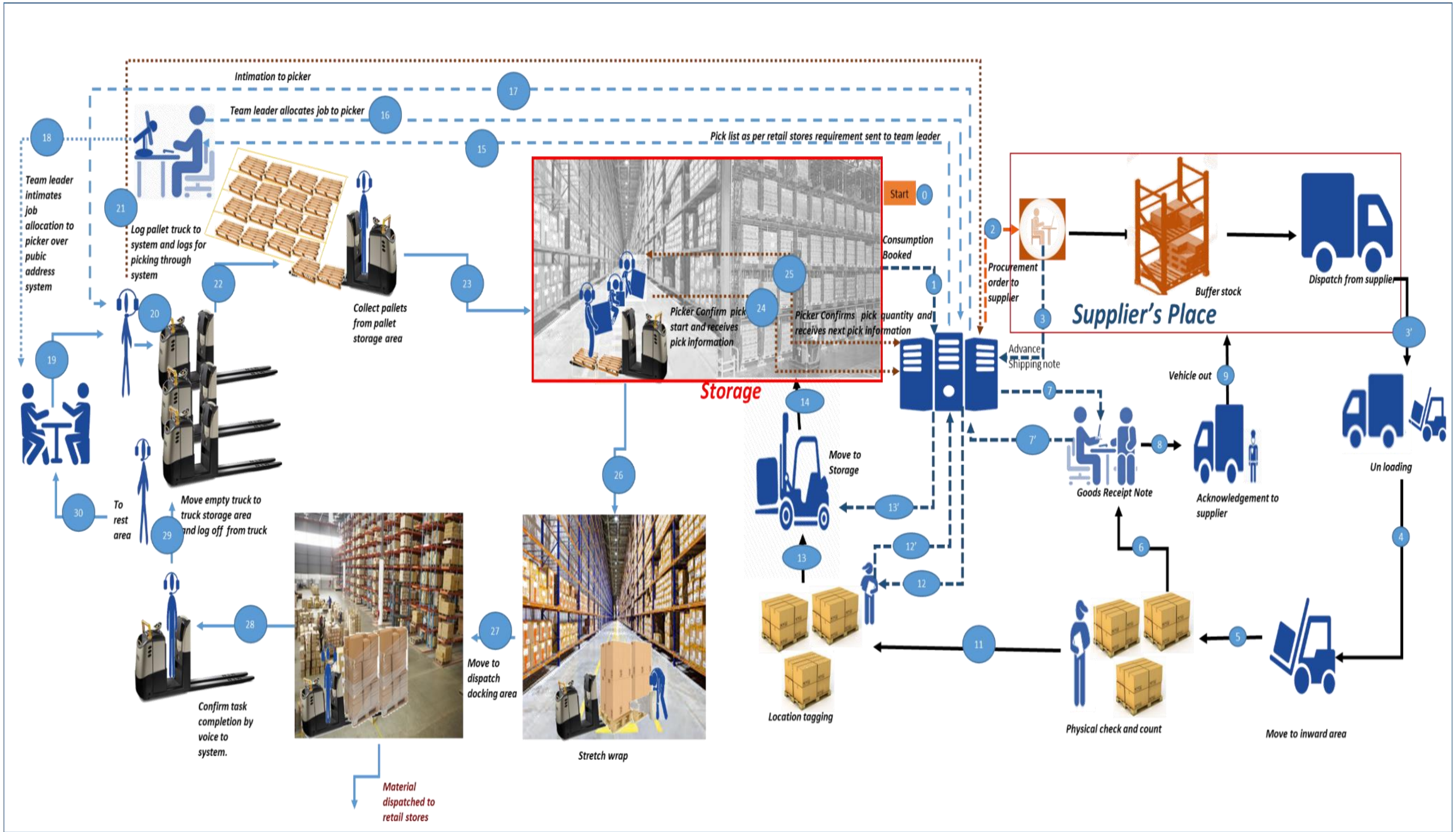

Figure 19: Delta pre-intervention process

The process started with the consumption being booked (1), which was processed by the server to send a request for product dispatch to the supplier (2). The supplier then sent the material and issued an advance-shipping notice through the supplier portal (3, 3'). The supplier vehicle reached the stores, where the physical unloading was done, items verified, goods receipt note updated, and a receiving acknowledgment signed in the copy supplier invoice/ packing list and handed to the vehicle driver (4-9). The items were moved to an intermediate location for allotment of storage space (10), subsequently, the system intimated the allotter, who scanned the pallets (11). The system processed the information and intimated the forklift driver, who moved the pallets, placed at the system allotted slot (12-14) and completed the receiving process.

The picking process started when the system sent the pick list as per retail store requirement to the team leader at a rate of two pallets per operator and a maximum of 240 items (15). The team leader allocated the operators and intimated through a public address system, each operator in turn logged through voice recognition system, C7 (16-19). The operator moved to pick the pallet truck, tagged the truck through his identity card, which the system correlated to the allotted Job (20-21). Subsequently, the system, through C7, intimated the operator on the first pick slot and quantity, the operator moved the truck to collect the pallet and proceeded to the stock slot, collected the material and confirmed pick through C7 to the system, which in turn was directed to the next slot and the cycle continued until the pick list was completed (22-25).

During the pick, whenever the material height equalled the hip height of the operator, the first stretch wrapping was done to secure the material, then the pick was continued and whenever the height was above their head, the next stretch wrapping was done and the pallet was considered complete (26). Once both pallets were stretch wrapped, the operator confirmed pick completion or confirmed partial pick to the system through C7, dropped the pallet in the dock area, stored the pallet truck in the truck storage area and moved to the rest area (27-30). The cycle took one hour, and the entire process was defined as palletising to order. The process had various stressors and associated biases that affected the process productivity.

4.5.4. Delta process biases

The study revealed that the process had been impacted by various biases that were due to the stressors in the process, refer to Figure 20 below.

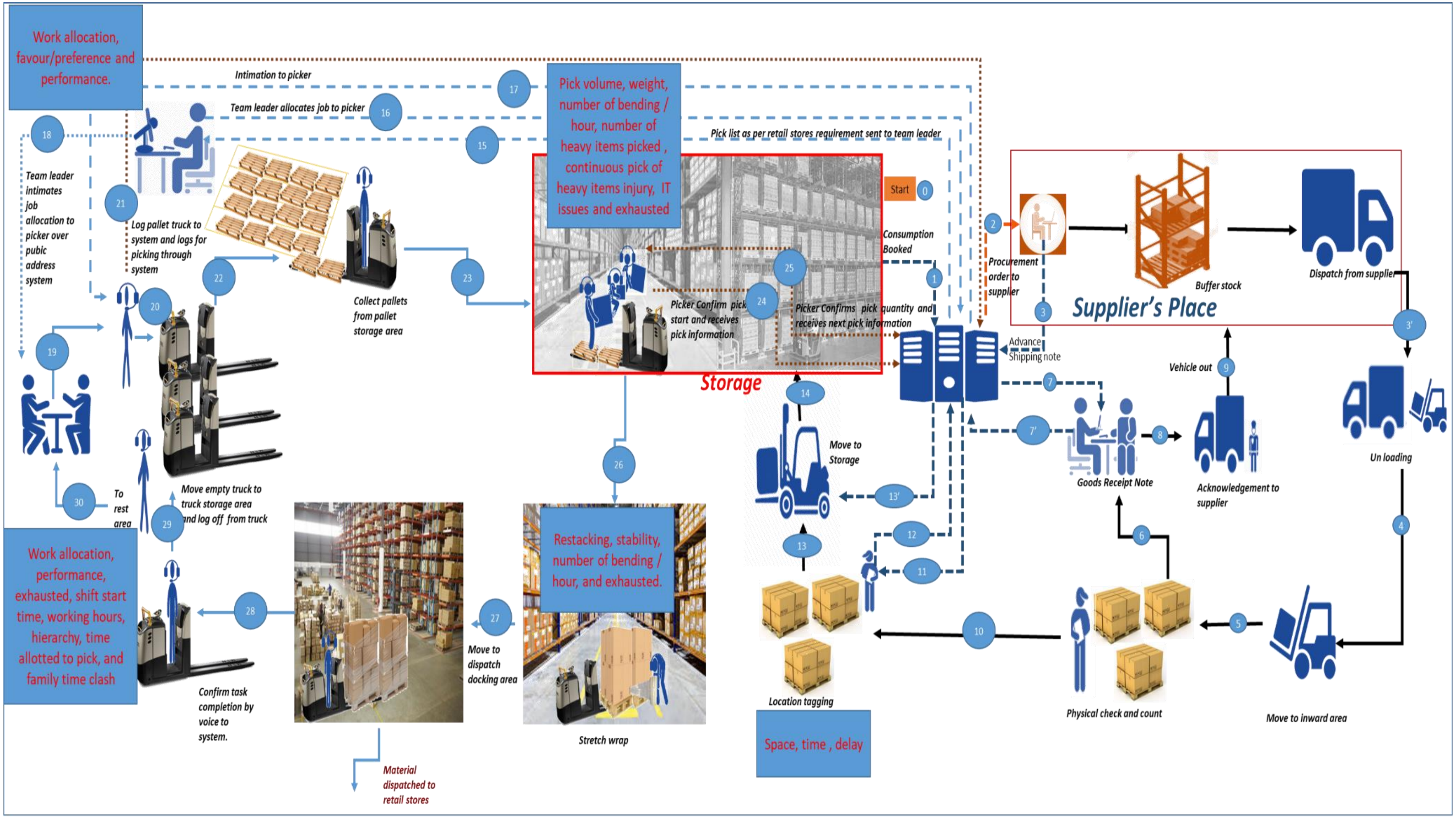

Figure 20: Delta stressors

These process stressors and various biases' influence are shown in Table 26 and the key issues are explained in the subsequent section.

Table 26: Delta stressors and associated biases

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Space	Low job control	Role	The operating staff had minimum influence on the storage and movement method, they followed instructions from the system.	Congruence, system- human, problem set, bounded awareness, and in- attentional blindness.
Time	Time	Role	Materials were ordered and supplied without considering time or congestion, and window time allotted was not effective.	Attentional, automation adherence, congruence, bounded awareness, and in attentional blindness.
Delay	Time	Role	Space constrains caused delay.	Bounded awareness and in attentional blindness.
Pick volume and weight	Physical	Performance	Pick volume was fixed based on a number of items without considering weight, travel distance, and stacking sequence.	Automation, bandwagon effect, bounded awareness, in attentional blindness, and overdo.
Number of bending/hour, number of heavy items picked, number of heavy items picked, and time allotted to pick	Physical	Health and safety	Operators bend to lift heavy material and drop in the pallet at a rate of 240 cartons per hour.	Overdo, fear of job loss, and fear of failure.
Injury	Physical	Health and safety	The cartons did not support lift from the sides as per the standard operating procedure, people lifted from the top opening, which caused physical strain on their back and shoulders.	Overdo, fear of job loss, and fear of failure.
IT issues	Data entries	Monotonous work	Voice recognition, connectivity, and visibility of the next pick and error correction time.	Overdo.
Exhausted	Physical	Health and safety	The pick volume, number of picks and method of the pick was extensive, which drained the energy of the people.	Overdo, fear of job loss, fear of failure, and no time and energy.

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Restacking and stability	Physical	Health and safety	The parts storage did not match fast/slow moving or pick stacking pattern, which induced difficulty while stacking and people reshuffled to keep the pallet load stable.	Overdo, automation, and in-attentional blindness.
Work allocation and favour/ preference	Physical	Role	Favour reported in work allocation.	In-group/out-group.
Performance	Physical	Health and safety	Highly focused on pick performance irrespective of logical errors.	Overdo, bounded awareness, escalation of commitment, and bandwagon effect.
Shift start time, working hours and family time	Physical	Health and safety	12 hour Shift started at 4.30 am.	Overdo and long work.
Hierarchy	Criticism, trust deficit, suspicion	Role	The hierarchy was used to counsel, criticise and train the operators irrespective of other issues that dropped their performance.	Anti-Trust, illusion of control, and autocratic.

4.5.5. Delta Key Issues

The warehouse picking process had key issues such as picking method, stacking method and shift timing. The pick procedure defined the 12-step picking method, as illustrated in Figure 21 below.

4.5.5.1. Picking Method

Figure 21: Delta pick procedure

From Figure 21, it can be seen that the operator approached to pick (1), bent to hold material, lifted and turned (2-7), then bent to place the material in the pallet and stood up to pick the next material (8-12). The procedure had 8 stretches with weight and 4 stretches without weight (1, 2, 11 and 12). The operator picked 240 cartons per hour, which equated to 23040 stretches with weight and 11520 stretches without weight for a 12-hour shift. Moreover, cartons had top-lifting provision instead of side-lifting, as required by the standard operating procedure, which forced operators to lift from top thus deviating from the procedure and straining their body.

4.5.5.2. Stacking and stretch wrapping issue

The storage pattern was based on the height of the incoming pallet from the supplier and the pick sequencing followed the storage location sequence. When the operator picked and placed cartons in the pallet as directed, the stalking did not follow the stable standard pallet stacking patterns such as block, brick, row, or pinwheel. This led to improper stacking and operators re-stacked based on their experience, adding to their work. Further, to keep the pallet stacking intact, operators were assigned to do the stretch wrapping. They moved around the pallet in a bent position, which caused considerable strain on their back (refer to Figure 22 below).

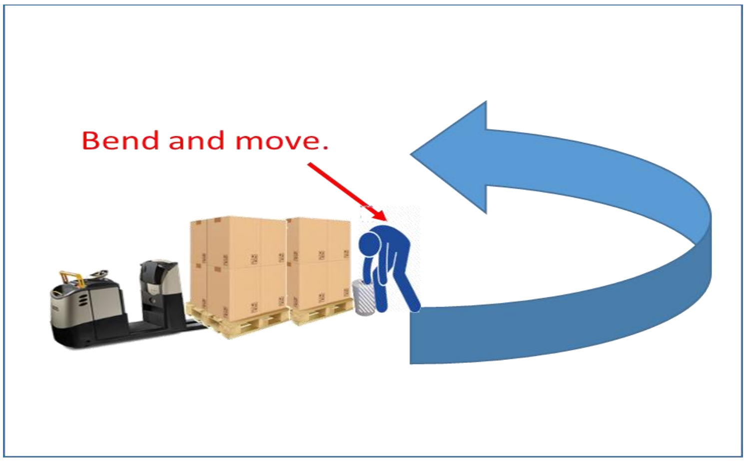

Figure 22: Delta stretch wrapping

The stretch wrapping added to the physical issues and exhaustion, which reduced the operator's quality family time.

4.5.5.3. Shift Timing

In addition, the shift timing added to the physical issues, which reduced operators' and staff's sleeping time to 5 ½ hours. Figure 23 below illustrates the activities and timings.

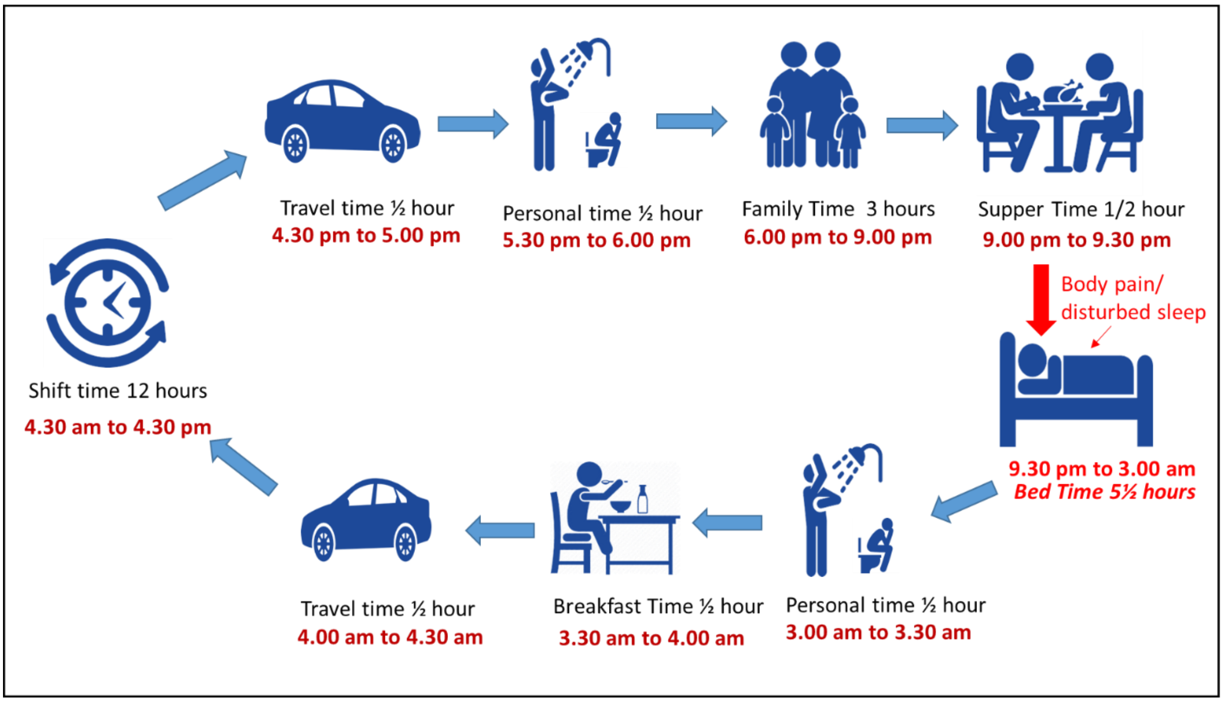

Figure 23: Delta shift timing

Further, operators reported that strain caused sleeping issues and hence they were not able to wake up at 4.30 am to come to work, leading to absenteeism. The absenteeism combined with performance and staff pressure lead to employee attrition, as illustrated in Figure 24 below.

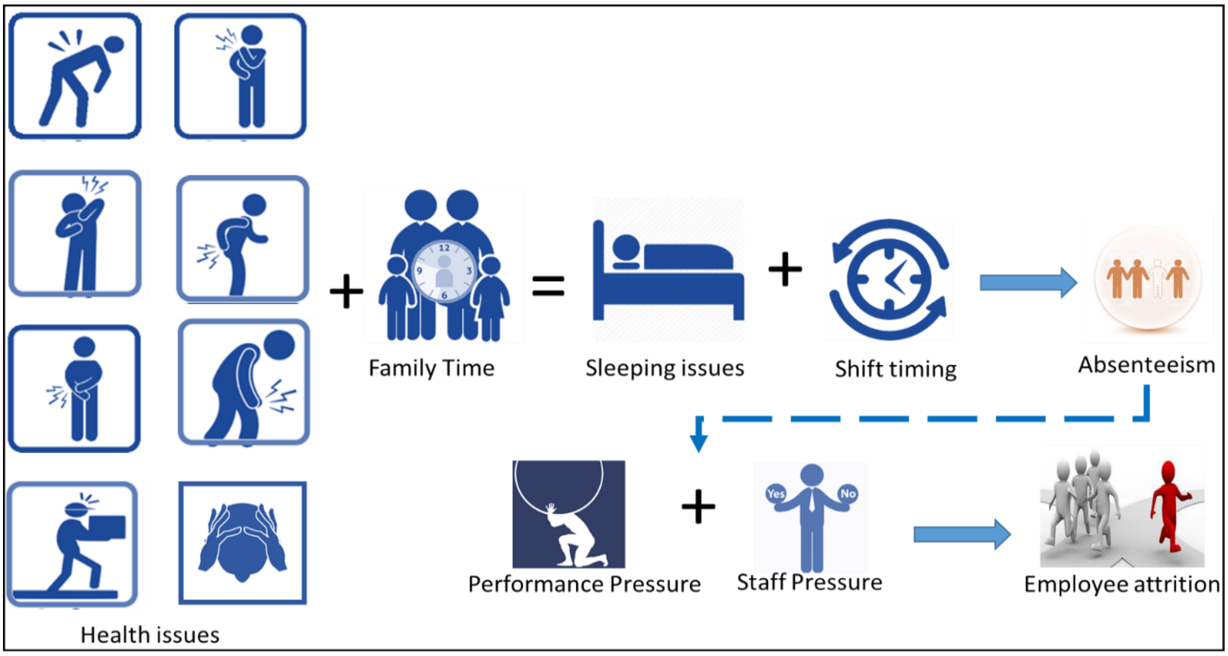

Figure 24: Delta people issues

4.5.6. Delta suggested process improvements:

The case study analysis revealed that the process could be improved by understanding the stressors and biases in the system. The approach was to reduce, avoid, or transfer the risks associated with the people working in the picking process to reduce attrition and absenteeism by reducing the stressors and biases impact. The key issues addressed were the picking and stacking methods. The picking improvements were based on relay picking, raised storage level, and standard pallets.

The organisation had used a concurrent picking method, split the order into two pallets each, and assigned people to pick materials. To reduce the risk, relay picking was recommended, in which the shorter person picked and stored material in the pallet until 0.9 meter and handed over to a tall person to pick and store up to 1.8 meter's height. Further, the materials stored on the floor for picking was recommended to be raised by 150 mm from ground level to aid easy picking to reduce the bending and strain on people.

The existing picking method induced physical strain in employees. The data analysis of 24 months revealed that five categories of material contributed 59.81% volume and 30 retail stores provided 79.83% of the business. Discussions revealed that the suppliers were capable of supplying a different product mix in a single pallet. The information on the consumption pattern of the top 30 stores was recommended to be used to derive the specific product mix and standardise the pallet for each of the five categories, an order placed with suppliers accordingly, received, and dispatched in standard pallets using forklifts. This would avoid handling of materials up to 59.81% of the volume, reducing strain on operators. The five categories and standardised pallet for soft drinks category are shown in Figure 25 below.

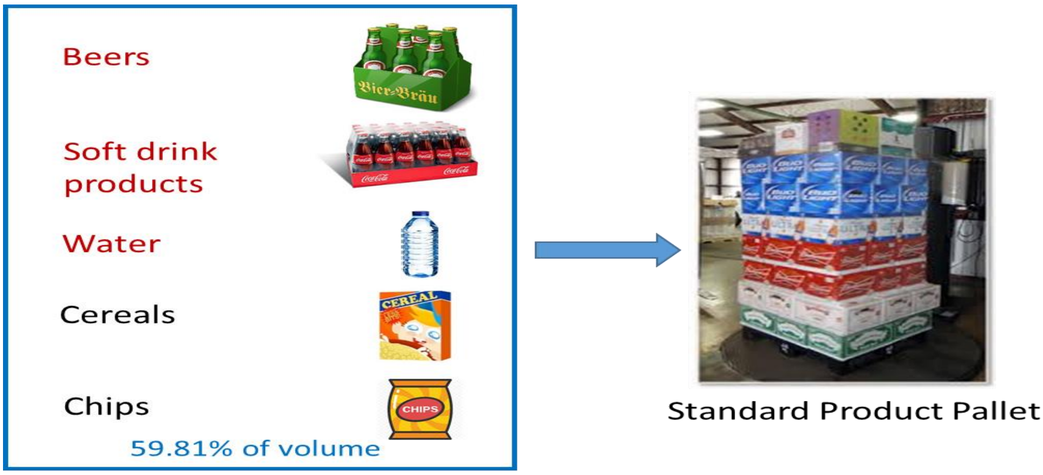

Figure 25: Delta standard Pallet

Further, the stacking and stretch wrap issue was addressed by recommending the use of a standard cage pallet (refer to Figure 26 below), which eliminated the concern of cartons falling down, and avoided stretch wrapping.

Figure 26: Cage pallet

The storage method was recommended to be altered based on fast movement and weight of the carton. Then the pick sequence was to be aligned such that heavy boxes were at a lower level and light boxes were at higher level. The suggested process is represented in Figure 27 below.

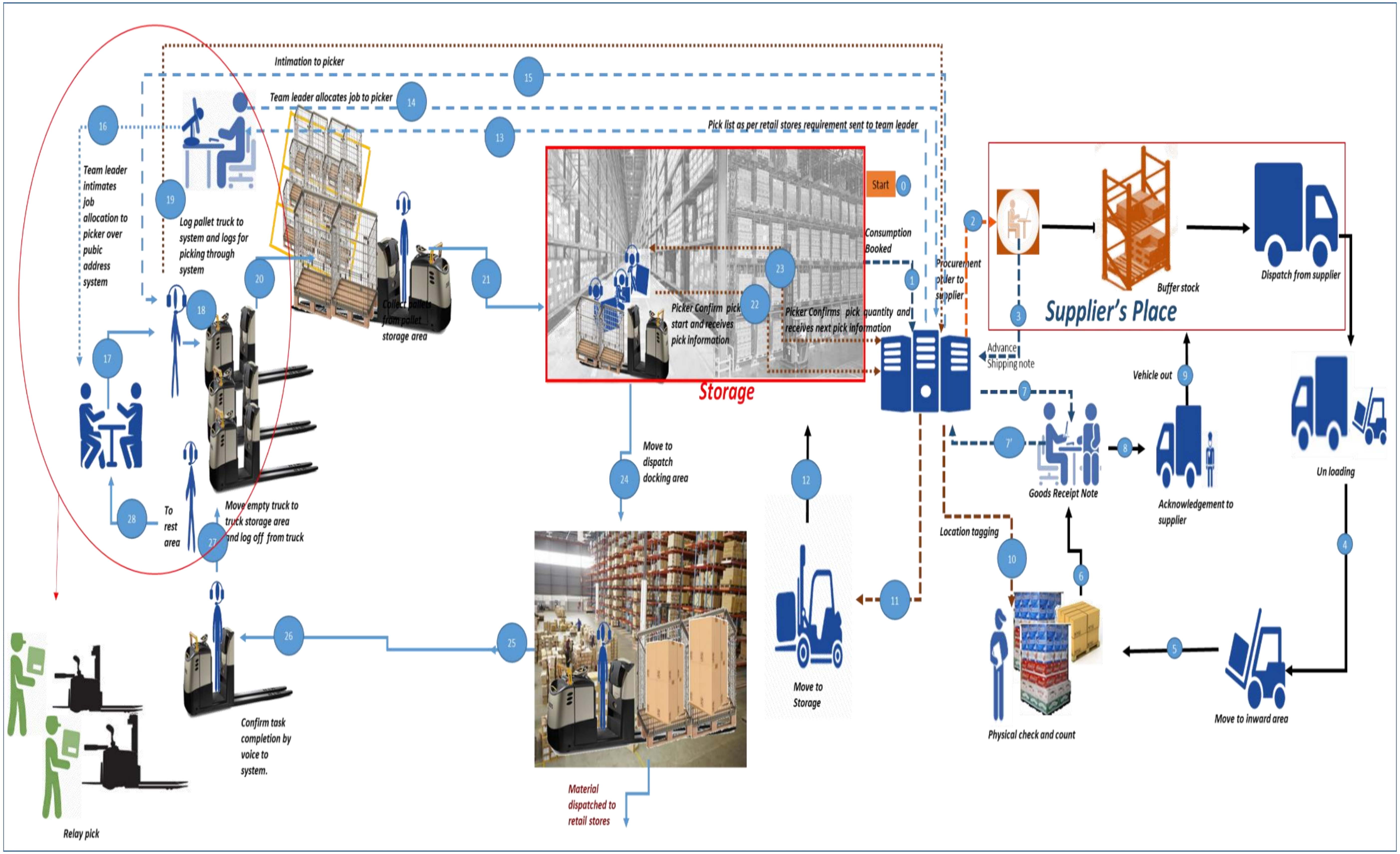

Figure 27: Delta suggested process

The suggested process started with the consumption being booked (1), which would be processed by the server to send a request for dispatch to the supplier (2). The supplier would send the material in a standardised multi-product pallet and issued advance shipping notice through the supplier portal (3). The supplier vehicle reached the stores, where the physical unloading would be done, items verified, goods receipt note updated and a receiving acknowledgment signed in the copy supplier invoice/packing list and handed to the vehicle driver (4-9). Subsequently, the system would process the information and intimate the forklift driver, who moved the pallets, placed at the allotted slot (10-12) and completed the receiving process.

The picking process would start when the system sent a pick list as per the retail store requirement to the team leader at a rate of two pallets per operator and a maximum of 240 items (13). The team leader would allocate short and tall operators for relay picking from racks that were organised per weight and movement, intimated through a public address system, and respective operators in turn logged through C7, the voice recognition system (14-17). The short operator would move to pick the pallet truck, tagged the truck through his identity card, which the system would correlate to the allotted Job (18-20). The operator would be intimated by system through C7 on the first pick slot and quantity, the operator would then move the truck to collect a cage pallet and proceeded to stock slot collected the material and confirm the pick through C7 to the system, which in turn would be directed to the next slot until half the pallet was completed (21-23). The tall operator would take over the pick and once both pallets were completed, the operator would confirm pick completion or partial pick to system through C7, drop the pallet in the dock area, store the pallet truck in the truck storage area and move to the rest area (24-28). The cycle would take one hour while each operator would work on the pallet truck for ½ hour and move on to next pick.

The shift timing was recommended to be altered to 6.30 am to 6.30 pm, which gave 7 ½ hours' sleep time to people. Figure 28 below, illustrates the activities and timings.

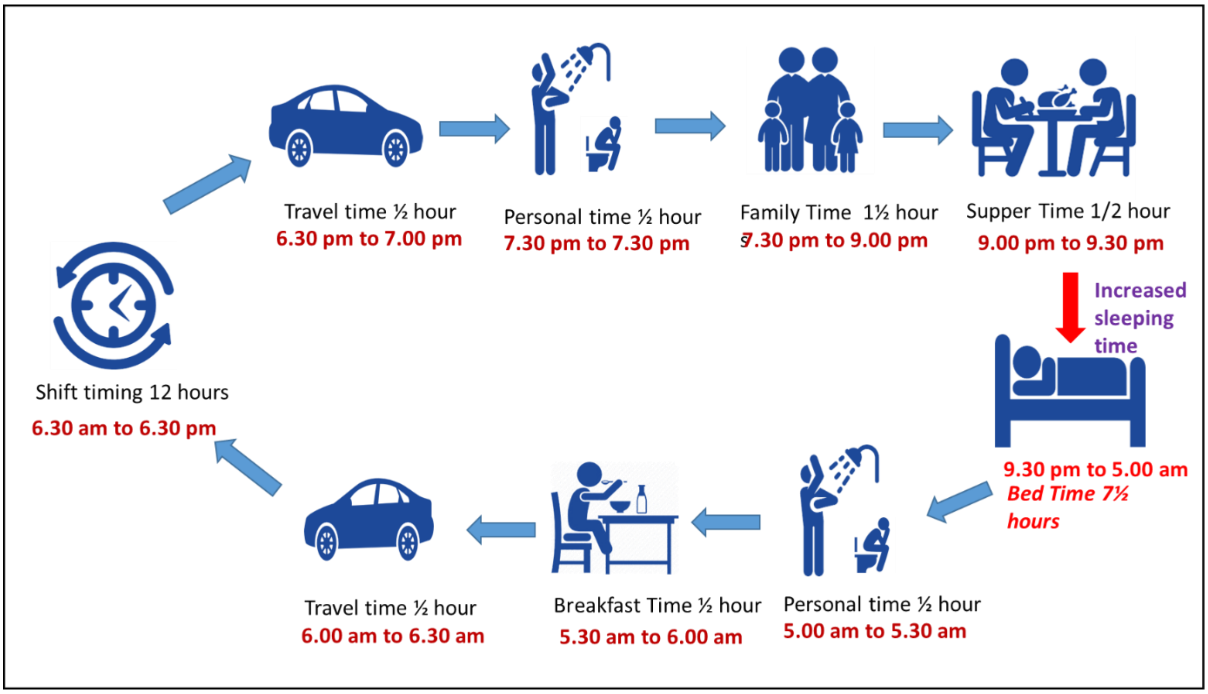

Figure 28: Delta recommended shift timing

As shown in Figure 28, the shift time change would reduce the family time on the four working days in a week, the other three days were available for the family. The recommended shift time change and suggested improvements would reduce the impact of stressors and associated biases.

The stressors and biases addressed are shown in Table 27.

Table 27: Delta suggested process stressors and biases predicted status

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Space	Low job control	Role	Intermediate location, step 11 of pre- intervention process was removed and the material was moved to storage location from receiving bay, which would reduce space constrain.	Congruence, system- human, problem set, bounded awareness, and in-attentional blindness.
Time	Time	Role	Intermediate location, step 11 of as pre- intervention process was removed and the material was moved to storage location from receiving bay, which would reduce conjunction.	Attentional, automation adherence, congruence, bounded awareness, and in attentional blindness.
Delay	Time	Role	Intermediate location, step 11 of as pre- intervention process was removed and the material was moved to storage location from receiving bay, which would reduce delay.	Bounded awareness and in attentional blindness.
Pick volume and weight	Physical	Performance	Standardised pallet reduced heavy items pick and travel distance. Re-organised storage as per weight and movement combined with cage pallet reduce stacking issues.	Automation, bandwagon effect, bounded awareness, in attentional blindness, and overdo.
Number of bending/hour, number of heavy items picked, number of heavy items picked, and time allotted to pick	Physical	Health and safety	Standardised pallet reduced heavy items pick and relay pick would reduce bending. Cage pallets introduced that removed stretch wrapping and would reduce bending.	Overdo, fear of job loss, and fear of failure.
Injury	Physical	Health and safety	Standardised pallet reduces heavy items pick and injury.	Overdo, fear of job loss, and fear of failure.
IT issues	Data entries	Monotonous work	IT system issues such as voice recognition, connectivity, visibility of next pick and error correction time would still exist.	Overdo.
Exhausted	Physical	Health and safety	Standardised pallet and relay pick reduce effort.	Overdo, fear of job loss, fear of failure, and no time and energy.
Restacking and stability	Physical	Health and safety	Re-organised storage as per weight and movement	Overdo, automation, and in-

Process stressors	Primary stressors	Resultant stressors	Remarks	Associated biases
			combined with cage pallet reduce stacking issues.	attentional blindness.
Work allocation Favour/ preference	Physical	Role	Favour reported in work allocation would still exist.	In group/ out group.
Performance	Physical	Health and safety	Standard pallets, cage pallets, and relay pick reduce effort and aid performance improvement.	Overdo, bounded awareness, escalation of commitment, and bandwagon effect.
Shift start time, working hours and family time	Physical	Health and safety	12 hour Shift recommended to start at 6.30 am was aimed to improve sleep time.	Overdo and long work.
Hierarchy	Criticism, trust deficit, suspicion	Role	The hierarchy would probably continue and problems may exist.	Anti-Trust, illusion of control, and autocratic.

The report was presented to the management, and the management team confirmed the pre-intervention process and acknowledged the stressors. The management stated that the physical strain of operators (number of bends a person does in an hour), standardised pallet, shift timing, and relay pick were new dimensions revealed in the study. Further, the management communicated by email that recommendations were sent to a project team for further consideration, and the following suggestions would continue to receive attention from the team:

- Stacking and wrapping of the product;
- Pallet stability;
- Use of stretch wrap or a suitable and sustainable alternative; and
- Risk avoidance with respect to weight handled, shift timings and bending of operators.

The management and staff acknowledged the time and effort in the compilation of the well-presented document.

4.5.7. Delta Lean tool Status

The status of Lean tools used is tabulated as shown in Table 28 below.

Table 28: Delta Lean tools status

Tool	**Status**	**Remarks**
5S	Implemented	Clearly evidenced at the shop floor. Clear focus, awareness, and following owing to previous accidents.
Andon	Partially implemented	The concept and focus were basically on people productivity and ignored process issues to improve productivity.
Bottleneck Analysis	Partially implemented	Evidenced for customer complaints, need to analyse and take steps to solve people issues.
Continuous Flow	Partially implemented	Continuous concurrent picking and consolidation method adopted. However, the possibility existed to consider continuous flow.
Gemba	Implemented.	Evidenced Gemba practice for internal/external complaint. However, not recorded systematically.
Heijunka	Partially implemented	People reported struggle in daily routine, levelled scheduling depended on retail-store order inflow and stock.
Hoshin Kanri	Implemented	Policy deployment at all levels was evidenced.
Jidoka	Partially implemented	Picking information and sequencing automated, automation of storage and retrieval possibility not explored, people reported fear of job loss.
JIT	Implemented	JIT based on the forecasting model and minimum stock level.
Kaizen	Implemented	The focus was to collect suggestions and continue as a project, obtain management and union agreement to implement any suggestion. This procrastinates and delays suggestion implementation. Selective suggestions were passed to management and systematically implemented. However, in most cases, the response or feedback was not given on time or not given at all.
Kanban	Implemented	Scheduling and forecasting based model implemented.
KPI	Implemented	Individual KPI defined and monitored.
Muda	Partially implemented	Not systematically captured. However, people work to reduce based on their belief.
OEE	Partially implemented	Not captured systematically, needed.
PDCA	Implemented	Project management culture where changes are systematically implemented.
Poka-Yoke	Partially implemented	Error proofing for safety evidenced, process error proofing inadequate.
RCA	Implemented	Root cause analysis for customer complaint evidenced. However, internal issues analysis not evidenced.
SMED	Implemented	The battery bay replaces the battery within five minutes.
Six Big Losses	Not implemented	Not evidenced
SMART Goals	Partially implemented	Organisational goals evidenced. Individual and department or function level not systematically passed to individuals.
Standardised Work	Implemented	SOP available. However not followed, revisited, and updated periodically.
Takt Time	Not implemented	Capturing TAKT time requirement, implementing measures would improve the performance.
TPM	Not implemented	Capturing would improve productivity and reduce cost.
VSM	Not implemented	Value stream mapping would improve productivity and reduce cost
Visual Factory	Implemented	Clear layout and displays evidenced. However, the lack of line process information display and control.

4.5.8. Delta waste status

The case study observation revealed various types of waste in the system, which the participant's discussion and interview confirmed. The waste evident in the process are tabulated (refer to Table 29).

Table 29: Delta waste status

Waste	Participants confirmation	Remarks
Manufacturing waste	30/30	All waste were evidenced.
Environment waste	30/30	Stretch film, paper, and power waste evidenced.
Information technology waste	26/30	Evidenced Voice recognition, WMS software, blue tooth connectivity, and system block out issues. Multiple steps to collect data evidenced. Automatic information interchange not evidenced. For example, data on the pick was not shared to all concerned daily.
Decision-making individual waste	25/30	Issues such as procrastination, passing the blame, micromanagement, suggestions not taken on time, depending on management and union to act were reported.
Department or Function Waste	18/30	Policy and procedure were reported as elaborate or inadequate. Approval procedures were long and passed through positions induced delay.
Decision-making cross-functional team waste	2/30	Delays in the agreement between departments/union and implementation of suggestions were reported.
Human resources waste	30/30	People reported a lack of training in IT and Lean skills. Attrition issue reported. Health focus was not evident.
Enterprise engagement waste	2/30	Audits were reported helpful with respect to safety and regulations, other audits were reported as formalities and at times blame focused.
Stress Waste	30/30	Stress evidenced in daily job routine.
Methods waste		
Design waste	0/30	System design not focused on the continuous movement of material and health of people.
Overhead waste	30/30	Large hierarchy focused on managing people.
Eagerness waste	26/30	People reported self-experimenting since all changes were routed through project team that delayed implementation.

4.6. Epsilon case study:

4.6.1. Epsilon Introduction

The Epsilon case study focused on the effects of biases in a large-scale supermarket regional distribution centre transportation and was conducted during a peek distribution season that covered Good Friday to Easter Monday holiday sales. The regional distribution centre dispatched materials for an additional four days requirement owing to holiday period closure.

The organisation was having issues with meeting KPIs to its customers, which resulted in delays in delivery to the retail stores. During the observation process, records such as graphs, KPI, dispatch documents, emails from allied departments, safety policy, and HR policy displays were reviewed. Further, the system-related transactions such as dispatch list, transport-related entries, and error rectification, truck allocation procedures, and complaint handling were reviewed. In addition, the operations of the distribution centre, transporter, and customer (retail stores) were observed. The problem was defined from a management perspective as a delay in delivery.

4.6.2. Epsilon collective happening in the process

The CHIP was mapped, and the inputs to the process included truck schedule, retail store order, materials from storage, return from stores and pallet receipts. The processing operation was transportation, which included inspection, loading, sealing and transiting, the outputs were material and pallet delivery to a retail store, and the seepages were scrap and damages. Figure 29 shows the CHIP, the sub-processes considered for the study is discussed in the next section.

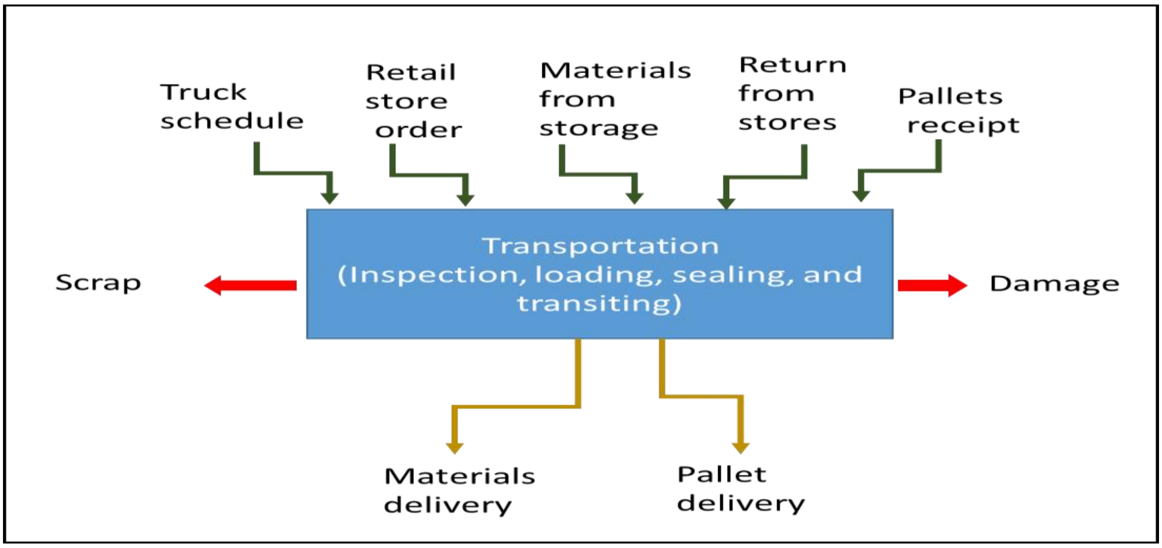

Figure 29: Epsilon CHIP

4.6.3. Epsilon pre-intervention process

For the study, the materials from storage, transportation process that included inspection, loading, sealing and transiting, and material delivery were considered, and a detailed pre-intervention process was plotted. The pre-intervention process cycle is shown in Figure 30.

Figure 30: Epsilon pre-intervention process

The transportation process started two hours after the truck docked. Firstly, the pallet was inspected at dock area (1), followed by a reshuffling of cartons between pallets of the same retail store order, to match 1000 kg weight per pallet and within 1.8-metre height approximately. The primary aim was to reduce the number of pallets per order, since the payment to the transporter was based on the number of pallets (2). Then dispatch staff orally intimated the loader, the loader loaded the pallets into the truck (3) and confirmed the number of pallets loaded to the dispatch staff (4). The dispatch staff updated the details in the system and passed the document print to the transport staff, the transport staff prepared a transit document and handed over to the driver (5-6). The driver checked the number of pallets and sealed the container, which the dispatch staff verified, then signed the transit document and cleared the dispatch (7-9). Subsequently, the driver cleared the security check and reached the retail stores, where unloading was done, and empty pallets were loaded, and the truck returned to the distribution centre (10-12).

The vehicle was held at a dock for 2 hours before loading. The total time earmarked for the process was 8 ½ hours, which expected a vehicle utilisation rate of 2.5 trips per 24 hours. The allotted process step time breakup is given in Table 30 below:

Table 30: Allotted trip time

Process step	Allotted time in hours
Truck hold at the dock prior to loading	2
Loading time (1-6)	2
Transit document preparation (7)	½
Truck seal (8-9)	½
Transit (10-11)	1½
Retail stores time to unload and reload empty pallets(11)	½
Return transit (12)	1½
Truck trip	***8 ½***

Documents viewed confirmed that the average vehicle utilisation rate over 12 months was at 2.465 trips per 24 hours and payment to the transporter was based on the number of pallets dispatched.

4.6.4. Epsilon process biases

The study revealed that the process was centred on reducing the number of pallets dispatched, which was done manually based on operators experience and had been impacted by various biases that were due to the system stressors. The observation and discussion revealed the stressors in the process: refer to Figure 31.

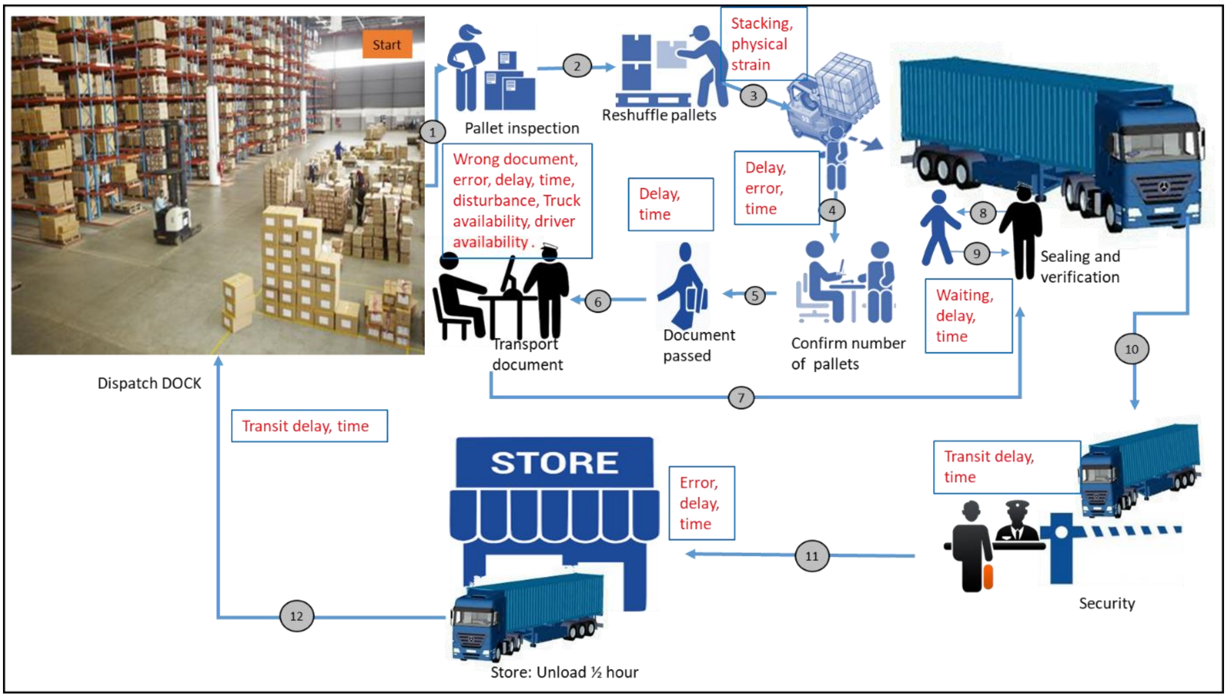

Figure 31: Epsilon stressors

The process stressors and various biases influence are shown in Table 31 the key issues are discussed in the next sub-section.

Table 31: Epsilon stressors and associated biases

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Stacking and physical strain	Physical	Health and safety	People reshuffle heavy items between pallets to maintain 1000 kg weight per pallet.	Overdo, fear of job loss, long work, and fear of failure.
Delay, time, and waiting	Time	Role	Delay in preparing transit document. The truck waited for 5 hours before transiting the material that included 2 hours hold at the dock prior to the start of the process. The truck driver waited for dispatch staff to check sealing and give clearance.	Bounded awareness, bandwagon effect, no time and energy, and in attentional blindness.
Wrong document /Error	Communication	Role	Evidenced operators error in reporting the number of pallets loaded, which reflected at the retail store and affected customer commitment. Evidenced distribution centre staff hand over the wrong document to transport staff. Evidenced wrong data update while preparing a transit document.	Absent-mindedness and wrong information.
Truck and driver availability	Information	Role	Truck and truck drivers' availability information was not shared across the system.	Bounded awareness.
Transit delay/time	Physical	Role	The transit delay affected customer commitment.	External influence.

4.6.5. Epsilon key issues

The key issues were reshuffling the pallet and holding the vehicle at a dock for 2 hours due to lack of online communication of the truck's status. The reshuffling was performed to achieve 1,000 kg weight per pallet, while documents revealed that the allowable weight as per pallet supplier was 1,200 kg. The process was manual dependent and information available with the IT system was not used for data interchange and process actions. In addition, the time study of seven instances covering both shifts over two peak load days revealed that the average time taken for the process was 75.29 minutes, the process step-wise average time is shown in Table 32.

Table 32: Epsilon average time of internal process steps

Process Step	Average time (minutes)
Pallet inspection	8.57
Reshuffle pallets	10.14
Loading	8.86
Confirmation and document passing	3.00
Transport document	20.14
Sealing	16.43
Total trip	***75.29***

The stressors and key issues elimination combined with time study data formed the platform for the suggested process.

4.6.6. Epsilon suggested process improvements:

The case study analysis revealed that the process could be improved by understanding the stressors and biases in the system. The approach was to reduce the vehicle hold time in the distribution centre (5 hours) instead of focusing the transit and retail unload time (3½ hours) that depended on uncontrollable external factors. The suggested process is represented in Figure 32.

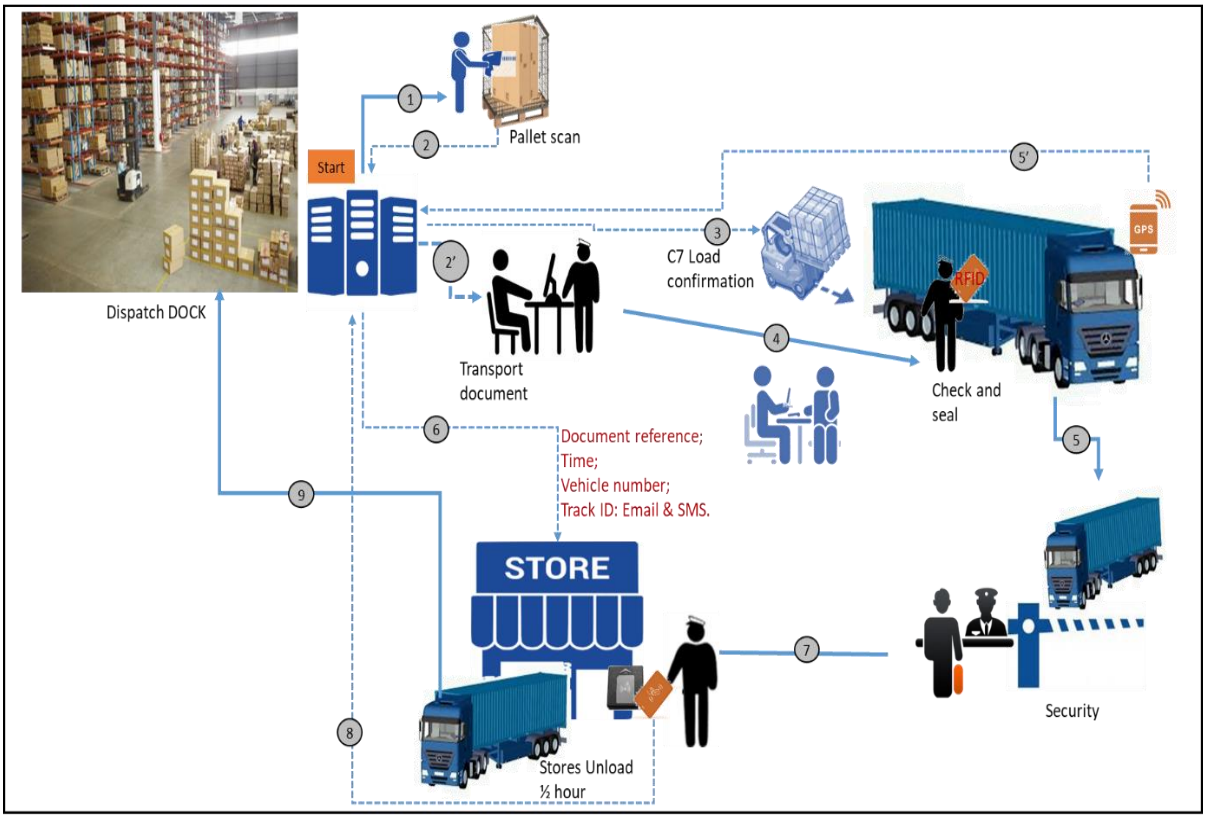

Figure 32: Epsilon suggested process

The suggested process recommended prerequisites were:

- Weight per pallet to be increased to 1,200 kg;
- Cage pallet type to be adopted with a bar code tag;
- GPS tracking system for vehicles;
- An RFID reader at retail stores to register a vehicle in and out times; and
- The work scheduling software and C7 voice recognition system that was in practice within the organisation for picking was to be extended to the loading operation.

The process started with the operator to scan the pallet and information sent to the system (1). The system would then verify the number of estimated pallets, send documentation processing information to the transport staff and in parallel notify loading operator. The loading operator, on receipt of information through the C7 system, loads the pallets onto the truck, and confirms with the system (2-3). In parallel, the transport staff would prepare the transit document, assign the truck to a specific store in the online portal and pass the information to the driver. The driver would subsequently verify the number of pallets and seal the container, pass security, reach the retail stores and swipe his access card to register his arrival (4, 5, and 7). The GPS fitted to the truck would regularly communicate the status to the server and the specific stores assigned to the truck would be informed on the truck's status periodically through an online portal (5'- 6). Subsequently, once the truck was unloaded and the empty pallet was loaded at retail stores, the vehicle would return to the distribution centre to take the next allotted job (8-9). This process would eliminate inspection, reshuffling, the manual number of pallets confirmation and documents passing while adding a pallet scan step. The estimated average time taken for an improved process is shown in Table 33.

Table 33: Epsilon improved process internal process steps estimated time.

Process Step	**Average time (minutes)**
Pallet Scan	3.00
Loading / Transport document	20.00
Sealing	10.00
Total time	***33.14***

The suggested internal process estimated time would be ¾ hours, considering minor delays. Further, the GPS tracking system would provide continuous monitoring of truck status that would reduce the truck holding time at a dock by 1 ¾ hours to ¼ hour. The total estimated truck time breakup is given in Table 34.

Table 34: Estimated trip time

Process step	Estimated time in hours
Truck hold time at dock prior to loading	¼
Loading, transit document preparation and truck seal time the (1-5)	¾
Transit time (5, 7)	½
Retail stores time to unload and reload empty pallets (8)	½
Return transit time(9)	1½
Total trip	***4 ½***

The total process time would reduce from 8½ hours to 4½ hours, with an estimated average vehicle utilisation rate at 5.33 trips per 24 hours, and the increase in weight per pallet to 1,200 kg would reduce the number of pallets dispatched and in turn the transport cost. The improvised process addresses the stressors and biases, which are tabulated in Table 35 below.

Table 35: Epsilon suggested process stressors and biases predicted status

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Stacking and physical strain	Physical	Health and safety	Reshuffle avoided.	Overdo, fear of job loss, long work, and fear of failure.
Delay, time, and waiting	Time	Role	Loading operator reporting to dispatch station avoided. Parallel transit document preparation reduced process time. The truck operator waits for dispatch staff to check sealing and give clearance eliminated.	Bounded awareness, bandwagon effect, no time and energy, and in attentional blindness.
Wrong document /Error	Communication	Role	Pallet scan avoided a mistake in reporting the number of pallets loaded and distribution centre staff handing over the wrong document to transport staff. Staff updating wrong data while preparing a transit document was not addressed.	Absent-mindedness and wrong information.
Truck and driver availability	Information	Role	GPS tracked and shared truck and driver availability.	Bounded awareness.
Transit delay/time	Physical	Role	The delays on the road that reflected at the retail store and affected customer commitment were not directly addressed. However, the overall time reduction from 8 ½ hours to 4 ½ hours would reduce the delay considerably.	External influence.

The report was presented to the management, and the management team confirmed the pre-intervention process and acknowledged the stressors. The management stated that internal timing and delays were new dimensions revealed in the study and would focus on internal aspects more than the external traffic-related issues in the future. Further, the management communicated by email that recommendations were sent to a project team for further consideration and the following suggestions will continue to receive attention by the team:

- Stacking and wrapping of a product;
- Pallet stability;
- Use of stretch wrap or a suitable and sustainable alternative;
- Reduction of dwell/dock time;
- Delivery rosters;
- Store delivery windows;
- Communication methods; and
- Data management.

The management and staff acknowledged the time and effort in the compilation of the well-presented document.

4.6.7. Epsilon Lean tool Status

The case study revealed the status of Lean tools used and the waste prevalent in the system. The status of Lean tools used is tabulated as shown in Table 36.

Table 36: Epsilon Lean tools status

Tool	Status	Remarks
5S	Implemented	Evidenced at the shop floor. Clear focus, awareness, and following owing to previous accidents.
Andon	Partially implemented	The concept and focus were on people productivity, displays evidenced. However, lacked online process information display and control.
Bottleneck Analysis	Partially implemented.	Evidenced for customer complaints. However, there is a need to analyse and take steps to solve process issues.
Continuous Flow	Not implemented.	The continuous flow could be achieved with the existing layout and resources by altering the process design.
Gemba	Implemented	Evidenced Gemba practice for internal/external complaint. However, not recorded systematically.
Heijunka	Partially implemented.	People reported struggle in daily routine, levelled scheduling depended on retail-store order inflow and stock.
Hoshin Kanri	Implemented.	Policy deployment at all levels was evidenced.
Jidoka	Not implemented.	IT automation possible.
JIT	Implemented.	JIT evidenced, material received and dispatched as per planned just in time.
Kaizen	Implemented	The focus was to collect suggestions and continue as a project, obtain management and union agreement to implement any suggestion. This procrastinated and delayed suggestion implementation. Selective suggestions were passed to management and systematically implemented. However, in most cases, the response or feedback was not given on time or not given at all.
Kanban	Implemented.	Scheduling and forecasting based model implemented.
KPI	Implemented	Individual KPI defined and monitored.
Muda	Partially implemented	Not systematically captured, but people work to reduce based on their belief.
OEE	Not implemented	Not captured, needed.
PDCA	Implemented	Project management culture where changes are systematically implemented.
Poka-Yoke	Not implemented	The possibility existed by linking steps in the process.
RCA	Implemented	Root cause analysis for customer complaint evidenced. However, internal issues analysis not evidenced.
SMED	Implemented	The battery bay replaces the battery within five minutes.
Six Big Losses	Not implemented.	Not evidenced.
SMART Goals	Partially implemented	Organisational goals evidenced. Individual and department or function level not systematically passed to individuals.
Standardised Work	Partially implemented	SOP not evidenced for transiting.
Takt Time	Not implemented.	Capturing TAKT time requirement and implementing measures would improve the performance.
TPM	Not implemented.	Capturing would improve productivity and reduce cost.
VSM	Not implemented.	Value stream mapping would improve productivity and reduce cost.
Visual Factory	Implemented	Clear layout and displays evidenced, however, lack online process information display and control.

4.6.8. Epsilon waste status

The case study observation revealed various types of waste in the system. The waste evident in the process are tabulated, refer to Table 37.

Table 37: Epsilon waste status

Waste	**Participants confirmation**	**Remarks**
Manufacturing waste	14/14	All waste were evidenced.
Environment waste	14/14	Stretch film, paper, and power waste evidenced.
Information technology waste	13/14	WMS software issues, inventory team flaws, and lack of automated information interchange evidenced.
Decision-making individual waste	13/14	Issues such as procrastination, passing the blame, micromanagement, suggestions not taken on time, and depending on management and union to act were reported.
Department or Function Waste	8/14	Policy and procedure were reported as elaborate or inadequate. Approval procedures were lengthy and passed through positions induced delay.
Decision-making cross-functional team waste	1/14	Delay in an agreement between departments/ union and implementation of suggestions were reported.
Human resources waste	14/14	People reported a lack of training in IT and Lean skills. Attrition issue reported. Health focus was not evident.
Enterprise engagement waste	5/14	Audits were reported helpful concerning safety and regulations, other audits were reported as formalities and at times blame focused.
Stress Waste	14/14	Stress evidenced in daily job routine.
Methods waste		
Design waste	0/14	System design not focused on the continuous movement of material and health of people.
Overhead waste	14/14	Large hierarchy focused on managing people.
Eagerness waste	14/14	People reported self-experimenting as all changes were routed through a project team that delayed implementation.

4.7. Zeta case study:

4.7.1. Zeta Introduction

The Zeta case study focused on the effects of biases in a large-scale supermarket national distribution centre. The organisation was having issues with meeting KPI to its customers, attrition, and performance. There were levels of hierarchy such as plant manager, shift manager, assistant shift managers, supervisors, team leaders, assistant team leaders, and operators to manage the workforce and process the incoming orders. During the observation process, records such as graphs, KPI, layouts, continuous improvement sheets, and emails from allied departments, safety policy, and HR policy displays were reviewed. Further, the system related transactions, such as dispatch list, allocated pick list, data entries, inventory transactions, error rectification, storage allocation procedures, transport-related entries, and error rectification, truck allocation procedures, complaint handling, and fault correction were reviewed. Additionally, the operations of shift manager, safety officer, supervisors, team leaders, and operators were observed, which included receiving, picking material from storage, drop off at dock area, communication to job changeover, equipment handling, maintenance, packaging rework and shift change over. The problem was defined from a management perspective as performance issues. The process had reported delays and individual performance issues that resulted in non-adherence to a customer commitment.

4.7.2. Zeta collective happening in the process

The CHIP was mapped, the inputs included receiving, transfers, and positive adjustments, material returned from the field/rework, and system update of unaccounted items. The processing operation was warehouse palletising to order; outputs included items moved to dock for dispatch to retail stores, transfers to other depots, internal consumption, rework, exports and negative adjustments of stock variation. The seepages were scrap and rejections. The items moved to the dock were the primary input to the subsequent transportation process. The other inputs included truck schedule, retail store order, materials from storage, return from stores and pallet receipts. The second processing operation was transportation, which included inspection, loading, sealing, and transiting, and outputs included material and pallet delivery to a retail store. The seepages for the second operations were scrap and damages. The CHIP is represented in Figure 33 below, and the sub-processes considered for the study is discussed in the next section.

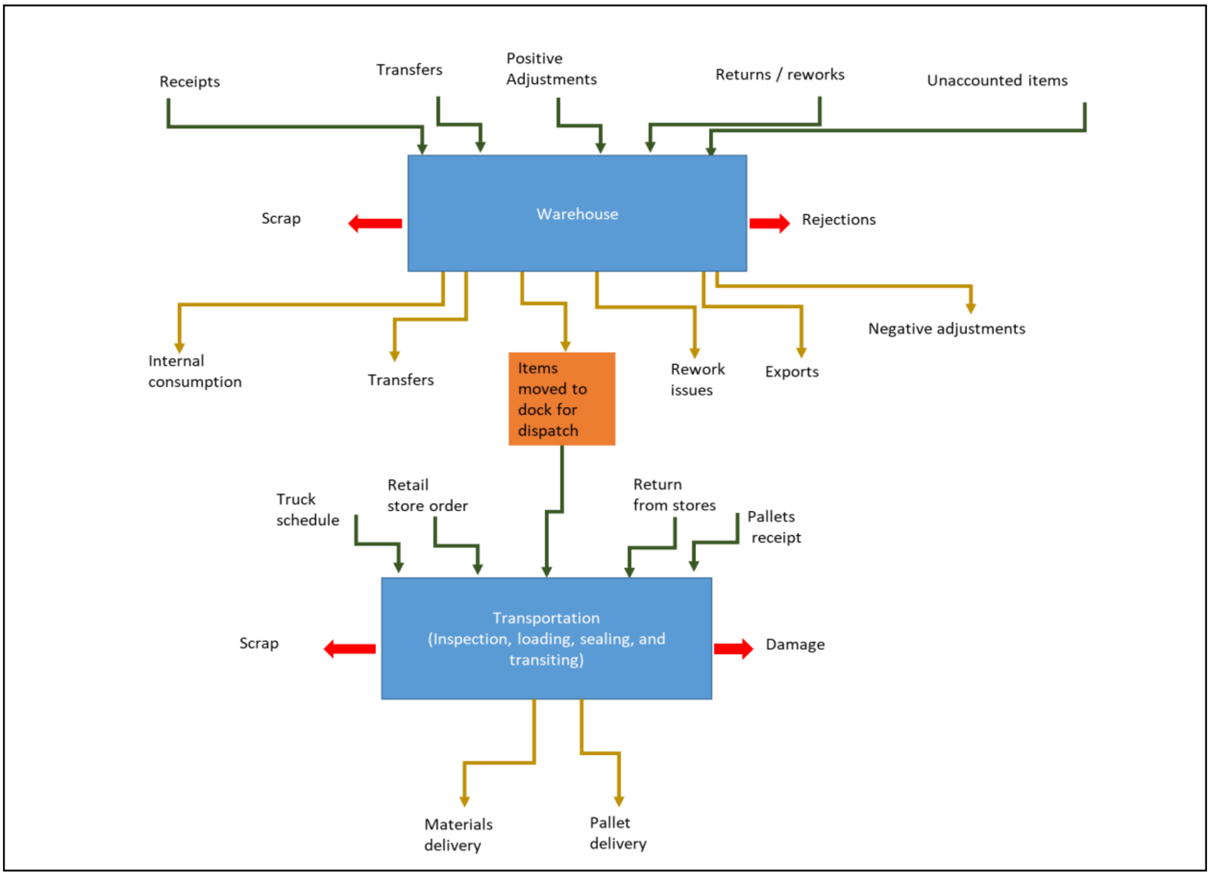

Figure 33: Zeta CHIP

4.7.3. Zeta pre-intervention process

For the study, the receipt, warehouse process, items moved to dock for dispatch, transportation process, and material delivery were considered, and a detailed pre-intervention process cycle was plotted. The pre-intervention process cycle is shown in Figure 34. The process was similar to the Delta and Epsilon case study combined, and the transporter and customer were the same. The organisation had the same union and followed practices like that of Delta. However, comparatively, the weight lifted was less, and the number of items per pallet was higher.

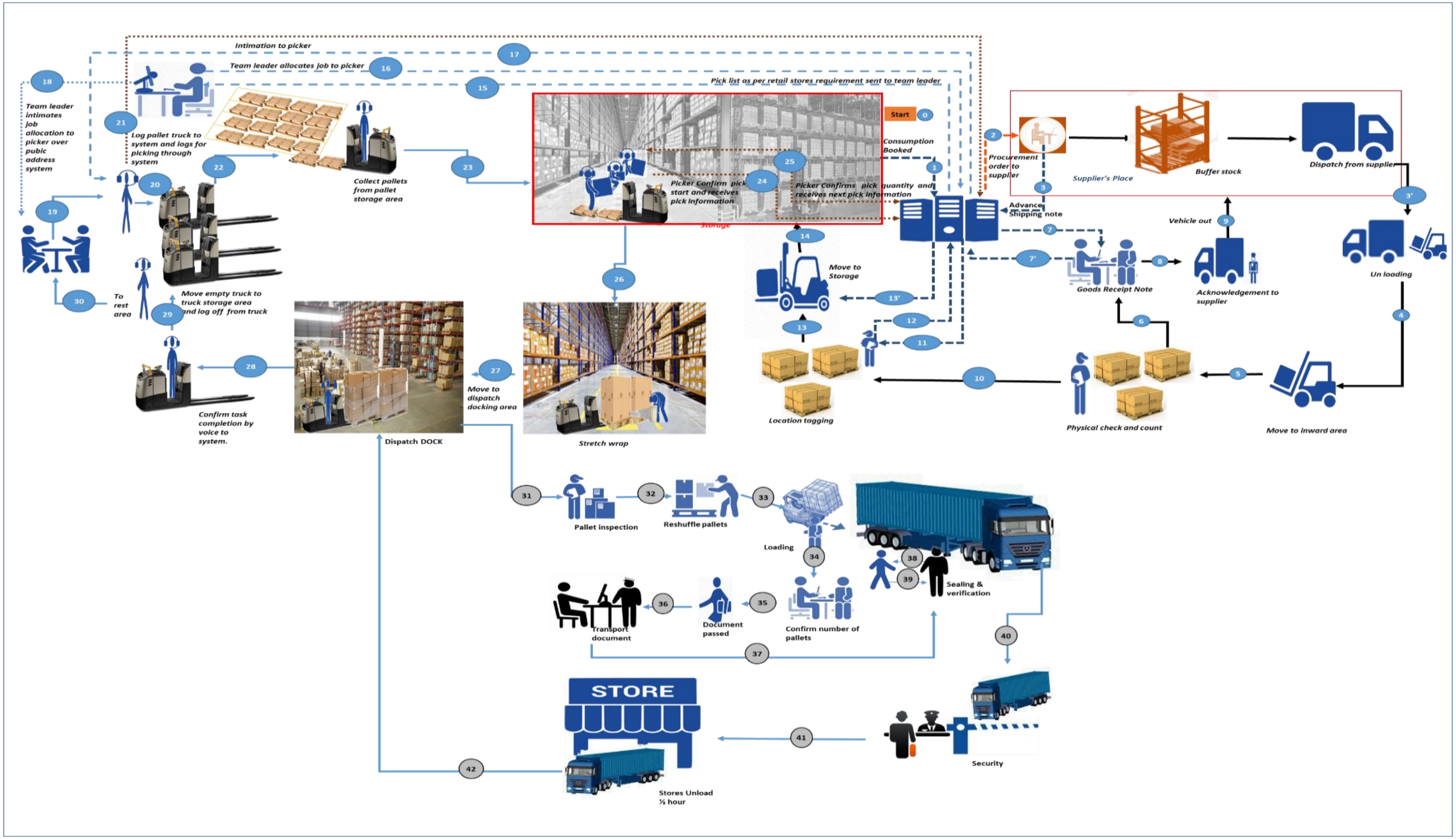

Figure 34: Zeta pre-intervention process

The process started with the consumption being booked (1), which was processed by the server to send a request for product dispatch to the supplier (2). The supplier sent the material and issued an advance-shipping notice through the supplier portal (3, 3'). The supplier vehicle reached the stores, where the physical unloading was done, items verified, goods receipt note updated, and a receiving acknowledgement was signed in the copy supplier invoice/ packing list and handed to the vehicle driver (4-9). The items were then moved to an intermediate location for allotting the storage space (10); subsequently, the system intimated the allotter, who scanned the pallets (11). The system processed the information and intimated the forklift driver, who moved the pallets, placed at the system allotted slot (12-14) and completed the receiving process.

The picking process started when the system sent the pick list as per retail store requirement to the team leader at a rate of two pallets per operator and a maximum of 240 items (15). The team leader allocated the operators and intimated through a public address system, and each operator, in turn, logged through the voice recognition system, C7 (16-19). The operator then moved to pick the pallet truck, tagged the truck through his identity card, which the system correlated to the allotted Job (20-21). Subsequently, the system, through C7, intimated the operator on the first pick slot and quantity, the operator moved the truck to collect the pallet and proceeded to the stock slot, collected the material and confirmed the pick through C7 to the system, which in turn directed them to the next slot and the cycle continued until the pick list was completed (22-25).

During the pick, whenever the material height equalled the hip height of the operator, the first stretch wrapping was done to secure the material. The pick was continued and whenever the height was above their head, the next stretch wrapping was done, and the pallet was considered complete (26). Once both pallets were stretch wrapped, the operator confirmed pick completion or confirmed partial pick to the system through C7, dropped the pallet in the dock area, stored the pallet truck in the truck storage area and moved to the rest area (27-30). The cycle took one hour.

The transportation process started two hours after the truck docked. As a first step, the pallet was inspected at the dock area (31), followed by reshuffling of cartons between pallets of the same retail store order, to match 1000 kg weight per pallet and within 1.8-meter height approximately. The primary aim was to reduce the number of pallets per order, as the payment to the transporter was based on the number of pallets (32). Then dispatch staff orally intimated the loader, and the loader loaded the pallets into the truck (33) and confirmed the number of pallets loaded to the dispatch staff (34). The dispatch staff updated the details in the system and passed the document print to the transport staff. The transport staff prepared a transit document and handed it over to the driver (35-36). The driver then checked the number of pallets and sealed the container, which the dispatch staff verified, signed the transit document and cleared the dispatch (37-39). Subsequently, the driver cleared the security check and reached the retail stores, where unloading was done, and empty pallets were loaded, and the truck returned to the distribution centre (40-42). The total time earmarked for the process was similar to Epsilon at 8 ½ hours, and expected a vehicle utilisation rate of 2. 5 trips per 24 hours. The process had various stressors and associated biases that affected the process productivity.

4.7.4. Zeta process biases

The study revealed that the process had been impacted by various biases which were due to the system stressors, as shown in Figure 35.

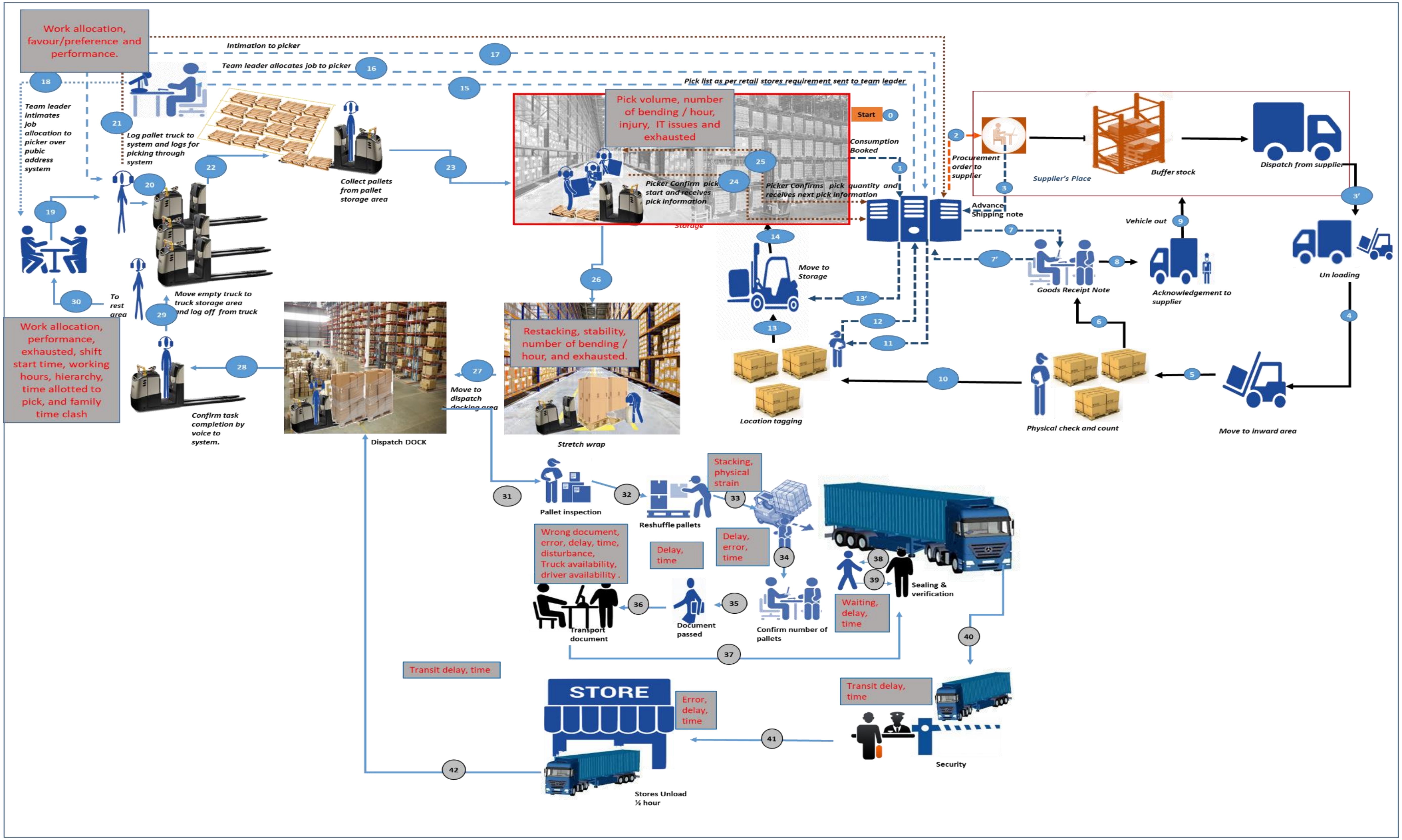

Figure 35: Zeta stressors

These process stressors and various biases' influence are represented in Table 38.

Table 38: Zeta stressors and associated biases

Process stressors	Primary stressors	Resultant stressors	Remarks	Associated biases
Pick volume	Physical	Performance	Pick volume was fixed based on the number of items without considering weight, travel distance, and stacking sequence.	Automation, bandwagon effect, bounded awareness, in attentional blindness, and overdo.
Number of bending/hour and time allotted to pick	Physical	Health and safety	Operators bend to lift material and drop in the pallet at a rate of 240 cartons per hour.	Overdo, fear of job loss, and fear of failure.
IT issues	Data entries	Monotonous work	Voice recognition, connectivity, visibility of next pick, and error correction time.	Overdo.
Exhausted	Physical	Health and safety	The pick volume, number of picks and method of the pick was extensive, which drained the energy of the people.	Overdo, fear of job loss, fear of failure, and no time and energy.
Restacking, stability, and physical strain	Physical	Health and safety	The parts storage did not match fast/slow moving or pick stacking pattern, which induced difficulty while stacking and people reshuffled to keep the pallet load stable.	Overdo, automation, and in-attentional blindness.
Work allocation and favour/ preference	Physical	Role	Favour reported in work allocation.	In group/ out group.
Performance	Physical	Health and safety	Highly focused on pick performance irrespective of logical errors.	Overdo, bounded awareness, escalation of commitment, and bandwagon effect.
Shift start time, working hours and family time	Physical	Health and safety	12 hour Shift started at 4.30 am.	Overdo and long work.
Hierarchy	Criticism, trust deficit, suspicion	Role	The hierarchy was used to counsel, criticise and train the operators irrespective of other issues that dropped their performance.	Anti-Trust, illusion of control, and autocratic.
Delay, time and waiting	Time	Role	Delay in preparing transit document. The truck waited for 5 hours before transiting the material. The truck driver waited for dispatch staff to check sealing and give clearance.	Bounded awareness and in attentional blindness.
Wrong document /error	Communication	Role	Errors reported in reporting the number of pallets loaded, and distribution centre staff handed over the wrong document to transport staff and wrong data	Absent-mindedness and wrong information.

Process stressors	Primary stressors	Resultant stressors	Remarks	Associated biases
			update while preparing transit document.	
Truck/driver availability	Information	Role	Truck and truck drivers' availability information was not shared across the system.	Bounded awareness.
Transit delay/time	Physical	Role	The transit delay affected customer commitment.	External influence.

The stressors and associated biases elimination combined formed the platform for the suggested process.

4.7.5. Zeta suggested process improvements:

The case study analysis revealed that the process could be improved by understanding the stressors and biases in the system. The prerequisite was similar to the Delta and Epsilon studies, which included the materials should be stored at a minimum of 350 mm above the ground level, re-organise storage as per weight and adopt a cage pallet to reduce stacking issues, and implement a 12-hour shift starting at 6.30 am. The approach was to reduce absenteeism by reducing the stressors' impact and biases. The suggested process is shown in Figure 36.

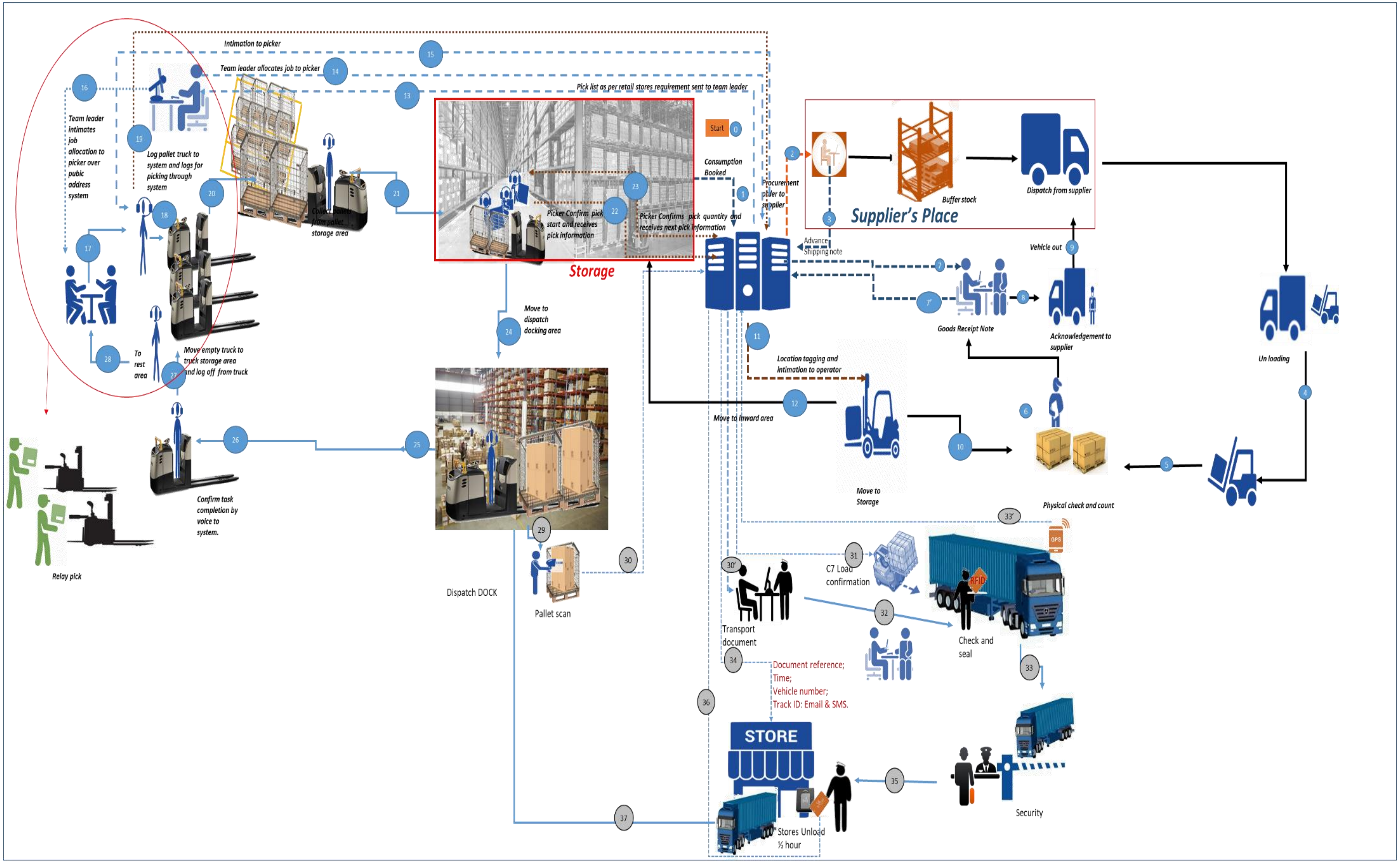

Figure 36: Zeta suggested process

The process started with the consumption being booked (1), which would be processed by the server to send a request for dispatch to the supplier (2). The supplier then dispatched the material and issues advance shipping notice through the supplier portal (3). The supplier vehicle reached the stores, where the physical unloading would be done, items verified, goods receipt note updated, and a receiving acknowledgement would be signed in the copy supplier invoice/ packing list and handed to the vehicle driver (4-9). Subsequently, the system would process the information and intimate the forklift driver, who would move the pallets, place at the allotted slot (10-12) and complete the receiving process.

The picking process would start when the system sent pick list as per the retail store requirement to the team leader at a rate of two pallets per operator and a maximum of 240 items (13). The team leader would allocate short and tall operators for relay picking from racks organised per weight and stock movement, intimate through the public address system, and respective operators in turn logged through C7, the voice recognition system (14-17). The short operator would then move to pick the pallet truck, tag the truck through his identity card, which the system would correlate to the allotted Job (18-20). The operator would be intimated by system through C7 on the first pick slot and quantity (21). The operator would move the truck to collect the cage pallet and proceeded to the stock slot, collect the material and confirm the pick through C7 to the system, which in turn would direct the operator to the next slot until half the pallet was loaded (22-23). Then, the tall operator would take over the pick, and once both pallets were completed, the operator would confirm the pick completion or partial pick to the system through C7, drop the pallet in the dock area, store the pallet truck in the truck storage area and move to the rest area (24-28). The cycle would take one hour while each operator worked on the pallet truck for hour an hour and moved on to the next pick.

The transporting process would start when the operator scanned the pallet and information was sent to the system (29). The system would then verify the number of estimated pallets, send documentation processing information to the transport staff and in parallel notify the loading operator. The loading operator, on receipt of information through the C7 system, would load the pallets onto the truck, and confirm to the system (30-31). In parallel, the transport staff would prepare the transit document, assign the truck to a specific store in the online portal and pass the information to the driver (32). The driver would subsequently verify the number of pallets and seal the container, pass security, reach the retail stores and swipe his access card to register his arrival (33, and 35). The GPS fitted to the truck would regularly communicate the status to the server, and the specific stores assigned to the truck would be informed on the truck’s status periodically through an online portal (33'- 34). Subsequently, once the truck was unloaded, the empty pallet would be loaded at retail stores, and the vehicle would return to the distribution centre to take the next allotted job (36-37).

The suggested process addresses the stressors and biases, which are tabulated in Table 39.

Table 39: Zeta suggested process stressors and biases predicted status

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Pick volume	Physical	Performance	Re-organised storage as per weight and stock movement combined with cage pallet reduce stacking issues.	Automation, bandwagon effect, bounded awareness, in attentional blindness, and overdo.
Number of bending/hour	Physical	Health and safety	Material storage lifted by 350 mm from the ground would reduce operator bending. Cage pallets introduced would remove the stretch wrapping and reduce bending.	Overdo, fear of job loss, and fear of failure.
IT issues	Data entries	Monotonous work	IT system issues and error correction time will exist.	Overdo.
Exhausted	Physical	Health and safety	Relay pick would reduce effort. Material storage lifted by 350 mm from the ground would reduce operator bending.	Overdo, fear of job loss, fear of failure, and no time and energy.
Restacking, Stability, and physical strain	Physical	Health and safety	Re-organised storage as per weight and movement combined with cage pallet reduced stacking issues.	Overdo, automation, and in-attentional blindness.
Work allocation and favour/ preference	Physical	Role	Favour reported in work allocation would still exist.	In group/ out group.
Performance	Physical	Health and safety	Cage pallets and relay pick reduce effort and aimed performance improvement.	Overdo, bounded awareness, escalation of commitment, and bandwagon effect.
Shift start time, working hours, and family time	Physical	Health and safety	12-hour shift that starts at 6.30 am was aimed to improve sleep time.	Overdo and long work.
Hierarchy	Criticism, trust deficit, suspicion	Role	The hierarchy would probably continue.	Anti-Trust, illusion of control, and autocratic.
Delay, time and waiting	Time	Role	Loading operator reporting to dispatch station would be avoided. Parallel transit document preparation reduces process time. The truck operator waits for dispatch staff to check the sealing and give clearance would be eliminated.	Bounded awareness and in attentional blindness.

Process stressors	Primary stressors	Resultant stressors	Remarks	Associated biases
Wrong document /Error	Communication	Role	Pallet scan would avoid the mistake in reporting a number of pallets loaded and distribution centre staff handing over the wrong document to transport staff. Staff updating wrong data while preparing a transit document was not addressed.	Absent-mindedness and wrong information.
Truck availability, Driver availability	Information	Role	GPS would track and share truck and driver availability.	Bounded awareness.
Transit delay/time	Physical	Role	The delays on the road that reflected at the retail store and affected customer commitment were not addressed.	External influence.

The report was presented to the management, and the management team confirmed the pre-intervention process and acknowledged the stressors. The management stated that the physical strain on operators (number of bends a person does in an hour), shift timing, and relay pick were new dimensions revealed in the study. Further, the management communicated by email that recommendations were sent to a project team for further consideration, and the following suggestions will continue to receive attention from the team:

- Stacking and Wrapping of a product;
- Pallet Stability;
- Use of Stretch Wrap or a suitable and sustainable alternative;
- Risk avoidance with respect to weight handled, shift timings and bending of operators;
- Reduction of Dwell/Dock time;
- Delivery Rosters;
- Store Delivery Windows;
- Communication Methods; and
- Data Management.

4.7.6. Zeta Lean tool Status

The case study revealed the status of Lean tools used and the waste prevalent in the system. The status of Lean tools used is tabulated as shown in Table 40 below.

Table 40: Zeta Lean tools status

Tool	Status	Remarks
5S	Implemented	Evidenced at the shop floor. Clear focus, awareness, and following owing to previous accidents.

Tool	Status	Remarks
Andon	Partially implemented	The concept and focus were on people productivity, and process related issues were not displayed online.
Bottleneck Analysis	Partially implemented	The team needed to analyse bottlenecks and take steps to solve issues.
Continuous Flow	Partially implemented	Continuous concurrent picking and consolidation method adopted. However, a possibility existed to consider continuous flow.
Gemba	Implemented	Evidenced Gemba practice for internal/external complaint. However, not recorded systematically.
Heijunka	Partially implemented	People reported struggle in daily routine, levelled scheduling depended on retail-store order inflow and stock.
Hoshin Kanri	Implemented	Policy deployment at all levels was evidenced.
Jidoka	Partially implemented	Picking information and sequencing automated, automation of storage and retrieval possible.
JIT	Implemented	JIT based on the forecasting model and minimum stock level.
Kaizen	Implemented	The focus was to collect suggestions and continue as a project, obtain management and union agreement to implement any suggestion. This procrastinated and delayed suggestion implementation. Selective suggestions were passed to management and systematically implemented. However, in most cases, the response or feedback was not given on time or not given at all.
Kanban	Implemented	Scheduling and forecasting based model implemented.
KPI	Implemented	Individual KPI defined and monitored.
Muda	Partially implemented	Not systematically captured, but people work to reduce based on their belief.
OEE	Not implemented	Not captured, needed.
PDCA	Implemented	Project management culture where changes are systematically implemented.
Poka-Yoke	Partially implemented	Error proofing for safety evidenced, process error proofing inadequate.
RCA	Implemented	Root cause analysis for customer complaint evidenced. However, internal issues analysis not evidenced.
SMED	Implemented	The battery bay replaces the battery within five minutes.
Six Big Losses	Not implemented.	Not evidenced.
SMART Goals	Partially implemented	Organisational goals evidenced. Individual and department or function level not systematically passed to individuals.
Standardised Work	Implemented.	SOP available, however not followed, revisited, and updated periodically. SOP not evidenced for transiting.
Takt Time	Not implemented.	Capturing TAKT time requirement, implementing measures would improve the performance.
TPM	Not implemented.	TPM would improve productivity and reduce cost.
VSM	Not implemented.	Value stream mapping would improve productivity and reduce cost
Visual Factory	Implemented	Clear layout and displays evidenced. Andon concept and focus were on people productivity, process related issues were not displayed online.

4.7.7. Zeta waste status

The case study observation revealed various types of waste in the system. The waste evident in the process are shown in Table 41 below.

Table 41: Zeta waste status

Waste	Participants confirmation	Remarks
Manufacturing waste	9/9	All waste were evidenced.
Environment waste	9/9	Stretch film, paper, and power waste evidenced.
Information technology waste	9/9	Evidenced voice recognition, WMS software, blue tooth connectivity, and system block out issues. Multiple steps to update data evidenced. Automatic information interchange not evidenced. For example, data on the pick was not shared to all concerned daily.
Decision-making individual waste	9/9	Issues such as procrastination, passing the blame, micromanagement, suggestions not taken on time, and depending on management and union to act were reported.
Department or Function Waste	6/9	Policy and procedure were reported as elaborate or inadequate. Approval procedures were lengthy and passed through positions that induced delay.
Decision-making cross-functional team waste	6/9	Delay in an agreement between departments/union and implementation of suggestions were reported.
Human resources waste	9/9	People reported a lack of training in IT and Lean skills. Attrition issue reported. Health focus was not evident.
Enterprise engagement waste	5/9	Audits were reported helpful concerning safety and regulations, other audits were reported as formalities and at times blame focused.
Stress Waste	9/9	Stress evidenced in daily job routine.
Methods waste		
Design waste	0/9	System design not focused on the continuous movement of material and health of people.
Overhead waste	9/9	Large hierarchy focused on managing people.
Eagerness waste	7/9	People reported self-experimenting since all changes were routed through a project team that delayed implementation.

4.8. Eta case study:

4.8.1. Eta introduction

The Eta case study focused on the effects of biases in the suggestion process of a cool store and pack house. The organisation was engaged in procurement, segregation, packaging, storage, and sale of fruits. The organisation had issues with receiving suggestions from their staff. Management's view was that the suggestions from employees were less and those submitted were mostly related to maintenance. The pack house process was labour intensive, and most of the labours were not permanent staff. However, management had issues with their employees' suggestions (being few) and continuous improvement. After the initial walk-through of the process, the approach was to study the suggestion process and issues associated with them.

The observation happened in two phases. Phase I was peak season, and Phase II was repack season. During Phase I, a team of Lean consultants were present. During the observation process, records such as problem and opportunity (P&O) forms, KPI records, productivity graphs, employee turnout records, emails, HR policy displays, company policies, suggestion records, feedback records, software reports on suggestions, storage process and packhouse process records were reviewed. Further, the operations of four pack houses, 12 cool stores, fruit picking at an orchard, transport team, office team, morning meetings, departmental meetings, and cross-functional team (CFT) meetings were observed, which included receiving, inspection, packing, cool store operations and outbound activities. The problem was defined from a management perspective as suggestion-giving issues.

4.8.2. Eta collective happening in the process

The CHIP was mapped, and the inputs included enhancement and problem-related recording. The processing operation was suggestion processing, and the outputs included facility enhancement and maintenance problem-solving. Further, the seepages were failure and rejection of the issue. The CHIP is shown in Figure 37. All the sub-processes were considered for the study that is discussed in the next section.

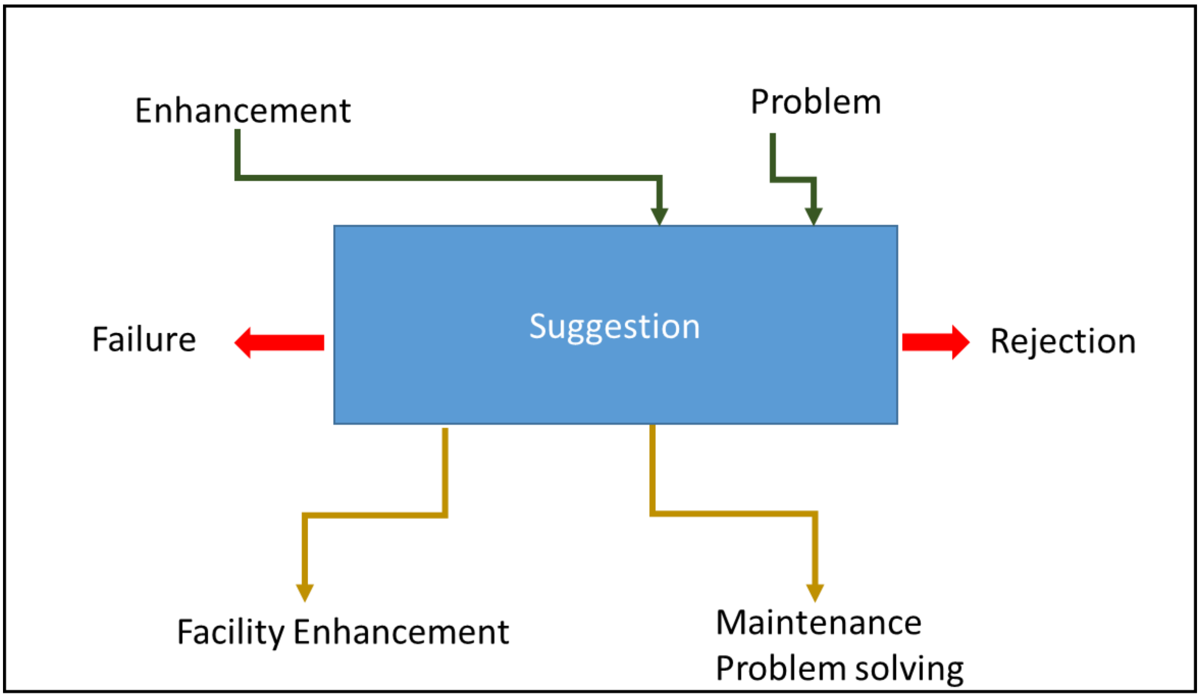

Figure 37: Eta CHIP

4.8.3. Eta pre-Intervention Process

The ‘pre-intervention' process had changed between the two observation periods. A detailed pre-intervention process in both the phases was plotted. The pre-intervention process cycle Phase I is shown in Figure 38.

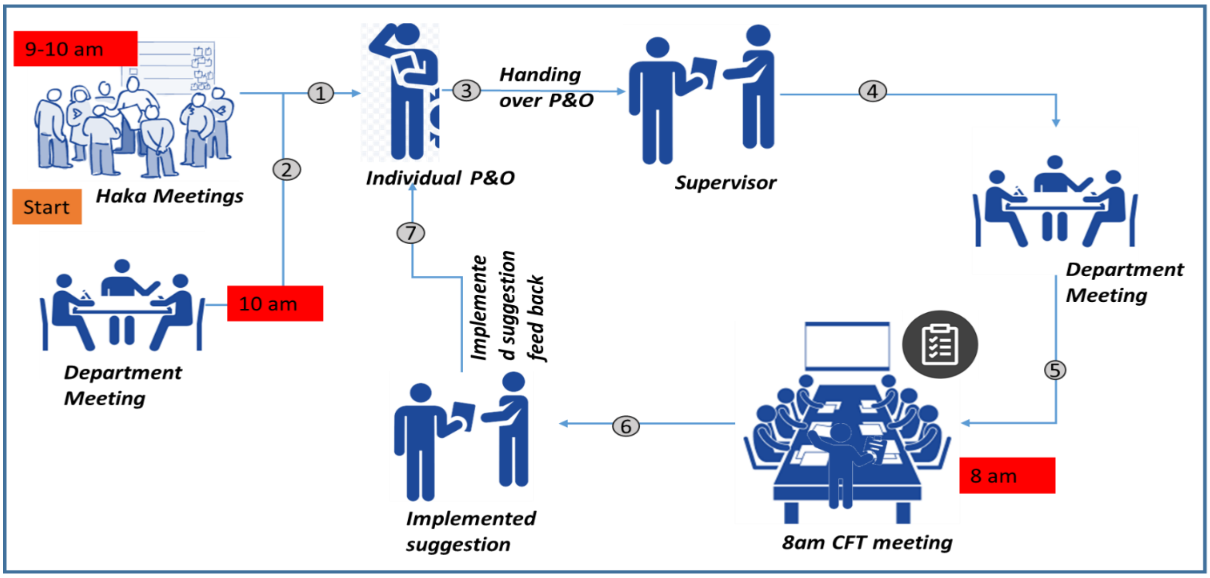

Figure 38: Eta pre-intervention process: Phase I

The process started with the discussions during the 9-10 am morning meeting internally known as ‘haka' meeting (1) and/or the discussions during the 10 am morning department meeting (2). The staff reported a requirement for facility enhancement or maintenance issue, filled a problem and opportunity (P&O) form, and handed it to their supervisor (3). The supervisor brought forward the issue for discussion and obtained approval from the respective managers during the next department meeting (4). Subsequently, the approved forms were brought forward for discussion in the next day 8 am CFT meeting, and the issue was assigned to the responsible department (5). When the suggestion was implemented, the feedback was given to the supervisor, who in turn informed the staff, mostly verbally, and where staff had an email account, the feedback was given via email occasionally (6-7).

The suggestion process dealt with enhancement in facility and maintenance issues. The morning meetings and department meetings were conducted after the CFT meetings. Lack of systematic approach and unintentional miss delayed the issues discussion at CFT. At the CFT meeting, the P&O forms were placed at an allocated slot, and review of forms indicated actions pending for eight months. Inordinate delays were evident, no timelines were fixed for actions and priorities varied based on the influence of people and situation.

During Phase II the process had undergone a change, where the P&O data were captured digitally. The pre-intervention process cycle Phase II is shown in Figure 39.

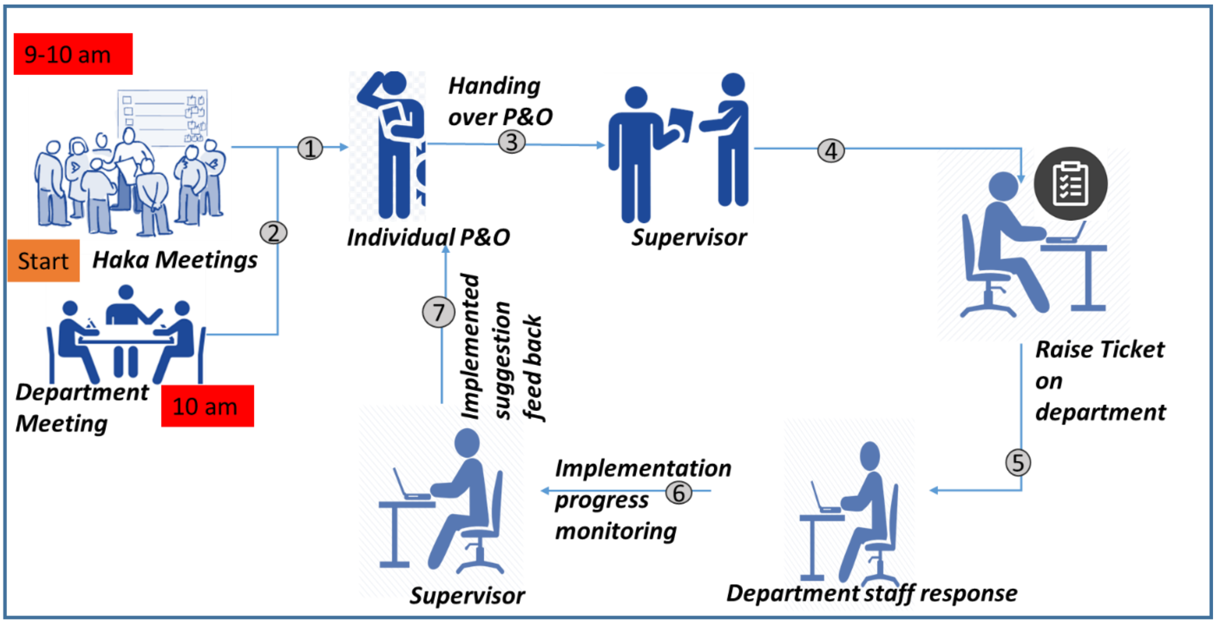

Figure 39: Eta pre-intervention process: Phase II

The process started with the discussions during the 9-10 am operators' morning gathering (called the 'haka' meeting) (1) and/or the discussions during the 10 am morning department meeting (2). The staff reported a requirement for facility enhancement or a maintenance issue, filled up a P&O form and handed over to a supervisor (3). Then, the supervisor digitally raised a ticket on the respective department (4). Subsequently, the respective department head assigned the ticket to a staff member, who responded to the ticket and periodically updated the progress (5). The supervisor monitored the progress and raised it to the next level whenever required; and when the suggestion implementation was completed, the feedback was given to the staff, mostly verbal, and whichever staff had an email account, the feedback was given via email occasionally (6-7).

Phase II's suggestion process also dealt with enhancement in facility and maintenance issues. An enhancement example evidenced, was a visibility improvement P&O and ticket requested for a staff table on the shop floor that had a progress update from the engineering department. The issues were captured systematically, but CFT was excluded from the process. The issues that needed CFT intervention were left to the individual staff member who was assigned to solve the issue. Phase II's process continued to have inordinate delays, as no timelines were fixed for actions and priorities varied based on the influence of people and situation. Further, the process had stressors and associated biases that affected the process productivity.

4.8.4. Eta process biases

The study revealed that the process had been impacted by various stressors and associated biases. Further, lack of management commitment for systematic suggestion analysis and implementation was a stressor to the process. Figure 40 shows the process stressors.

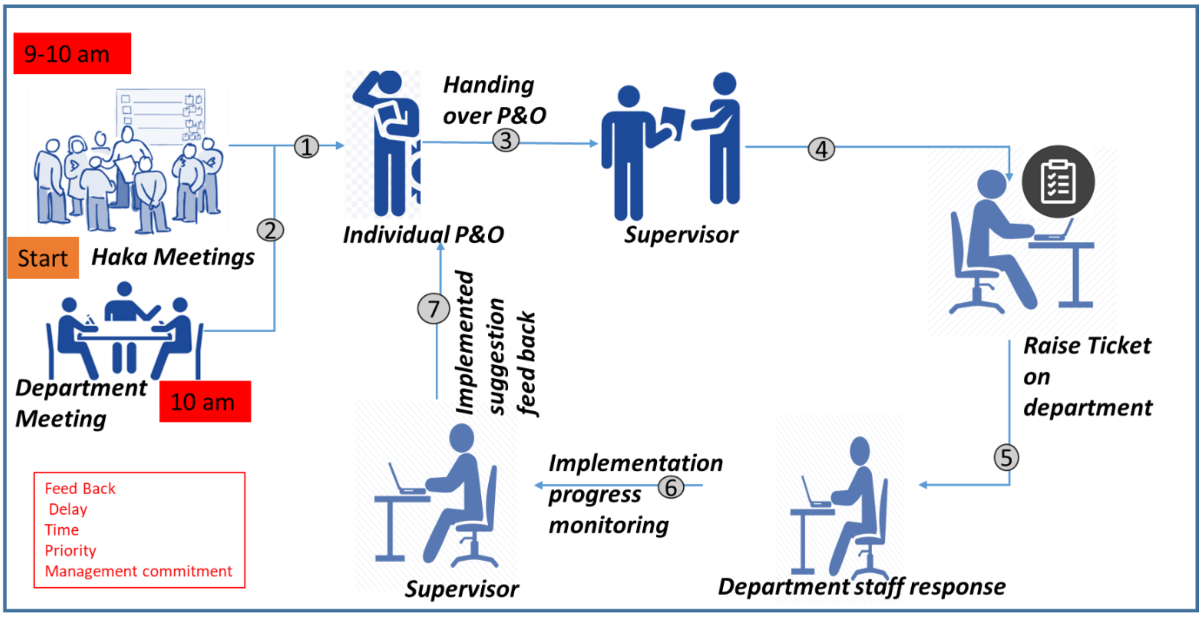

Figure 40: Eta stressors

These process stressors were the cause for the system and the people stressors, and had various biases' influence, as represented in Table 42.

Table 42: Eta stressors and associated biases

Process stressors	**Primary stressors**	**Resultant stressors**	**Remarks**	**Associated biases**
Feedback	Information	Intellectual discretion	Supervisor and managerial staff assumed that people do not need feedback and did not identify a person to appreciate the effort. Supervisor and managerial staff were waiting, watching and being unresponsive.	An appeal to probability, bandwagon effect, (no) person identification, and no response.
Delay	Time	Role	People were driven by priorities and were unaware of the consequences to others when there was a delay.	Bounded awareness and priority.
Time	Priority	Role	Staff were driven by priorities and emergencies instead of the process.	Bounded awareness and priority.
Priority	Priority	Role	Staff were driven by priorities and emergencies instead of the process.	Priority.
Management commitment	Commitment	Performance	Management viewed their suggestions and improvement projects more than P&O and unconsciously avoided equal opportunity. No staff was discussing the commitment to P&O. Further, the data, fact, or view were used only in a traditional way, as previously used, or as per the original intended purpose.	Opportunity, lead, in attentional blindness, bandwagon effect, and functional fixedness.

The stressors and associated biases' elimination combined with consideration of additional avenues for suggestion formed the platform for an improved process.

4.8.5. Eta suggested process improvements:

The case study analysis revealed that the process could be improved by understanding the stressors and biases in the system. Further, the field returns and complaint data were not used to drive the suggestion process. Incorporating the returns, complaints and operation process as additional inputs, a new CHIP was developed as shown in Figure 41.

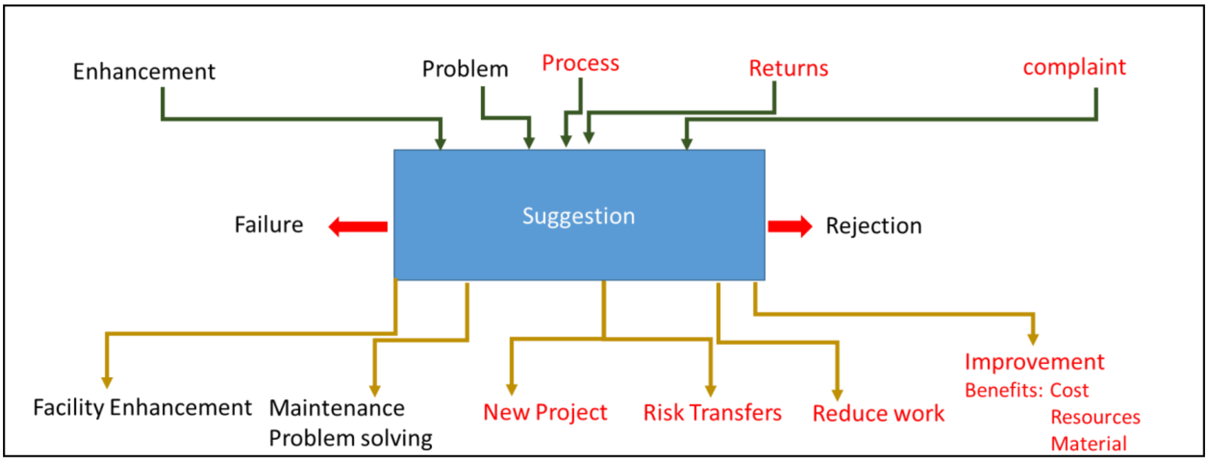

Figure 41: Eta suggested CHIP

The suggested CHIP derived output scope for the new project, risk transfers, reduced work, and improvements in the process with respect to cost, resources, and material. The failure and rejection remained as seepages. Based on the CHIP, the process was suggested to have two pathways, one for the problem, enhancement, returns, and complaints, and another for improving operation process.

4.8.5.1. Improved suggestion process for enhancement, problem, return, and complaint.

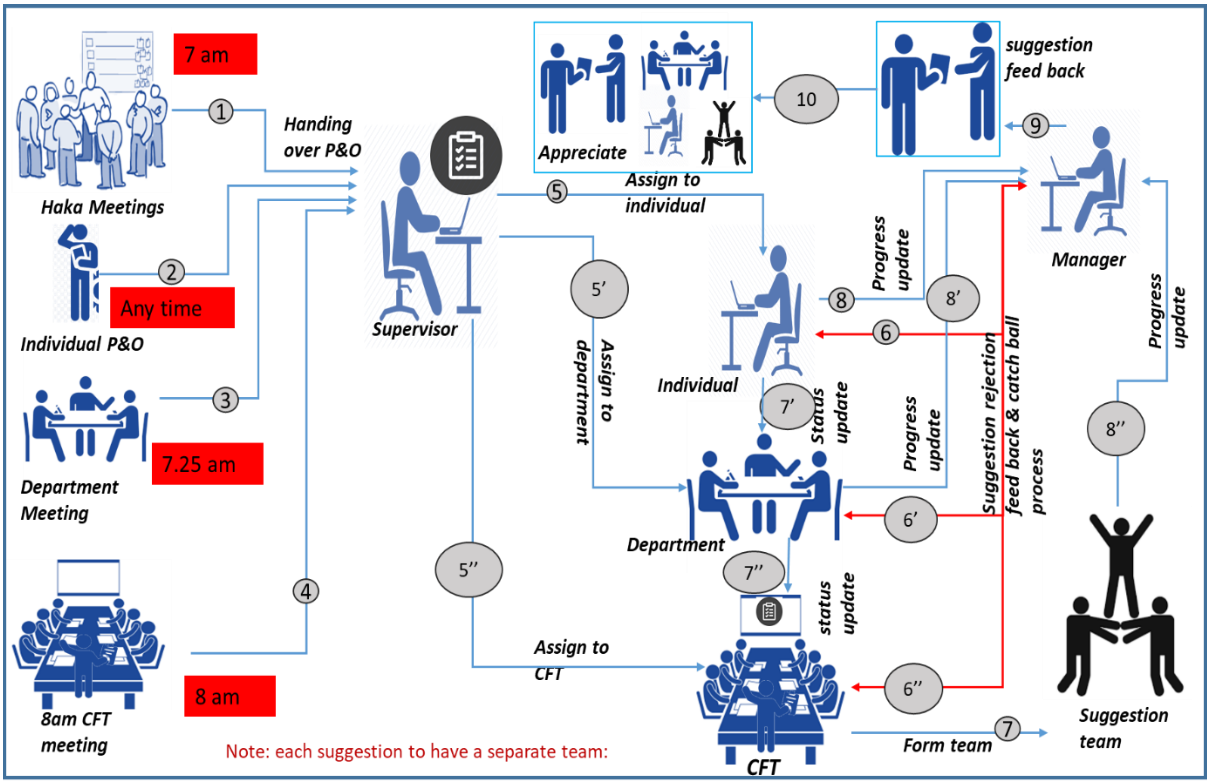

Figure 42: Eta improved suggestion process, pathway 1.

The improved process pathway 1, refer to Figure 42, focused on online updating of all relevant data, involving CFT and periodic communication to all stakeholders. On a daily basis, field return, complaint, suggestions from ‘haka' meetings at 7 am during the start of the day (1), individual (2), department meeting (3) and the 8 am CFT meeting (4) were to be used by the respective supervisor to raise tickets in the system. The supervisor would then assign the task to an individual (5) or department (5') or the CFT (5'') based on the work and departments involved. The assigned person (6) or department (6') or CFT (6'') would review the issue and/or suggestions and reject them if inappropriate or not viable. This would be communicated electronically to the ticket originating department manager.

Subsequently, for the rejected suggestions, the manager would perform a catch-ball process either to accept the rejection, convince the assigned person to accept and proceed, or assign it to another person. Once the suggestion was accepted for implementation, the assigned person would give a status update at the departmental meeting (7'), and his head of department would update the CFT daily (7''). Next, the CFT based on progress and/or based on the nature of suggestion would form a suggestion team for each suggestion (7).

The next stage would be an electronic periodic progress update by the assigned person (8, 8’, 8’’), which would be systematically passed on to the individual by email or a memo (9). Once the suggestion implementation was complete, the suggestion provider, assigned individual, or team were to be acknowledged in their respective daily meetings, and visuals would be displayed at their meeting board to encourage more suggestions in future (10).

4.8.5.2. Improved suggestion process for operation process

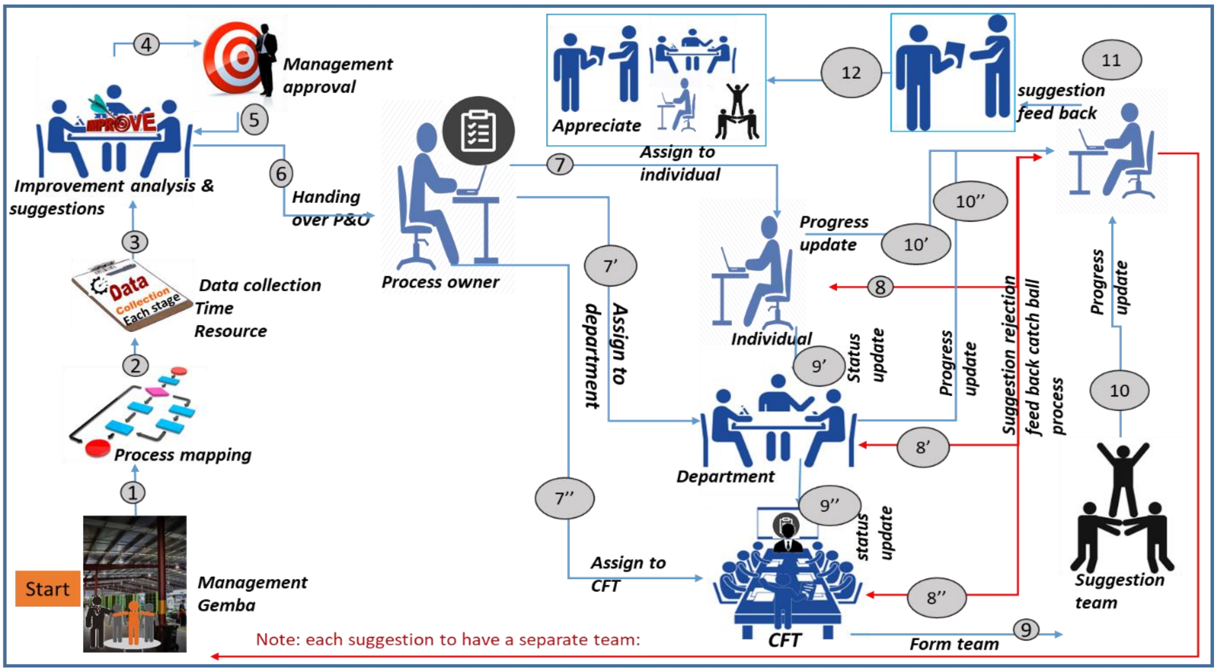

Figure 43: Eta improved suggestion process, pathway 2.

The improved process pathway 2, refer to Figure 43, focused on Gemba, online updating of all relevant data, involving CFT and parodic communication to all stakeholders. Every month, one process per department was suggested to be taken for a Gemba visit, the process needed to be mapped (1), followed by data collection, which included but was not limited to time and resources (2). The process mapping and data collected were to be analysed by the department manager to fix a target, raise a P&O form (3) and present it to management for approval (4).

Management approval would be essential to get any needed resources and investment (5). After the approval, the P&O form was to be handed to an identified process owner who would raise tickets and assign the task to an individual (7) or department (7') or the CFT based (7'') on the work and departments involved. The assigned person (8) or department (8') or CFT (8'') would review the issue and suggestion, reject if inappropriate or not viable. This would be electronically communicated to the ticket originating department manager. Subsequently, for the rejected suggestions, the manager would perform a catch-ball process either to accept the rejection, convince the assigned person to accept and proceed, or assign another person. Once the suggestion was accepted for implementation, the assigned person would give a status update at the departmental meeting (9'), and his head of department would update the CFT daily (9’’). Subsequently, the CFT based on progress and/or based on the nature of suggestion would form a suggestion team for each suggestion (9).

The next stage would be an electronic periodic progress update by the assigned person (10, 10’, 10’’), which would be systematically passed to process owner by email or a memo (11). Once the suggestion implementation was complete, the suggestion provider, process owner, assigned individual, and team were to be acknowledged in their respective daily meetings, and visuals would be displayed at their meeting board to encourage more suggestions in future (12).

The following guidelines were suggested to be included as a part of the improved suggestion process, refer to Table 43 below:

Table 43: Guidelines for improved suggestion process

Discerption	Guidelines
Meeting agendas	Suggestions review; New suggestions update; Suggestions -Complains update; Suggestions -Returns update; and Process improvement Update.
Target	2 suggestions / person / month; 15 suggestion / department; 1 Process improvement / month/ department; Complaint resolution 15 working days; and Returns resolution 15 working days.
Feedback	Appreciate even when a suggestion is rejected; and Issue appreciation certificates for ➢ Speed; ➢ Quality; ➢ Suggestion; ➢ Cost prudence; ➢ Productivity gain; ➢ Execution; and ➢ Involvement.
Timelines	Initial feedback is given within two working days; Management to approve timelines above 15 days; and Implementation timeline based on the task to be discussed and agreed for ➢ Individual ➢ Department ➢ Team; and ➢ Management Review.
Motivation	Cash reward or gift; Certificate of appreciation; Appreciation on the floor; Fast Approvals; The annual budget for suggestions; Set timelines; Sharing data in meetings on suggestions; and Showcase improvements.

The improvised suggestion process pathways address the stressors and associated biases, which are shown in Table 44.

Table 44: Eta improved process stressors and biases status

Process stressors	**Primary stressors**	**Resultant stressors**	**Improvement in Improvised process**	**Associated biases**
Feedback	Information	Intellectual discretion	Systematic feedback would be given. The person who gave the P&O and the implementer would be appreciated and motivated. Supervisor and managerial staff would be involved in the process.	An appeal to probability, bandwagon effect, (no) person identification, and no response.
Delay	Time	Role	Systematic review and update.	Bounded awareness and priority.
Time	Priorities	Role	The process would drive the staff instead of priorities and emergencies.	Bounded awareness and priority.
Priority	Priorities	Role	The process would drive the staff instead of priorities and emergencies.	Priority
Management commitment	commitment	Performance	Management would view all suggestions equally. Staff would be discussing the commitment to P&O. Further, the data, fact, or view would be used to identify the improvement opportunities.	Opportunity, lead, in attentional blindness, bandwagon effect, and functional fixedness.

Subsequently, the production team that participated in the case study was motivated to try a process improvement through a Gemba study as suggested in the improved process pathway 2.

4.8.6. Eta Gemba Study

A Gemba study was conducted in a Phase II visit to demonstrate improvement in a process to substantiate the improvised suggestion process. The study was undertaken in the repacking process where the fruits were inspected and repacked. After three discussions, the team agreed to take the trial. The process was mapped and plotted, refer to Figure 44.

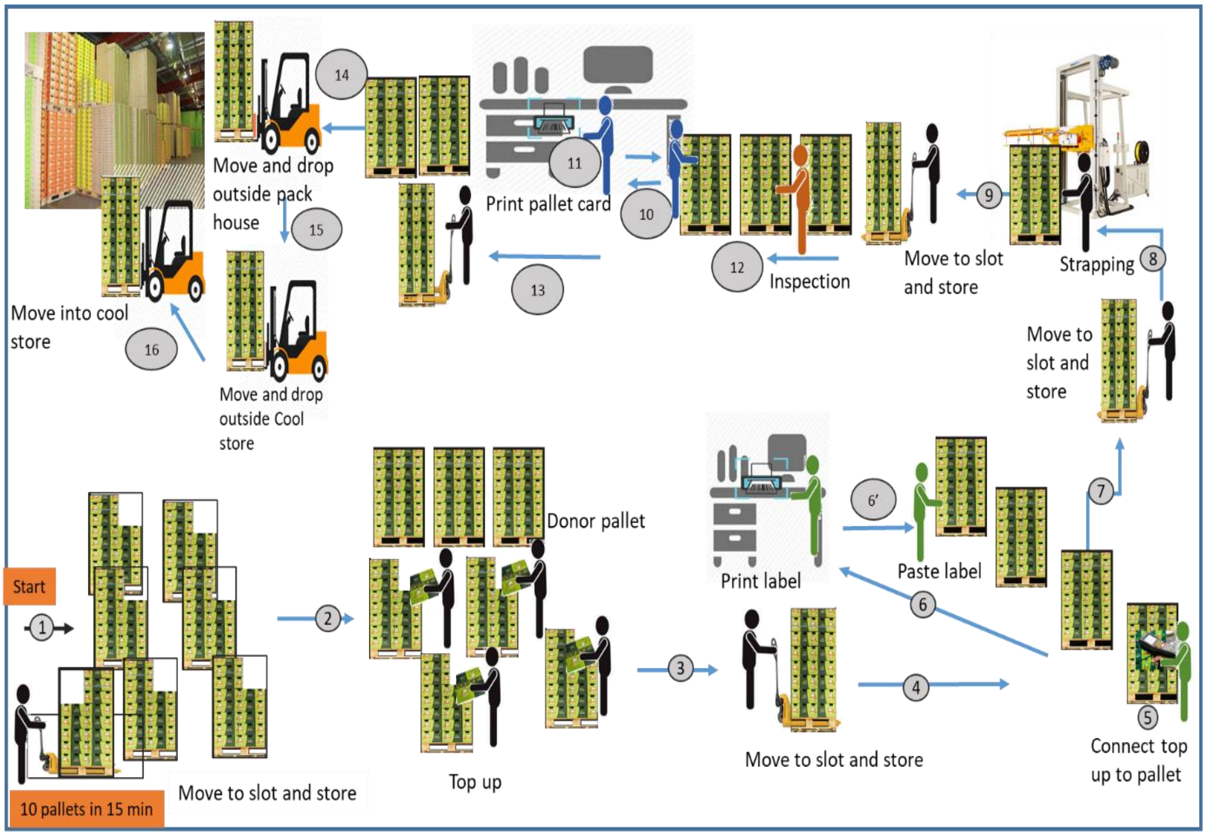

Figure 44: Eta repack pre-intervention process

The process started when the pallets from the inspection table flowed at a rate of 10 pallets per 15 minutes. An operator moved the pallet, aligned and stored it in the designated slot (1). The pallets were short of fruit boxes due to rejection at the inspection stage. Then, another set of operators topped up the pallet with fruit boxes from donor pallets, which were of the same quality and quantity requirement (2). The pallet was then moved, aligned, and placed in the labelling area slot (3). The labels for each topped up box was then scanned by an operator, who then moved to the station to print customer specific labels and pasted it on the boxes (4-6). Then the pallet was moved, aligned, and stored at the strapping area (7). After strapping, the boxes were moved, aligned, and stored at pallet card area (8-9). An operator removed the old pallet card and scanned it. Subsequently, the system generated and printed a new pallet card that was pasted on the pallet by the operator (10-11). This was followed by inspection, and the pallet was passed (12). The inspected pallets were then moved and stored at a designated area for further movement to a cool store (13). As a next step, the pallets were moved, aligned and stored by forklift operator at a designated area outside the packhouse (14), which was moved later by another forklift to a designated area outside the cool store, properly aligned, and stored (15). Then the pallet was moved into a cool store, aligned, and stored at designated slot by another forklift operator (16). Further, the process was impacted by stressors and associated biases as shown in Table 45.

Table 45: Eta Gemba study stressors and associated biases

Process stressors	Primary stressors	Resultant stressors	Remarks	Associated biases
Direction for next work	waiting	Role	The process was directed by staff, and people waited for instruction. Process errors were evident.	Illusion of control, absent-mindedness, bandwagon effect, automation omission, functional fixedness, in attentional blindness, and overdo.
Delay	Time	Role	Delay and fear of missing process were evident.	Bounded awareness and priority.
Time	Priorities	Role	The team was under constant time pressure.	Bounded awareness, automation, and priority.
Priority	Priorities	Role	The team acted on priorities.	Priority.

In the next phase, a series of trails were taken along with the team to arrive at the improved process, the finalised process is shown in Figure 45.

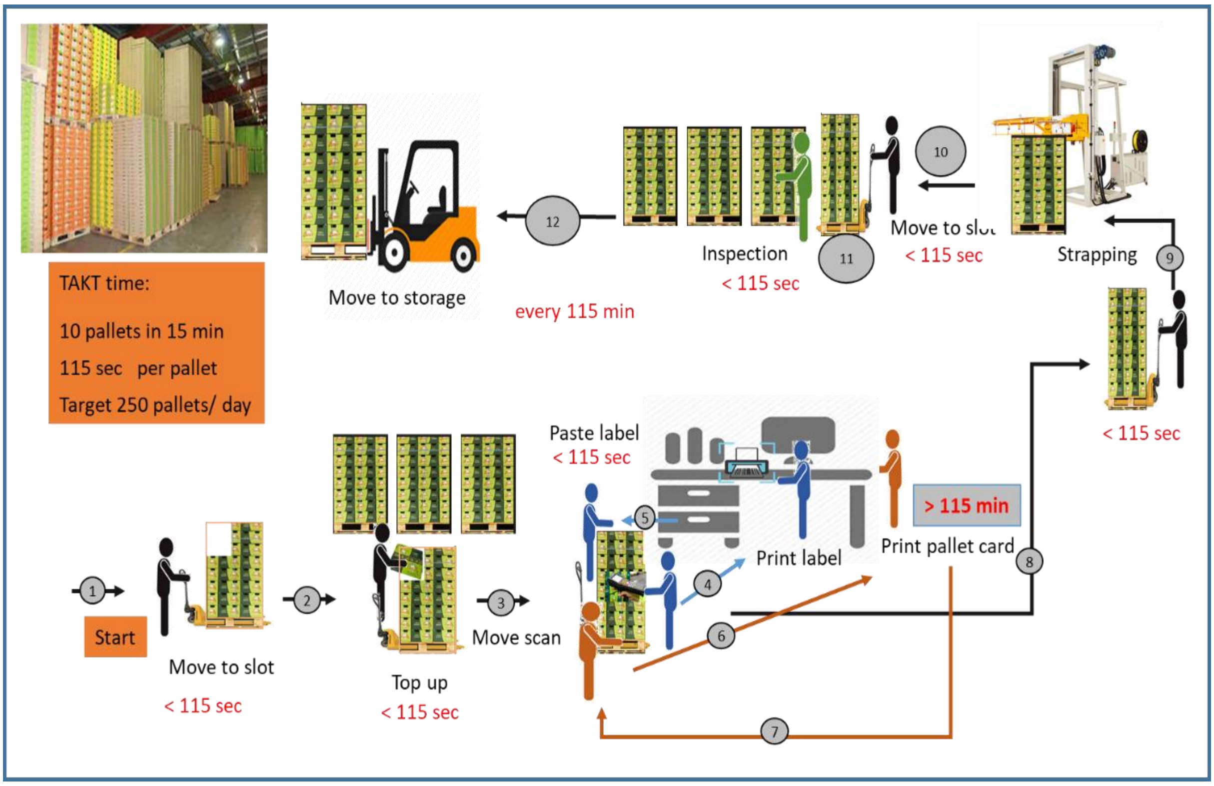

Figure 45: Eta improved repack process

The improved process started with the pallets from the inspection table flowing at a rate of 10 pallets per 15 minutes. An operator moved the pallet, aligned and stored it in the designated slot (1). Then, another set of operators topped up the pallet with fruit boxes from donor pallets, which were of the same quality and quantity requirement (2). The pallet was then moved, aligned, and placed in the labelling area slot (3). The labels for each top up was then scanned by an operator, who then moved to the station to print customer specific labels and pasted them on the boxes (4-5). Simultaneously, another operator removed and scanned the pallet card, and once label printing was completed, the pallet card was printed pasted to the pallet (6-7). In the next step, the pallet was moved to strapping, and once strapping was completed it was moved to the inspection slot (8-10). This was followed by inspection and the pallet was passed (11). The inspected pallets were then moved to the cool store, aligned and stored at a designated slot by another forklift (12). This stage required two forklifts to be operated simultaneously. When the report was presented to the management, they identified that a trolley could be fabricated and used to transport the fruit pallets to the cool store by using a forklift, which would carry more pallets and reduce the number of trips.

The results of the trial were that four operation steps were reduced, and staff were freed to organise the donor pallets and their next jobs. The congestion and space requirement for the operation were reduced while the process adhered the Takt Time requirements. The status of stressors and associated biases are shown in Table 46.

Table 46: Eta Gemba study improved process stressors and biases status

Process stressors	**Primary stressors**	**Resultant stressors**	**Improvement in Improvised process**	**Associated biases**
Direction for next work	Waiting	Role	The flow was continuous, and everyone was working on a set task which eliminated the direction, absent mindedness, provided an alternative solution, prompted information other than system generated and was a new experience to the participants.	Illusion of control, absent-mindedness, bandwagon effect, automation omission, functional fixedness, in attentional blindness, and overdo.
Delay	Time	Role	Continuous flow within Takt time reduced delays and fear of missing a process step.	Bounded awareness and priority.
Time	Priorities	Role	Visual information, data during the Gemba study aided the continuous flow and reduced time required to perform the overall process.	Bounded awareness, automation, and priority.
Priority	Priorities	Role	Continuous flow within Takt time avoided priorities at this stage.	Priority.

The report was presented to the management on suggestion improvement and the Gemba study. The management team confirmed the pre-intervention process and acknowledged stressors. Further, the management communicated that they adored the report presentation style and contents, and intended to consider the suggestions provided and further discuss them with the operational team when the load came off the department.

4.8.7. Eta Lean tool Status

The case study revealed the status of Lean tools used and the waste prevalent in the system. The status of Lean tools used is tabulated as shown in Table 47.

Table 47: Eta Lean tool status

Tool	Status	Remarks
5S	Implemented	Evidenced 5s practices.
Andon	Implemented	Line stoppage for errors, emergencies are in place. Production status was manually updated, can be digital and updated online.
Bottleneck Analysis	Partially implemented	Evidenced as a part of delay analysis, the team needed to analyse bottlenecks in the process.
Continuous Flow	Implemented	The production line was continuous. However, repacking, storage, load-out, and dispatch processes did not follow the continuous flow.
Gemba	Implemented	Gemba practised when internal/external customer complaints were received, but details were not recorded systematically.
Heijunka	Partially implemented	Seasonal business. However, within the season, the levelling should be done to optimally utilise resources and reduce labour availability issues arising out of uneven production plan, they give time off to workers when the workload was low. Partial implementation evidenced in automated production lines.
Hoshin Kanri	Implemented	Policy deployment at organisation level evidenced, however, individual departmental policy and breakdown to a finite level not evidenced.
Jidoka	Implemented	The production line was semi-automated, and management was looking for opportunities to automate all processes wherever the return on investment was less than 12 months.
JIT	Not implemented	Procurement was based on season and orchid's plan to sell. However, JIT could be implemented considering weekly procurement while maintaining 48-hour fruit cooling. In spite of the IT system, the manual process was encouraged as people trust their experience and follow the existing practice.
Kaizen	Implemented	Selective but lacked systematic implementation. In most cases, the feedback was deficient. Workers and staff suggestions of small cost were implemented to motivate them.
Kanban	Implemented	Implemented for office requirements. Kanban for fruits not attempted citing practical difficulty due to seasonal business.
KPI	Implemented	KPI on production, receipt, quality, and delivery was well understood, and the entire team takes it as their KPI. However, KPI for individuals, departments and catch ball concept to set targets was not evidenced.
Muda	Partially implemented	Not systematically captured. However, people work to reduce waste based on their belief.
OEE	Not implemented	Automated lines, forklifts and other equipment OEE not calculated. Required to improve efficiency and effectiveness of the process.
PDCA	Partially implemented	Just do it culture, actions were mostly top-down approach, and open discussions were not evidenced.
Poka-Yoke	Implemented	Implemented for size segregation and fruit inspection. However other processes provide scope for improvement in error proofing.
RCA	Implemented	Root causes for customer complaint evidenced. However, internal issues analysis not evidenced.
SMED	Implemented	Setup changes in the packhouse process were less than 10 minutes.
Six Big Losses	Not implemented	Need to capture data and analyse to justify future investments.
SMART Goals	Not implemented	Department or function goals not evidenced.
Standardised Work	Implemented	SOP available, however not followed, revisited, and updated periodically.
Takt Time	Not implemented	Capturing TAKT time requirement from all stakeholders would improve the performance of the organisation.
TPM	Not implemented	Not evidenced.
VSM	Not implemented	Value stream mapping not evidenced. VSM would enhance productivity.
Visual Factory	Implemented	Could be upgraded and improved.

4.8.8. Eta waste status

The case study observation revealed various types of waste in the system, which are shown in Table 48.

Table 48: Eta waste status

Waste	Participants confirmation	Remarks
Manufacturing waste	20/20	All seven waste types were evidenced.
Environment waste	20/20	Diesel forklift polluted the air, paper and corrugated box waste noticed, organic waste was recycled and sold free of cost.
Information technology waste	19/20	Periodic glitches in the IT system, too many update steps were required for updating a transaction, and reports did not provide all the required information. However, staff reported that the IT system was reliable.
Decision-making individual waste	20/20	Relaxed working in the absence of priorities and emergencies, however, the team geared up during peak season.
Department or Function Waste	18/20	Policy and procedure were reported as elaborate or inadequate. Approval procedures were lengthy and passed through positions induced delay.
Decision-making cross-functional team waste	16/20	Delay in the agreement between departments and implementation of suggestions was reported.
Human resources waste	20/20	People reported a lack of training in Lean skills. HR focused on health and safety. People availability issue noticed in the production line. Skilled forklift drivers at load-out/ delivery areas availability issue reported.
Enterprise engagement waste	13/20	Audits were reported as formalities. However, safety audits were reported effective.
Stress Waste	18/20	Stress evidenced to complete the priorities and emergencies.
Methods waste		
Design waste	0/20	Inefficient process and layout design at the receipt, unload, empty pallets, cool storage area location and distance travelled.
Overhead waste	20/20	The hierarchy was evident, the supervisors and managers did not focus on eliminating the root cause of the problem.
Eagerness waste	20/20	Small trials were conducted often, but systematic capturing of the trial method, process, effectiveness, resources spent and cost were not evident.

4.9. Consolidated process bias data

The case studies revealed a number of biases in the industries. To identify similar biases in industries, the identified process biases were compared. The comparative data on various process biases from the case studies are shown in Table 49, where a “✓” mark indicates the presence of bias in the case study.

Table 49: Consolidated process biases

Sl. no	Bias	Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	Count
1	Absent-mindedness			✓		✓	✓	✓	4
2	An appeal to probability							✓	1
3	Anti-trust		✓	✓	✓		✓		4
4	Attentional				✓				1
5	Autocratic				✓		✓		2
6	Automation				✓		✓	✓	3
7	Automation adherence				✓				1
8	Automation omission		✓	✓				✓	3
9	Bandwagon effect	✓	✓	✓	✓	✓	✓	✓	7
10	Bounded awareness	✓	✓	✓	✓	✓	✓	✓	7
11	Congruence		✓	✓	✓				3
12	Endogeneity		✓	✓					2
13	Escalation of commitment		✓	✓	✓		✓		4
14	External influence/Illusion of external agency					✓	✓		2
15	Fear of Failure	✓	✓	✓	✓	✓	✓		6
16	Fear of Job loss	✓			✓	✓	✓		4
17	Functional fixedness							✓	1
18	Herd instinct		✓						1
19	Illusion of control						✓	✓	2
20	In attentional blindness	✓	✓	✓	✓	✓	✓	✓	7
21	In-group favouritism/In-group–out-group		✓	✓			✓		3
22	Lack of control		✓	✓					2
23	Lead							✓	1
24	Levelling and sharpening.		✓	✓					2
25	Long work	✓		✓	✓	✓	✓		6
26	No time and energy	✓	✓	✓	✓	✓	✓		6
27	Opportunity							✓	1
28	Over do	✓	✓	✓	✓	✓	✓	✓	7
29	Person identification							✓	1
30	Priority	✓	✓	✓				✓	4
31	Problem set				✓				1
32	Reactance		✓	✓					2
33	Standardisation		✓	✓					2
34	System- human				✓				1
35	Technology aversion			✓					1
36	Wrong information	✓	✓	✓	✓	✓	✓		5

4.10. Key takeaway: a few other tendencies

The key takeaway from the case studies was that, compared to the literature survey, there were other biases that affected the process and performance. For example, the discussion, interview, and observation revealed that people interpret organisational policies and health and safety policies at their convenience. Further, BOM and SOPs were not updated periodically, and non-adherence was observed. Furthermore, people had not considered the reactions of the entire chain (system-wide) that was involved in the process and did not consider the critical responses from the chain on current issues and changes in the process.

Similarly, as an organisation and an individual, the system-wide approach was not evident. In addition, analysis revealed that people inclined or declined actions based on group reactions and stress. The new tendencies that were observed in all the case studies are identified as biases and are listed below.

- Chain reaction: The tendency of being unaware or unresponsive to the people reaction happening in the process chain;
- Convenience: The tendency to miss or decline actions based on convenience of interpretation of instructions, policies, or procedures;
- Critical Response: The tendency to miss or avoid critical responses with all stakeholders;
- Group reaction: The tendency to decline support based on predicted reactions of their group;
- Health and safety: The tendency to incline or decline based on predicted consequences of health and/ or safety;
- Organisational Policy: The tendency to incline or decline based on the understanding of policies or legal requirements;
- SOP: The tendency to miss, deviate or decline action stated in standard operating procedure;
- Stress: The tendency to decline actions based on predicted stress on oneself or the process; and
- System-wide approach: The tendency to discount or not consider stakeholders in the system for a situation, issue, or action.

The Primary code, key words and connected words, actions, and behaviour to observe during data collection are shown in Table 50.

Table 50: New biases and primary code

Bias	Primary code	key words	Connected words, actions, and behaviour to observe during data collection
Chain reaction	Management	Reaction	Consider reactions of all stake holders
Convenience	People	Decline	Decline based on convenience
Critical Response	Management	Response	Consider the response of all stake holders
Group reaction	Group	Reaction	Predict group reactions to decline
Health and safety	Zero	Risk	Predict the consequence of Health and safety
Organisational Policy	Management	Policy	Incline/decline based on policies
SOP	Standardisation	Actions	Miss or deviate actions specified in the document.
Stress	People	Stress	Incline/decline based on stress
System-wide approach	Management	Approach	Not consider all stake holders

4.11. Descriptive statics

In this section, the descriptive statistics of Lean tools, different types of waste and biases are tabulated. First, the Lean tools statistics are tabulated, followed by waste and biases.

4.11.1. Lean tools status

Table 51, below, summarises the status of Lean tools implementation obtained for each of the case studies described in Chapter 4. The Lean tools implemented are denoted by "**+**", partially implemented are represented by "P", not implemented are expressed by "**-**", and blank cells indicate not applicable.

Table 51: Lean tool status

Tool	Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	Count of not implemented	Count of partially implemented	Count of implemented
5S	-	P	P	+	+	+	+	1	2	4
Andon	-	P	P	P	P	P	+	1	5	1
Bottleneck Analysis	P	P	P	P	P	P	P		7	
Continuous Flow	-	P	P	P	-	P	+	2	4	1
Gemba	+	+	+	+	+	+	+			7
Heijunka	P	P	P	P	P	P	P		7	
Hoshin Kanri	-	+	+	+	+	+	+	1		6
Jidoka	-	P	P	P	-	P	+	2	4	1
JIT	P	P	P	+	+	+	-	1	3	3
Kaizen	+	+	+	+	+	+	+			7
Kanban	-	P	P	+	+	+	+	1	2	4
KPI	+	+	+	+	+	+	+			7
Muda-Waste	P	P	P	P	P	P	P		7	
OEE	-	P	+	P	-	-	-	4	2	1
PDCA	+	P	P	+	+	+	P	4	3	
Poka-Yoke	-	-	-	P	-	P	+	4	2	1
RCA	+	+	+	+	+	+	+			7
SMED	-			+	+	+	+	1		4
Six Big Losses	-			-	-	-	-	5		
SMART Goals	-	P	P	P	P	P	-	2	5	
Standardised Work	-	+	+	+	-	+	+	2		5
Takt Time	-	-	-	-	-	-	-	7		
TPM	-	-	-	-	-	-	-	7		
VSM	-	-	-	-	-	-	-	7		
Visual Factory	-	P	P	+	+	+	+	1	2	4

Overall the study witnessed a mixed implementation status of the 25 Lean tools, the data showed that:

- Gemba, Kaizen, KPI, RCA were implemented in all seven cases;
- Bottleneck Analysis, Heijunka, and Muda were partially implemented in all seven cases;
- Takt Time, TPM, and VSM were not implemented in all seven cases;

- Hoshin Kanri and Standardised work in were implemented six and five cases respectively;
- 5S, Kanban, and Visual Factory were implemented in four cases and partially implemented in two cases;
- SMED was implemented in four cases;
- Continuous Flow and Jidoka were implemented in one case and partially implemented in four cases;
- Andon was implemented in one case and partially implemented in five cases;
- SMART Goals and Six Big Losses were partially implemented in five cases;
- JIT was implemented in three cases and partially implemented in two cases;
- PDCA was implemented in one case and partially implemented in three cases; and
- OEE and Poka-Yoke were implemented in one case and partially implemented in two cases.

The results of this study on waste indicate that Lean tools implementation status was mixed and had many possible explanations. This study set out to explore one such influence, that of cognitive biases.

4.11.2. Waste statistics

The analysis of observations, interviews and a review of records indicated the prevailing waste types in the case studies. The observation, records, and the participants' narrated experiences were analysed to tabulate the waste. These waste types were analysed based on the case study, level of participants and their years of experience. Table 52 shows the summary of waste analysis for each case study indicating the number of participants who confirmed experiencing the various waste types prevalent in the process and the system.

Table 52: Waste analysis case study wise.

Waste	Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	Total
Manufacturing waste	6	9	11	30	14	9	20	99
Environment waste	6	9	11	30	14	9	20	99
Information technology waste	2	9	11	26	13	9	19	89
Decision-making individual waste	6	9	11	25	13	9	20	93
Department or Function Waste	0	9	10	18	8	6	18	69
Decision-making cross-functional team waste	0	3	5	2	1	6	16	33
Human resources waste	6	9	11	30	14	9	20	99
Enterprise engagement waste	1	2	0	2	5	5	13	28
Stress Waste	6	9	11	30	14	9	18	97
Methods waste								
Design Waste	0	0	0	0	0	0	0	0
Overhead Waste	0	6	11	30	14	9	20	90
Eagerness and Error Waste	6	6	10	26	14	7	20	89
No of participants	6	9	11	30	14	9	20	99

The data was further analysed based on the position of the participants in their respective organisations. The data collected from the participants during the interview classified participants into three positions as management, staff, and operator. Senior managers, department heads, and chief executive officers were considered to be in the management category, staff in the ranks of managers and below were categorised as staff and value adders were categorised as operators. Table 53 shows the position-wise data, and the numbers indicate the types of waste experienced by the number of participants.

Table 53: waste analysis position wise

Position	***Number of Participants***	**Manufacturing**	**Environment waste**	**Information technology waste**	**Decision-making individual waste**	**Department or Function Waste**	**Decision-making cross-functional team waste**	**Human resources waste**	**Enterprise engagement waste**	**Stress Waste**	**Method Waste: Overhead Waste**	**Method Waste: Eagerness and Error Waste**
Management	*17*	17	17	17	16	15	12	17	13	17	16	17
Staff	*44*	44	44	41	41	28	19	44	14	42	43	40
Operator	*38*	38	38	31	36	26	2	38	1	38	31	32
Total	*99*	99	99	89	93	69	33	99	28	97	90	89

The experience data were collected during the interviews, which were analysed to plot the experience-wise waste data. The experience was split as:

- Trainee and fresh: In New Zealand, people start working when they are students, mostly part-time or 20 hours a week, which is considered in their overall experience. The participants with 0 to 5 years' experience (who had 2 to 3 years' part time experience and an additional 1-2 years' professional experience) were grouped in this category;
- Adequate Experience: The participants with 6-10 years' experience who possess adequate knowledge on the process and Lean tools were grouped in this category;
- Reasonable experience: The participants with 11-20 years' experience who possess adequate knowledge on the process and Lean tools were grouped in this category;
- Good experience: The participants with 21-30 years' experience who possess good knowledge of process and Lean tools were grouped in this category; and
- Superior Experience: The participants with more than 30 plus years' professional experience who possess good knowledge of process and Lean tools were grouped in this category. These participants had manual and digital era experience.

The data is represented in Table 54, and the numbers indicate the waste experienced by the number of participants.

Table 54: Waste data by experience

Experience	***Number of Participants***	**Manufacturing waste**	**Environment waste**	**Information technology waste**	**Decision-making individual waste**	**Department or Function Waste**	**Decision-making cross-functional team waste**	**Human resources waste**	**Enterprise engagement waste**	**Stress Waste**	**Method Waste**	
											Overhead Waste	**Eagerness and Error Waste**
Trainee	*14*	14	14	12	13	8	4	14	2	12	12	11
Adequate	*16*	16	16	14	15	10	5	16	4	16	15	15
Reasonable	*34*	34	34	30	32	25	15	34	11	34	33	32
Good	*19*	19	19	18	17	14	5	19	6	19	16	17
Superior	*16*	16	16	15	16	12	4	16	5	16	14	14
Total	*99*	99	99	89	93	69	33	99	28	97	90	89

The waste data indicated that the department or function, decision-making cross-functional team, and enterprise engagement waste were having lower confirmations by participants compared to the other waste. The data indicated that department or function waste was reported across positions and experience distribution, refer to Table 53 and Table 54 above that notified the significance. However, decision-making cross-functional team and enterprise engagement waste had lower confirmations, that is, 33 and 28 respectively out of possible 99. A possible explanation for these low numbers might be that the people who were not engaged with external agencies or cross-functional teams may possibly not have confirmed decision-making cross-functional team waste and enterprise enterprise-engagement waste. The study was not designed to collect this information, and hence there was a lack of evidence and this remained an assumption. For further analysis and discussion in this thesis, all types of waste are considered.

4.11.3. System-wide biases descriptive statistics

The process studies addressed the process stressors and its related biases, as described in Chapter 4. However, the study further revealed that there were cognitive biases which could affect all the processes system wide. For this thesis, these are referred to as system-wide biases. The second pathway and framework analysis method of data analysis, as represented in Figure 3 in sub-section 3.8, included the participant observation/discussions, interview recordings and interview notes of the semi-structured interviews where the same set of questions revealed system-wide biases (Examples given in Appendix 5). The participant observation/ discussions were regularly noted in internal journals and hand-written notes. In addition, the individual participant interview recordings were systematically coded and stored as audio files and hand-written interview notes. Owing to the confidentiality agreement and risk of individuals being exposed to the organisations, the individual results are kept confidential and not revealed in any form. The consolidated data was used for the narration of results.

Similar to the types of waste, the biases were analysed based on the case study, level, and experience. Furthermore, the percentage mean for each type of analysis based on number of responses (R) and number of participants (P) and its median were calculated and plotted.

The formula of % mean calculation

$$\%\ Mean_{\text{Case study}} = \text{Average}\left((R_{\text{Alpha}} / P_{\text{Alpha}} \times 100) + (R_{\text{Beta}} / P_{\text{Beta}} \times 100) + (R_{\text{Gamma}} / P_{\text{Gamma}} \times 100) + (R_{\text{Delta}} / P_{\text{Delta}} \times 100) + (R_{\text{Epsilon}} / P_{\text{Epsilon}} \times 100) + (R_{\text{Zeta}} / P_{\text{Zeta}} \times 100) + (R_{\text{Eta}} / P_{\text{Eta}} \times 100)\right)$$

$$\%\ Mean_{\text{Experience}} = \text{Average}\left((R_{\text{trainee}} / P_{\text{trainee}} \times 100) + (R_{\text{Adequate}} / P_{\text{Adequate}} \times 100) + (R_{\text{Reasonable}} / P_{\text{Reasonable}} \times 100) + (R_{\text{Good}} / P_{\text{Good}} \times 100) + (R_{\text{Superior +}} / P_{\text{Superior +}} \times 100)\right)$$

$$\%\ Mean_{\text{Position}} = \text{Average}\left((R_{\text{Management}} / P_{\text{Management}} \times 100) + (R_{\text{operator}} / P_{\text{operator}} \times 100) + (R_{\text{Staff}} / P_{\text{Staff}} \times 100)\right)$$

The results are shown in Table 55 below. The numbers indicate the number of participants who identified the biases. The experience, position and case study data, along with the count of participants' response and percentage responses are shown in columns. The responses are further subdivided into positive, negative and nil response. The different types of identified biases are shown in rows.

Table 55: System-wide biases data

Bias	Experience						Position				Case study								Count of Participant response	% Response		
	Trainee	Adequate	Reasonable	Good	Superior	% Mean	Management	Operator	Staff	% mean	Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	% Mean		Positive	negative	Nil
Absent-mindedness	13	16	35	19	16	100.00	17	38	44	100.00	6	9	11	30	14	9	20	100.00	99	4.0	96.0	0.0
Agreement or collective consciousness	10	13	30	15	13	80.82	14	27	40	81.44	5	7	5	24	11	9	20	80.73	81	81.8	0.0	18.2
Anchoring and adjustment	13	15	33	16	15	93.20	17	33	42	94.10	6	7	7	29	14	9	20	91.15	92	92.9	0.0	7.1
Anchoring or focalise	7	13	19	9	9	58.60	16	5	36	63.03	1	3	4	8	14	7	20	55.83	57	55.6	2.0	42.4
Anecdotal	11	15	32	16	15	89.55	17	31	41	91.59	1	7	10	30	12	9	20	81.58	89	89.9	0.0	10.1
Anti-trust	11	14	30	16	13	84.66	16	29	39	86.36	5	7	3	30	14	5	20	77.71	84	83.8	1.0	15.2
Attentional	12	14	32	17	15	90.89	17	32	41	92.46	1	9	8	29	14	9	20	83.72	90	90.9	0.0	9.1
Authorisation	12	13	31	17	15	89.07	16	30	42	89.51	1	8	7	29	14	9	20	80.84	88	81.8	7.1	11.1
Autocratic	5	5	20	9	9	46.09	15	13	20	55.97	1	2	3	22	7	7	6	42.47	48	47.5	1.0	51.5
Automation	10	15	34	19	16	93.56	17	35	42	95.85	4	8	11	29	13	9	20	92.15	94	86.9	8.1	5.1
Automation adherence	9	14	33	16	16	87.05	15	32	41	88.54	4	4	9	29	13	9	20	83.21	88	76.8	12.1	11.1
Automation omission	11	15	34	19	16	95.10	17	36	42	96.73	4	9	11	29	13	9	20	93.74	95	86.9	9.1	4.0
Bandwagon effect	11	15	34	18	15	92.80	17	33	43	94.86	1	8	11	30	14	9	20	86.51	93	92.9	1.0	6.1
Belief	12	15	34	17	15	93.28	17	33	43	94.86	1	8	11	30	14	9	20	86.51	93	93.9	0.0	6.1
Bounded awareness	13	16	35	19	16	100.00	17	38	44	100.00	6	9	11	30	14	9	20	100.00	99	100.0	0.0	0.0
Chain of command	11	15	32	18	15	91.66	17	31	43	93.10	1	9	11	27	14	9	20	86.67	91	90.9	1.0	8.1
Chain reaction	13	16	35	19	16	100.00	17	38	44	100.00	6	9	11	30	14	9	20	100.00	99	100.0	0.0	0.0
Change dilution	9	11	24	14	9	67.30	14	23	30	70.35	1	9	5	20	5	7	20	63.18	67	65.7	2.0	32.3
Change of job	10	13	27	11	12	73.64	14	28	31	75.50	1	7	1	30	12	7	15	63.15	73	64.6	9.1	26.3
Confirmation	11	14	33	16	15	88.87	16	31	42	90.38	1	5	11	30	14	8	20	80.16	89	89.9	0.0	10.1
Confirmation evidence trap	10	13	31	13	13	79.28	15	24	41	81.53	1	3	3	30	14	9	20	68.18	80	80.8	0.0	19.2
Confirmatory	11	13	34	13	13	82.54	16	25	43	85.88	1	4	6	30	14	9	20	73.67	84	84.8	0.0	15.2
Congruence	11	15	34	19	16	95.10	17	36	42	96.73	4	9	11	29	13	9	20	93.74	95	94.9	1.0	4.0

Bias	Experience						Position				Case study								Count of Participant response	% Response		
	Trainee	Adequate	Reasonable	Good	Superior	% Mean	Management	Operator	Staff	% mean	Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	% Mean		Positive	negative	Nil
Context-dependent cues	11	15	33	18	15	92.23	17	33	42	94.10	2	7	11	30	14	8	20	85.71	92	87.9	5.1	7.1
Convenience	12	14	34	19	16	95.39	17	38	40	96.97	6	9	10	30	14	8	18	95.69	95	93.9	1.0	5.1
Critical response	13	16	35	19	16	100.00	17	38	44	100.00	6	9	11	30	14	9	20	100.00	99	100.0	0.0	0.0
Cross-race effect own-race other-race	0	0	3	2	1	5.07	2	1	3	7.07	2	0	0	0	1	3	0	10.54	6	6.1	0.0	93.9
Cryptomnesia	0	0	1	0	0	0.57	1	0	0	1.96	0	1	0	0	0	0	0	1.59	1	1.0	0.0	99.0
Cue-dependent forgetting	12	16	34	18	16	96.84	16	37	43	96.40	5	8	11	30	14	8	20	94.44	96	90.9	6.1	3.0
Curse of knowledge	10	14	33	16	15	87.33	17	29	42	90.59	1	5	10	30	14	8	20	78.86	88	87.9	1.0	11.1
Digital amnesia	11	15	34	19	16	95.10	17	36	42	96.73	4	9	11	29	13	9	20	93.74	95	86.9	9.1	4.0
Disagreement	11	15	32	16	14	88.30	15	30	43	88.30	1	7	8	29	14	9	20	80.55	88	86.9	2.0	11.1
Duration neglect	10	13	32	17	14	85.32	17	26	43	88.72	1	5	8	29	14	9	20	77.37	86	85.9	1.0	13.1
Easy study	9	11	26	15	9	69.49	16	23	31	75.03	1	9	5	21	6	8	20	66.27	70	60.6	10.1	29.3
Escalation of commitment	12	15	33	18	15	93.77	17	33	43	94.86	1	9	11	29	14	9	20	87.62	93	93.9	0.0	6.1
External influence/ Illusion of external agency	4	5	14	7	6	35.27	15	1	20	45.44	1	4	2	8	4	6	11	36.60	36	30.3	6.1	63.6
Fading affect	12	15	32	17	14	90.89	15	33	42	90.18	0	8	11	30	13	8	20	81.52	90	87.9	3.0	9.1
False-consensus	0	0	1	2	2	5.18	2	1	2	6.31	1	0	2	0	1	1	0	7.59	5	4.0	1.0	94.9
Fear of failure	11	15	34	16	15	90.69	17	32	42	93.22	1	7	10	30	14	9	20	83.62	91	91.9	0.0	8.1
Fear of job loss	11	16	33	19	16	95.78	16	37	42	95.65	5	9	10	30	12	9	20	94.28	95	89.9	6.1	4.0
Fix it fallacy	11	16	35	18	16	95.87	17	35	44	97.37	5	7	11	30	14	9	20	94.44	96	96.0	1.0	3.0
Frequency illusion	6	5	25	11	11	55.10	16	21	21	65.70	1	4	2	30	8	7	6	49.17	58	56.6	2.0	41.4
Fundamental attribution	12	14	34	17	15	92.03	17	32	43	93.98	1	7	11	30	14	9	20	84.92	92	92.9	0.0	7.1
Gender	0	0	3	0	1	2.96	2	1	1	5.56	1	0	0	1	1	1	0	5.46	4	2.0	2.0	96.0
Generation effect	10	14	28	15	13	80.92	15	28	37	82.00	1	5	10	28	12	4	20	69.52	80	80.8	0.0	19.2
Group attribution error	1	1	5	0	3	9.40	4	3	3	12.75	1	3	1	0	1	4	0	15.81	10	8.1	2.0	89.9

Bias	Experience						Position				Case study								Count of Participant response	% Response		
	Trainee	Adequate	Reasonable	Good	Superior	% Mean	Management	Operator	Staff	% mean	Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	% Mean		Positive	negative	Nil
Group escalation of commitment	9	11	29	14	11	72.65	16	24	34	78.18	1	8	5	24	8	8	20	68.15	74	74.7	0.0	25.3
Group formation	2	3	14	8	6	30.75	14	8	11	42.80	1	7	5	2	7	5	6	40.30	33	33.3	0.0	66.7
Group polarization	9	11	29	14	11	72.65	16	22	36	77.94	1	8	3	23	11	8	20	68.14	74	74.7	0.0	25.3
Group reaction	10	13	30	15	13	80.82	14	27	40	81.44	5	7	5	24	11	9	20	80.73	81	81.8	0.0	18.2
Group think	8	11	30	12	11	69.58	16	20	36	76.19	1	6	2	23	11	9	20	65.25	72	72.7	0.0	27.3
Guidance	11	16	33	19	16	95.78	17	34	44	96.49	5	9	11	27	14	9	20	96.19	95	96.0	0.0	4.0
Health and safety	8	5	25	9	11	56.07	8	25	25	56.56	5	0	2	30	14	7	0	54.18	58	56.6	1.0	42.4
Herd instinct	9	11	31	14	13	76.30	16	24	38	81.21	1	8	5	24	11	9	20	72.80	78	78.8	0.0	21.2
Hyperbolic discounting	10	13	31	17	13	83.49	17	28	39	87.44	1	7	8	29	11	8	20	75.90	84	83.8	1.0	15.2
Identifiable victim effect	1	0	6	1	3	9.77	2	4	5	11.22	1	0	0	6	0	4	0	11.59	11	10.1	1.0	88.9
Illusion of asymmetric insight	11	11	32	15	14	82.25	16	29	38	85.60	6	3	7	29	9	9	20	79.70	83	82.8	1.0	16.2
Illusion of control	11	12	31	15	13	81.68	17	27	38	85.81	1	6	8	30	10	7	20	72.18	82	77.8	5.1	17.2
Illusory truth effect	11	15	32	16	15	89.55	17	31	41	91.59	1	7	10	30	12	9	20	81.58	89	89.9	0.0	10.1
Immune neglect	13	16	34	19	16	99.43	17	37	44	99.12	6	9	11	29	14	9	20	99.52	98	1.0	98.0	1.0
Impossibility	9	12	29	13	12	74.10	15	23	37	77.62	1	3	2	30	11	8	20	62.23	75	72.7	3.0	24.2
In attentional blindness	13	16	35	17	16	97.89	17	37	43	98.37	6	8	10	30	14	9	20	97.11	97	98.0	0.0	2.0
In-group favouritism/In-group–out-group	8	8	26	13	9	62.10	14	19	31	67.60	1	4	4	21	11	6	17	56.82	64	63.6	1.0	35.4
Irrational escalation	11	14	31	16	15	87.73	15	30	42	87.55	1	5	10	30	13	8	20	77.84	87	86.9	1.0	12.1
Lack of control	10	16	30	19	16	92.53	17	33	41	93.34	5	9	11	26	11	9	20	92.65	91	78.8	13.1	8.1
Lack of trust	11	15	33	17	15	91.17	17	32	42	93.22	2	9	9	28	14	9	20	86.93	91	86.9	5.1	8.1
Lake wobegon effect	6	11	28	11	9	61.81	16	19	30	70.77	1	2	4	24	10	7	17	55.64	65	58.6	7.1	34.3
Lead	10	12	31	15	14	81.39	17	31	34	86.28	1	9	7	30	14	9	12	77.19	82	81.8	1.0	17.2
Less-is-better	9	13	28	13	14	77.28	15	23	39	79.13	1	3	5	29	11	8	20	65.65	77	77.8	0.0	22.2
Long work	11	16	35	18	16	95.87	17	35	44	97.37	5	7	11	30	14	9	20	94.44	96	97.0	0.0	3.0
Loop hole	1	2	13	5	7	25.48	6	11	11	29.75	1	3	1	13	1	9	0	29.94	28	27.3	1.0	71.7
Loss aversion	10	13	33	16	15	86.08	17	29	41	89.83	4	4	8	29	13	9	20	81.91	87	84.8	3.0	12.1
Memory inhibition	12	15	33	17	15	92.71	17	33	42	94.10	1	8	11	30	14	8	20	84.92	92	92.9	0.0	7.1

Bias	Experience						Position				Case study								Count of Participant response	% Response		
	Trainee	Adequate	Reasonable	Good	Superior	% Mean	Management	Operator	Staff	% mean	Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	% Mean		Positive	negative	Nil
Mental accounting	6	7	22	9	10	52.53	16	10	28	61.36	1	2	6	14	12	8	11	52.81	54	54.5	0.0	45.5
Mere-exposure effect	13	16	35	19	16	100.00	17	38	44	100.00	6	9	11	30	14	9	20	100.00	99	98.0	2.0	0.0
Misinformation effect	11	15	32	16	15	89.55	17	32	40	91.71	1	7	11	30	12	8	20	81.29	89	86.9	3.0	10.1
Modality effect	12	15	34	17	15	93.28	17	33	43	94.86	1	8	11	30	14	9	20	86.51	93	93.9	0.0	6.1
Moral credential effect	5	3	22	11	9	46.84	16	15	19	58.92	1	2	3	25	8	5	6	41.74	50	50.5	0.0	49.5
Myside diagnostic	2	5	7	2	2	17.93	5	4	9	20.13	1	5	1	0	1	8	2	26.76	18	18.2	0.0	81.8
Negativity	11	14	33	17	15	89.92	17	30	43	92.22	1	7	9	30	14	9	20	82.32	90	90.9	0.0	9.1
No time and energy	11	14	32	15	15	87.25	17	30	40	89.95	4	8	5	29	12	9	20	83.34	87	87.9	0.0	12.1
Non-rational escalation of commitment	10	14	33	16	14	86.08	17	27	43	89.59	1	4	9	30	14	9	20	77.56	87	87.9	0.0	12.1
Not invented here	4	9	22	9	6	46.95	13	9	28	54.60	1	4	2	10	7	8	18	48.79	50	44.4	6.1	49.5
Occupational	11	13	31	16	14	85.23	16	30	39	87.23	1	6	9	30	12	7	20	75.52	85	84.8	1.0	14.1
Omission	2	0	11	1	2	12.92	3	8	5	16.69	1	0	0	8	1	6	0	16.73	16	16.2	0.0	83.8
Optimism	12	15	32	17	14	90.89	16	32	42	91.26	1	8	10	30	13	8	20	82.60	90	87.9	3.0	9.1
Organisational policy	12	14	34	19	16	95.39	17	38	40	96.97	6	9	10	30	14	8	18	95.69	95	93.9	1.0	5.1
Outcome	10	13	33	16	15	86.08	17	29	41	89.83	4	4	8	29	13	9	20	81.91	87	84.8	3.0	12.1
Over do	11	13	24	15	12	77.68	9	33	33	71.59	0	7	10	26	6	6	20	66.41	75	75.8	0.0	24.2
Overconfidence effect	8	12	28	14	13	74.29	15	23	37	77.62	1	1	5	28	12	8	20	63.02	75	75.8	0.0	24.2
Patenting	12	15	34	19	16	96.64	17	36	43	97.49	4	9	11	29	14	9	20	94.76	96	97.0	0.0	3.0
Person -environment fit	8	14	29	12	12	74.01	17	22	36	79.90	5	5	5	23	9	8	20	73.45	75	75.8	0.0	24.2
Person identification	1	2	13	5	7	25.48	6	11	11	29.75	1	3	1	13	1	9	0	29.94	28	27.3	1.0	71.7
Picture superiority effect	12	15	33	18	15	93.77	16	34	43	93.77	1	9	11	30	13	9	20	87.07	93	93.9	0.0	6.1
Priority	12	16	35	19	16	98.46	17	37	44	99.12	5	9	11	30	14	9	20	97.62	98	99.0	0.0	1.0
Problem set	10	15	32	17	15	89.07	17	29	43	91.35	1	6	10	29	14	9	20	81.56	89	89.9	0.0	10.1
Project success or project short comings	11	15	31	16	15	88.98	17	28	43	90.47	1	8	10	26	14	9	20	83.30	88	88.9	0.0	11.1

Bias	Experience						Position				Case study								Count of Participant response	% Response		
	Trainee	Adequate	Reasonable	Good	Superior	% Mean	Management	Operator	Staff	% mean	Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	% Mean		Positive	negative	Nil
Reactance	12	15	33	16	15	91.66	17	31	43	93.10	1	7	10	30	14	9	20	83.62	91	91.9	0.0	8.1
Recollection	13	16	35	18	16	98.95	17	37	44	99.12	6	8	11	30	14	9	20	98.41	98	96.0	3.0	1.0
Reverse psychology	11	15	33	17	16	92.42	17	33	42	94.10	6	6	10	30	12	8	20	90.31	92	91.9	1.0	7.1
Selection	2	0	10	1	2	12.34	2	8	5	14.73	1	0	0	8	1	5	0	15.15	15	14.1	1.0	84.8
Self-integrity or preserving moral integrity	13	16	35	19	16	100.00	17	38	44	100.00	6	9	11	30	14	9	20	100.00	99	100.0	0.0	0.0
Self-perceived job insecurity	11	15	31	16	15	88.98	14	33	41	87.46	1	6	10	30	12	9	20	79.99	88	85.9	3.0	11.1
Self-reference effect	12	15	33	17	15	92.71	16	34	42	93.02	1	8	11	30	14	8	20	84.92	92	90.9	2.0	7.1
Semmelweis reflex or effect	9	14	30	13	13	78.42	16	24	39	81.97	1	3	5	30	12	8	20	67.15	79	78.8	1.0	20.2
Social desirability	12	15	33	16	15	91.66	16	32	43	92.02	1	7	10	30	14	9	20	83.62	91	87.9	4.0	8.1
Sop	11	15	34	18	15	92.80	17	34	42	94.98	2	9	11	28	14	9	20	89.52	93	93.9	0.0	6.1
Standardisation	11	15	34	18	15	92.80	17	34	42	94.98	2	9	11	28	14	9	20	89.52	93	1.0	92.9	6.1
Status quo	12	15	34	18	15	94.34	17	34	43	95.73	1	9	11	30	14	9	20	88.10	94	93.9	1.0	5.1
Stereotype	11	15	34	17	15	91.75	17	32	43	93.98	1	7	11	30	14	9	20	84.92	92	91.9	1.0	7.1
Stress	11	16	35	19	16	96.92	17	38	42	98.48	6	9	11	30	14	9	18	98.57	97	98.0	0.0	2.0
Subjective validation	12	15	34	16	15	92.23	17	32	43	93.98	1	7	11	30	14	9	20	84.92	92	92.9	0.0	7.1
Sunk cost	5	6	21	8	9	46.86	15	10	24	56.37	1	1	6	14	8	8	11	47.15	49	49.5	0.0	50.5
Survivorship or survival	11	15	34	18	15	92.80	17	33	43	94.86	1	8	11	30	14	9	20	86.51	93	92.9	1.0	6.1
System- human	12	15	34	19	16	96.64	17	36	43	97.49	4	9	11	29	14	9	20	94.76	96	86.9	10.1	3.0
System-wide approach	13	16	35	19	16	100.00	17	38	44	100.00	6	9	11	30	14	9	20	100.00	99	100.0	0.0	0.0
Talent misjudgement	5	7	24	11	10	54.24	16	18	23	64.59	1	4	5	24	8	9	6	53.39	57	55.6	2.0	42.4
Technology aversion	10	13	28	17	14	83.03	14	32	36	82.79	4	9	10	22	11	9	17	84.93	82	67.7	15.2	17.2
Tip of the tongue.	13	16	35	18	16	98.95	17	37	44	99.12	6	8	11	30	14	9	20	98.41	98	3.0	96.0	1.0
Underreporting	12	15	34	16	15	92.23	17	33	42	94.10	1	8	11	30	14	8	20	84.92	92	75.8	17.2	7.1
Zero defect	11	16	35	18	15	94.62	17	35	43	96.61	5	9	11	27	14	9	20	96.19	95	2.0	93.9	4.0
Zero-risk	11	16	35	19	15	95.67	17	36	43	97.49	5	9	11	28	14	9	20	96.67	96	97.0	0.0	3.0
Median						**89.02**				**90.43**								**81.75**				

4.12. Chapter summary

The chapter, through the case studies, described the process-related biases that included bias directly evident in the process as stressor associated biases. The sub-sections narrated the process and biases, followed by the improvements and their effect on identified biases. Further, the chapter described the new biases identified and tabulated the consolidated process biases identified in the case studies. In addition, the sub-sections discussed the Lean tool and waste status of each study.

5. Data analysis

5.1. Introduction

This chapter analyses the results of the seven system-wide case studies. Following the data collected from case studies using the methodology and method described in Chapter 3, insights into the practical interaction between Lean tools, waste and biases were constructed. In order to underpin the interaction, the analysis of descriptive statistics on Lean tools and waste biases are discussed in section 5.2 of this chapter, followed by the generalisation of biases in section 5.3. The Lean tools waste interaction; bias waste interaction; and bias, Lean tools, and waste interaction are described and mapped in sections 5.4 to 5.6. In the process, an introduction to a non-traditional way to represent bias, Lean tools, and waste interaction is described and plotted in sub-section 5.6.1. The chapter is concluded with a summary in section 5.7.

5.2. Lean and waste

The research focused on obtaining knowledge on the cognitive biases' interaction with Lean tools and types of waste in organisations. The multiple site and source system-wide studies involved in-depth qualitative focus through process observation, participant observation, and semi-structured interviews with open-ended questions. The seven system-wide case studies revealed data on Lean tools status and waste prevalent in the industry.

The data on Lean tools (refer to Table 51, sub-section 4.11.1, Chapter 4) showed that overall the study witnessed a mixed implementation status of the 25 Lean tools. However, this pattern aided in understanding the waste generated and the biases' impact. Data revealed that, while the implemented Lean tools assisted in waste reduction, the partially implemented and unimplemented Lean tools provided scope for identification of more waste in the system and its reduction. The current study statistics revealed that waste is widely prevalent in the processes that show Lean tools implementation was widely inadequate. The partial and unimplemented status revealed the waste generated and biases impacted, while the implemented tools exposed the waste and biases that existed despite adherence to Lean methodology.

The waste data (refer to Table 54, sub-section 4.11.2, Chapter 4) indicated that the department or function, decision-making cross-functional team, and enterprise engagement waste were having lower confirmations by participants compared to the other waste. The data indicated that department or function waste were reported by 69 participants. However, the data, also revealed that department or function waste were significant, since it was reported across all positions and experience ranges (refer to Table 53 and Table 54 sub-section 4.11.2, Chapter 4).

The waste data (refer to Table 54, sub-section 4.11.2, Chapter 4) showed that decision-making cross-functional team and enterprise engagement waste were 33 and 28 responses respectively. The position-wise analysis indicated that operators had not confirmed the decision-making cross-functional team and enterprise engagement waste that resulted in a low response. The operator's roles and responsibilities records in the case studies indicated that they were not part of the engagement of external agencies and cross-functional teams. However, the analysis indicated that 12 out of 17, and 13 out of 17 management persons confirmed decision-making cross-functional team waste and enterprise engagement waste respectively (refer to Table 53, sub-section 4.11.2, Chapter 4).

In addition, the analysis indicated that 19 out of 44, and 14 out of 44 staff confirmed decision-making cross-functional team waste and enterprise-engagement waste respectively. A possible explanation for decision-making cross-functional team and enterprise engagement waste low numbers might be that the people not engaged with external agencies or cross-functional teams may not have confirmed decision-making cross-functional team waste and enterprise enterprise-engagement waste. However, the interview and records review did not reveal this information, and hence there was a lack of evidence to correlate staff engagement with external agencies or cross-functional teams, and thus this remained an assumption.

In conclusion, the importance of department or function waste, decision-making cross-functional team waste, enterprise engagement waste were considered significant, as the relevance of these three types are based on the people who have roles and responsibilities allied to them. For further analysis and discussion in this thesis, all the types of waste were considered.

5.3. Generalisation of bias

The data on bias revealed that a total of 122 biases were identified during this study and the responses for each of them varied, refer to Table 55, sub-section 4.11.3, Chapter 4. The list was long and had varied responses that necessitated the need to identify prominent biases. Identification of the predominant biases was achieved through analysis for its generalisability. In order to have a fair consideration, the biases above the median of % mean of the case study (81.75), experience (89.02) and position (90.43) from the results in Table 55 (refer to section 4.11.3, Chapter 4) were taken and compared. The data which appeared in all the three analysis were considered prominent and referred to as generalised biases. Further, to identify the polarity, the positive, negative and nil responses, percentages of these generalised biases are shown in Table 56. In addition, Table 56 shows the count of process biases identified in the case studies sub-section 4.9.

Table 56: Generalised biases

Sl. No.	Bias	% Mean			% Response			Identified process biases count
		Experience	Position	Case study	Positive	Negative	Nil	
1.	Absent-mindedness	100.0	100.0	100.0	4.0	96.0	0.0	4
2.	Anchoring and adjustment	93.2	94.1	91.2	92.9	0.0	7.1	
3.	Automation	93.6	95.9	92.2	86.9	8.1	5.1	3
4.	Automation omission	95.1	96.7	93.7	86.9	9.1	4.0	3
5.	Bandwagon effect	92.8	94.9	86.5	92.9	1.0	6.1	7
6.	Belief	93.3	94.9	86.5	93.9	0.0	6.1	
7.	Bounded awareness	100.0	100.0	100.0	100.0	0.0	0.0	7
8.	Chain reaction	100.0	100.0	100.0	100.0	0.0	0.0	
9.	Congruence	95.1	96.7	93.7	94.9	1.0	4.0	3
10.	Context-dependent cues	92.2	94.1	85.7	87.9	5.1	7.1	
11.	Convenience	95.4	97.0	95.7	93.9	1.0	5.1	
12.	Critical response	100.0	100.0	100.0	100.0	0.0	0.0	
13.	Cue-dependent forgetting	96.8	96.4	94.4	90.9	6.1	3.0	
14.	Digital amnesia	95.1	96.7	93.7	86.9	9.1	4.0	
15.	Escalation of commitment	93.8	94.9	87.6	93.9	0.0	6.1	4
16.	Fear of job loss	95.8	95.6	94.3	89.9	6.1	4.0	4
17.	Fix it Fallacy	95.9	97.4	94.4	96.0	1.0	3.0	
18.	Fundamental attribution	92.0	94.0	84.9	92.9	0.0	7.1	
19.	Guidance	95.8	96.5	96.2	96.0	0.0	4.0	
20.	Immune neglect	99.4	99.1	99.5	1.0	98.0	1.0	
21.	In attentional blindness	97.9	98.4	97.1	98.0	0.0	2.0	7
22.	Long work	95.9	97.4	94.4	97.0	0.0	3.0	6
23.	Memory inhibition	92.7	94.1	84.9	92.9	0.0	7.1	
24.	Mere-exposure effect	100.0	100.0	100.0	98.0	2.0	0.0	
25.	Modality effect	93.3	94.9	86.5	93.9	0.0	6.1	
26.	Organisational policy	95.4	97.0	95.7	93.9	1.0	5.1	
27.	Patenting	96.6	97.5	94.8	97.0	0.0	3.0	
28.	Picture superiority effect	93.8	93.8	87.1	93.9	0.0	6.1	
29.	Priority	98.5	99.1	97.6	99.0	0.0	1.0	4
30.	Recollection	98.9	99.1	98.4	96.0	3.0	1.0	

Sl. No.	Bias	% Mean			% Response			Identified process biases count
		Experience	Position	Case study	Positive	Negative	Nil	
31.	Reverse psychology	92.4	94.1	90.3	91.9	1.0	7.1	
32.	Self-Integrity or preserving moral integrity	100.0	100.0	100.0	100.0	0.0	0.0	
33.	Sop	92.8	95.0	89.5	93.9	0.0	6.1	
34.	Standardisation	92.8	95.0	89.5	1.0	92.9	6.1	2
35.	Status quo	94.3	95.7	88.1	93.9	1.0	5.1	
36.	Stereotype	91.7	94.0	84.9	91.9	1.0	7.1	
37.	Stress	96.9	98.5	98.6	98.0	0.0	2.0	
38.	Subjective validation	92.2	94.0	84.9	92.9	0.0	7.1	
39.	Survivorship or Survival	92.8	94.9	86.5	92.9	1.0	6.1	
40.	System-human	96.6	97.5	94.8	86.9	10.1	3.0	1
41.	System-wide approach	100.0	100.0	100.0	100.0	0.0	0.0	
42.	Tip of the tongue	98.9	99.1	98.4	3.0	96.0	1.0	
43.	Underreporting	92.2	94.1	84.9	75.8	17.2	7.1	
44.	Zero defect	94.6	96.6	96.2	2.0	93.9	4.0	
45.	Zero-risk	95.7	97.5	96.7	97.0	0.0	3.0	

The generalisation was made on system-wide biases identified by pathway 2, as referred to in section 3.8, which had a higher sample size compared to pathway 1 that had in-depth insights on processes. The results revealed that 13 generalised biases were identified in both pathways, indicated in the "identified process biases count" column in Table 56 above. In addition, the results revealed that of the generalised biases (blank cells in the “identified process biases count” column) in Table 56, 32 were additionally identified through pathway 2. Further, the following process biases identified through pathway 1 of the method identified in section 3.8 did not appear in generalised biases:

- An appeal to probability;
- Anti-trust;
- Attentional;
- Autocratic;
- Automation adherence;
- Endogeneity;
- External influence /Illusion of external agency;
- Fear of failure;

- Functional fixedness;
- Herd instinct;
- Illusion of control;
- In-group favouritism/In-group–out-group;
- Lack of control;
- Lead;
- Levelling and sharpening;
- No time and energy;
- Opportunity;
- Overdo;
- Person identification;
- Problem set;
- Reactance;
- Technology aversion; and
- Wrong information.

A possible explanation for this difference might be that pathway 1 limited itself to the process while pathway 2 expanded itself system-wide to identify biases. The generalised biases were further considered for analysing the interaction between biases, Lean tools and waste.

The literature review identified 25 Lean tools, ten types of waste and 239 biases. Out of 239, this research identified 113 prevalent in the industry and further detected nine unfamiliar prejudices, which were generalised to obtain 45 prominent biases. Each of the generalised biases' primary code, keywords, and connected words, actions, and behaviour observed during data collection alongside the waste primary code and Lean tools were correlated to construct the interaction between Lean tools and waste, biases and waste, and biases and Lean tools. The results of the interactions were plotted in two stages:

- Interaction between Lean tools and types of waste; and
- Interaction between generalised biases, Lean tools, and waste.

As the first step, the Lean tool and waste interactions were plotted, as discussed in the next section.

5.4. Lean tool - waste interaction

Types of waste in the system are influenced by the Lean tools used, which aim to reduce the waste prevalent in the system (Womack & Jones, 2010). It is essential to establish the interaction between the Lean tools used and its effect on waste categories. The case studies revealed that Lean tools and waste interaction had two possibilities:

- Waste reduction due to effective use of Lean tools; and
- Increase in waste due to effective use of Lean tools.

Waste reduction due to effective use of Lean tools had negative polarity or impact on waste while the increase in waste due to effective use of Lean tools had positive polarity or impact on waste. Table 57 summarises the findings where "**-**" indicates negative polarity and "**+**" indicates positive polarity.

Table 57: Lean tools and waste interaction

Lean tools	**Manufacturing waste**	**Decision-making individual waste**	**Department or Function Waste**	**IT waste**	**Enterprise engagement waste**	**Decision-making cross-functional team waste**	**Human resources waste**	**Environment waste.**	**Stress waste**	**Methods waste**
5S	-							-	-	
Andon	-	-		-					+	
Bottleneck Analysis	-							-	-	
Continuous Flow	-								+	
Gemba	-	-				-		-	-	
Heijunka	-	-	-			-			-	
Hoshin Kanri	-	-	-		-			-	-	
Jidoka	-	-		-				-	-	
Just-In-Time	-							-	+	
Kaizen	-	+	-	-	-	-	-	-	-	-
Kanban	-	-						-	+	
Key Performance Indicators	-	+	+	-	-	+	-	-	+	+
Muda	-	-	-	-	-	-	-	-	-	-
Overall Equipment Effectiveness	-								+	
PDCA	-	-		-				-	-	-
Poka-Yoke	-	-						-	-	-
Root Cause Analysis	-	-	-	-	-	-	-	-	-	-
Single-Minute Exchange of Dies	-								+	

Lean tools	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Six Big Losses	-								+	
SMART Goals	-	-	-				-	-	-	-
Standardised Work	-	-					-		+	-
Takt Time	-								+	
Total Productive Maintenance	-								-	
Value Stream Mapping	-								-	
Visual Factory	-	-						-	-	

The next critical phase was to plot the interaction between Lean tools and waste. The waste's primary code and Lean tools alongside the recordings and notes from interview and observation were correlated to construct the interaction between Lean tools and waste (Appendix 1 and 4). A system mapping process was used to represent the constructed connection between each of the Lean tools and waste in the system. Figure 46 below shows the connectivity, where the red dotted arrows represent the Lean tool's influence to reduce waste and blue arrows represent the Lean tool's influence to increase waste. The green arrows represent the various Lean tools' influence to increase process productivity, and orange arrows represent the various waste types' influence to decrease process productivity.

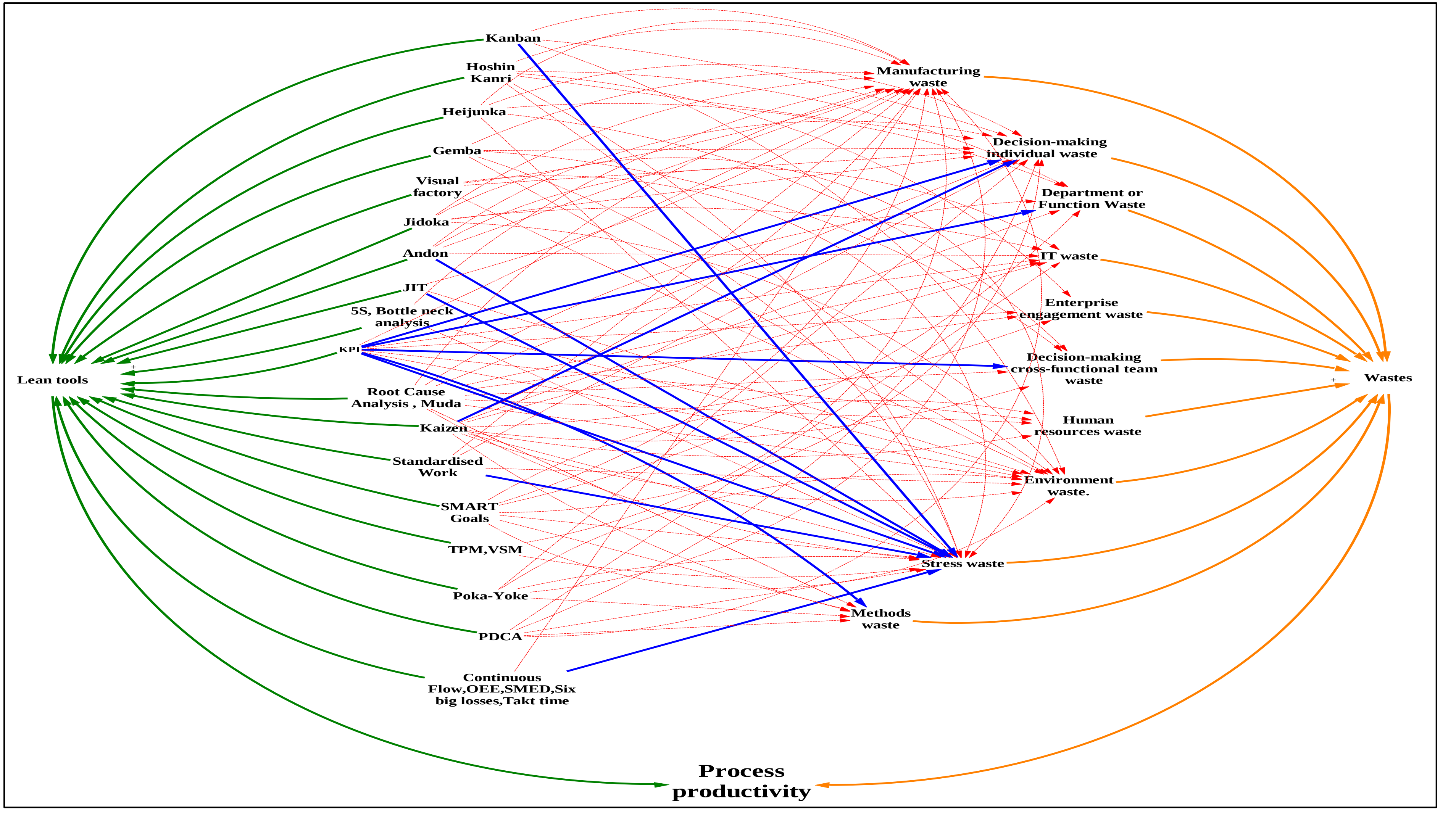

Figure 46: System mapping Lean tools and waste

5.5. Bias impact on waste

In the second stage, to plot the interaction between generalised biases, Lean tools, and waste, the connectivity between bias and waste were tabulated. Each of the generalised bias primary codes, keywords, and connected words, actions, and behaviour observed during data collection alongside the waste primary code were correlated to construct the interaction between biases and waste (Appendix 2). Table 58 summarises the findings where "-" indicates negative polarity, meaning bias reduced the specific waste, and "+" indicates positive polarity, meaning bias increased the specific waste.

Table 58: Bias and waste interaction

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Absent-mindedness	+	+	+	+	+	+	+	+	+	
Anchoring and adjustment	+	+	+	+	+	+	+	+	+	
Automation	+	+		+		+			+	
Automation omission	+	+		+		+			+	
Bandwagon effect	+	+	+	+	+	+	+	+	+	+
Belief	+	+	+	+			+	+	+	
Bounded awareness	+	+	+			+			+.	
Chain reaction	+	+	+	+		+		+	+	+
Congruence	+				+				+	
Context-dependent cues	+	+		+		+			+	
Convenience	+	+	+	+	+	+	+	+	+	+
Critical response	+	+	+	+		+		+	+	+
Cue-dependent forgetting	+	+		+		+			+	
Digital amnesia	+	+		+		+			+	
Escalation of commitment	-	-				-		-	+	
Fear of job loss	+	+		+		+	+	+	+	+
Fix it Fallacy	+	+		+		+			+	
Fundamental attribution	+	+				+		+	+	
Guidance	+	+				+			+	
Immune neglect	+	+				+			+	
In attentional blindness	+	+				+			+	
Long work	+	+	+	+	+	+	+	+	+	+
Memory inhibition	-	-				-			-	
Mere-exposure effect	+	+		+	+	+		+	+	
Modality effect	+	+				+			+	
Organisational policy	+	+	+	+	+	+	+	+	+	+
Patenting	+								+	
Picture superiority effect	+	+				+			+	
Priority	+	+				+			+	
Recollection	-	-				-			-	
Reverse psychology	-	-	+			-			+	
Self-Integrity or preserving moral integrity	+	+							+	

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
SOP	+	+	+	+		+	+	+	+	+
Standardisation	+	+				+			+	
Status quo	+	+	+	+	+	+	+	+	+	+
Stereotype	+	+	+	+	+	+	+	+	+	+
Stress	+	+	+	+	+	+	+	+	+	+
Subjective validation	+	+	+	+			+	+	+	
Survivorship or Survival	+	+	+	+	+	+	+	+	+	+
System-human	+	+	+	+	+	+	+	+	+	+
System-wide approach	+	+	+	+	+	+	+	+	+	+
Tip of the tongue	+	+				+			+	
Underreporting	+	+				+			+	
Zero defect	+	+	+	+	+	+	+	+	+	+
Zero-risk	+	+	+	+	+	+	+	+	+	+

Further to the Lean tools waste system mapping, the biases' waste mapping was added to represent the constructed connection between each of the biases and waste types in the system. Figure 46 was extended by adding the generalised biases connectivity to the waste, as shown in Figure 47 below. The red dotted arrows represent influences that reduced waste and blue arrow lines represent influences that increased waste. The green arrows represent the various Lean tools' influence to increase process productivity, and orange arrows were used to represent the various waste types' influence to decrease process productivity.

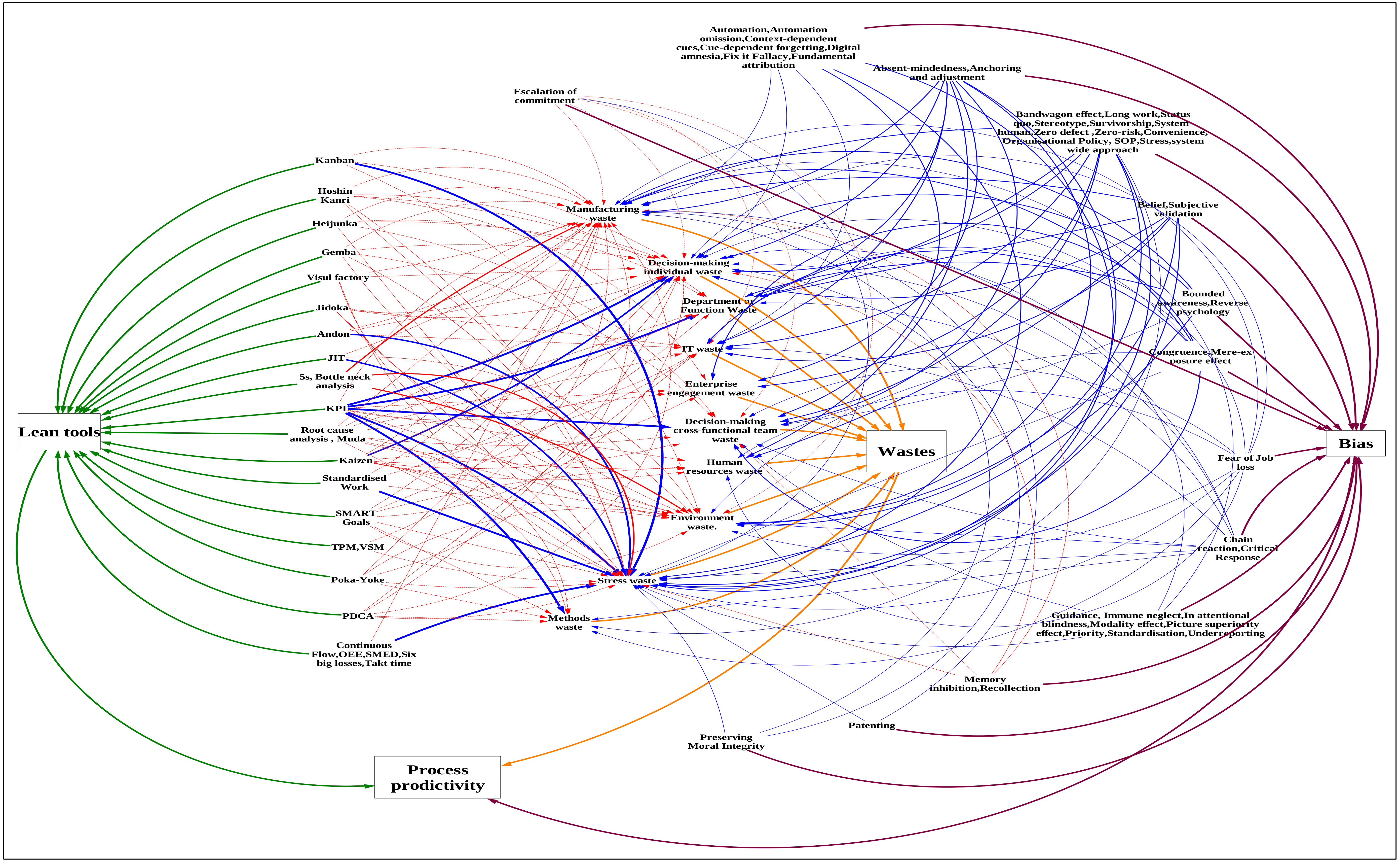

Figure 47: Biases waste connection

5.6. Bias influence on Lean tools and waste.

In the next phase, each of the generalised bias primary code, keywords, and connected words, actions, and behaviour observed during data collection alongside the Lean tools were correlated to construct the interaction between biases and Lean tools (Appendix 3). The biases' influence on Lean tools is shown in Table 59 below where "**-**" indicates the biases' influence reduced Lean tool effectiveness, and "**+**" indicates the biases' influence increased Lean tool effectiveness.

Table 59: Biases influence on Lean tools

Bias	**5S**	**Andon**	**Bottleneck Analysis**	**Continuous Flow**	**Gemba**	**Heijunka**	**Hoshin Kanri**	**Jidoka**	**JIT**	**Kaizen**	**Kanban**	**KPI**	**Muda**	**OEE**	**PDCA**	**Poka-Yoke**	**RCA**	**SMED**	**Six Big Losses**	**SMART Goals**	**Standardised Work**	**Takt Time**	**TPM**	**Value Stream Mapping**	**Visual Factory**
Absent-mindedness			-		-	-	-			-		-			-		-			-	-				
Anchoring and adjustment			-		-	-	-			-		-			-		-			-	-				
Automation		-		-	-	-		-	-		-		-			-	-				-				
Automation omission		-		-	-	-		-	-		-		-			-	-				-				
Bandwagon effect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Belief	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bounded awareness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chain reaction			-	-	-	-	-		-	-	-	-	-	-	-		-	-	-	-		-	-		-
Congruence		-	-		-					-		-			-		-			-					
Context-dependent cues			-							-					-		-								
Convenience	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Critical response	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cue-dependent forgetting			-		-					-					-		-								
Digital amnesia			-		-					-					-		-								
Escalation of commitment	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Fear of job loss	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fix it fallacy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Bias	**5S**	**Andon**	**Bottleneck Analysis**	**Continuous Flow**	**Gemba**	**Heijunka**	**Hoshin Kanri**	**Jidoka**	**JIT**	**Kaizen**	**Kanban**	**KPI**	**Muda**	**OEE**	**PDCA**	**Poka-Yoke**	**RCA**	**SMED**	**Six Big Losses**	**SMART Goals**	**Standardised Work**	**Takt Time**	**TPM**	**Value Stream Mapping**	**Visual Factory**
Fundamental attribution			-		-	-	-		-	-	-	-	-		-		-			-				-	
Guidance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Immune neglect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
In attentional blindness	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Long work	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Memory inhibition			+		+					+					+		+								
Mere-exposure effect			-		-					-					-		-				-				
Modality effect	-	-	-		-					-					-		-				-				-
Organisational policy			-		-					-					-		-				-				
Patenting								-		-					-										
Picture superiority effect	-	-	-		-					-					-		-				-				-
Priority	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Recollection			+		+					+					+		+								
Reverse psychology		-			-					-		-								-					
Self-integrity or preserving moral integrity	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sop	-				-					-											-				
Standardisation	-				-					-											-				
Status quo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Bias	5S	Andon	Bottleneck Analysis	Continuous Flow	Gemba	Heijunka	Hoshin Kanri	Jidoka	JIT	Kaizen	Kanban	KPI	Muda	OEE	PDCA	Poka-Yoke	RCA	SMED	Six Big Losses	SMART Goals	Standardised Work	Takt Time	TPM	Value Stream Mapping	Visual Factory
Stereotype	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stress	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subjective validation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Survivorship or survival	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
System- human	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
System-wide approach	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tip of the tongue			-		-					-					-		-								
Underreporting	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zero defect	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zero-risk	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

The System mapping used to represent the constructed connection between each of the biases and types of waste in the system (refer to Figure 47) is difficult for readers to understand. This became more complicated when the influence of 45 biases on 25 Lean tools was added, increasing the congestion of arrows. To improve the readability and map the interactions of biases, Lean tools, and waste types, a non-traditional, new way of representing the influence, the Circle Slice Diagram was plotted.

5.6.1. Construction of the Circle Slice Diagram.

The steps to construct the Circle Slice Diagram is shown in Figure 48 below.

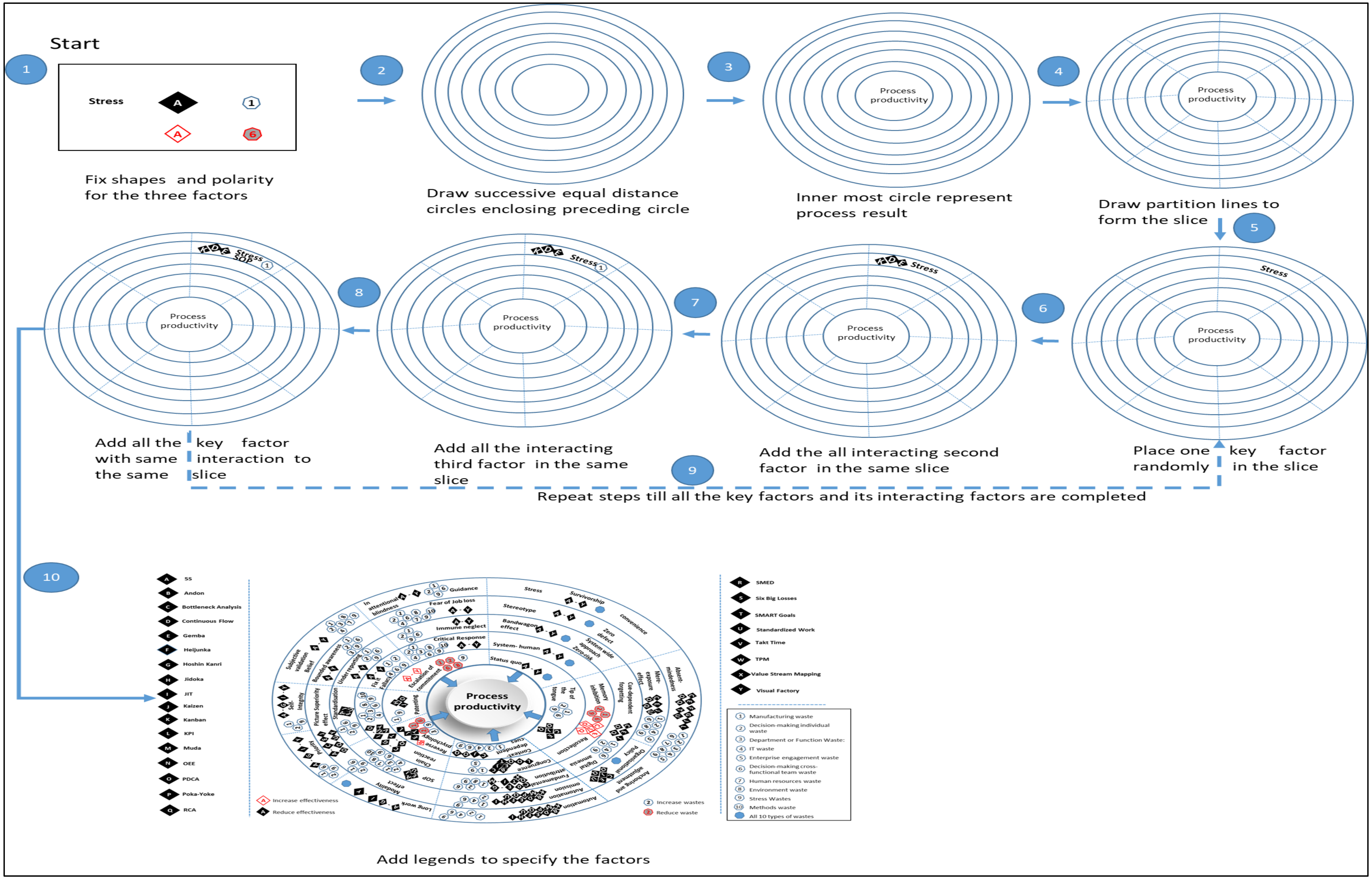

Figure 48: Construction of Circle Slice Diagram

As a first step (1), the three factors, namely, bias, Lean tools, and waste were represented as below.

- The 45 generalised biases were represented by name;
- Lean tools were represented in a diamond shape; each of the 25 tools was assigned a specific alphabet; for example, 5S was assigned alphabet "A". Colour codes were used to represent the interaction polarity,
  - The polarity of biases that increased the effectiveness of a specific Lean tool was represented in red A ; and
  - Biases that decreased the effectiveness of the specific Lean tool was represented in black and white A .

Wherever Lean tools were sequential, for example, if it was from A, B, C, D, E, F, and G, it was represented as A-G: A - G ;

- Waste types were represented by a hexagon shape; each of the ten waste categories was assigned a specific number; for example, manufacturing waste was assigned number "1". Colour codes were used to represent the interaction polarity:
  - Biases increasing waste were colour coded blue and black 1 ; and
  - Biases reducing waste were represented as grey and red 1 .

In the second step (2), seven successive equal distance circles enclosing each preceding circle were drawn. The innermost circle represented the process productivity (3). This was followed by drawing the partition lines to form the slice (4). In the next step (5), the key factor, bias, was placed randomly at the circle. Subsequently, the second-factor Lean tools that interacted with specific biases were clustered and placed in the same slice (6). Similarly, waste types that interacted with the same specific bias were clustered and placed in the same slice (7). All the key factors, in this case the biases that had similar interactions with the other two factors, the Lean tools and waste were added to the same slice (8). The steps 5 to 8 were repeated until all the interactions were placed in the slices (9).

Finally, the diagram was completed by adding the legends that specify the Lean tools, waste, and their polarity, followed by the thick arrows that were added between the first enclosing circle and inner circle to represent the influence of bias, Lean and waste interaction on the process productivity (10). Subsequently, the Circle Slice Diagram to the interaction of factors of this case study was plotted as shown in Figure 49 below.

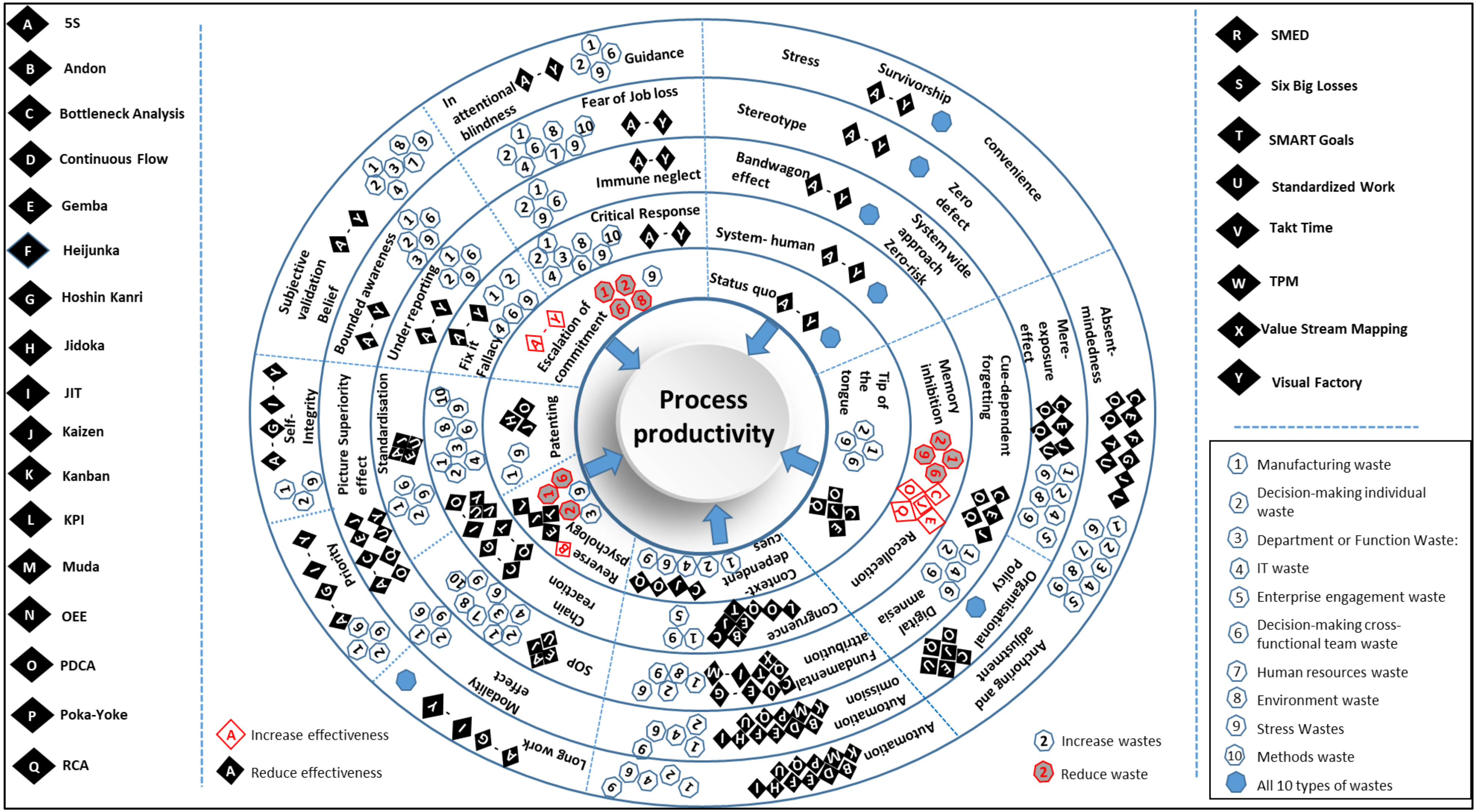

Figure 49: Circle Slice Diagram representing interaction between generalised biases', Lean tools, and waste.

5.6.2. Circle Slice Diagram for interaction of biases, Lean tools, and waste.

The literature review in Chapter 2 identified 25 Lean tools, ten types of waste and 239 biases. Out of 239 biases, this research identified 113 prevalent in the industry and detected a further nine that were generalised to obtain 45 prominent biases. Each of the generalised bias primary codes, keywords, connected words, actions, and behaviour observed during data collection, alongside the waste primary code and Lean tools, were correlated to construct the interaction between biases and waste types, and biases and Lean tools. The interactions of biases, Lean tools, and waste types, was plotted in the Circle Slice Diagram. Figure 49 shows the Circle Slice Diagram that represents the interaction of biases, Lean tools, and waste types. For example, survivorship bias shown in the top right outer slice reduced the effectiveness of Lean tools A to Y and increased all types of waste. Similarly, escalation of commitment shown in the top left inner slice, increases the effectiveness of all Lean tools and reduces manufacturing, decision-making individual, decision-making cross-functional and environment waste while it increases stress waste. The readability of the system mapping improved with the Circle Slice Diagram. However, the difficulty level in plotting remained the same when compared to the traditional methods and it needed to be plotted and printed in colour, unlike the other traditional models.

The analysis indicates that biases had a mixed influence on Lean tools and waste. Each bias influenced specific tools and waste types. Notably, escalation of commitment, reverse psychology, increased effectiveness of associated Lean tools and reduced waste. Memory inhibition and recollection increased the effectiveness of associated Lean tools but had a mixed effect on waste. All other generalised biases reduced the effectiveness of Lean tools and increased waste. Particularly, the bandwagon effect, stress, survivorship, convenience, stereotype, zero defect, system-wide approach, zero risk, system human, and status quo biases had a negative influence on all Lean tools and waste types. The interactions of bias Lean and waste mapping indicated the strong connectivity that influenced the productivity of the process. The analysis affirms that there are system-wide interactions between cognitive biases, Lean tools, and waste in an organisational process.

5.7. Chapter Summary:

The chapter provided analysis on Lean, waste and system-wide biases. The system-wide biases were generalised and compared with process biases identified in Chapter 4. This was followed by the interaction between the Lean tools and waste system mapping. Subsequently, the generalised biases and waste interaction was added to the Lean tools and waste system mapping. In the next step, generalised biases and Lean tool interaction was tabulated, followed by biases, Lean tools, and waste interaction, which was plotted in a non-traditional Circle Slice Diagram. The chapter concluded with the chapter summary.

6. Discussion

6.1. Introduction:

This chapter amalgamates the key findings of the current study to the research questions, followed by a discussion that postulates the key findings of this thesis. The continuous knowledge upgradation and new literature contribution to Lean are numerous and large. Although much of the literature provides a meaningful and rich context to the discussions, in this chapter, reference is made only to that literature which aided in resolving the research questions and research gaps. The chapter revolves around the research question and sub-questions:

RQ: What are the interactions between cognitive biases' interventions, Lean tools, and waste types in organisational processes?

Sub-questions:

- How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?
- What are the system-wide cognitive bias interventions in workplaces that interact and influence waste and Lean tools in organisational processes?
- What are the different types of waste prevalent in organisations?
- What is the interaction between Lean tools and waste types?

The combination of a multiple case study data collection method and replication logic provided similar results or contradicting results with predictable reasons. The results analysis in Chapter 5 underpinned the interaction between Lean tools and the categories of waste and the interaction between bias, Lean tools, and waste. The results in Chapter 4 established the improvements in processes identifying the biases and stressors. This chapter includes an introduction in section 6.1; section 6.2, which furnishes an overview of research; and section 6.3, which discusses the interaction between Lean and waste types and compares it to existing literature. Section 6.4 discusses the identification of stressors and biases. This is followed by section 6.5, which discusses the interaction between biases, Lean, and waste types and includes a comparison of the main findings to the existing literature. The chapter ends with the summary in section 6.6.

6.2. Overview of the research:

The research focused on obtaining knowledge on the cognitive biases with respect to Lean tools and waste in work practices, which was sought from participants system-wide through understanding their experiences of a particular process. In order to explore the research questions and obtain knowledge, this research adopted a qualitative narrative inquiry methodology that leaned profoundly on an interpretivist theoretical framework and constructivist epistemology. The research aimed at a fair degree of generalisation and focused on the interaction between cognitive bias, Lean tools, and waste.

The research aimed to keep away from ethical issues related to the workplace (e.g. maintained confidentiality, alleviated discomforts and risks and protected individual privacy). Further, this research used the previous literature on bias and used a method that would be understandable to academics and industry professionals and aimed to address practical issues. For this research, the narrative inquiry methodology was substantiated with data collection through multiple system-wide case study approaches with emphasis on in-depth qualitative focus through process observation, participant observation, and semi-structured interviews with open-ended questions. The sample size was based on the snowballing principle, where the participants were recruited based on the process requirement, which varied in numbers for each case study.

The research provided an insight into the processes studied and suggested process improvements at four large-scale organisations and one small-scale organisation for seven different processes at a particular time. Participants recruited were from multi-cultural backgrounds, held different positions and had varied experience. The participant position and experience distribution P value was well below 0.05, signifying the participants' reliable input to the study. Reliability, validity, and triangulation reflected the multiple ways of establishing veracity. Chapter 5 provided insights on the descriptive statistics, results, the generalisation of biases, interactions between Lean and waste, followed by interactions between bias, Lean, and waste, represented through a new Circle Slice Diagram model. This model provided a different outlook on peoples' tendencies in a process through a system-wide approach and established the interaction between cognitive biases, Lean tools, and waste types.

6.3. The interaction between Lean tools and waste

Researchers have provided evidence that Lean, through its tools, aided waste reduction (refer to Table 3, section 2.2), and elimination initiatives played an important role in organisational performance. Lean reduced waste and non-value added activity, through continuous improvement and utilised fewer resources that resulted in improved productivity, added value, and garnished product flow (Bhamu & Sangwan, 2016; DeBusk, 2012; Lacerda et al., 2016; Susilawati et al., 2015). Lean methodologies meet expected profit margins and served customer requirements systematically, using tools to optimise operations (Helleno et al., 2016). Substantiating the benefits, Zakaria et al. (2017) showed that Lean tools aided waste reduction, which improved productivity, performance, and workforce utilisation in Malaysian industries.

What are the different types of waste prevalent in organisations?

This research identified and classified all the possible waste types in organisation and business processes into ten different waste categories grouped as core manufacturing, non-manufacturing, and well-being waste, and showed their influence through a system-wide approach. The approach followed the classifications described in section 2.3. The results of this research showed that participants across all studies reported manufacturing and environment waste (refer to Chapter 4, Table 52, sub-section, 4.11.2), which was in harmony with the literature. IT waste received 89 responses, which are in agreement with the observations of previous studies referred in Chapter 2, sub-section 2.3.1.3. Conversely, this research classified and provided evidence of seven other categories of waste that had not previously been described.

This research witnessed a high response to the decision-making individual, stress, human resources, overhead and eagerness, and error waste types. Refer to Chapter 4, Table 52, sub-section 4.11.2, that established the presence of these waste types in industries. Nevertheless, this study was unable to demonstrate design waste, which received a nil response from participants. A possible explanation for these results may be that the studied industries did not have a design function as a part of their process. The waste data (refer to Chapter 4, Table 52, sub-section, 4.11.2) indicated that the department or function, decision-making cross-functional team, and enterprise engagement waste were having lower confirmations by participants compared to the other waste. The data indicated that department or function waste was reported across positions and experience distribution. Refer to Chapter 4, Table 53 and Table 54, sub-section, 4.11.2, that demonstrates the significance. However, decision-making cross-functional team and enterprise engagement waste had lower confirmations, that is, 33 and 28 respectively out of a possible 99. A possible explanation for these low numbers might be that the people who were not engaged with external agencies or cross-functional teams may not have confirmed decision-making cross-functional team waste and enterprise enterprise-engagement waste. The study was not designed to collect this information. Hence there was a lack of evidence, and this remained an assumption.

The synthesis of waste remained a significant challenge, and available classifications had proven to be unreliable as it was often equated to Ohno's seven waste types. The primary challenge faced by many researchers, barring a few, is that they attempted to equate all waste to the seven types suggested by Ohno (1988), as referred in Chapter 2, section 2.2.1, which restricted the focus, induced difficulty in understanding and limited expanding it to reach the industry. The literature review revealed that manufacturing waste (refer to Chapter 2, section 2.3.1.1) and environment waste (refer to Chapter 2, section 2.3.1.2) were the predominant focus of academics and industry (refer to Table 3, section 2.2, Chapter 2).

In the past two decades, IT-related waste (refer to Chapter 2, section 2.3.1.3) was equated to Ohno's seven types of waste by researchers. The decision-making, well-being and external deficiencies (refer to Chapter 2, sections 2.3.1.4 to 2.3.1.10) that created waste remained a by-product or essential need of the organisational process. Considering that the organisations deployed various tools and encountered various waste types, this research, for the first time, explored and categorised the different kinds of waste (refer to section 2.3) to identify the interaction of set Lean tools and various waste types in a system-wide process study approach. The deficiencies identified in sections 2.3.1.4 to 2.3.1.10 existed in fields of research other than manufacturing, and this research has only correlated those to the organisational process as waste to attain focus that aid in productivity and people's well-being.

What is the interaction between Lean tools and waste types?

The most apparent finding to emerge from the analysis was that certain Lean tools increased the specific waste. However, Chapter 5, Figure 46, section 5.4, substantiates the insights drawn from scholarly literature that most of the Lean tools aid in manufacturing waste reduction. This research found that the themes identified from the case study observation, narration and responses confirmed that all Lean tools aided in the reduction of manufacturing waste (refer to Table 57 of section 5.4, Chapter 5), which is consistent with the literature referred in Chapter 2, Table 3, section 2.2. Extensive research has shown that Lean tools influence waste reduction and elimination. However, these research studies were focused heavily on manufacturing waste and environmental waste.

This study substantiated that Lean tools indicated with "-" in Chapter 5, Table 57, section 5.4, which included 5S, Bottleneck Analysis, Gemba, Heijunka, Hoshin Kanri, Jidoka, JIT, Kaizen, Kanban, KPI, Muda, PDCA, Poka-Yoke, RCA, SMART Goals, and Visual Factory aid in reducing environmental waste. However, environmental waste had a mixed response from researchers. The literature showed that Lean tools reduced environmental waste. For example, Garza-Reyes et al. (2018) substantiated the fact that that TPM and JIT had the strongest significance on environmental performance, Kaizen only showed an effect on the use of materials and release of pollutants and noted that automation and VSM did not show any impact on environmental performance. In contrast, Sartal et al. (2018) observed that JIT increased environmental waste. The contrary results obtained in the current study could be attributed to the participants' response and research design that specifically had not focused on environmental waste.

Spreading wings, this study observed an increase of stress waste that occurred with the implementation of Andon, Continuous flow, JIT, Kanban, KPI, OEE, SMED, Six big losses, Standardised work and Takt Time. In contrast, the study also showed a reduction of stress waste with the implementation of 5S, Bottleneck analysis, Gemba, Heijunka, Hoshin Kanri, Jidoka, Poka-Yoke, Kaizen, Muda, PDCA, RCA, Smart goals, TPM, VSM, and Visual factory.

The results highlighted that 97 of 99 participants reported that stress waste was prevalent in the industry. The data showed that all 17 management personnel, 42 out of 44 staff, and all 38 operators reported stress waste. The trend showed that both management and staff reported stress waste similar to operators. A note of caution is due here, since the level of stress may vary based on the position, role and responsibility. The waste data by experience indicated that, except for two trainees, all other categories reported stress waste (refer to Chapter 4, Table 54 in sub-section 4.11.2). Stress waste reported included physical and cognitive exhaustion due to their roles, time pressure, priorities, emergencies, supervisory counselling and long work hours. Staff reported priorities and people disturbance as stressful. The participants reported stress waste caused by physical and cognitive exhaustion, similar to the claim by Womack and Jones (2010) that people take the maximum stress in Lean. A study participant noted:

> Everyone is breathing down your neck, everyone above you, telling what to do, how to do, and oh man having one resource, the levels above you ask to do this first and others are not important… and another one comes in to completely overturn the work you started, finally landing up in doing different things half-baked and just stress man … every one above you wants his thing to be first as it's his performance at stake man.

This study observed that Lean tools were associated with stress waste and is consistent with that of Womack et al. (2007), who stated in various publications that Lean is a methodology that imparts and increases stress to people.

An unanticipated finding was that Kaizen increased the decision-making individual waste, which is contrary to expectations that Kaizen reduces waste (Garcia et al., 2010; Von Thiele Schwarz et al., 2016). A possible explanation for this might be that individuals view every Kaizen through KPI radar, delay or reject Kaizen citing performance, 87 of the 99 respondents of the study related Kaizen acceptance to the outcome that is performance-related KPI enhancement. This study additionally revealed that KPIs increased decision-making individual, department or function, decision-making cross-functional, stress and methods waste.

The participants reported department or function waste due to KPIs that could be attributed to an alignment of policies and procedures to departmental KPIs, particularly safety policies. This was noticed in all case studies, except Alfa. Further, it seems possible that decision-making cross-functional waste was due to different departments' delayed or rejected decisions which would affect their KPI. The study found that Delta, Epsilon and Zeta had operational hierarchies focused on achieving KPIs that resulted in department or function waste. Individuals were eager to try things on their own to achieve KPIs that resulted in methods waste. Another important finding was that the study participants viewed KPIs as a critical factor for stress waste. These results seem to augment the findings of Womack et al. (2007) that Lean is stressful to value adders. A possible explanation for this might be that the KPIs to operators were not role-specific in Alpha, Beta, Gamma, Epsilon and Eta, and in the case of Delta and Zeta, the KPIs were fixed without considering key issues, such as physical exhaustion and long work hours.

Each studied process had KPIs set internally and based on customer requirements. However, participants across positions and experience pointed out that the KPI set has not considered factors which are not in their control. The issues reported were:

- Alpha: Customer KPI of 3 days irrespective of weather conditions that affect print quality;
- Beta: KPI did not consider material availability for fifty-year-old installations and weather conditions that bring mass power outages;
- Gamma: KPI did not consider traffic, material availability, and weather conditions that bring mass power outages;
- Delta: KPI did not consider the surge in seasonal holiday orders and people availability;
- Epsilon: KPI did not consider material availability, people availability, and traffic and weather conditions;
- Zeta: KPI did not consider holiday seasonal orders material availability, people availability, traffic, and weather conditions; and
- Eta: KPI did not consider fruit quality that needed to be in the cool store within 24 hours and people availability.

Nevertheless, this study result confirmed that KPIs aid in the reduction of manufacturing and environmental waste, which was in line with previous literature (Dawood & Abdullah, 2018; D.

Shah & Patel, 2018; Virmani et al., 2018). These findings agreed and contradicted previous studies, which have suggested that KPIs aided in waste reduction.

Summarising, the system mapping, as illustrated in Chapter 5, Figure 46, section 5.4, showed that Lean tools affect core-manufacturing waste, non-manufacturing waste, and well-being waste. Notably, KPIs increased non-manufacturing and well-being waste, and Andon, Continuous flow, JIT, Kanban, OEE, Six Big losses, SMED, standardised work, and Takt Time increased well-being waste.

The identification of stressors in Chapter 4 showed that stress that created waste is inherent to the process and it is related to process design and operating methods. This study agreed with Conti, Angelis, Cooper, Faragher, and Gill (2006) that "Lean is not inherently stressful, and stress is significantly related to management decisions in designing and operating Lean systems". The research led to an understanding that the stressors did not have a direct impact on peoples' stress proposition. The key factors were biases, which are the way people individually respond to situations based on the tendencies that transform the stressors into stress.

6.4. Cognitive Biases

Research interest in cognitive factors affecting processes has gained significance (Stanney & Hale, 2014) as the cognising human in manufacturing has a significant effect on quality and productivity. The success of an organisation was attributed to the operation of people, processes, and technology (Hilton & Sohal, 2012). People are important to achieving organisation performance; nevertheless, people are bounded, rational and can suffer from a variety of biases (Nickerson et al., 2007). Individuals most likely inclined to act or influence action are biased toward current conceptions of the world, behaviourally, the prejudice of people is evident in the assignments that they are eager to perform (Kogut & Kulatilaka, 2006). Practically, people cannot avoid biases in perception and attitudes (Plous, 1993).

How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?

Chapter 4 described the identification of stressors and their related biases, and suggested processes predicted the stressors and in turn bias reduction. The theoretical framework, methodology, and methods (refer to Chapter 3) provided insights for waste elimination through the identification of stressors and biases in a system to improve the process productivity through a system-wide approach. The narrative analysis provided the base from which to identify the stressors and biases in the system through a system-wide approach. The steps to identify biases and optimise outcomes were:

- Identify the process to improve;
- Involve people system-wide;
- Prepare ethical considerations and confidentiality agreement;
- Communicate with the people involved;
- Recruit voluntary participants involved in the process and obtain consent;
- Observe the process and participants and take notes;
- Engage in short conversations and take notes;
- Interview the participants, record, and take notes;
- Map the process (visual);
- Plot stressors against each step based on analysis of observation, short discussion and interview outcomes;
- Associate biases involved with stressors. Table 7, section 2.4, Chapter 2 may help as a ready reference;
- Plan and propose the elimination of stressors and biases;
- Implement actions; and
- Process correction and reiterate process.

In all the case studies, the feedback from management staff stated that the understanding was better in the steps followed. Though the problem was known to them, the root causes identified were different both in method and steps followed. Suggested processes evoked interest, and the implementation results would have further strengthened the findings. However, the organisations had their procedures, timeline and resource constraints that varied implementation and remained a limitation of this study. The process studies addressed the process stressors, and related biases, as described in Chapter 4, could improve employee well-being.

Lean sustainability failures were associated with the push for waste reduction at the cost of employee well-being (Sawhney et al., 2019). The model, developed at the University of Tennessee, incorporated employee quality of life as one of the pillars of sustainable Lean (Sawhney et al., 2019). The other pillars were strategic problem definition, system growth, competitiveness, and enhanced throughput and capacity (Sawhney et al., 2019). The stressor identification and elimination method proposed in this research, which potentially improves work well-being and stress reduction, could form the fifth pillar: “eliminate stressors” for sustainable Lean. The current study further revealed that there were system-wide biases which affect all the processes system-wide.

What are the system-wide cognitive bias interventions in workplaces that interact and influence waste and Lean tools in organisational processes?

The second pathway and framework analysis method of data analysis, as represented in Chapter 3, Figure 3, section 3.8, revealed system-wide biases. The results of the study on system-wide biases, shown in Chapter 4, Table 55, section 4.11.3, indicate that 126 out 239 studies surveyed biases, those related to ability and decision-making were not evidenced. A possible explanation for this, might be that the study observation and interview had not focused on capturing these biases. A total of 113 biases were identified, and the prominent biases were ascertained by generalising the outcome of case studies, experience, and position-wise analysis are shown in Chapter 5, Table 56 in section 5.3.

Further, the study identified nine new biases that were unfamiliar and not identified in the literature published in English (refer to Chapter 4, section 4.10). This research identified that people tended to decline support based on predicted reactions of their group. This is an addition to previous literature that identified individual views related to the group (Allison & Messick, 1985; Hamill et al., 1980), support to the group (P. E. Jones & Roelofsma, 2000), group formation (K. Y. Williams & O'Reilly III, 1998), incline to majority view in the group (Kotlyar & Karakowsky, 2007; Lamm, 1988; Pech, 2001), and garner group support (Janis & Mann, 1977; Kahneman et al., 2011).

The current study on biases found that people follow the chain of command (Dent, 1991), had lack of control (Jensen & Meckling, 1976), identified loopholes to blame (Leun, 2003; Sterman, 2006) and sought guidance (H. Arrow & McGrath, 1993; Kotlyar & Karakowsky, 2007). This study additionally revealed that people were unaware or unresponsive to the people reaction happening in the process chain (Chain reaction bias), had a tendency to miss or avoid critical responses with all stakeholders (Critical Response bias) and discount or not consider stakeholders in the system for a situation, issue, or action (System-wide approach). The study results showed that 93.9% of people would decline actions based on convenience of interpretation of instructions, policies, or procedures (Convenience bias). Mostly, people incline or decline based on the understanding of policies or legal requirements (Organisational policy bias), out of which 56% of people specifically predicted the consequences of health and/or safety (Health and safety bias); refer to Chapter 4, Table 55, sub-section 4.11.3.

Furthermore, the findings presented here showed that 92% of people reported documents were not in a standard format, and different reports were available for the same situation, and this differs from Ungan (2006), who revealed that people tended to document in a standard format. In addition, 93.9% of people reported a tendency to miss, deviate or decline action stated in a standard operating procedure (SOP bias). The most interesting finding was that 98% of people stated that for every change they would determine benefits, such as reduced work /effort, or else decline actions based on predicted stress on oneself or the process (stress bias). A note of caution is due here, since these may be biased, which are specific to the process or industries and thus may not have been identified in other fields.

The process improvement for case studies has been suggested based on stressors and process related biases. However, a note of caution is due here, since, in certain process situations, the list of biases identified using pathway 1 and pathway 2 mentioned in Chapter 3, section 3.8 may be long and impractical to handle. On such occasions, generalising biases (using the formula described in section 4.11.3 of Chapter 4) and approaching solutions may help. It can thus be suggested that the generalisation method and formula be used to truncate the list for practical applications. Further, the generalised biases referred in Chapter 5, Table 56, section 5.3 of in this research may help to understand commonly prevalent biases in the organisation, which can be used as a starting point for process optimisation.

This research identified fear of failure, change of job, lack of control, and self-perceived job insecurity as system-wide biases (refer to Chapter 4, Table 55, sub-section 4.11.3), and fix it fallacy, standardisation, and status quo as prominent biases (refer to Chapter 5, Table 56, section 5.3). Previously, researchers have also identified self-perceived job insecurity (Keyser et al., 2016), fear of failure (Bieraugel, 2015; Emiliani, 1998; Salonitis & Tsinopoulos, 2016), change of job (Bieraugel, 2015), fix it fallacy (Antony et al., 2012), lack of control, standardisation (Bhuvanesh Kumar & Parameshwaran, 2018) and status quo bias (Kim & Kankanhalli, 2009; Samuelson & Zeckhauser, 1988). Moreover, (Keyser et al., 2016) identified extrinsic incentives bias as a barrier to Lean; this research did not identify the extrinsic incentives bias. A possible explanation for not identifying extrinsic incentives bias might be that the interview questioners lacked adequate focus or participants did not reveal this tendency explicitly.

Interestingly, in this deductive approach that used existing literature to identify various biases, 96% of the participants responded relevantly to questions sharing their past and future experiences, demonstrating a negative response to absent-mindedness and tip of tongue biases, and positive response to recollection. Similarly, participant observation and interviews showed that 98% of participants were able to adapt to negativity and had a negative response to immune neglect bias. It is somewhat surprising that guidance bias was noticed in a unionised environment similar to a non-unionised environment, with 96% of participants wanting suggestions to be implemented after management approval. Further, the observation and interview supported the negative response of standardisation, and participants expressed that deviations from SOP in a practical work situation are practised as the SOP is documented by people who were not doing the actual work. However, participants inclined or declined situations based on the SOP. The literature review did not reveal any identical articles that discussed the above biases with respect to the process or Lean manufacturing. However, the evidence of the above biases was provided in researchers' other fields; refer to Chapter 2, Table 7, section 2.4.

This result is somewhat counterintuitive with respect to zero defect, where 93.9% of respondents stated they did not expect to have zero defects. Interestingly, except for one staff member, 94 participants in the staff, management, and operator cadre had stated they did not expect zero defects. This differed from the previous articles of Calvin (1983); Florida (1996); Ghosh et al. (2006); Lee, Siu, and Zhang (2017). However, 97% of participants were in favour of zero risk, which confirmed the findings of Baron et al. (1993); Friedman (2017); Gudivada, Ramaswamy, and Srinivasan (2018); Viscusi et al. (1987). A possible explanation for this might be that participants avoid risk to the best of their knowledge and possibly accepted defects if they happened despite the extensive scrutiny.

The study found similarities in peoples' responses on the bandwagon effect, stereotype, survivorship, and status quo biases. These relations may be partly explained in that people tend to follow successful practices (bandwagon effect), repeatedly (stereotype), maintain the current level of performance (status quo), and focus on their survival (survivorship), thus offering fewer suggestions to improve the process productivity. Another important finding, was that people relied on IT system information (automation), had missed information other than those provided by IT systems (automation omission), did not remember vital data (digital amnesia), often relied on direct data (congruence), and ignored obvious or visual facts (in attentional blindness). Surprisingly, 86.9% of participants failed to realise system human influence and 75.8% were under-reporting the situation. In this study, 89.95% of participants reported fear of job loss. This data must be interpreted with caution, because it is difficult to explain this result, but it might be related to all the various factors such as stress, biases, age, organisation management, performance, and automation.

Though the study revealed the tendencies in processes and Lean manufacturing, the above biases were demonstrated previously by researchers in other fields; refer to Chapter 2, Table 7, section 2.4 for references. Further, the current study revealed that multiple biases were prevalent in the system which impacts Lean tools adopted and waste types in the process.

6.5. Interactions between cognitive biases, Lean and waste

The research design, findings, and system mapping model of the current research have significant implications for the understanding of how bias influences Lean tools and waste in a practical work environment that could be adopted by academic and industry personnel. Previously, researchers have approached human influence from a behavioural perspective rather than focusing on the tendencies that people display with respect to a situation or issue to act or react (De Treville et al., 2009).

In reviewing the literature, very little was found on the question of the association between bias and Lean tools (refer to Chapter 2, section 2.4.1). The reason for this is not apparent, but it may have something to do with the research methodology, confidentiality, ethics, anonymous research method, expertise in multiple field, cautious and truthful participant approach, gaining participant and management confidence, and three-dimensional system mapping. This study was able to demonstrate that designing ethical research combined with the new three-dimensional model to represent system mapping could address the gaps in understanding cognitive bias influences on Lean tools and waste.

Case studies Beta, Gamma, Delta, Epsilon, Zeta and Eta were done in large and complex organisations, with established systems and processes. The effectiveness of Lean tools was mixed and waste categorisation and capturing lagged. It was interesting to note that in all the cases of this study biases played an important role in Lean tools' effectiveness and waste elimination. However, the identified biases had both positive and negative responses that aided or reduced the effectiveness of the Lean tools.

The results of this study indicate that there is a significant interaction between biases, Lean tools, and waste. Table 59 in section 5.6 and Table 58 in section 5.5, Chapter 5, shows the generalised biases' influence on Lean tools and waste. The results of the study (refer to Chapter 5, Table 59 in section 5.6 and Table 58, section 5.5) showed that biases had a mixed impact on the associated tools and waste. The interactions had positive and negative impacts and indicated that more than one bias would influence a tool at a given point of time in a process. The results also show that the critical response, system-wide approach, convenience, SOP, organisational policy, stress and chain reaction biases identified during this research play a vital role in process productivity.

According to the research, data stress, survivorship, convenience, stereotype, zero defect, bandwagon effect, system-wide approach, zero risks, system human and status quo biases affect every specified Lean tool and all categories of waste. These results partly reflect those of Samuelson and Zeckhauser (1988) and Kim and Kankanhalli (2009), who also found that status quo bias is a significant factor in process performance. The generalised bias list of this study did not reflect fundamental attribution error and self-serving bias, which contradicted McNamara (2014), who observed that both tendencies influence 5S. A possible explanation for these contradicting results may be due to the lack of adequate focus in interview questioners, participants did not reveal this tendency explicitly, or the study design that focused on various biases and Lean tools.

In this study, biases were found to cause a negative impact on Lean tools, decrease the effectiveness, and increase the waste, as shown in Chapter 5, Figure 49, section 5.6. For example, organisational policy and long work biases influenced and increased all categories of waste. Another important finding was that biases like the escalation of commitment, memory inhibition, recollection, and reverse psychology would increase effectiveness and reduce waste. It is interesting to note that memory inhibition and recollection increased the effectiveness of all associated Lean tools and decreased associated waste types. Surprisingly, escalation of commitment was found to increase stress waste while it increased the effectiveness of all associated Lean tools and decreased associated waste. Similarly, reverse psychology increased the effectiveness of Andon and reduced manufacturing, decision-making individual and decision-making cross-functional waste while it decreased the effectiveness of other associated Lean tools and increased associated waste. This result may be explained by the fact that the decision-making of individuals and cross-functional teams were faster for customer complaints that had a negative projection compared to improvement of suggestion decisions. Records of the organisations showed that feedback and actions on complaints were solved in a set timeframe. However, 64 out of 99 participants reported delayed or no feedback on suggestions.

It is noteworthy to mention that Figure 49 shows a negative impact on tools and waste, as the research followed a positive response-based construction of the model. For example, if the response to absent-mindedness would have been positive, it would affect the effectiveness of the Lean tools negatively and increase waste. The constructive finding on zero defect is contrary, as adhering to the bias will eliminate defects and associated manufacturing waste, other possibilities driving zero defect would require more cautious and perfected process steps which increase all other types of waste. Furthermore, Figure 49 indicates three-dimensional interaction between other cognitive biases, Lean tools, and waste types identified in the multiple system-wide process studies.

Traditionally, the identified biases would be linked to Lean tools, and then Lean tools would be linked to waste, correlating the influence in a straight pattern; suggesting that if a bias influenced a Lean tool it would affect the associated waste type. This method is particularly useful in studying the influence of two factors separately. However, the influence of the third factor may change the dynamics significantly. This study constructively approached three-dimensional influence to obtain further in-depth information on the biases' influence on Lean tools and waste types. Historically, researchers have subscribed to the belief that interactions in the system have to be systematically mapped to understand their complexity. A system map was an accurate overall visual representation of the interrelationship of elements of a system (Simsekler, Ward, & Clarkson, 2018).

During the research journey to system map the three-dimensional interaction between bias, Lean tools and waste in a process, it was noticed that the traditional system mapping was difficult for readers to understand without following the arrow paths. Further, the mapping was congested and needed a large paper size to draw clearly. The researcher attempted to plot in a new way: a Circle Slice Diagram where the three-dimensional interaction between bias, Lean tools and waste types in a process was mapped with better readability than existing models. Figure 49, shown in Chapter 5, section 5.6, is constructed with bias as the primary focus. However, the model allows flexibility to change the primary focus element. Figure 50, shown below, is constructed with Lean tools as the primary focus, and Figure 51 is structured with waste as the primary focus. This demonstrates the flexibility and interchangeable focus through the Circle Slice Diagram, which was not possible through other available models, such as the cluster or brain dump, connected circles, sunburst chart, behaviour over time, iceberg model, causal loop diagram, relationship, domain, process diagram, and structural system maps.

The Circle Slice Diagram mapped 45 biases, 25 Lean tools and ten waste types, totalling a combination of 11,250 factors' influence, the readability was comparatively higher than the existing models while fitting on an A4 sheet. The readability of the system mapping improved with the Circle Slice Diagram. However, the difficulty level in plotting remained the same when compared to the traditional methods, and it needed to be plotted and printed in colour, unlike the other traditional models.

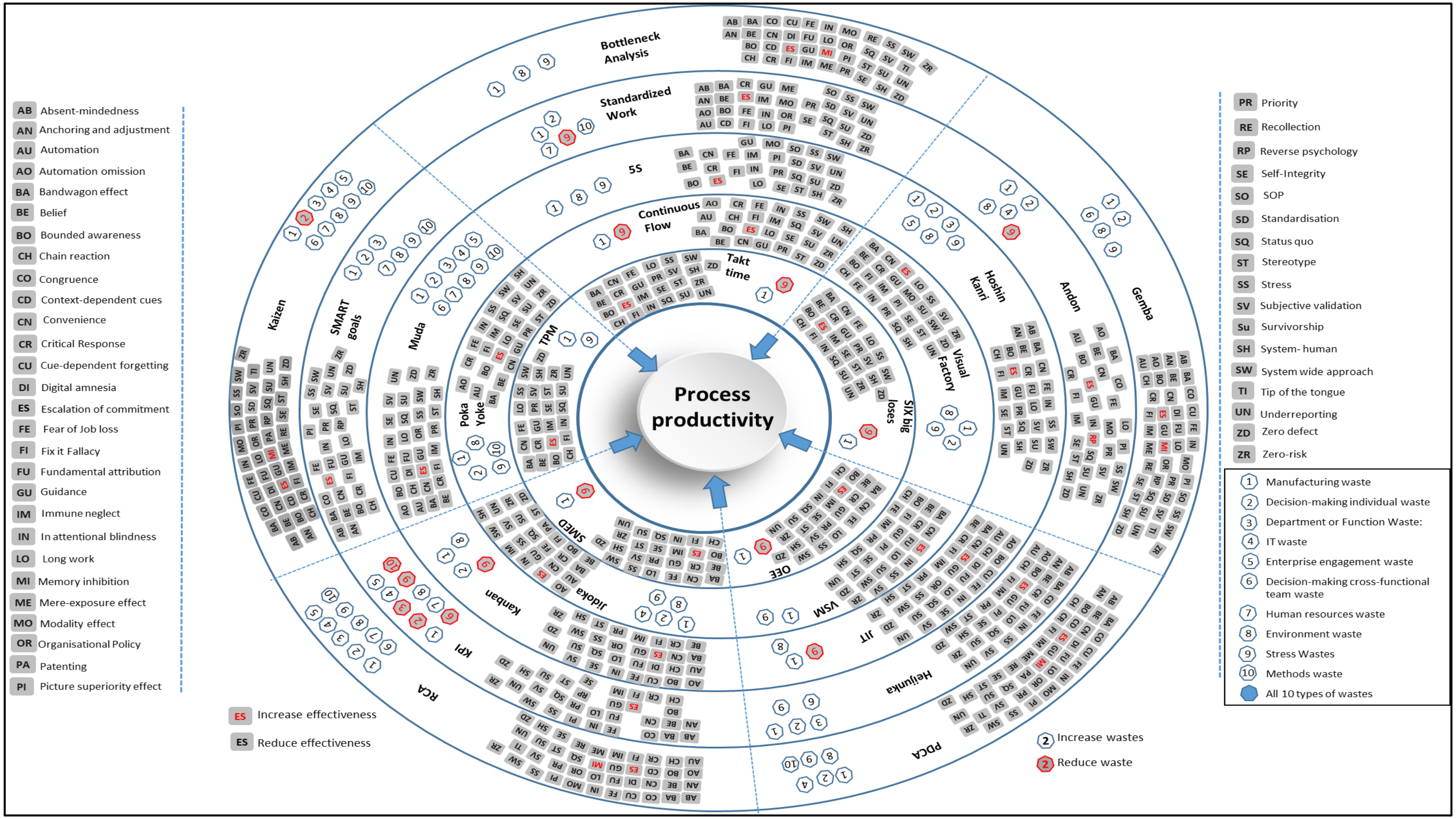

Figure 50: Circle Slice Diagram Lean tools, bias, and waste

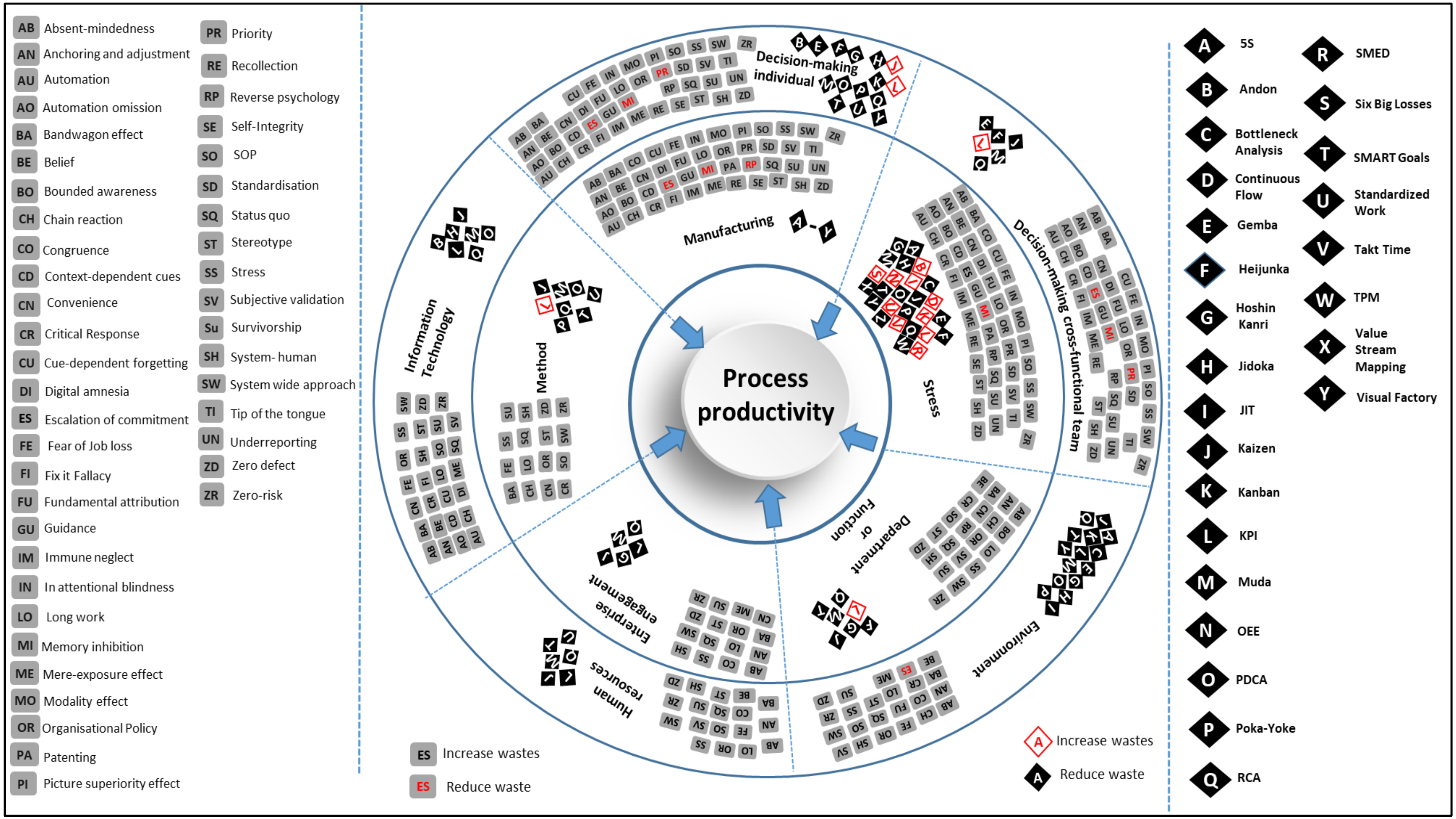

Figure 51: Circle Slice Diagram waste, Lean tools, and bias

The study on biases' interaction with Lean tools and waste was conducted at New Zealand organisations which had migrants from across the globe. Table 11 in section 3.7.4 of Chapter 3 shows the mix of participants in three broad categories from different employment conditions and organisational culture. It is possible, therefore, that the findings may be relevant across the globe for organisations practising Lean. It can thus be suggested that the methodology followed in this research can be adapted to identify biases and stressors in the process through a system-wide approach in any organisation. Further, the study demonstrated and received a response to the interaction between biases, Lean tools and different types of waste in an organisation. It is, therefore, likely that such connections exist between biases, Lean tools, and waste in any Lean organisation around the globe. These findings suggest that the generalised biases and Circle Slice Diagram could be used by any organisation to identify process improvements. Hence, it could conceivably be affirmed that there are system-wide interactions between cognitive biases, Lean tools, and waste in an organisational process.

6.6. Summary

The chapter provided an overview of the research, followed by a discussion on the interaction between Lean tools and waste types, cognitive biases and interaction between biases, Lean tools and waste types wherein the findings were compared to the existing literature, and contradicting results were provided with possible explanations. Further, the chapter discussed steps to identify biases and stressors in the process through a system-wide approach, generalised biases, and interactions mapped with a Circle Slice Diagram. The chapter concluded that there are system-wide interactions between cognitive biases, Lean tools, and waste types in an organisational process. The chapter is closed with the chapter summary.

7. Conclusion and beyond

7.1. Introduction

The chapter provides the background of the research, the practical and theoretical contribution to knowledge and the effectiveness of this research. Section 7.2 provides an overview of the research, followed by section 7.3 and section 7.4 that provide insights on research questions and findings. Next, section 7.5 highlights the contribution, and section 7.6 underpins the effectiveness of the research. This is followed by the limitations in section 7.7, and future research beyond this thesis based on the emerging themes in section 7.8. The research findings' evaluation is given in section 7.9, and the chapter is concluded with the thesis concluding remarks in section 7.10.

7.2. Overview

The research set out to obtain insights on the cognitive biases' interaction with Lean tools and waste in organisations. The research design covered participants from throughout chosen processes to gather their experiences of their particular process and work habits. The study embraced a research design that determined the interactions of cognitive bias, Lean tools, and waste, adopted a qualitative narrative inquiry methodology within an interpretivist theoretical framework and constructivist epistemology and obtained knowledge. The research design addressed ethical issues and maintained strict confidentiality to avoid any risk to the volunteering participants. To ensure confidentiality, the research methodology and design were subjected to ethics review, only participants who volunteered were recruited, and confidentiality was assured in writing. The voluntary participants were staff, operators and management personnel involved in the particular process.

The multiple site and source system-wide case study approach adopted for data collection included data, theory, methodological and environmental triangulation. In this research, the in-depth qualitative focus was attained through process observation, participant observation, and semi-structured interviews with open-ended questions. The research provided an insight into the processes studied and suggested process improvements at four large-scale organisations and one small-scale organisation for seven different processes at a particular time. The research recruited multi-cultural voluntary participants who held different positions and possessed varied experience. The sample size of each study was based on the snowballing principle that varied for each process studied. The participant position and experience distribution P values were well below 0.05, signifying the reliability of participants' input to the study.

This research used content, narrative, and framework analysis methods to obtain interactions between cognitive bias, Lean tools, and waste types. The biases were constructed in two pathways. In the first pathway, the data gathered from process observation, participant observation, interview recordings, and interview notes were used to construct the studied process and identify the related biases through narrative analysis. In the second pathway, the process observation/discussions, participant observation/discussions, interview recordings, and notes were used to identify biases through framework analysis and the same pathway was used to identify waste types in the system. Further, the documents, process observation, and participant observation were used to identify Lean tools through content analysis. Furthermore, the research embraced the preceding explanations on types of cognitive biases and lean tools from the literature and aimed to address practical issues, which would be understandable to academics and industry professionals.

The reliability of the study was achieved with ethics considerations, large sample size, multiple sites, triangulation, data from large organisations, careful sampling, and rigorous coding, an approach similar to that of Walliman (2017). In line with Denzin (1978), Yin Yin (1994), Carter et al. (2014), and Golafshani (2003), validity was realised by using the same protocol across all studies, carried out in normal life settings using a robust ethical research design, and data representativeness from multiple case studies and triangulation that reflected the multiple ways of establishing the reality. Further, the confirmability of the study was ensured by presenting the analysis and the process improvement to respective top management and obtaining feedback on the usefulness of the study. Furthermore, following Patton (1999), credibility was ensured by gathering and analysing triangulated high-quality data from multiple case studies, mostly large reputable organisations that had implemented Lean. The research was conducted in normal work life settings with high ethical practices that ensured transferability.

7.3. Research Question

The foremost objective of the research was to develop an empirical understanding of the interaction of cognitive biases, Lean tools and waste in an organisational process that aimed for a degree of generalisation of the relating three factors. Over the last two decades, only a few studies have identified bias influence on Lean. For example, Gino and Pisano (2008) noted many operational analytical models assume people are rational without cognitive influence, whereas research in economics, finance, and marketing have incorporated how people influence their models, unlike operations. This study focused on understanding system-wide interactions between cognitive biases, Lean tools, and waste in an organisational process and obtained knowledge on the following research question and sub-questions:

RQ: What are the interactions between cognitive biases' interventions, Lean tools, and waste types in organisational processes?

Sub-questions:

- How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?
- What are the system-wide cognitive bias interventions in workplaces that interact and influence waste and Lean tools in organisational processes?
- What are the different types of waste prevalent in organisations?
- What is the interaction between Lean tools and waste types?

7.4. Findings

The current research, through multiple case studies, identified and grouped the different waste types prevalent in organisations and business processes and focused on the commonly-used 25 Lean tools in organisations to improve productivity. The system mapping of the interaction of Lean tools and waste substantiated scholarly literature that most of the Lean tools aided in waste reduction. However, the unanticipated finding that emerged from this research is that certain Lean tools increased specific waste types, as shown in Chapter 5, Figure 46, section 5.4. This study confirmed that Lean tools are associated with stress waste and are consistent with that of Womack et al. (2007), who stated Lean as a methodology imparts stress to people.

The study has identified a reduction of stress waste with the implementation of 5S, Bottleneck analysis, Gemba, Heijunka, Hoshin Kanri, Jidoka, Poka-Yoke, Kaizen, Muda, PDCA, RCA, Smart goals, TPM, VSM, and Visual factory. An increase in stress waste occurred with implementation of Andon, Continuous flow, JIT, Kanban, KPI, OEE, SMED, Six Big Losses, Standardised work and Takt Time. Contrary to expectations, this study has shown that Kaizen increased decision-making individual waste. Further, this study revealed that KPI increases decision-making individual and cross-functional, department or function, stress, and methods waste.

This study identified stressors and their related biases to improve processes. The research also showed that waste elimination or reduction is possible through the identification of stressors and biases in the system to improve process productivity in a system-wide approach. The approach to reducing stressors in processes could aid sustainable Lean in industries and invoke research interest for academics. The methodology developed (refer to Chapter 3) provided a base to identify the stressors and biases in the system through a system-wide approach to optimise outcomes that are given in section 6.4 of Chapter 6.

The research results revealed the system-wide biases prevalent in an organisation. The prominent biases were identified by generalising the outcome of case studies, experience, and position of participants, considering those above the median percentage response of all three analysis (refer to section 5.3, Chapter 5). A significant finding to emerge from this study, is the interaction between bias, Lean tools, and waste. The research adopted a novel Circle Slice Diagram to plot the three-dimensional interaction between bias, Lean tools and waste types in a process. The Circle Slice Diagram has better readability, flexibility, and interchangeable focus than other available models, such as cluster or brain dump, connected circles, behaviour over time, iceberg model, causal loop diagram, relationship, domain, process diagram, and structural system maps. Furthermore, it is possible to include snowballing of factors and subfactors and the Circle Slice Diagram is infinitely expandable.

This study has found that, in general, people display cognitive biases with respect to a situation or issue to act or react. The research design, findings, and system mapping model have significant implications for the understanding of how bias influences Lean tools and waste in a practical work environment that could be adopted by academic and industry personnel.

The results of the study show that biases can have positive and negative impacts on Lean tools and waste. The key study findings on bias are:

- In all the cases of this study, biases played an important role in Lean tools effectiveness and waste elimination;
- Results indicate a negative response to standardisation; participants opted for deviations from SOP in a practical work situation and did not expect zero defects. However, people were in favour of zero risk;
- Guidance bias was noticed in a unionised environment similar to a non-unionised environment, and people were able to adapt to negativity and had a negative response to immune neglect;
- People tended to follow successful practices (Bandwagon effect), repetition (Stereotype) and maintain the current level of performance (Status quo) while focusing on their survival (survivorship);
- People relied on IT system information (Automation) and had missed information other than those provided by IT systems (Automation omission). People did not remember vital data (Digital amnesia), often relied on direct data (congruence) and ignored obvious or visual facts (In attentional blindness);
- Critical response, system-wide approach, convenience, SOP, organisational policy, stress, and chain reaction biases identified during this research play a vital role in the process productivity;

- Stress, survivorship, convenience, stereotype, zero defect, bandwagon effect, system-wide approach, zero risk, system human and status quo bias affected all Lean tools and all categories of waste;
- Biases like memory inhibition, recollection, escalation of commitment and reverse psychology would increase effectiveness and reduce waste. Memory inhibition and recollection increased the effectiveness of Bottleneck analysis, Gemba, Kaizen, PDCA, and RCA, and decreased manufacturing, decision-making individual, decision-making cross-functional and stress waste;
- Escalation of commitment was found to increase stress waste while it increased the effectiveness of all Lean tools, and decreased manufacturing, decision-making individual, decision-making cross-functional and environmental waste;
- Reverse psychology increased the effectiveness of Andon and reduced manufacturing, decision-making individual and decision-making cross-functional waste, and decreased the effectiveness of Gemba, Kaizen, KPI, and Smart goals, increased department or function, and stress waste; and

The study demonstrates, constructively proposes and concludes that there are system-wide interactions between cognitive biases, Lean tools, and waste in an organisational process. If these system-wide interactions are found and treated, it can lead to increased productivity.

7.5. Contribution

Productivity, competitiveness, and waste reduction initiatives drive an organisation to its future profit and sustainability. To improve productivity, Lean methodologies are adopted globally that aid in reducing waste, which also induces stress on people. Considering productivity along with people's stress reduction should be the goal of any organisation that considers social responsibility as one of their priorities. Equally, Lean organisations adopt Human Factors Engineering management to deal with human well-being, health, and safety.

The importance of this thesis lies in transferring the epidemiological research techniques from occupational health and psychology to the field of manufacturing. Previous research in the manufacturing psychology field over the last few decades has focused on emotions, engagement, attitude, behaviour, job satisfaction, skills, and training. This research focused beyond conventional thinking to seek knowledge on the cognitive biases that influence a process approach, engaging system-wide stakeholders to improve productivity and reported the cognitive biases influence on Lean tools and waste.

The research concentrated and laid its importance on the specific methodological framework that is crucial to obtain the desired knowledge. The research amalgamated the epidemiological system-wide process study approach based on a narrative inquiry that is constituted with an interpretive methodological work, which is firmly grounded with constructive epistemology to the blossoming field of cognitive influence on business process management tools and waste reduction. In general, it seems that this research has added following distinctive contributions:

- Identified cognitive biases in a business process through a system-wide approach method that exposed human tendencies in an organisation which, when treated, aid in waste reduction, effective Lean tool usage, stressor reduction and productivity improvement in New Zealand and probably internationally. This could enable an area to focus and future research for academics and aid productivity and the well-being of people involved in the process;
- Identified stressors in a business process through a system-wide approach method that, when treated, improved process productivity, reduced work stress for people and aid Lean sustenance in New Zealand and probably internationally. Stressor identification could enable a field to focus and future research for academics', aid productivity and the well-being of people involved in the process;
- Identified and classified ten different waste categories in organisation and business processes through a system-wide approach that an organisation could find and reduce to improve productivity in New Zealand and probably internationally. Waste categories could enable a new area of focus and future research to academics', identification and elimination of stress-related waste would aid the well-being of people involved in the process;
- Identified unfamiliar biases present in the business processes that exposed unfamiliar human tendencies in an organisation, which, when treated, aid in productivity improvement in New Zealand and probably internationally. Unfamiliar biases could enable a new expanse of focus and future research for academics;
- Generalised biases that influence a business process productivity that exposed prominent human tendencies in an organisation, which could be considered universally present in organisations. Generalised biases, when treated, aid in waste reduction, effective lean tool usage, stressor reduction and productivity improvement in New Zealand and probably internationally. Generalised biases could enable a new topic of focus and future research for academics and aid the well-being of people involved in the process;
- Mapped the interaction of generalised biases with 25 specific Lean tools and ten waste categories in organisations. The interactions provide insights on cognitive barriers and enhancers of Lean tools effectiveness and waste reduction that improve productivity in organisations and reduce stress for involved people in New Zealand and probably

internationally. This could enable a new area of focus and future research to academics; and

- Developed a Circle Slice Diagram for plotting the influence of three factors: cognitive bias, Lean tools, and waste. The Circle Slice Diagram provided a better understanding of three-dimensional interactions, which could be used by academics and professionals to demonstrate relationships and that could mostly be plotted on a single A4 sheet.

System-wide approach to identify cognitive biases, stressors, and waste in a business process:

This research has provided a deeper insight into cognitive biases, stressors, and waste in the business process. The insights were identified through the reliable and validated results from a system-wide ethical research methodology that assured confidentiality to the expert voluntary participants with varied experience and position. The findings could be of relevance to industry and academics to improve productivity and well-being with a better understanding of cognitive bias and stressors.

The study identified unfamiliar biases that existed in the industry, such as:

- Chain reaction;
- Convenience;
- Critical response;
- Group reaction;
- Health and safety;
- Organisational policy;
- SOP;
- Stress; and
- System-wide approach.

This work contributes to existing knowledge of cognitive biases by providing insights into specific Lean industries related biases, which could be relevant to industry and academics to improve productivity and well-being by reducing waste and stressors in a business process.

Generalised biases that influence a business process and its interaction with 25 specific Lean tools and ten waste categories

Prior to this research, cognitive bias influences on Lean tools and waste were unavailable, a probable reason being the list of biases identified by previous research in the cognitive field is so long that it complicated the research process. The approach used for identifying and generalising the biases will prove beneficial to enlarging our understanding and may be applied across industries elsewhere in the world, thus paving the way to handle multiple biases.

The empirical outcomes of this research offer a new understanding of general biases' interaction with 25 specific Lean tools and ten waste categories in the industry, contributing to recent historiographical debates over human cognitive influences on productivity and well-being. This new insight should aid to improve predictions of the impact of cognitive biases on specific Lean tools and waste categories.

Circle Slice Diagram

This model contributes to existing knowledge of system mapping by providing a three-dimensional influence that has better readability, flexibility and interchangeable focus. This model reduces the difficulty of understanding the influences and could probably be plotted on a single A4 sheet in most cases. Further, it is possible to include snowballing of factors and subfactors and the model is infinitely expandable. The model contributes to a better understanding of three-dimensional factors' influence with a distinct possibility of increasing the factors to multi-dimensional that could be useful for research across the globe. The Circle Slice Diagram representing three-dimensional interaction of bias, Lean tools and waste is given below in Figure 52.

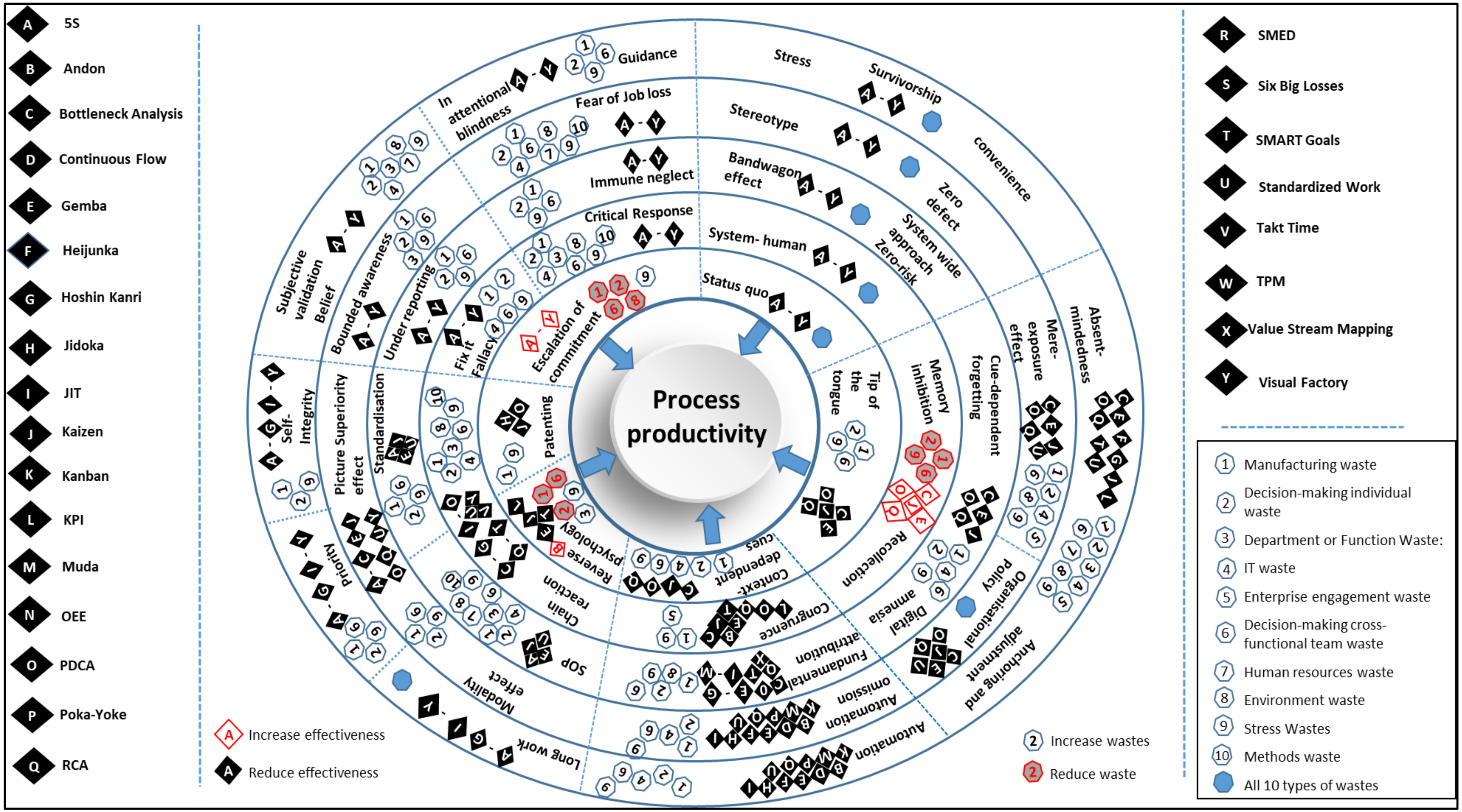

Figure 52 : Circle Slice Diagram

Specific recommendations to industries

The specific set of recommendations to the industry is given below:

- Identify the process to improve productivity.
- Map collective happnings in the process (CHIP) using the system mapping diagram to capture the inputs to the process, process actions, output to process and seepages to the process in a complete system-wide happening.
- Involve people system-wide to identify stressors, waste and Lean tools involved in the process by conducting semi-structured interviews and process observation.
- Identify the biases prevalent in the system from the semi-structured interviews and process observation; Table 7 can be used as a reference for related key important words, actions, or behaviour and for connected words, actions, and behaviour to be observed during data collection.
- Enhance the process based on stressors and biases to increase the effectiveness of the process and eleminate waste thus improving productivity.

The contributions and impact are summarised in Table 60.

Table 60: Research contribution and impact.

Contribution	Industry	Academic	People in an organisation		Stakeholders in an organisation
			Productivity	Stressor reduction	
Method to identify cognitive biases in a business process	Aid in improving productivity	Future research on cognitive biases in a business process	Aid in improving productivity	Aid in stressor reduction that improves wellbeing.	Aid in improving productivity and stressors reduction
Method to ascertain stressors in a business process	Aid in improving productivity	Future research on stressors in a business process	Aid in improving productivity		Aid in improving productivity and stressors reduction
Identified ten types of waste	Aid in improving productivity	Future research on additional types of waste classified.	Aid to reduce stressors in process		Aid in improving productivity and stressors reduction
Identification of system-wide biases	Aid in improving productivity	Future research on system-wide biases	Aid in improving productivity		Aid in improving productivity and stressors reduction
Generalised biases	Ready reckoner that aid in improving productivity	Future research on generalised biases	Aid in improving productivity		Aid in improving productivity and stressors reduction
Interaction of generalised biases with 25 specific Lean tools and ten waste categories	Aid in understanding interactions and productivity	Future research on interaction factors that affect concurrently.	Aid in improving productivity		Aid in improving productivity and stressors reduction
Circle Slice Diagram	Aid in understanding interactions and productivity	A new way to represent three-dimensional interaction will aid future researchers.	Aid in understanding interactions and productivity		Aid in improving productivity

7.6. The effectiveness of the research

Golafshani (2003) emphasised that the effectiveness of quantitative research is generally associated with reliability and validity, this research relied on ensuring reliability and validation.

For this research, the seven actions were taken to ensure reliability:

- Ethical research: The research was designed to maintain the confidentiality of the participant and organisation and participation was voluntary and protected from any risk;
- The research was conducted with substantial participation;
- The research was conducted on multiple sites;

- Data was collected by adopting methods, theory, environment, and data triangulation;
- Smaller organisations or commercial companies' records are difficult to examine for reliability. Large organisations were encouraged to participate, and six out of seven case studies were from large organisations;
- Importance was given to the quality of participants, who were the actual employees at the workplace and were able to communicate in English so that participant experience data could be examined to achieve generalisability and the development of knowledge; and
- The data collection for this research employed three sources of evidence: direct process observation, recorded interviews, and documentation.

Similarly, validity was ensured through:

- The same semi-structured interview protocol was developed and was used for different participants and different case studies;
- External validity was achieved by conducting case studies at reliable organisations involving employees as participants;
- The design of the research aided in obtaining data that genuinely reflected the influences of the variables (biases, Lean tools, and waste);
- Data was collected by adopting methods, theory, environment, and data triangulation;
- Methods, environment, theory, and data triangulation methods used to analyse the data;
- Followed the same study protocol and obtained feedback for all case studies on the reports presented to the senior management team.
- Process observation, participant observation, and document review happened at multiple actual work sites, which practised Lean;
- Confirmability: The research generalised theory through the analysis of multiple case study data, reported the process improvements to the organisation and obtained feedback on the usefulness of the study;
- Credibility: Following Patton (1999), the credibility was ensured by gathering and analysing high-quality multiple case study data from mostly large reputable organisations that had implemented Lean;
- Transferability: The research was conducted in normal work life settings with high ethical practices ensuring transferability.

Nevertheless, the study like any other research, had limitations.

7.7. Study Limitations:

One of the critical aspects of qualitative research is to state the limitations of the research. This research set out to obtain insights on the cognitive biases' interaction with Lean tools and waste in organisations, recruited system-wide participants of a chosen process to gather their experiences of that particular process and their work. The limitation of the study in New Zealand and its sample size needs to be acknowledged. The study recruited participants with different positions and varied experiences, covering the printing, warehousing, power distribution, and fruit cool storage sectors. Though the study covered a range of industries, the following limitations existed:

- Single culture environment not studied and may see a different set of biases influence;
- Core manufacturing sectors, like original equipment, construction and automobile, and non-core manufacturing sectors like health, education, and government functions were not covered, and they may yield differences in findings; and
- The study covered a limited five sectors; other sectors may use different or additional Lean tools, which may yield additional knowledge to the field.

The research method adopted on multiple case studies with pre-determined factors has the limitation that it reveals only those sought. However, the constant outlook for new tendencies led to the identification of unfamiliar biases and their influences and restricted the influence of this limitation. Further, the research focused on process and placed limited or no emphasis on the individual's ability and decision-making biases. This may affect the Lean tools and waste that need to be acknowledged, and future studies may focus on their impacts.

The biases defined as new biases could be unfamiliar biases that could have been identified elsewhere in the literature that had not been published in English. The research recognised this limitation and hence referred to as unfamiliar biases instead of newly-identified biases. In addition, the list of biases identified in Chapter 2 would not have considered all biases that were previously identified due to shortcomings in searching the vast literature and needs to be acknowledged as a limitation.

Like any qualitative research, constructivism and narrative analysis are subjected to understanding, which is based on knowledge gained on the subject, and data may have been interpreted differently. Constructivist co-recreation of process scenarios-based result limitations are therefore acknowledged. However, research design and generalisation based on data collection and analysis methods limit the effects of these and findings are reliable to a greater extent. The interactive participation in exploring the knowledge sought after, and interaction could have a probable influence on the participant needs to be acknowledged.

However, the research design and multiple methods of data collection limit the effect of the influence. In addition, the research design aimed to involve as many participants as possible.

The study recruited participants from a particular process chosen for study in consultation with the management; overall, 15% of people approached declined to participate. The limitation that 100% participation was not obtained, given the circumstance that the real world would need complete participation of people for process improvement, needs to be acknowledged. However, the study recruited an overall 84.62% of people system-wide, and the participation range was 73.17% to 100%, which covered all process steps that limited the effects on outcome and a high percentage of participation ensured findings are reliable largely.

The recruitment of participants in the process of an organisation involved management. Further, recording responses and reporting to the management could have probably impacted the participant's response. These factors were considered in ethics and research design, and people deceptions were addressed by capturing data by repeating interview questions suitably and observing the process steps performed three times. Further, multiple methods of data collection, observation and interview and generalisation technique used reduced the influence of this limitation.

The research is principally a qualitative study. The participant cautiousness, interview process, and interpretations of participant's views need to be recognised and acknowledged as limitations. Further, the assumption is that reality is sought with human interests, the participants share their personal or witnessed experiences, and the interactive dimension is constructive and represented sought after knowledge. The participants' responses during the interview are assumed to be real and specific to that particular participant, and researcher bias may have added to the interpretation and findings and needs to be acknowledged as a limitation. However, the multiple methods of data collection and generalisation techniques used limited researcher bias influence and aided in increasing the reliability of the findings.

The limitation of the new system mapping method, the Circle Slice Diagram that is used to represent the interaction of cognitive biases, Lean tools, and waste needs to be acknowledged. The Circle Slice Diagram mapped 45 biases, 25 Lean tools and ten waste types, totalling a combination of 11,250 factors influence. The readability was comparatively higher than the existing models while fitting on an A4 sheet. The model is infinitely expandable for the number of factors and subfactors. However, the more the factors there are, the lower the readability and focus. The difficulty level in plotting remained the same when compared to the traditional methods, and the Circle Slice Diagram needed to be plotted and printed in colour, unlike the other traditional models. Despite its exploratory nature, this model offers some insight into three-dimensional influence with better readability that highlighted the key factor in focus. Nonetheless, the model adequately covered the research scope.

The scope of this study was limited to cognitive bias in workplaces, while there may be effects of other cognitive biases such as social, economic, and culture that may affect the productivity in workplaces. This limitation needs to be acknowledged, and future studies may focus on their impacts. Nevertheless, the research was able to demonstrate the designed research on interactions of cognitive biases in workplaces.

Although this research relied on a sample of 99 participants, the findings provide insights into the interactions of cognitive bias at the workplace, Lean tools, and waste. Further, this being the first empirical research and exploratory in nature in identifying the interactions of cognitive bias, Lean tools, and waste that contributes to the body of knowledge in the human factors-business field has certain limitations. The limitations being no different from other qualitative researches, such limitations may be noted and catered by future researchers.

7.8. Future research

The exploratory multi-field nature of this research has brought forward many questions for further investigation. Potential future research directions are:

- Research on the long-term effects of cognitive biases in the work environment and influences on management tools, waste, productivity, and well-being;
- More broadly, ability and decision-making biases' influence on management tools and waste empirical research would provide new insights;
- This research worked on a multicultural environment. Future work to study the impact of cognitive biases on Lean tools and waste in a predominantly monoculture work environment would highlight more or different set of biases;
- A study more focused on the interaction of cognitive biases on management tools and waste in other work environments such as original equipment manufacturing, automobiles, construction, health care, education, and government organisations would offer interesting outcomes that account more for these work environments;
- Empirical research to determine social, economic and culture related biases that affect the productivity in workplaces would prove beneficial;
- This research provided methods to identify stressors. Many works of literature relate stressors in workplaces to the stress of people and their well-being. More empirical studies in the future to determine the impact of this stressor identification and elimination method on the stress of the people and their well-being would be beneficial;

- Research based on social cultures to determine the cognitive biases influence on management tools and waste could be taken up as future research in this field;
- Research to study the cognitive bias prevalent during the implementation of improved processes could be taken up to reveal improvement-related impact;
- Research to study biases on small scale industries and comparison to large organisational biases would be beneficial; and
- Research to study the influence of cognitive biases on management tools, other than discussed in this research, would be beneficial for organisations and academics.

7.9. Research finding Evaluation

This section evaluates the research questions and outcomes. The evaluation is shown in Table 61.

Table 61: Research finding evaluation

Sl No.	Research Question	Status
1	What are the interactions between cognitive biases' interventions, Lean tools, and waste in organisational processes?	Addressed, refer to section 5.6 in Chapter 5.
1A	How can cognitive biases and stressors be identified and systematically understood to optimise the outcomes of an organisation?	Addressed, refer to Chapters 3 and 4, and section 6.4 in Chapter 6.
1B	What are the system-wide cognitive biases' interventions in workplaces that interact and influence waste and Lean tools in organisational processes?	Addressed, refer to sub-section 4.11.3 and 5.3 in Chapters 4 and 5 respectively.
1C	What are the different types of waste prevalent in organisations?	Addressed, refer to section 2.3 in Chapter 2 and 4.11.2 in Chapter 4.
1D	What is the interaction between Lean tools and waste?	Addressed, refer to section 5.4 in Chapter 5.

7.10. Concluding remarks

The exploratory nature of this research offers new insight into the interaction of cognitive biases, Lean tools and waste in a real workplace environment, which may be applicable globally. In spite of its limitations, it is hoped that the study certainly adds to our understanding of the interaction of cognitive biases, Lean tools and waste in a real workplace environment that is represented through a new system mapping Circle Slice Diagram model. The research suggests that a better understanding of cognitive bias influence on Lean tools and waste in real workplace environment improves the productivity of organisations and the well-being of people. For example, the Eta Gemba study demonstrated productivity improvement and the

Beta team implemented a few suggestions immediately to enhance productivity. Ultimately, this research and the method adopted would support industry and academic personnel to increase productivity and well-being through the better understanding of stressors and cognitive biases, and cognitive bias interaction with Lean tools and waste types in a real workplace environment globally. The research has as its limitation that it is by an individual researcher. However, the method and findings would provide significant support to a large team that intends to take up similar research. The research with seven case studies involving five organisations and 99 participants in New Zealand and the feedback suggests possible practical implementation. The findings support and affirm that there are system-wide interactions between cognitive biases, Lean tools, and waste types in an organisational process.

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Appendices

Appendix 1: Lean tools and waste interaction

Lean tools	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
5S	Reduce defects, movement, waiting, and inventory.							Reduce movement and related pollution.	Reduce searching and related stress.	
Andon	Reduces defects and waiting.	Individuals alerted to act on time.		Alerts error on time to solve software and hardware glitches					Induces stress as it escalates pressure on people to act.	
Bottleneck Analysis	Reduce transportation, movement, waiting, inventory and over processing.							Reduce environmental waste.	Reduces stress as constraints are identified.	
Continuous Flow	Reduce waste								Stress level increase as processes are set to achieve maximum efficiency.	

Lean tools	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Gemba (The Real Place)	Reduces defects, over production, transportation, movement, waiting, inventory, and over-processing.	Reduce individual delay in decision making				Reduce delay in decision making		Reduce environmental waste.	Real place visit and problem solving reduce stress.	
Heijunka (Level Scheduling)	Reduce waste	Individuals align to achieve levelled scheduling, reduce waste.	Individual functions align polices and procedure to achieve levelled scheduling, reduce waste.			Cross functions align polices and procedure to achieve levelled scheduling, reduce waste			Decreases stress as schedules are levelled, each individual focuses on a set level of productivity.	
Hoshin Kanri (Policy Deployment)	Reduce waste	Policies guide individual to deliver productivity, reduce waste	Policies guide individual functions to deliver productivity, reduce waste		Policies guide external engagement to deliver productivity, reduce waste			Policies guide to reduce waste	Policies guide to deliver productivity, reduces stress	
Jidoka (Automation)	Reduce waste	Automated process eliminates individual waste.		Automated process data captured reduce data input time and errors.				Reduce waste	Fear of job loss induce stress.	

Lean tools	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Just-In-Time (JIT)	Reduce waste							Reduces waste	Increases follow up that induce stress.	
Kaizen (Continuous Improvement)	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce stress.	Reduce waste
Kanban (Pull System)	Reduce waste.	Reduce waste						Reduce waste	Increases follow up that induce stress.	
KPIs (Key Performance Indicators)	Reduce waste.	Individual KPI drives individuals to take a conservative stand, induces waste.	Department KPI drives departments to take a conservative stand, induces waste.	Reduce waste.	Reduce waste.	cross functional teams stick to their department KPI, induces waste	Reduce waste.	Reduce waste.	Individual performance pressure increase stress.	KPI monitoring increases overheads. KPI increase eagerness waste.
Muda (Waste)	Systematic capturing of waste, provide an opportunity to reduce.	Systematic capturing of waste, provide an opportunity to reduce.	Systematic capturing of waste, provide an opportunity to reduce.	Systematic capturing of waste, provide an opportunity to reduce.	Systematic capturing of waste, provide an opportunity to reduce.	Systematic capturing of waste, provide an opportunity to reduce.	Systematic capturing of waste, provide an opportunity to reduce.	Systematic capturing of waste, provide an opportunity to reduce.	Systematic capturing of wasts, provide an opportunity to reduce waste and stress.	Systematic capturing of waste, provide an opportunity to reduce.
Overall Equipment Effectiveness (OEE)	Reduce waste.								Constant pressure to achieve efficiency increase stress	
PDCA (Plan, Do, Check, Act)	Reduce waste.	Reduce waste.		Reduce waste.				Reduce waste.	Systematic effort reduces stress	Reduce waste.

Lean tools	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Poka-Yoke (Error Proofing)	Reduces defects.	Reduce waste.						Reduce waste.	Reduces defect related stress.	Reduce waste.
Root Cause Analysis	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce waste	Reduce stress.	Reduce waste
Single-Minute Exchange of Dies (SMED)	Reduce waste								Increases stress as it sets the time limit.	
Six Big Losses	Reduce waste								Constant pressure to keep loss under target increase stress.	
SMART Goals	Reduce waste	Reduce waste	Reduce waste				Reduce waste	Reduce waste	Reduce stress.	Reduce waste
Standardised Work	Reduce waste	Reduce waste					Reduce waste		Increases stress due to monotonous work and high productivity expectation	Reduce waste
Takt Time	Reduce waste								System is constantly under stress.	
Total Productive Maintenance (TPM)	Reduce waste								Reduces breakdown related stress.	
Value Stream Mapping	Reduce waste								Reduce stress.	

Lean tools	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Visual Factory	Reduce waste	Reduce waste						Reduce waste	Reduce stress.	

Appendix 2: Bias and waste interaction

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Absent-mindedness	Missing an action, forgetting facts will increase waste	missing an action, forgetting facts will increases waste	missing an action, forgetting facts will increases waste	missing an action, forgetting facts will increases waste	missing a suggested action, forgetting facts will increases waste	missing an agreed action, forgetting facts will increases waste	missing to schedule training on time, forgetting facts will increases waste	missing an action, forgetting facts will increases waste	missing an action, forgetting facts will increases waste	
Anchoring and adjustment	Relating to prominence impacts the data and fact analysis, which may tend to increase waste	Relating to prominence impacts the data and fact analysis, which may tend to increase waste	Relating to prominence impacts the data and fact analysis, which may tend to increase waste	Relating to prominence impacts the logics and hardware needs which may tend to increase waste	Relating to prominence impacts implementation of the suggestions given, data and fact analysis, which may tend to increase waste	Relating to prominence impacts the data and fact analysis, which may tend to increase waste	Relating to prominence impacts the training needs and skill set analysis, which may tend to increase waste	Relating to prominence impacts the data and fact analysis, which may tend to increase waste	Relating to prominence impacts the data and fact analysis, which may tend to increase stress	
Automation	People tend to relay on information from automation which do not state every type of these defects.	People tend to miss information when not prompted by automation which creates waste.		Programs and logic defects would create waste		People tend to miss information when not prompted by automation which creates waste.			When defects surface without automated information stress levels increase.	

Biases	**Manufacturing waste**	**Decision-making individual waste**	**Department or Function Waste**	**IT waste**	**Enterprise engagement waste**	**Decision-making cross-functional team waste**	**Human resources waste**	**Environment waste.**	**Stress waste**	**Methods waste**
Automation omission	People tend to relay on information from automation which do not state every type of these defects.	People tend to miss information when not prompted by automation which creates waste.		Programs and logic defects would create waste		People tend to miss information when not prompted by automation which creates waste.			When defects surface without automated information stress levels increase.	
Bandwagon effect	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase personal productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce stress.	Shedding this bias provide new ideas, provide chance to reduce waste.
Belief	Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce waste.	Shedding this bias provide scope to revisit policies and procedures, which helps to reduce waste.	Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce waste.	Shedding this bias provide scope to investigate new technologies, logics, data or information, which helps to reduce waste.			Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce waste.	Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce waste.	Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce stress.	
Bounded awareness	Failing to notice the crucial information, options, and roles induce waste.	Failing to notice the crucial information, options, and roles induce waste.	Failing to notice the crucial information, options, and roles induce waste.			Failing to notice the crucial information, options, and roles induce waste.			Failing to notice the crucial information, options, and roles leads to unexpected	

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
									issues which induce stress.	
Chain reaction	awareness of reactions in the process chain reduces waste	awareness of reactions in the process chain reduces waste	awareness of reactions in the process chain reduces procedural requirements and waste	awareness of reactions in the process chain reduces waste on new system implementation		awareness of reactions in the process chain reduces waste		awareness of reactions in the process chain reduces waste	awareness of reactions in the process chain reduces waste	awareness of reactions in the process chain reduces eagerness waste
Congruence	Shedding this bias provide way to new tests, provide a chance to reduce these waste.				Shedding this bias provide way to new tests, provide a chance to reduce these waste.				Giving out this bias reduces Stress due to expensive test methods and correctness of tests.	
Context-dependent cues	Helps in reducing waste when past experiences are considered.	Helps in reducing waste when past experiences are considered.		Helps in reducing waste when past experiences are considered.		Helps in reducing waste when past experiences are considered.			Helps in reducing stress when past experiences are considered, which stops issues being repeated.	
convenience	Increases the waste	Increases the waste	Increases the waste	Increases the waste	Increases the waste	Increases the waste	Increases the waste	Increases the waste	Increases the waste	Increases the waste
Critical Response	Awareness the on response in the process chain reduces waste	Awareness the on response in the process reduces waste	Awareness the on response in the process chain	Awareness the on response in the process chain reduces waste		Awareness the on response in the process reduces waste		Awareness the on response in the process chain	Awareness the on response in the process reduces waste	Awareness the on response in the process chain

Biases	**Manufacturing waste**	**Decision-making individual waste**	**Department or Function Waste**	**IT waste**	**Enterprise engagement waste**	**Decision-making cross-functional team waste**	**Human resources waste**	**Environment waste.**	**Stress waste**	**Methods waste**
			reduces waste					reduces waste		reduces waste
Cue-dependent forgetting	Issues will repeat when events are forgotten and when recollected will stop waste.	Issues will repeat when events are forgotten and when recollected will stop waste.		Programming defects and hardware defects would repeat if past failures are not recollected.		Issues will repeat when events are forgotten and when recollected will stop waste.			Forgetting being repeated issues and increase stress.	
Digital amnesia	People tend to relay on information from digital sources which do not state every type of these defects.	People tend to miss information when not prompted by digital sources which create waste.		Programs and logic defects in digital sources would create waste		People tend to miss information when not prompted by digital sources which create waste.			When defects surface from sources other than digital source, stress levels increase.	
Escalation of commitment	Holding to commitment would reduce waste	Holding to commitment would reduce waste				Holding to commitment would reduce waste		Holding to commitment would reduce waste	Holding to commitment would reduce waste. However, it may increase stress	
Fear of Job loss	Shedding this bias provide way to analyse data, adopt new ideas, new technologies, provide chance to reduce these waste.	Shedding this bias provide way to analyse data, adopt new ideas, new technologies, provide chance to reduce these waste.		Shedding this bias provide way to analyse data, adopt new logics and adopting new technologies, provide chance to reduce these waste.		Shedding this bias provide way to analyse data, adopt new ideas, provide chance to reduces these waste.	Encouraging people to shed this bias provide a chance for a reduction in attrition rate.	Shedding this bias provide way to analyse data, adopt, new ideas, provide chance to reduce these waste.	Shedding this bias provide way to analyse data, adopt new ideas, provide chance to reduces the stress.	Shedding this bias provide way to analyse data, adopt, new ideas, provide chance to reduce these waste.

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Fix it Fallacy	Shedding this bias provide way to analyse data, adopt new ideas for long standing solutions, provide chance to reduce these waste.	Shedding this bias provide way to analyse data, adopt new ideas for long standing solutions, provide chance to reduce these waste.		Shedding this bias provide way to analyse data, adopt new ideas for long standing solutions, provide chance to reduce these waste.		Shedding this bias provide way to analyse data, adopt new ideas for long standing solutions, provide chance to reduce these waste.			Shedding this bias provide way to analyse data, adopt new ideas for long standing solutions, provide a chance to reduce the stress.	
Fundamental attribution	Shedding this bias provide way to analyse system-wide (internal & external) data, adopt system-wide ideas for long standing solutions, provide chance to reduces these waste.	Shedding this bias provide way to analyse system-wide (internal & external) data, adopt system-wide ideas for long standing solutions, provide chance to reduces these waste.				Shedding this bias provide way to analyse system-wide (internal & external) data, adopt system-wide ideas for long standing solutions, provide chance to reduces these waste.		Shedding this bias provide way to analyse system-wide (internal & external) data, adopt system-wide ideas for long standing solutions, provide chance to reduces these waste.	Shedding this bias provide way to analyse system-wide (internal & external) data, adopt system-wide ideas for long standing solutions, provide chance to reduces these waste.	
Guidance	Shedding this bias provide way to individual actions and ideas, provide chance to reduce these waste.	Shedding this bias provide way to team actions and ideas, provide chance to reduce these waste.				Shedding this bias provide way to individual/ team actions and ideas, provide chance to reduces these waste.			Shedding this bias provide way to individual actions and ideas and not wait for management to approve and act, provide	

Biases	**Manufacturing waste**	**Decision-making individual waste**	**Department or Function Waste**	**IT waste**	**Enterprise engagement waste**	**Decision-making cross-functional team waste**	**Human resources waste**	**Environment waste.**	**Stress waste**	**Methods waste**
									chance to reduces the stress.	
Immune neglect	Shedding this bias provide a chance to understand their strengths and opportunity to adopt to negative situations and reduce waste which happens unexpectedly.	Shedding this bias provide a chance to understand their strengths and opportunity to adopt to negative situations and work productively to reduce waste.				Shedding this bias provide a chance to understand their strengths and opportunity to adopt to negative situations and work productively to reduce waste.			Shedding this bias provide a chance to understand their strengths and opportunity to adopt to negative situations and work productively to reduce stress.	
In attentional blindness	Shedding this bias provide way to visual information, provide a chance to reduce these waste.	Shedding this bias provide way to visual information, provide a chance to reduce these waste.				Shedding this bias provide way to visual information, provide a chance to reduce these waste.			Shedding this bias provide way to visual information, provide chance to reduce these waste, increase productivity and stress.	

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Long work	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste	Timely working provide more energy and fresh thought, shedding this bias naturally reduce these waste
Memory inhibition	Holding to this may lead to remembering relevant fact and situation and lead to a faster reduction of waste.	Holding to this may lead to remembering relevant fact and situation and lead to a faster reduction of waste.				Holding to this may lead to remembering relevant fact and situation and lead to a faster reduction of waste.			Holding to this may lead to remembering relevant fact and situation and lead to faster elimination of repeated stressors and thereby those stress.	
Mere-exposure effect	Shedding this bias provide way to analyse data, adopt new ideas, provide chance to reduces these waste.	Shedding this bias provide way to analyse data, adopt new ideas, provide chance to reduces these waste.		Shedding this bias provide way to analyse data, adopt new logics and adopting new technologies, provide chance to reduce these waste.	Shedding this bias provide way to adopt new suggestions, provide chance to reduces these waste.	Shedding this bias provide way to analyse data, adopt new ideas, provide chance to reduces these waste.		Shedding this bias provide way to analyse data, adopt, new ideas, provide chance to reduce these waste.	Shedding this bias provide way to analyse data, adopt new ideas, provide chance to reduces the stress.	

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Modality effect	Shedding this bias and understanding the crucial information, options, and roles irrespective of presentation method helps to reduce waste.	Shedding this bias and understanding the crucial information, options, and roles irrespective of presentation method helps to reduce waste.				Shedding this bias and understanding the crucial information, options, and roles irrespective of presentation method helps to reduce waste.			Shedding this bias and understanding the crucial information, options, and roles irrespective of presentation method helps to reduce stress.	
Organisational Policy	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste
Patenting	Reduces Defects, Over Production, Transportation, Movement, Waiting, and Inventory and Over Processing.								Reduces stress due to a doable solution and non-secrecy clause.	
Picture superiority effect	Holding to this bias is effective when an organisation visually displays information, however shedding this bias and understanding the crucial information, options, and	Holding to this bias is effective when an organisation visually displays information, however shedding this bias and understanding the crucial information, options, and				Holding to this bias is effective when an organisation visually displays information, however shedding this bias and understanding the crucial information, options, and			Holding to this bias is effective when organisation visually displays information, however shedding this bias and understanding the crucial information, options, and	

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
	roles irrespective of presentation method helps to reduce waste.	roles irrespective of presentation method helps to reduce waste.				roles irrespective of presentation method helps to reduce waste.			roles irrespective of presentation method helps to reduce stress.	
Priority	Shedding this bias provide way to adopt new ideas to work systematically, provide chance to reduce these waste.	Shedding this bias provide way to adopt new ideas to work systematically, provide chance to reduce these waste.				Shedding this bias provide way to adopt new ideas to work systematically, provide chance to reduce these waste.			Shedding this bias provide way to adopt new ideas to work systematically, provide a chance to reduce the stress.	
Recollection	remembering the crucial information, options, and roles reduce waste.	remembering the crucial information, options, and roles reduce waste.				remembering the crucial information, options, and roles reduce waste.			remembering the crucial information, options, and roles reduce stress.	
Reverse psychology	Holding this bias provide way to extract commitment, provide chance to reduce these waste.	Holding this bias provide way to extract commitment, provide chance to reduce these waste.	Shedding this bias provide way to reduce procedural requirements, provide			Holding this bias provide way to extract commitment, provide chance to reduce these waste.			Holding this bias provide way to extract commitment and increases stress. However,	

Biases	**Manufacturing waste**	**Decision-making individual waste**	**Department or Function Waste**	**IT waste**	**Enterprise engagement waste**	**Decision-making cross-functional team waste**	**Human resources waste**	**Environment waste.**	**Stress waste**	**Methods waste**
			chance to reduces these waste.						Shedding this bias provide way to reduced procedures, provide a chance to reduce the stress.	
Self-Integrity or Preserving Moral Integrity	Shedding this bias would reduce these waste arising out of fear.	Shedding this bias would reduce these waste arising out of fear.							Shedding this bias would reduce stress on one self and others reduce these waste	
SOP	Inclination reduces waste while declining induces waste	Inclination reduces waste while declining induces waste	Induces waste	Inclination reduces waste while declining induces waste		Induces waste	Induces waste	Inclination reduces waste while declining induces waste	Induces waste	Inclination reduces waste while declining induces waste
Standardisation	Shedding this bias would help in quick and understandable documentation suitable to the organisation, which in turn helps reduce waste.	Shedding this bias would help in quick and understandable documentation suitable to the organisation, which in turn helps reduce waste.				Shedding this bias would help in quick and understandable documentation suitable to the organisation, which in turn helps reduce waste.			Shedding this bias would help in quick and understandable documentation suitable to the organisation, which in turn helps reduce stress.	

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Status quo	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase personal productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce stress.	Shedding this bias provide new ideas, provide chance to reduce waste.
Stereotype	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase personal productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce stress.	Shedding this bias provide new ideas, provide chance to reduce waste.
Stress	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste	Induces waste
Subjective validation	Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce waste.	Shedding this bias provide scope to revisit policies and procedures, which helps to reduce waste.	Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce waste.	Shedding this bias provide scope to investigate new technologies, logics, data or information, which helps to reduce waste.			Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce waste.	Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce waste.	Shedding this bias provide scope to investigate new ideas, data or information, which helps to reduce stress.	

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Survivorship or Survival	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase personal productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce stress.	Shedding this bias provide new ideas, provide chance to reduce waste.
system- human	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.	Shedding this bias would reduce these waste arising out of miss conceptions.
System-Wide approach	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste	System-wide approach would identify and eliminate these waste
Tip of the tongue	Forgetting the crucial information, options, and roles increase waste.	Forgetting the crucial information, options, and roles increase waste.				Forgetting the crucial information, options, and roles increase waste.			Forgetting the crucial information, options, and roles increase stress.	
Underreporting	underreporting the crucial information, options, and roles increase waste.	underreporting the crucial information, options, and roles increase waste.				underreporting the crucial information, options, and roles increase waste.			underreporting the crucial information, options, and roles increase waste.	

Biases	Manufacturing waste	Decision-making individual waste	Department or Function Waste	IT waste	Enterprise engagement waste	Decision-making cross-functional team waste	Human resources waste	Environment waste.	Stress waste	Methods waste
Zero defect	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase personal productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce stress.	Shedding this bias provide new ideas, provide chance to reduce waste.
Zero-risk	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase personal productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce waste and increase productivity.	Shedding this bias provide new ideas, provide chance to reduce stress.	Shedding this bias provide new ideas, provide chance to reduce waste.

Appendix 3: Bias and Lean tools interaction

Bias	5S	Andon	Bottleneck Analysis	Continuous Flow	Gemba	Heijunka	Hoshin Kanri	Jidoka	JIT	Kaizen	Kanban	KPI
Absent-mindedness			Forgetting facts affects the analysis		Forgetting facts after Gemba affects the analysis	Forgetting situations and fact affects scheduling	Forgetting facts affects deployment			Forgetting events, situations, or facts affects suggestion decision		Forgetting situations, or facts leads to fixing incorrect KPI
Anchoring and adjustment			Relating facts to a prominent person's view and later adjust to it while talking decisions affects the analysis		Relating facts to a prominent person's view and later adjust to it while talking decisions after Gemba affects the analysis	Relating facts to a prominent person's view and later adjust to it while talking decisions affects scheduling	Relating facts to a prominent person's view and later adjust to it while talking decisions affects deployment			Relating facts to a prominent person's view and later adjust to it while talking decisions affects suggestion decision		Relating facts to a prominent person's view and later adjust to it while talking decisions to fixing incorrect KPI
Automation		Heavily relied on automation and ignore differing facts		Heavily relied on automation and ignore other areas	Heavily relied on IT information and ignore differing facts	Heavily relied on IT information and ignore differing facts		Heavily relied on automation	Heavily relied on IT information and ignore differing facts		Heavily relied on IT information and ignore differing facts	
Automation omission		Does not display information, defects, data, and facts when not prompted by automation.		Does not deduct information, defects, data, and facts when not prompted by automation.	Miss information, data, and facts when not prompted by automation.	Miss information, defects, data, and facts when not prompted by automation.		Does not display information, defects, data, and facts when not prompted by automation.	Miss information, defects, data, and facts when not prompted by automation.		Miss information, defects, data, and facts when not prompted by automation.	
Bandwagon effect	The tendency to follow methods of previous success stops innovation	The tendency to follow methods of previous success stops new information and displays	The tendency to follow methods of previous success blocks analysis	The tendency to follow methods of previous success stops innovation	The tendency to follow methods of previous success stops innovation	The tendency to follow methods of previous success blocks analysis	The tendency to follow methods of previous success blocks new ways of deployment	The tendency to follow methods of previous success stops innovation	The tendency to follow methods of previous success blocks new practices	The tendency to follow methods of previous success stops innovation	The tendency to follow methods of previous success lead to incorrect KPI that ignore facts out of individual's control	The tendency to follow methods of previous success blocks new practices
Belief	Not accept the method, solution, procedure or process that does not match their belief delay's implementation and improvement	People do not act when Andon display does not match their belief	People do not analyse till problem match their belief	People do not act until their belief prompts continuous flow	Not accept the method, solution, procedure or process that does not match their belief delay's improvement	Not accept the method, solution, procedure or process that does not match their belief delay's implementation and improvement	Not accept the policy that does not match their belief delay's implementation	People do not act until their belief prompts Jidoka	People do not adopt JIT till need match their belief	People do not accept kaizen if it does not match their belief	People do not adopt Kanban until need match their belief	Not accept the policy that does not match their belief delay's implementation and differ achieving KPI target
Bounded awareness	Failing to notice the crucial information, options, roles, and parties involved affects adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information affected the analysis	Failing to notice the crucial information, options, roles, and parties involved affected improvement and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected scheduling and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected deployment and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance

Bias	5S	Andon	Bottleneck Analysis	Continuous Flow	Gemba	Heijunka	Hoshin Kanri	Jidoka	JIT	Kaizen	Kanban	KPI
Chain reaction			Failing to consider the crucial reaction affect the analysis	Failing to consider the crucial reaction affect implementation and sustenance	Failing to consider the crucial reaction affect the analysis and improvement	Failing to consider the crucial reaction affect sustenance and improvement	Failing to consider the crucial reaction affect sustenance		Failing to consider the crucial reaction affect sustenance and improvement	Improvement without considering other areas the crucial reaction affect other areas	Failing to consider the crucial reaction affect sustenance and improvement	Failing to consider the crucial reaction affect sustenance
Congruence		Rely on direct data truncates useful information on performance	Rely on direct data affects the analysis		Rely on direct data affects the analysis					Rely on direct data affects the analysis and improvement		Rely on direct data affects fixing KPI, derived data on special conditions help in fixing KPI
Context-dependent cues			Not recollecting without nurtured with past examples or situation affect the analysis							Not recollecting without nurtured with past examples or situation affect the decision on improvement suggestions		
convenience	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the analysis	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the decision on suggestions provided	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance
Critical Response	Miss or avoid critical responses with all stakeholders affects sustenance	Miss or avoid critical responses with all stakeholders affects sustenance	Miss or avoid critical responses with all stakeholders affects the analysis	Miss or avoid critical responses with all stakeholders affects adaptation and sustenance	Miss or avoid critical responses with all stakeholders affects the analysis	Miss or avoid critical responses with all stakeholders affects adaptation and sustenance	Miss or avoid critical responses with all stakeholders affects adaptation and sustenance	Miss or avoid critical responses with all stakeholders affects adaptation and sustenance	Miss or avoid critical responses with all stakeholders affects adaptation and sustenance	Miss or avoid critical responses with all stakeholders affects sustenance of implemented suggestion	Miss or avoid critical responses with all stakeholders affects adaptation and sustenance	Miss or avoid critical responses with all stakeholders affects adaptation and sustenance
Cue-dependent forgetting			Not recollecting without nurtured with past examples or situation affect the analysis		Not recollecting without nurtured with past examples or situation affect Gemba study and the analysis					Not recollecting without nurtured with past examples or situation affect the analysis		
Digital amnesia			Not remember information that is readily available in digital mode affect the analysis and subsequent discussions		Not remember information that is readily available in digital mode affect the analysis and subsequent discussions					Not remember information that is readily available in digital mode affect the analysis and subsequent discussions		
Escalation of commitment	Extra committed when the outcome is negative aids	Extra committed when the outcome is negative aids sustenance	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids sustenance	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids sustenance	Extra committed when the outcome is negative aids	Extra committed when the outcome is negative aids	Extra committed when the outcome is negative aids sustenance	Extra committed when the outcome is negative aids improvement	Extra committed when the outcome is negative aids sustenance	Extra committed when the outcome is negative aids

Bias	5S	Andon	Bottleneck Analysis	Continuous Flow	Gemba	Heijunka	Hoshin Kanri	Jidoka	JIT	Kaizen	Kanban	KPI
	implementation and sustenance						deployment and sustenance	implementation and sustenance		decision process and sustenance		deployment and sustenance
Fear of Job loss	Fear of job loss affects implementation and sustenance	Fear of job loss affects implementation and sustenance	Fear of job loss affects the analysis	Fear of job loss affects adaptation and sustenance	Fear of job loss affects the analysis	Fear of job loss affects adaptation and sustenance	Fear of job loss affects adaptation and sustenance	Fear of job loss affects adaptation and sustenance	Fear of job loss affects adaptation and sustenance	Fear of job loss affects the decision on suggestions provided	Fear of job loss affects adaptation and sustenance	Fear of job loss affects adaptation and sustenance
Fix it Fallacy	Naive solutions affect implementation and sustenance	Naive solutions affect implementation and sustenance	Naive solutions affect the analysis	Naive solutions affect adaptation and sustenance	Naive solutions affect the analysis	Naive solutions affect adaptation and sustenance	Naive solutions affect adaptation and sustenance	Naive solutions affect adaptation and sustenance	Naive solutions affect adaptation and sustenance	Naive solutions affect the decision on suggestions provided	Naive solutions affect adaptation and sustenance	Naive solutions affect adaptation and sustenance
Fundamental attribution			Value internal factors or characteristics more than external factors affect the analysis		Value internal factors or characteristics more than external factors affect the analysis	Value internal factors or characteristics more than external factors affect adaptation and sustenance	Value internal factors or characteristics more than external factors affect deployment and sustenance		Value internal factors or characteristics more than external factors affect adaptation and sustenance	Value internal factors or characteristics more than external factors affect suggestion the analysis and implementation	Value internal factors or characteristics more than external factors affect adaptation and sustenance	Value internal factors or characteristics more than external factors affect adaptation and sustenance
Guidance	Seeking guidance from superior / management delays affect the implementation and sustenance	Seeking guidance from superior / management delays affect the implementation and sustenance	Seeking guidance from superior / management delays affect the analysis	Seeking guidance from superior / management delays affect adaptation and sustenance	Seeking guidance from superior / management delays affect the analysis	Seeking guidance from superior / management delays affect adaptation and sustenance	Seeking guidance from superior / management delays affect adaptation and sustenance	Seeking guidance from superior / management delays affect adaptation and sustenance	Seeking guidance from superior / management delays affect adaptation and sustenance	Seeking guidance from superior / management delays affect the decision on suggestions provided	Seeking guidance from superior / management delays affect adaptation and sustenance	Seeking guidance from superior / management delays affect adaptation and sustenance
Immune neglect	being unaware of one ability to adapt to negativity affect implementation and sustenance	being unaware of one ability to adapt to negativity affect implementation and sustenance	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect adaptation and sustenance	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect adaptation and sustenance	being unaware of one ability to adapt to negativity affect adaptation and sustenance	being unaware of one ability to adapt to negativity affect adaptation and sustenance	being unaware of one ability to adapt to negativity affect adaptation and sustenance	being unaware of one ability to adapt to negativity affect the decision on suggestions provided	being unaware of one ability to adapt to negativity affect adaptation and sustenance	being unaware of one ability to adapt to negativity affect adaptation and sustenance
In attentional blindness	Missing obvious or visual information when focusing on a particular task affect implementation and sustenance	Missing obvious or visual information when focusing on a particular task affect implementation and sustenance	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance	Missing obvious or visual information when focusing on a particular task affect the decision on suggestions provided	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance
Long work	long work affect implementation and sustenance	long work affect implementation and sustenance	long work affect the analysis	long work affect adaptation and sustenance	long work affect the analysis	long work affect adaptation and sustenance	long work affect adaptation and sustenance	long work affect adaptation and sustenance	long work affect adaptation and sustenance	long work affect the decision on suggestions provided	long work affect adaptation and sustenance	long work affect adaptation and sustenance
Memory inhibition			Not remembering irrelevant facts aid in the analysis		Not remembering irrelevant facts aid in the analysis					Not remembering irrelevant facts aid in suggestion the analysis and implementation		
Mere-exposure effect			Positively judge based on		Positively judge based on					Positively judge based on		

Bias	5S	Andon	Bottleneck Analysis	Continuous Flow	Gemba	Heijunka	Hoshin Kanri	Jidoka	JIT	Kaizen	Kanban	KPI
			familiarity affects the analysis		familiarity affects the analysis					familiarity affects Suggestion the analysis and decision		
Modality effect	The dependency on the presentation method for clarity in understanding affects implementation and sustenance	The dependency on the presentation method for clarity in understanding affects implementation and sustenance	The dependency on the presentation method for clarity in understanding affects the analysis		The dependency on the presentation method for clarity in understanding affects the analysis and improvement					The dependency on the presentation method for clarity in understanding affects suggestion the analysis and decision		
Organisational Policy			Understanding of policies or legal requirements influences the analysis		Understanding of policies or legal requirements influences the analysis					Understanding of policies or legal requirements influences the analysis and decision		
Patenting								Patenting affects automation and initial developer requires additional investment		Patenting affects the analysis and decision		
Picture superiority effect	Absence of picture or image displays affects sustenance.	Absence of picture or image displays affects sustenance.	Forgetting the essence of documents written purely in words with the absence of picture or image affects the analysis .		Absence of picture or image displays affects the analysis and improvement.					Forgetting the essence of documents written purely in words with the absence of picture or image affects the analysis .		
Priority	Working based on priority or urgent options affects implementation and sustenance	Working based on priority or urgent options affects implementation and sustenance	Working based on priority or urgent options affects the analysis	Working based on priority or urgent options affects adaptation and sustenance	Working based on priority or urgent options affects the analysis	Working based on priority or urgent options affects adaptation and sustenance	Working based on priority or urgent options affects adaptation and sustenance		Working based on priority or urgent options affects adaptation and sustenance	Working based on priority or urgent options affects the decision on suggestions provided	Working based on priority or urgent options affects adaptation and sustenance	Working based on priority or urgent options affects adaptation and sustenance
Recollection			Recollecting information from the past for any situation aids the analysis		Recollecting information from the past for any situation aids the analysis and improvement					Recollecting information from the past for any situation aids the analysis and the decision		
Reverse psychology		Projecting negative factors to a situation creates stress affects performance			Projecting negative factors to a situation affects the analysis and improvement					Projecting negative factors to a situation affects suggestion the analysis and implementation		Projecting negative factors to a situation creates stress affects performance
Self-Integrity or Preserving Moral Integrity	preserving moral integrity in all situations affects	Preserving moral integrity in all situations affects implementation and sustenance	Preserving moral integrity in all situations affects the analysis	Preserving moral integrity in all situations affects adaptation and sustenance	Preserving moral integrity in all situations affects the analysis and improvement	Preserving moral integrity in all situations affects adaptation and sustenance	Preserving moral integrity in all situations affects adaptation and sustenance	Preserving moral integrity in all situations affects adaptation and sustenance	Preserving moral integrity in all situations affects adaptation and sustenance	Preserving moral integrity in all situations affects the decision on	Preserving moral integrity in all situations affects adaptation and sustenance	Preserving moral integrity in all situations affects adaptation and sustenance

Bias	5S	Andon	Bottleneck Analysis	Continuous Flow	Gemba	Heijunka	Hoshin Kanri	Jidoka	JIT	Kaizen	Kanban	KPI
	implementation and sustenance									suggestions provided		
SOP	Miss, deviate or decline action stated in standard operating procedure affects sustenance				Miss, deviate or decline action stated in standard operating procedure affects the analysis and improvement					Miss, deviate or decline action stated in standard operating procedure affects the decision on suggestions provided and its implementation		
Standardisation	Not adopting document format understood by team affects implementation and sustenance				Not adopting document format understood by team affects the analysis and improvement					Not adopting document format understood by team affects the decision on suggestions provided and its implementation		
Status quo	Holding on to the current situation or method affects implementation and sustenance	Holding on to the current situation or method affects implementation and sustenance	Holding on to the current situation or method affects the analysis	Holding on to the current situation or method affects adaptation and sustenance	Holding on to the current situation or method affects the analysis	Holding on to the current situation or method affects adaptation and sustenance	Holding on to the current situation or method affects adaptation and sustenance	Holding on to the current situation or method affects adaptation and sustenance	Holding on to the current situation or method affects adaptation and sustenance	Holding on to the current situation or method affects the decision on suggestions provided	Holding on to the current situation or method affects adaptation and sustenance	Holding on to the current situation or method affects adaptation and sustenance
Stereotype	Following certain beliefs and ways of execution affects implementation and sustenance	Following certain beliefs and ways of execution affects implementation and sustenance	Following certain beliefs and ways of execution affects the analysis	Following certain beliefs and ways of execution affects adaptation and sustenance	Following certain beliefs and ways of execution affects the analysis	Following certain beliefs and ways of execution affects adaptation and sustenance	Following certain beliefs and ways of execution affects adaptation and sustenance	Following certain beliefs and ways of execution affects adaptation and sustenance	Following certain beliefs and ways of execution affects adaptation and sustenance	Following certain beliefs and ways of execution affects the decision on suggestions provided	Following certain beliefs and ways of execution affects adaptation and sustenance	Following certain beliefs and ways of execution affects adaptation and sustenance
Stress	Declining actions based on predicted stress on oneself or the process affects implementation and sustenance	Declining actions based on predicted stress on oneself or the process affects implementation and sustenance	Declining actions based on predicted stress on oneself or the process affects the analysis	Declining actions based on predicted stress on oneself or the process affects adaptation and sustenance	Declining actions based on predicted stress on oneself or the process affects the analysis	Declining actions based on predicted stress on oneself or the process affects adaptation and sustenance	Declining actions based on predicted stress on oneself or the process affects adaptation and sustenance	Declining actions based on predicted stress on oneself or the process affects adaptation and sustenance	Declining actions based on predicted stress on oneself or the process affects adaptation and sustenance	Declining actions based on predicted stress on oneself or the process affects the decision on suggestions provided	Declining actions based on predicted stress on oneself or the process affects adaptation and sustenance	Declining actions based on predicted stress on oneself or the process affects adaptation and sustenance
Subjective validation	Agreeing with a fact or data only if it match personal belief affects implementation and sustenance	Agreeing with a fact or data only if it match personal belief affects implementation and sustenance	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance	Agreeing with a fact or data only if it match personal belief affects the decision on suggestions provided	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance
Survivorship or Survival	Believing in mechanisms that gave success in past and neglecting other options affects implementation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affects implementation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing on mechanisms that gave success in past and neglecting other options affects adaptation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing in mechanisms that gave success in past and neglecting other options affects adaptation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affects adaptation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affects adaptation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affects adaptation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affect the decision on suggestions provided	Believing in mechanisms that gave success in past and neglecting other options affect adaptation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affect adaptation and sustenance

Bias	5S	Andon	Bottleneck Analysis	Continuous Flow	Gemba	Heijunka	Hoshin Kanri	Jidoka	JIT	Kaizen	Kanban	KPI
System-human	Not acknowledging system and /or human influences affect implementation and sustenance	Not acknowledging system and /or human influences affect implementation and sustenance	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect adaptation and sustenance	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect adaptation and sustenance	Not acknowledging system and /or human influences affect adaptation and sustenance	Not acknowledging system and /or human influences affect adaptation and sustenance	Not acknowledging system and /or human influences affect adaptation and sustenance	Not acknowledging system and /or human influences affect the decision on suggestions provided	Not acknowledging system and /or human influences affect adaptation and sustenance	Not acknowledging system and /or human influences affect adaptation and sustenance
System-wide approach	Discount or not considering all stakeholders in the system affect implementation and sustenance	Discount or not considering all stakeholders in the system affect implementation and sustenance	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect adaptation and sustenance	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect adaptation and sustenance	Discount or not considering all stakeholders in the system affect adaptation and sustenance	Discount or not considering all stakeholders in the system affect adaptation and sustenance	Discount or not considering all stakeholders in the system affect adaptation and sustenance	Discount or not considering all stakeholders in the system affect the decision on suggestions provided	Discount or not considering all stakeholders in the system affect adaptation and sustenance	Discount or not considering all stakeholders in the system affect adaptation and sustenance
Tip of the tongue			Failing to recollect familiar words, events, or situation affects the analysis		Failing to recollect familiar words, events, or situation affects the analysis and improvement					Failing to recollect familiar words, events, or situation affects the decision on suggestions provided		
Underreporting	Underreporting situations or facts affects implementation and sustenance	Underreporting situations or facts affects implementation and sustenance	Underreporting situations or facts affects the analysis	Underreporting situations or facts affects adaptation and sustenance	Underreporting situations or facts affects the analysis	Underreporting situations or facts affects adaptation and sustenance	Underreporting situations or facts affects adaptation and sustenance	Underreporting situations or facts affects adaptation and sustenance	Underreporting situations or facts affects adaptation and sustenance	Underreporting situations or facts affects the decision on suggestions provided	Underreporting situations or facts affects adaptation and sustenance	Underreporting situations or facts affects adaptation and sustenance
Zero defect	Insisting on zero defects affects implementation and sustenance	Insisting on zero defects affects implementation and sustenance	Insisting on zero defects affects the analysis	Insisting on zero defects affects adaptation and sustenance	Insisting on zero defects affects the analysis	Insisting on zero defects affects adaptation and sustenance	Insisting on zero defects affects adaptation and sustenance	Insisting on zero defects affects adaptation and sustenance	Insisting on zero defects affects adaptation and sustenance	Insisting on zero defects affects the decision on suggestions provided	Insisting on zero defects affects adaptation and sustenance	Insisting on zero defects affects adaptation and sustenance
Zero-risk	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects implementation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects implementation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects adaptation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects adaptation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects adaptation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects adaptation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects adaptation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects the decision on suggestions provided	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects adaptation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affects adaptation and sustenance

Bias	Muda	OEE	PDCA	Poka-Yoke	RCA	SMED	Six Big Losses	SMART Goals	Standardised Work	Takt Time	TPM	Value Stream Mapping	Visual Factory
Absent-mindedness			Forgetting situations, or facts leads to errors in the PDCA cycle		Forgetting facts affect the analysis			Forgetting facts affect goals and deployment	Forgetting facts affect standard operating procedures.				
Anchoring and adjustment			Relating facts to a prominent person's view and later adjust to it while talking decisions leads to errors in the PDCA cycle		Relating facts to a prominent person's view and later adjust to it while talking decisions affects the analysis			Relating facts to a prominent person's view and later adjust to it while talking decisions affects goals and deployment	Relating facts to a prominent person's view and later adjust to it while talking decisions affects standard operating procedures.				
Automation	Heavily relied on IT information and ignore differing facts			Heavily relied on automation, not working on other alternatives.	Heavily relied on IT information and ignore differing facts				Procedures adopted based on IT information and ignore differing facts				
Automation omission	Miss information, defects, data, and facts when not prompted by automation.			Does not deduct defects when not prompted by automation.	Miss information, defects, data, and facts when not prompted by automation.				Miss information, defects, data, and facts when not prompted by automation.				
Bandwagon effect	The tendency to follow methods of previous success blocks new practices	The tendency to follow methods of previous success blocks the analysis and new practices	The tendency to follow methods of previous success blocks the analysis	The tendency to follow methods of previous success stops innovation	The tendency to follow methods of previous success blocks the analysis	The tendency to follow methods of previous success blocks the analysis and new practices	The tendency to follow methods of previous success blocks the analysis and new practices	The tendency to follow methods of previous success blocks improvement.	The tendency to follow methods of previous success blocks new policy deployment	The tendency to follow methods of previous success blocks the analysis	The tendency to follow methods of previous success blocks the analysis and new practices	The tendency to follow methods of previous success blocks the analysis	The tendency to follow methods of previous success stops innovation
Belief	People do not analyse until problem match their belief	People do not analyse until need match their belief	People do not analyse until problem match their belief	People do not act until their belief prompts Poka-yoke	People do not analyse until problem match their belief	People do not analyse until need match their belief	People do not analyse until need match their belief	Not accept the policy that does not match their belief delay's implementation	Not accept the method, solution, procedure or process that does not match their belief delay's implementation and improvement	People do not act and implement until need match their belief	People do not adopt TPM until need match their belief	People do not analyse until need for VSM match their belief	Not accept the method, solution, procedure or process that does not match their belief delay's implementation and improvement
Bounded awareness	Failing to notice the crucial information affected the analysis	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected implementation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information affected the analysis	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affected adaptation and sustenance	Failing to notice the crucial information, options, roles, and parties involved affects adaptation and sustenance
Chain reaction	Failing to consider the crucial reaction	Failing to consider the crucial reaction	Failing to consider the crucial reaction		Failing to consider the crucial reaction	Failing to consider the crucial reaction	Failing to consider the crucial reaction	Failing to consider the crucial reaction		Failing to consider the crucial reaction	Failing to consider the crucial reaction		Failing to consider the crucial reaction

Bias	Muda	OEE	PDCA	Poka-Yoke	RCA	SMED	Six Big Losses	SMART Goals	Standardised Work	Takt Time	TPM	Value Stream Mapping	Visual Factory
	affect the analysis	affect sustenance and improvement	affect the analysis		affect the analysis	affect sustenance and improvement	affect sustenance and improvement	affect sustenance		affect the analysis	affect sustenance and improvement		affect sustenance
Congruence			Rely on direct data affects the analysis		Rely on direct data affects the analysis			Rely on direct data affects fixing goals, derived data on special conditions help in fixing goals					
Context-dependent cues			Not recollecting without nurtured with past examples or situation affect the analysis		Not recollecting without nurtured with past examples or situation affect the analysis								
convenience	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the analysis	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the analysis	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the analysis	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the analysis	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the analysis	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect adaptation and sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the analysis	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect sustenance	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect the analysis	Miss or decline actions based on convenience of interpretation of instructions, policies, or procedures affect sustenance
Critical Response	Miss or avoid critical responses with all stakeholders affect the analysis	Miss or avoid critical responses with all stakeholders affect the analysis	Miss or avoid critical responses with all stakeholders affect the analysis and sustenance	Miss or avoid critical responses with all stakeholders affect adaptation and sustenance	Miss or avoid critical responses with all stakeholders affect the analysis	Miss or avoid critical responses with all stakeholders affect sustenance	Miss or avoid critical responses with all stakeholders affect the analysis	Miss or avoid critical responses with all stakeholders affect adaptation and sustenance	Miss or avoid critical responses with all stakeholders affect sustenance	Miss or avoid critical responses with all stakeholders affect the analysis	Miss or avoid critical responses with all stakeholders affect sustenance	Miss or avoid critical responses with all stakeholders affect the analysis	Miss or avoid critical responses with all stakeholders affect sustenance
Cue-dependent forgetting			Not recollecting without nurtured with past examples or situation affect the analysis		Not recollecting without nurtured with past examples or situation affect the analysis								
Digital amnesia			Not remember information that is readily available in digital mode affect the analysis and subsequent discussions		Not remember information that is readily available in digital mode affect the analysis and subsequent discussions								
Escalation of commitment	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids implementation and sustenance	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids implementation and sustenance	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids deployment and sustenance	Extra committed when the outcome is negative aids sustenance	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids implementation and sustenance	Extra committed when the outcome is negative aids the analysis	Extra committed when the outcome is negative aids implementation and sustenance

Bias	Muda	OEE	PDCA	Poka-Yoke	RCA	SMED	Six Big Losses	SMART Goals	Standardised Work	Takt Time	TPM	Value Stream Mapping	Visual Factory
Fear of Job loss	Fear of job loss affect the analysis	Fear of job loss affect the analysis	Fear of job loss affect the analysis	Fear of job loss affect adaptation and sustenance	Fear of job loss affect the analysis	Fear of job loss affect sustenance	Fear of job loss affect the analysis	Fear of job loss affect adaptation and sustenance	Fear of job loss affect sustenance	Fear of job loss affect the analysis	Fear of job loss affect sustenance	Fear of job loss affect the analysis	Fear of job loss affect adaptation and sustenance
Fix it Fallacy	Naive solutions affect the analysis	Naive solutions affect the analysis	Naive solutions affect the analysis	Naive solutions affect adaptation and sustenance	Naive solutions affect the analysis	Naive solutions affect sustenance	Naive solutions affect the analysis	Naive solutions affect adaptation and sustenance	Naive solutions affect sustenance	Naive solutions affect the analysis	Naive solutions affect sustenance	Naive solutions affect the analysis	Naive solutions affect adaptation and sustenance
Fundamental attribution	Value internal factors or characteristics more than external factors affect the analysis		Value internal factors or characteristics more than external factors affect the analysis		Value internal factors or characteristics more than external factors affect the analysis			Value internal factors or characteristics more than external factors affect deployment and sustenance				Value internal factors or characteristics more than external factors affect the analysis	
Guidance	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis	Seeking guidance from superior / management affect / delays the analysis
Immune neglect	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect adaptation and sustenance	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect sustenance	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect adaptation and sustenance	being unaware of one ability to adapt to negativity affect sustenance	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect sustenance	being unaware of one ability to adapt to negativity affect the analysis	being unaware of one ability to adapt to negativity affect adaptation and sustenance
In attentional blindness	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect sustenance	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance	Missing obvious or visual information when focusing on a particular task affect sustenance	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect sustenance	Missing obvious or visual information when focusing on a particular task affect the analysis	Missing obvious or visual information when focusing on a particular task affect adaptation and sustenance
Long work	long work affect the analysis	long work affect the analysis	long work affect the analysis	long work affect adaptation and sustenance	long work affect the analysis	long work affect sustenance	long work affect the analysis	long work affect adaptation and sustenance	long work affect sustenance	long work affect the analysis	long work affect sustenance	long work affect the analysis	long work affect adaptation and sustenance
Memory inhibition			Not remembering irrelevant facts aid in the analysis		Not remembering irrelevant facts aid in the analysis								
Mere-exposure effect			Positively judge based on familiarity affect Suggestion the analysis and decision		Positively judge based on familiarity affect Suggestion the analysis and decision				Positively judge based on familiarity affect sustenance and improvements				
Modality effect			The dependency on the presentation method for clarity in		The dependency on the presentation method for clarity in				The dependency on the presentation method for clarity in				-

Bias	Muda	OEE	PDCA	Poka-Yoke	RCA	SMED	Six Big Losses	SMART Goals	Standardised Work	Takt Time	TPM	Value Stream Mapping	Visual Factory
			understanding affect the analysis		understanding affect the analysis				understanding affect sustenance				
Organisational Policy			Understanding of policies or legal requirements influences the analysis		Understanding of policies or legal requirements influences the analysis				Understanding of policies or legal requirements influences SOP				
Patenting			Patenting affect the analysis and implementation										
Picture superiority effect			Forgetting the essence of documents written purely in words with the absence of picture or image affect the analysis.		Forgetting the essence of documents written purely in words with the absence of picture or image affect the analysis.				The absence of picture or image displays affect sustenance.				The absence of picture or image displays affect sustenance.
Priority	Working based on priority or urgent options affect the analysis	Working based on priority or urgent options affect the analysis	Working based on priority or urgent options affect the analysis	Working based on priority or urgent options affect adaptation and sustenance	Working based on priority or urgent options affect the analysis	Working based on priority or urgent options affect sustenance	Working based on priority or urgent options affect the analysis	Working based on priority or urgent options affect adaptation and sustenance	Working based on priority or urgent options affect sustenance	Working based on priority or urgent options affect the analysis	Working based on priority or urgent options affect sustenance	Working based on priority or urgent options affect the analysis	Working based on priority or urgent options affect adaptation and sustenance
Recollection			Recollecting information from the past for any situation aids the analysis		Recollecting information from the past for any situation aids the analysis								
Reverse psychology								Projecting negative factors to a situation creates stress affect goal setting					
Self-Integrity or Preserving Moral Integrity	Preserving moral integrity in all situations affect the analysis	Preserving moral integrity in all situations affect the analysis	Preserving moral integrity in all situations affect the analysis	Preserving moral integrity in all situations affect adaptation and sustenance	Preserving moral integrity in all situations affect the analysis	Preserving moral integrity in all situations affect sustenance	Preserving moral integrity in all situations affect the analysis	Preserving moral integrity in all situations affect adaptation and sustenance	Preserving moral integrity in all situations affect sustenance	Preserving moral integrity in all situations affect the analysis	Preserving moral integrity in all situations affect sustenance	Preserving moral integrity in all situations affect the analysis	Preserving moral integrity in all situations affect adaptation and sustenance
SOP									Not adopting document format understood by team affect sustenance				
Standardisation									Miss, deviate or decline action stated in standard operating				

Bias	**Muda**	**OEE**	**PDCA**	**Poka-Yoke**	**RCA**	**SMED**	**Six Big Losses**	**SMART Goals**	**Standardised Work**	**Takt Time**	**TPM**	**Value Stream Mapping**	**Visual Factory**
									procedure affect sustenance				
Status quo	Holding on to the current situation or method affect the analysis	Holding on to the current situation or method affect the analysis	Holding on to the current situation or method affect the analysis	Holding on to the current situation or method affect adaptation and sustenance	Holding on to the current situation or method affect the analysis	Holding on to the current situation or method affect sustenance	Holding on to the current situation or method affect the analysis	Holding on to the current situation or method affect adaptation and sustenance	Holding on to the current situation or method affect sustenance	Holding on to the current situation or method affect the analysis	Holding on to the current situation or method affect sustenance	Holding on to the current situation or method affect the analysis	Holding on to the current situation or method affect adaptation and sustenance
Stereotype	Following certain beliefs and ways of execution affect the analysis	Following certain beliefs and ways of execution affect the analysis	Following certain beliefs and ways of execution affect the analysis	Following certain beliefs and ways of execution affect adaptation and sustenance	Following certain beliefs and ways of execution affect the analysis	Following certain beliefs and ways of execution affect sustenance	Following certain beliefs and ways of execution affect the analysis	Following certain beliefs and ways of execution affect adaptation and sustenance	Following certain beliefs and ways of execution affect sustenance	Following certain beliefs and ways of execution affect the analysis	Following certain beliefs and ways of execution affect sustenance	Following certain beliefs and ways of execution affect the analysis	Following certain beliefs and ways of execution affect adaptation and sustenance
Stress	Declining actions based on predicted stress on oneself or the process affect the analysis	Declining actions based on predicted stress on oneself or the process affect the analysis	Declining actions based on predicted stress on oneself or the process affect the analysis	Declining actions based on predicted stress on oneself or the process affect adaptation and sustenance	Declining actions based on predicted stress on oneself or the process affect the analysis	Declining actions based on predicted stress on oneself or the process affect sustenance	Declining actions based on predicted stress on oneself or the process affect the analysis	Declining actions based on predicted stress on oneself or the process affect adaptation and sustenance	Declining actions based on predicted stress on oneself or the process affect sustenance	Declining actions based on predicted stress on oneself or the process affect the analysis	Declining actions based on predicted stress on oneself or the process affect sustenance	Declining actions based on predicted stress on oneself or the process affect the analysis	Declining actions based on predicted stress on oneself or the process affect adaptation and sustenance
Subjective validation	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects sustenance	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance	Agreeing with a fact or data only if it match personal belief affects sustenance	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects sustenance	Agreeing with a fact or data only if it match personal belief affects the analysis	Agreeing with a fact or data only if it match personal belief affects adaptation and sustenance
Survivorship or Survival	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing on mechanisms that gave success in past and neglecting other options affects adaptation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing in mechanisms that gave success in past and neglecting other options affects sustenance	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing in mechanisms that gave success in past and neglecting other options affects adaptation and sustenance	Believing in mechanisms that gave success in past and neglecting other options affects sustenance	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing in mechanisms that gave success in past and neglecting other options affects sustenance	Believing in mechanisms that gave success in past and neglecting other options affects the analysis	Believing in mechanisms that gave success in past and neglecting other options affects adaptation and sustenance
System- human	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect adaptation and sustenance	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect sustenance	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect adaptation and sustenance	Not acknowledging system and /or human influences affect sustenance	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect sustenance	Not acknowledging system and /or human influences affect the analysis	Not acknowledging system and /or human influences affect adaptation and sustenance
System-wide approach	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect adaptation and sustenance	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect sustenance	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect adaptation and sustenance	Discount or not considering all stakeholders in the system affect sustenance	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect sustenance	Discount or not considering all stakeholders in the system affect the analysis	Discount or not considering all stakeholders in the system affect adaptation and sustenance
Tip of the tongue			Failing to recollect familiar words, events,		Failing to recollect familiar words, events,								

Bias	Muda	OEE	PDCA	Poka-Yoke	RCA	SMED	Six Big Losses	SMART Goals	Standardised Work	Takt Time	TPM	Value Stream Mapping	Visual Factory
			or situation affect the analysis		or situation affect the analysis								
Underreporting	Underreporting situations or facts affect the analysis	Underreporting situations or facts affect the analysis	Underreporting situations or facts affect the analysis	Underreporting situations or facts affect adaptation and sustenance	Underreporting situations or facts affect the analysis	Underreporting situations or facts affect sustenance	Underreporting situations or facts affect the analysis	Underreporting situations or facts affect adaptation and sustenance	Underreporting situations or facts affect sustenance	Underreporting situations or facts affect the analysis	Underreporting situations or facts affect sustenance	Underreporting situations or facts affect the analysis	Underreporting situations or facts affect adaptation and sustenance
Zero defect	Insisting on zero defects affect the analysis	Insisting on zero defects affect the analysis	Insisting on zero defects affect the analysis	Insisting on zero defects affect adaptation and sustenance	Insisting on zero defects affect the analysis	Insisting on zero defects affect sustenance	Insisting on zero defects affect the analysis	Insisting on zero defects affect adaptation and sustenance	Insisting on zero defects affect sustenance	Insisting on zero defects affect the analysis	Insisting on zero defects affect sustenance	Insisting on zero defects affect the analysis	Insisting on zero defects affect adaptation and sustenance
Zero-risk	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect adaptation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect adaptation and sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect sustenance	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect the analysis	Avoiding complete risk or preferring for reducing a small risk to zero over a greater reduction in a larger risk affect adaptation and sustenance

Appendix 4: Waste table and Lean tools and waste interaction examples

Waste	Description	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
Manufacturing waste	Waste generated by the manufacturing activities	Manufacturing	Process waste	Over-production, over-processing, transport, waiting, inventory, motion, and Defects.
Environment waste	Unnecessary or excess utilisation of resources or the material constituent disposed to air, water, or land that could harm the environment	Environment	Spills and discharges	Unnecessary or excess utilisation of resources or the material constituent disposed to air, water, or land.
Information technology waste	Deficiencies due to the information technology related activity	Information technology	Software and hard ware deficiencies	Wrong coding, inappropriate code, program delay, time lag between activities and processing, unnecessary series of IT applications navigated to complete repetitive tasks, lack of standard design in programs or more than requested data provided, data processing backlog, unwanted data storage like temporary files, unnecessary series of IT applications navigated by individuals to find files and documents, inadequate training and documentation, security threats, hardware defects, software bugs, connectivity defects, and inadequate or irrelevant licences for operating the systems.
Decision-making individual waste	The inadequacies caused by delayed, lack of and/or wrong decisions in individual decision-making	Decision-making individual	Decision making	Delayed, lack of and/or wrong decisions.
Department or function waste	Deficiencies due to department or function's activity	Department or function	Follow procedures and policy	Adopting boundaries, procedures, policies, and hierarchies.
Decision-making cross-functional team waste	Waste generated by the teams' delay, lack of decisions, or wrong decisions	Decision-making cross-functional team	Cross functional activity	Delay, lack of decisions, or wrong decisions.
Human resources waste	Deficiencies due to human resources department functional activity where talent is underutilised, wrong training being imparted, absenteeism, and overstaffing	Human resources	Human resources activity	Underutilised, wrong training being imparted, absenteeism, and overstaffing.
Enterprise engagement waste	Deficiencies by external experts,	Enterprise engagement	Engagement of consultant,	Delay, usefulness, or wrong decisions.

Waste	Description	Primary code	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.
	consultants, and auditors		auditors and certifiers	
Stress waste	Deficiencies due to stress in an organisation	Stress	Stressors	Stress break down, attrition, absentees, defects, fatigue, downtime, delay, lack or wrong decisions, pressure, strain, mentally tired, and overload.
Methods waste	Waste generated due to the method of performing an activity	Methods	Methods	Design related waste, experiment waste, and over staffing.

Lean waste interaction examples

5 S and Manufacturing waste: Alfa did not maintain 5S that affected movement, in Beta people were searching material (waiting) and issued wrong material (defect). Gamma had excess inventory because the identification of parts was difficult. Delta, Epsilon, zeta, and Eta had implemented 5S, and operations were streamlined. This implied that 5S implementation reduces defects, movement, waiting, and inventory.

Bottleneck analysis and Manufacturing waste: In all case studies, it was noted that customer complaints were analysed that reduced defects and waiting. The suggested processes proposed addressing the bottlenecks in process steps that reduced transportation in Epsilon defects and inventory in Beta, over processing in Epsilon and Delta. This implied that bottle neck analysis implementation reduce manufacturing related waste.

Continuous Flow and Stress waste: The flow in Eta was continuous. However, staff stress level increased as the process was set to achieve maximum efficiency. Eta also reported attrition and absenteeism in continuous flow lines, which implied continuous flow implementation increase stress related waste.

Gemba and Environmental waste: Gemba was practiced in all case studies for customer complaints that reduced defects. The suggested process in case studies was based on Gemba which could reduce defects (Beta), transportation (Epsilon and Zeta), movement (Alfa), waiting (Epsilon and Zeta), and over processing (Eta) of environment related waste. This implied that Gemba implementation reduces environmental related waste.

Heijunka and Decision making individual waste: Delta and Zeta staff aligned to achieve levelled scheduling that reduced delay in decision making. This implied that Heijunka implementation reduces individual decision-making related waste.

Hoshin Kanri and Manufacturing waste: Except Alfa all studies had policies for customer commitment and defect levels that guided the process to align to reduce all types of waste. This implied that Hoshin Kanri implementation reduces manufacturing related waste.

Jidoka vs IT Waste: The suggested process of Beta, Gamma, Delta, Epsilon and Zeta the automation of data could reduce data entry, which reduces over processing and unnecessary navigation related IT defect. This implied that Jidoka implementation reduces IT waste.

Just-In-Time and Environmental Waste: In Delta and Zeta, the JIT supplies to stores based on customer order, had no customer returns for excess supply. In Beta, the suggested process proposed van stock replacement based on JIT, which could reduce stock outs related to vehicle movement. This implied that JIT implementation reduce vehicle related environmental waste.

Kaizen and Human resources waste: Suggested process in case studies aid to reduce stressors. In the case of Delta and Zeta, the suggested process discusses reduction of people stress and physical strain that would reduce attrition and absenteeism. This implied that Kaizen implementation reduces vehicle related environmental waste.

Kanban and Decision making individual waste: Beta suggested process proposed two bin based electronic Kanban that eliminated internal requesting and would eliminate delay by the internal requestor. This implied that Kanban implementation reduces decision making individual waste.

KPI and Department or function waste: 17 out of 17 management staff were focused on the outcome that implies KPI drives departments they head take conservative stand that induces waste. This implied that KPI increase department and function waste.

Muda and IT waste: 89 participants reported IT waste, and Muda capturing was partial. This implied that effective Muda could reduce IT waste.

OEE and Manufacturing waste: Observed that OEE focus at Beta, Gamma and Delta aided no waiting for want of equipment (forklifts, van, and pallet trucks). This implied that effective OEE could reduce manufacturing waste.

PDCA and IT waste: Delta participants reported that voice recognition IT system C7 implementation by the project team that used PDCA methodology was satisfactory. This implied that effective PDCA could reduce IT waste.

Poka-Yoke and Stress waste: Delta and Zeta implemented Poka-Yoke for safety that aided in reducing accidents. This implied that effective Poka-Yoke could reduce accident related stress waste.

RCA and Manufacturing waste: In all case studies, RCA for customer complaint evidenced. However, internal issues RCA analysis not evidenced and 99 participants reported manufacturing waste. This implied that effective RCA for internal issues could reduce manufacturing waste.

Single-Minute Exchange of Dies (SMED) and Stress Waste: Observed that SMED focus at Eta in the production line for change of fruit had constant pressure and stress for people. Eta also reported attrition and absenteeism in continuous flow lines. This implied that effective SMED could increase stress related waste.

Six Big Losses and Manufacturing waste: Not implemented by any organisation. However, five processes required capturing. Literature suggests capturing will aid reduce defects.

Smart goals and Department or function waste: In all case studies, Smart goals at the department or function level not systematically passed to individuals and 69 participants reported department and function waste. Effective Smart goals could reveal and reduce department and function waste.

Standardised Work and Manufacturing waste: Delta and Zeta standardised work reduced waiting and movement. Eta standardised work reduced defects in manual screening segregation. This implied that effective Standardised reduce manufacturing waste.

Takt Time and Manufacturing waste, Total Productive Maintenance (TPM) and Manufacturing waste, and VSM and Manufacturing waste: Not implemented by any organisation. Literature suggests capturing will aid reduce defects.

Visual Factory and Manufacturing waste: Alfa had no Andon, Beta and Gamma had partially implemented policy and health and safety data online, and their safety procedure adherence was evidenced. People productivity focused displays in case of Delta, Epsilon and Zeta, which focused on productivity that reduced defects, and waiting. Eta had implemented line stoppage for errors and emergencies reducing defects. This implied that Andon implementation reduces manufacturing waste.

Appendix 5: Examples, quotes and remarks

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
1	Absent-mindedness	The tendency to forget events, situations, or facts	Recollect	Forgot, fail to recall, be unable to remember, erase from the mind, overlooked, not remember, and not recalled	Participants were judged based on their reply in interview and whether they forget events or actions during observation	
2	Anchoring and adjustment	The tendency to relate facts to a prominent person's view, prominent situation, or first information and later adjust to it while talking decisions.	Influence	Relevantly relate to superior, well-known, important, high-up, or top person views.	Yeah well in this company I've got a pretty good working relationship with my two bosses. I feel very very approachable. The way in which they asked me to do things is the correct way I believe they are very respective.	2.2
3	Automation	The tendency to rely on automation and ignore differing facts presented without automation.	Preference	Automation, computerisation, robotics or mechanisation focus for process step though other options are available	For invoicing or costing. The costs are calculated is my job and I have to look at the products in the bill of the material…. Not updated in the BOM…. It's the standard operating procedure starting from where who has to check who has to probably TC's can check and pass it to you and estimate and go to them. Note: Observation revealed that BOM was in IT system and anything that is not projected by IT system was ignored. I just work for the company just like, to help all the company and staff to feed our families and I just like working with this company because everything here is computerised	3.1
4	Automation omission	The tendency to miss information, events, data, facts when not prompted by automation.	Omit	Miss, neglect, forget, overlook, ignore, skip, exclude, or leave out data and facts when not prompted/ notified by automation, computerisation, robotics or mechanisation.		5.8

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
5	Bounded awareness	The tendency of failing to notice the crucial information, options, roles, and parties involved.	Omit	Missing crucial information, options, roles, and parties involved.		
6	Bandwagon effect	The tendency to believe in data, facts, or situations to align themselves to majority people belief in a particular way and follow them, irrespective of their own beliefs or the tendency to follow methods of previous success irrespective of their own beliefs.	Believe	Believe and follow the way that others believe as successful, fruitful, positive, effective, profitable, or productive	Refer to the example given below the table.	
7	Belief	The tendency to accept the method, solution, procedure or process that match their belief.	Belief	Accept the method, solution, procedure or process when belief/ faith match.	Refer to the example given below the table.	
8	Chain reaction	The tendency of being unaware or unresponsive to the people reaction happening in the process chain	Reaction	Consider reactions of all stake holders	Participants were judged based on their reply in the interview and whether they consider reactions of all stake holders.	
9	Congruence	The tendency to rely on direct data and fact rather than derived data or the tendency to adopt direct hypotheses test instead of possible alternative hypotheses tests.	Belief	Relying on direct data, information, facts, records or statistics.	Participants were judged based on their reply in the interview for technology dependence and whether they work based on automated reports.	

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
10	Context-dependent cues	The tendency to recollect in any situation after nurtured with past examples or situation.	Recollect	Recollect after giving examples	Participants were judged based on their reply in interview short discussions during process observations on implemented suggestions in process and whether they asked questions based on the same.	
11	Cue-dependent forgetting	The tendency to recollect after served with past examples or situation.				
12	Convenience	The tendency to miss or decline actions based on convenience of interpretation of instructions, policies, or procedures	Decline	Decline based on convenience	There are standard operating time. Not at all. See for eg, this one you can see, sorting and movement 7 ½ hours, it never ever works like that. Its always different. Because its not a machine, its human working here. Sometimes they are in bad mood, sometimes they are in good mood. Sometimes they have argument with me. Like just I scold my supervisor. You are supervisor but you are late. It is not good this is 4th time I am seeing him he is late. He should be here before my staff. I have never been later, never ever. He was late so not tonight after you, he come and asked me how I can say. So this will happen	5.9
13	Critical response	The tendency to miss or avoid critical responses with all stakeholders	Response	Consider response of al stake holders	Participants were judged based on their reply in interview and whether they consider response of all stake holders.	
14	Digital amnesia	The tendency to not remember information that is readily available in digital mode.	Recollect	Not remember information, data, statistics, facts, figures, or report when available digitally.	I just work for the company just like, to help all the company and staff to feed our families and I just like working with this company because everything here is computerised Participants were judged based on their working method that depended on digital technology and during short discussion during process// participant observation.	5.8
15	Escalation of commitment	The tendency to be more committed when the outcome is negative.	Committed	Working intensely, vigorously, rigorously, relentlessly or fast when results are negative.	And another important thing would be the KPI. You know how important to see a KPI?.... To me it's very important. Yeah and you asking us to make. Yes it's important because without a target we we don't know what we need to achieve….Yes we will review where the gaffer's and try and work out how we can cause that get to achieve that.	7.18

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
					. If I don’t meet my KPI that affects other colleagues. So they have to it doesn’t have to their KPI, whole connected together. If I don’t meet mine it affect theirs. That’s why I make sure that I try to meet my KPI. Then it was a good look for me as well to grow. If I don’t perform then I’ll leave my own. Low in the business that’s like no performing. Yeah, I do. I feel that I won’t meet anything I suppose to do. So I’ll try to find why so. Today I say something to see my manager how I can achieve my KPI’s. In addition participants were judged based on their commitment during the emergencies, surge in requirement and peak season	6.1
16	Fear of job loss	The tendency to fear job loss.	Fear	Fear to loose job	Not and I've been here for seven years. And that fear is absolutely not. Yes. I don't think people fear losing their jobs. Some people have lost their jobs for non-performance. I don't think there's a general fear of losing your job. But it does happen. I can guarantee you, in supermarkets, in retail industry, when there is a new technology coming, the first thing that strikes in an employee’s mind is they are going to cut my way of hours now, they are trying to exhaust service. Because everyone wants to make it easy for the team and customers. No job fear for them ye.. In addition participants shot conversations like “I will lose my job man “were noted…	7.18 5.6 6.9

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
17	Fix it Fallacy	The tendency to hurriedly solve the problem with naive solutions.	Resolve	Quickly solve problem/ issues	Yes. sometimes they change happen sometimes it can happen. But if there is no change yes they continue with that process but if there is a change and then we have to change accordingly if whatever they change. Participant observation also revealed people deviate from SOP and hurriedly solve the problem	7.9
18	Fundamental attribution	The tendency to value internal factors or characteristics more than external factors.	Valuate	Estimating internal factors more than external.	Judged based on the comment made for usefulness of external agencies. And you'll also get external agencies coming and auditing you giving traditions or consulting. I do find them renewed expedient of 29 years. You do find them in day out. They give you not more valuable solutions than the time you spend on them. Yeah not physically break Yeah. No walking. No one can give a suggestion from outside of D.C. mean I'll be very surprised. Surprise	6.5.1 6.3
19	Guidance	The tendency to seek guidance from management, people, or consultants in ambiguous situations.	Guidance	Seeking guidance or approval from superiors or management	If somebody is coming up with a good idea to me I will bring the managers meetings and they've talk with the whole team. If it's a good idea they make approval and then everybody know this is a safe. That's why we have a meeting.	7.6
20	Immune neglect	The tendency of being unaware of one ability to adapt to negativity.	Ability	Ability to adopt negativity or negative situation	. If I don't perform then I'll leave my own. Low in the business that's like no performing. Yeah, I do. I feel that I won't meet anything I suppose to do. So I'll try to find why so. Today I say something to see my manager how I can achieve my KPI's. Right. I suppose if you don't achieve your KPI will you become more committed to it.Yes definitely. Like I just find it	6.5

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
					out there like I was meeting like say my I was a 150 Cartons an hour. Are always trying to do 140 if I knew how to do 140 150 if he saw me trying to do better. In addition participants were judged based on their working commitment during the emergencies, surge in requirement and peak season	6.3
21	In attentional blindness	The tendency to miss obvious or visual information when focusing on a particular task.	Omit	Missing visual information.	For invoicing or costing. The costs are calculated is my job and I have to look at the products in the bill of the material…. Not updated in the BOM…. It’s the standard operating procedure starting from where who has to check who has to probably TC’s can check and pass it to you and estimate and go to them. Note: Observation revealed that BOM was in IT system and anything that is not projected by IT system was ignored. People working were physically obtaining material for errors in BOM from stores. Participants were judged based on the suggestions they gave based on the visual abnormalities to improve the process.	3.1
22	Long work	The tendency to work long hours for productivity, quality, earnings, promotions and job security.	Belief	Working long hours.	So the reactive guys as explained we don’t run a 24/7 stores. So the technical coordinators are responsible for packing any of the stocks for the old guys watch the store opening times as well to try and assess the freshness as well These are the two improvements which we did and we saw tremendous increase in productivity also commitment from the people when you saw yesterday and there is a job which has to be delivered by 10’o clock now the 9:45. I got to deliver now. You know they want it by 10’o clock. The job came around 3:45, 5’o clock, then you want to finish it , the Gelatine operator and the di cutting person, You saw what he said to	4.7 1.1

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
					me that I deliver by tomorrow morning by 9'o clock. So I will stay late and finish the job and go In addition participants were judged based on their working commitment during the emergencies, surge in requirement and peak season	
23	Memory inhibition	The tendency of not remembering irrelevant facts or situation	Recollect	Not remembering irrelevant facts.	Participants were judged based on their reply in interview and whether they answer irrelevantly actions during observation	
24	Mere-exposure effect	The tendency to positively judge based on familiarity.	Relate	Familiar things positive	I wouldn't say you've the good honest people they've make your team. We don't have a problem with them we have those you know we talk about the safety there as an excuse. Because we provide safety and everything else we accept it. They would have a thought that safety is not important over. It's the hard one here. We pride on safety with everything around here. If we catch anybody talking about safety not taking safety seriously we have seen lot of reactions from people.	6.9
25	Modality effect	The tendency to understand clearly based on the presentation method	Presentation	Understand based on presentation method.	Participants were judged based on their reply in interview, short discussions and displays in organisation. In addition Participant observation during process verses safety procedures adherence which was displayed was correlated.	
26	Organisational policy	The tendency to incline or decline based on the understanding of policies or legal requirements	Policy	Incline/decline based on policies	We don't have a problem with them we have those you know we talk about the safety there as an excuse.	6.9
27	Patenting	The tendency to believe that patents are unnecessary to gain returns.	Patent	Focus on exclusive technology that need to be patented for future business.	Interview and short discussion records were screened for any mention on technology/ new process/ new suggestions and talk on patent.	
28	Picture superiority effect	The tendency to remember pictures or images better than words.	Recollect	Remember pictures/images better than words	. We don't have a problem with them we have those you know we talk about the safety there as an excuse. Because we provide safety and everything else we accept it.	6.9

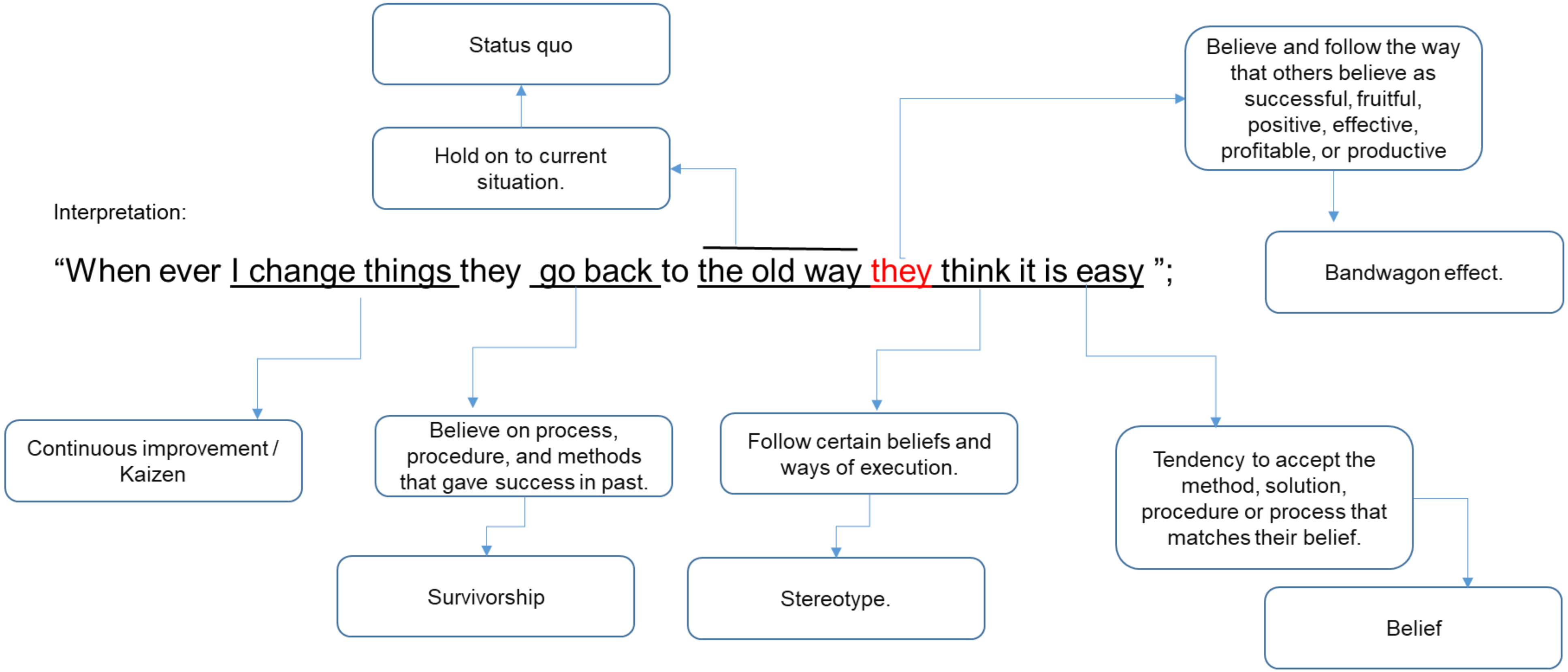
Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
					Participants were judged based on their reply in interview, short discussions and displays in organisation. In addition Participant observation during process verses safety procedures adherence which was displayed was correlated.	
29	Priority	The tendency to work based on priority, favour one of the response options, or perceived urgent options.	Preference	Working based on priority, not on first in first out or a set pattern.	These are the two improvements which we did and we saw tremendous increase in productivity also commitment from the people when you saw yesterday and there is a job which has to be delivered by 10'o clock now the 9:45. I got to deliver now. You know they want it by 10'o clock. The job came around 3:45, 5'o clock, then you want to finish it , the Gelatine operator and the di cutting person, You saw what he said to me that I deliver by tomorrow morning by 9'o clock. So I will stay late and finish the job and go Participants were judged based on their working in emergencies.	1.1
30	Recollection	The tendency to recollect information from the past for any situation.	Recollect	Recollect information from the past for any situation	Participants were judged based on their reply in interview and short discussions during process observations on implemented suggestions they gave previously in the process and whether they asked questions based on the same.	
31	Reverse psychology	The tendency to project negative factors to a situation to obtain desired results.	Projecting	Projecting or focused stating of negative factors	If I don't meet my KPI that affects other colleagues. So they have to it doesn't have to their KPI, whole connected together. If I don't meet mine it affect theirs. In addition participants were judged based on their reply in interview and short discussions during process observations on their KPI adherence and commitment.	6.1
32	Self-Integrity or preserving moral integrity	The tendency to preserve moral integrity in all situations	Integrity	Preserve moral integrity in any situation or the fear that one's integrity is under questioning when he performs his duties or process.	Nobody. No it's not okay if you don't count. Because that's essentially what my kind we just we're making sure is okay …. If you have a system which says you don't know how to count, like if you have a system that says you don't have to count until you find that stock periodically so…..We have a system we have a. Stock. Take. We have on the system where you cannot either return them and it tells you what it is. We're just making sure that that's correct. Right.	2.2

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
33	SOP	The tendency to miss, deviate or decline action stated in standard operating procedure;	Actions	Miss or deviate actions specified in document.	But I don't think the world really needs to know you will have standard operating procedures. I think 100 percent of the people cannot put to the standard operating procedures every time and they don't even follow what they're supposed to be followed. But to try to make them … somebody to do it and we don't keep our eye on people.	6.1
34	Standardisation	The tendency adopt to same way of operations	Actions	Work in the same way as followed by others.	The standard operating procedures been set up people are 100 percent of the time followed...Not terrible. In addition participants were observed if they follow SOP during process observation, mostly on safety.	7.19
35	Status quo	The tendency to hold on to the current situation or method.	Embrace	Hold on to the current situation	Refer to example given below the table.	
36	Stereotype	The tendency to follow certain beliefs and ways of execution.	Embrace	Follow certain beliefs and ways of execution.	Refer to example given below the table.	
37	Stress	The tendency to decline actions based on predicted stress on oneself or the process	Stress	Incline/decline based on stress	Three departments working get people to be here. The last time something like. We. Like. It affects me.	7.14
38	Subjective validation	The tendency to agree with a fact or data if it match personal belief.	Belief	Agree with a fact, data, information, statistics, if it match personal belief.	It probably just to give some context to that someday. Sometimes it's a bad thing. it's not a good outcome because I haven't followed up believe it or not because I think actually we can do	7.17
39	Survivorship or Survival	The tendency to believe on mechanisms that gave success in past and neglecting other options.	Belief	Believe on process, procedure, and methods that gave success in past.	Refer to example given below the table.	
40	System-human	The tendency not acknowledging system and /or human influences	Influence	Not acknowledging system and /or human influences	There are standard operating time. Not at all. See for eg, this one you can see, sorting and movement 7 ½ hours, it never ever works like that. Its always different. Because its not a machine, its human working here. Sometimes they are in bad mood, sometimes they are in	5.9

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
					good mood. Sometimes they have argument with me. Like just I scold my supervisor. You are supervisor but you are late. It is not good this is 4th time I am seeing him he is late. He should be here before my staff. I have never been later, never ever. He was late so not tonight after you, he come and asked me how I can say. So this will happen Participants were judged based on their reply in interview and short discussions during observation whether they acknowledge system and /or human influences on process.	
41	System-wide approach	The tendency to discount or not consider stakeholders in the system for a situation, issue, or action	Approach	Not consider all stake holders	Participants were judged based on their reply in interview and whether they consider all stake holders while discussing an issue.	
42	Tip of the tongue	The tendency to fail to recollect familiar events or situation.	Recollect	Fail to recollect events or situation in work place.	Participants were judged based on their reply in interview and whether they forget events or actions during observation	
43	Underreporting	The tendency to underreport situations or facts.	Report	Underreport situations or facts	Participants were judged based on their detailing in on short discussions and process observed	
44	Zero defect	The tendency to avoid complete risk or the preference for reducing a small risk to zero over a greater reduction in a larger risk.	Insist	Insist on zero defects in a process.	No. I still can’t figure out that thing honestly. Because its only few people never do mistakes, only one or two staff, they purposely don’t care.	5.9
45	Zero-risk	The tendency to avoid complete risk or the preference for reducing a small risk to zero over a greater reduction in a larger risk.	Avoid	Avoid complete risk	Tomorrow. If suggestion comes today do it tomorrow. I mean I just why. Good idea not a good idea. How do you decide that is good of the teams already? I don't it's up to the guy for us and it's not on or not it's the team leader you have a guy. And that should be some factors for consideration on an and ideas what are the factors what you would like the team to look at the I mean there's the piano pieces. There's the cost implications these are what. Yeah I mean basically there's an income. The implication is health and safety and the news	7.19

Sl. No.	Bias	Explanation	Important word, action, or behaviour	Connected words, actions, and behaviour to be observed during data collection.	Examples, quotes and remarks.	Reference
					there's the implication of basically of these going to be meat value are leaving a dollar return. The idea all these wellness return is wow.	

Participant (reference 4.25) quote: "When ever I change things they go back to the old way they think it is easy ".



Unintentionally the participant revealed that fellow participants also had experienced this tendency through their practice. During the process observation it was noted that the concerned operators repeated the process they followed each time mostly.

Appendix 4: Participant Information sheet employees

Participant Information Sheet

Information sheet for the participating employees of the organisation.

Date Information Sheet Produced:

14 November 2017

Project Title

Improving business processes through enhanced understanding of the interactions of Lean, waste and cognitive factors in workplaces (cognitive factors are limited to bias).

An Invitation

Hello, I am Mahesh, a research student at AUT, Auckland. I have 25 years of industrial experience, mostly focused on reducing human efforts and waste generated in an organisation, while improving productivity and am doing a PhD at Auckland University of Technology.

I would like to invite you to participate in my research project. Your participation is voluntary.

What is the purpose of this research?

The proposed study is aimed at identifying the stress and stressors, which improves the productivity for the organisation they are working in. I will gain Knowledge of practices in Lean methodology and organisations, a PhD degree, and academic publications. The findings may be used for my education, publications, and academic purposes.

The information gathered from will be kept confidentially, however, the report gave back to you and your organisation could be related to you.

The study will be based on your daily activity in a process of your choice which has been improved or needs improvement. You and your organisation will be given a report of the process indicating the stress and stressors in the process. There are no other conflicts or constraints with your participation.

How was I identified and why am I being invited to participate in this research?

Your organisation was approached to be a part of the study, which they accepted. You have been briefed about the project and your voluntary consent is essential to be involved in the study.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. Please fill and sign the consent form for agreeing to participate in the research. The signed consent forms may be given to me directly or dropped in the box kept in a commonplace (to be confirmed). If you wish to give the interview as a group or with a partner, kindly use group consent form.

What will happen in this research?

I would stand at a safe place that would not interrupt or disturb your work and observe for 15-30 minutes or till you do it thrice. After that, I would be arranging an interview at a nearby place convenient to you. The interview would be recorded if they consent to the same. Then I will be reviewing the archival data related to productivity and waste provided by your organisation. We would not review your personal data in any form. The timing of the semi-structured interview may last between 30 to 60 minutes. Most interviews will be once, however, the frequency may be increased as needed, however, the timeline of 60 minutes max will be adhered to. The research would capture the user experience in the process.

I will provide you with a report on good practices you follow. I will provide you with a copy of the report given to your organisation, which would contain a collated

Value stream mapping (pictorial if all participants in a process volunteer);

Stressors in the system;

Waste;

Work stress of employees;

Productivity improvements, which were already done,

Good practices,

Employee suggestions, and

General improvement suggestions and suggestions to ease employees' work (it will not explicitly identify you).

If you agree, the interview will be recorded. The information collected will be listened to and read only by me. My supervisors will have access to a collated version.

The results will be presented in the form of a thesis for my PhD and will be used for academic publications. In these publications, your organisation or your identification will not be revealed.

What are the discomforts and risks?

You may find my observation or some questions uncomfortable, but it does not pose any risk to you as they are used confidentially. Any questions you feel uncomfortable, you may deny answering them, and I will be happy to honour your choice.

The transcripts of the interview will not be provided.

The report to the organisation could be traced to you.

How will these discomforts and risks be alleviated?

Before the observation, I would ask for the safe place to be in, which would not disturb you in any manner. Also, the questions would be only in the process you follow and your work activity aimed to reduce your stress and improve productivity.

You can withdraw from this study at any time, all data pertaining to your participation will be destroyed. If you are uncomfortable, doubtful or adverse to any question you may choose not to answer it.

However, once the findings have been produced, the removal of your data may not be possible.

What are the benefits?

The following are the likely benefits.

You as a Participant: Opportunity to reflect on the work process, and associated stresses and stressors.

Organisation: Improve productivity and reduce waste.

Researcher: Knowledge of practices in Lean methodology and organisations, PhD degree, and academic publications.

Wider community: Reduce wastage in the workplace.

How will my privacy be protected?

Your privacy will be protected at all times. All information will be de-identified and your personal data remain limitedly confidential. In order to achieve privacy and confidentiality, the interview and audio file will be identified only by a code. However, your identity would be traceable in the report given to your employing organisation.

Due to the research design, you will be identifiable to your organisation. However, in the report to the organisation or in my academic publications and thesis, your name and your organisation name will not be revealed.

What are the costs of participating in this research?

The interviews will take approximately 30 to 60 minutes of your time.

What opportunity do I have to consider this invitation?

Two weeks

Will I receive feedback on the results of this research?

I will provide you with a report on good practices you follow. I will provide you with a copy of the report given to your organisation which would contain a collated report on stressors in the system, good practices and suggestions for improvement (it will not explicitly identify you).

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Dr Jeff Seadon, jeff.seadon@aut.ac.nz, +64 921999 ext.6789*.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz*, 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Name: Purushothaman Mahesh Babu Email: mahesh.babu@aut.cac.nz Phone: +64 9921999 ext. 4172.

Project Supervisor Contact Details:

Name: Dr Jeff Seadon Email: jeff.seadon@aut.ac.nz Phone: +64 9921999 ext. 6789.

Approved by the Auckland University of Technology Ethics Committee on 6 December 2017 AUTEC Reference number 17/351.

Appendix 5: Participant Information Sheet- participating organisation

Information Sheet for the participating organisation.

Date Information Sheet Produced:

14 November 2017

Project Title

Improving business processes through enhanced understanding of the interactions of Lean, waste and cognitive factors in workplaces.

An Invitation

Hello, I am Mahesh, a research student at AUT, Auckland. I have 25 years of industrial experience, mostly focused on reducing human efforts and waste generated in an organisation, while improving productivity.

I will like to invite you to participate in my research project. Your participation is voluntary. The information gathered from your organisation and that can identify the organisation will be kept confidentially retained.

What is the purpose of this research?

The proposed study is aimed at identifying stress and stressors, which improves the productivity of the organisation. I will gain Knowledge of practices in Lean methodology and organisations, a PhD degree, and academic publications. The findings may be used for my education, publications, and academic purposes.

The information gathered from will be kept confidentially. The study will be based on your daily activity in a process of your choice which has been improved or needs improvement. You and your organisation will be given a report of the process indicating the stress and stressors in the process. There are no other conflicts or constraints with your participation.

How was the organisation identified and why the organisation being invited to participate in this research?

Your organisation was approached for the study, through the conference contacts and personal contact. You have been identified as a key organisation that aims to improve productivity and adopt scientific management concepts like Lean. In addition, Your organisation has been selected because most of your employees can speak English.

How do I agree to participate in this research?

Please fill and sign the permission form for agreeing to participate in the research.

What will happen in this research?

You will identify a contact person, to fix dates for the study and to guide me on the policies and procedures of your organisation that I need to follow.The contact person identified by you would introduce me to the team and I would brief the potential participants the aim and process of the research study. A participant information sheet and consent form will be given to the potential participants. Their involvement in this research is voluntary and I would collect the consent forms directly or through a drop box.

The research involves three phases.

Observation of the process

Interview with the participant

Review of productivity and waste-related data provided by you.

During the observation phase, I would stand at a safe place that would not interrupt or disturb your employees' and observe their work for 15-30 minutes or until they do it thrice. After that, I would be arranging an interview at a nearby place convenient for the employees. The interview would be recorded if they consent to the same. Then I will be reviewing the archival data related to productivity and waste provided by you. We would not review your personal data in any form. The timing of the semi-structured interview may last between 30 to 60 minutes. Most interviews will be once, however, the frequency may be increased as needed, however, the timeline of 60 minutes max will be adhered to. The participants will have an option to choose between individual or group interview.

I would like to have a repeat of the same process with you if you consent.

I will provide you and your employees a report on good practices your employees follow. I will provide you report to your organisation, which would contain a collated

Value stream mapping (pictorial if all participants in a process volunteer);

Stressors in the system;

Waste;

Work stress of employees;

Productivity improvements, which were already done;

Good practices;

Employee suggestions, and

General improvement suggestions and suggestions to ease employees' work (it will not explicitly identify your employees for ethical reasons).

Promoting ethical practices, the report would not contain any comparison between employees, or data, which would identify or affect the participant.

Once this is complete, the data from interviews will help in plotting the work related biases that influenced the process waste. This will help to understand the motivations of people in a work environment. Moreover, the study will help me in my PhD Journey and the results will be included in my thesis. The results will be electronically sent to you if you wish to have them.

The results will be presented in the form of a thesis for my PhD. This will be used for academic publications. In these publications, your organisation or your employees' identification will not be revealed. The complete thesis will be made available in AUT Library on its completion.

What are the discomforts and risks?

Some of your employees may find my observation or some questions uncomfortable, but it does not pose any risk to the organisation. All data collected would be kept strictly confidential.

How will these discomforts and risks be alleviated?

Before the observation, I will ask for the safe place to be in, which will not disturb your employees in any manner. Also, the questions will be only in the process being followed and the work activity, which is aimed to understand the stressors and improve productivity.

Your organisation can withdraw from this study at any time all data pertaining to your participation will be destroyed. If any of your employees are uncomfortable, doubtful or adverse to any question they will be advised not to answer it. However, the data cannot be removed once the results are published.

What are the benefits?

The following are the likely benefits.

Your employees: Opportunity to reflect on the work process, and associated stresses and stressors.

Organisation: Improve productivity, and reduce waste.

Researcher: Knowledge of practices in Lean methodology and organisations, PhD degree, and academic publications.

Wider community: Reduce wastage in the workplace.

How will my privacy be protected?

Your organisation's privacy will be protected at all times. All information will be de-identified all data remain strictly confidential. In order to achieve privacy and confidentiality, the interview and audio file will be identified only by a code.

You will be knowing the participants, however, the report given to you will contain only positives and problems in the process and their activity.

Your name, employees name or organisations name will not be revealed in any of my reports, academic publications and thesis.

What are the costs of participating in this research?

The interviews will take approximately 30 to 60 minutes per employee time.

A contact person for the study.

What opportunity do I have to consider this invitation?

Two weeks

Will I receive feedback on the results of this research?

I will provide you with a report on good practices you follow. I will provide your organisation with a report which would contain a collated

Value stream mapping (pictorial if all participants in a process volunteer);

Stressors in the system;

Waste;

Work stress of employees;

Productivity improvements, which were already done,

Good practices,

Employee suggestions, and

General improvement suggestions and suggestions to ease employees' work (it will not explicitly identify you).

Promoting ethical practices, the report would not contain any comparison between employees, interview transcripts, or data, which would identify or affect the participant.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Dr. Jeff Seadon, jeff.seadon@aut.ac.nz, +64 921999 ext.6789*.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, Kate O'Connor, *ethics@aut.ac.nz*, 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

Researcher Contact Details:

Name: Purushothaman Mahesh Babu Email: mahesh.babu@aut.cac.nz Phone: +64 9921999 ext. 4172.

Project Supervisor Contact Details:

Name: Dr Jeff Seadon Email: jeff.seadon@aut.ac.nz Phone: +64 9921999 ext. 6789.

Approved by the Auckland University of Technology Ethics Committee on 6 December 2017

AUTEC Reference number 17/351.

Appendix 6: Observation protocol.

Name of the primary researcher.

Purushothaman Mahesh Babu

Date observation protocol Sheet Produced:

14 November 2017.

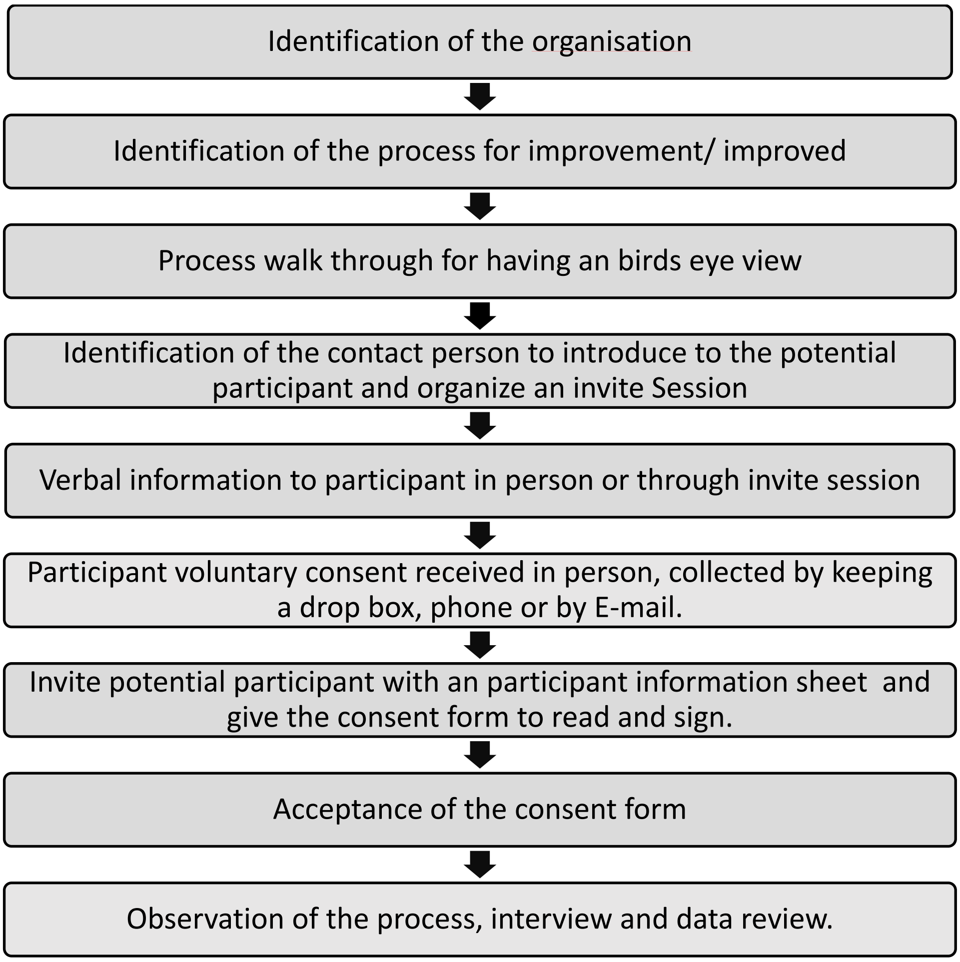
Project Title

Improving business processes through enhanced understanding of the interactions of Lean, waste and cognitive factors in workplaces. (Cognitive factors limited to bias in the workplace)

Observation Protocol.

- ***How will people be recruited?***

  The process flow is given below.



- ***How will people be informed about the observation?***
- The potential participants will be initially informed verbally by the contact person through invite session and then in person, and the potential participants will be given an information sheet and a consent letter.
- Then the participant voluntary consent is received in person, collected by keeping a drop box, phone or by E-mail. This will be followed by inviting the potential participant with a participant information sheet and give the consent form to read and sign.

- ***How will people consent to the observation?***

  By signing the acceptance in the consent letter.

- ***What will be observed and what data will be collected?***

  The daily routine activity performed by voluntary participants in a process will be observed and data will be noted by the primary researcher.

  Then a semi-structured interview of all voluntary participants in the process will be done for collecting data.

  Data collection would include, but not limited to a number of steps in the activity, input to the activity, output to the activity, the time is taken for the activity, interruptions in the activity and number of tools used to perform the activity.

  In addition, the frequent issues, constraints, interruptions, stressors, and difficulties in the activity would be collected.

  Then the archival data related to productivity and waste, provided by the participant or the organisation will be reviewed. We would not review personal data of anyone in any form. The data types reviewed will be, but not limited to departmental minutes, organisation minutes, union documents, union newspapers, minutes from union-management meetings, and training materials (not participant individual training details) for workers and managers.

- ***How will the data be collected?***

  The process will be observed and then a semi-structured interview of all participants in the process and data review will be done for collecting data. The timing of the semi-structured interview may last between 30 to 60 minutes. Most interviews will be once, however the frequency may be increased as needed. The convenience of respondent time and place of choice within the workplace or nearby public places like coffee shops will be adhered mostly.

  Recording the interviews, subject to respondents consent may include but not limited to

  - Digitally recorded and transcribed.
  - Notes by researcher,
  - Written and given by the respondent.

  Observation may include but not limited to

  - Observation of the business process.
  - Observation of people doing the activity in the process.
  - Observation of machines.

  In the semi-structured interview, all participants will be asked, their roles in the process, profession, level and their experience of the process. Respondents will be asked about the process, it’s issues, and their issue in relation to the process, their thought process, the waste generated, and suggestions to improve.

  The study deals with 12500 factors combination (250 biases, 25 Lean tools and 10 types of waste groups), hence specific questions would be difficult for the participants to answer. They will be fed with open-ended questions to respond. In addition, the interview will take specific topics on which they have specialized knowledge, such as issues and stressors in the process.

  Since the study is of cognitive factors influence, the open-ended question-design is chosen to avoid the influence of any researcher bias. The open-ended question design is also in the interest to protect the participant who can give his thoughts considered appropriate to him and his interests.

  This would be followed by the review of archival data.

- ***How any deception involved will be managed?***

  The activity would be observed for a repetition of 3 times and data would be noted.

- ***The data collection instrument***

  The recording will be through mobile phone and notes on a plain A4 paper.

- ***What does the researcher do during observation?***

  Introducing self.
  - Wait till the participant notices and attends to you.
  - Greet him and introduce myself
  - Thank him for being a part of the study

  Explaining the observation of activity.
  - Inform the participant that you are starting the observation process.
  - Inform the participant if he is uncomfortable at any time during the observation he can ask me to stop.
  - Request him to advice on the safe place to stand and observe.

  Observing the process.
  - Observe the process for three cycles.

  Noting the observation.
  - Note the activity observed in an A4 sheet.
  - Note the questions, if any

  Concluding the observation.
  - Thank the participant for letting me observe.
  - Check with the participant for any clarification and note down.
  - Thank the participant for cooperation.

What will be the outcomes of the observation?

- Present a report to the industry on stress, stressors, waste good practices, and improvements identified in the process.
- The report would contain and limited to

Value stream mapping (pictorial if all participants in a process volunteer); stressors in the system; waste; work stress of employees; productivity improvements were already done, good practices, and employee suggestions, general improvement suggestions and suggestions to ease employees work.
The report would not include a comparison between employees, statements, or data, which may have them at risk.

- Present an appreciation letter mentioning good practices and cooperation rendered along with the copy of organisation report presented to the participant

Appendix 7: Safety protocol.

Name of the primary researcher.

Purushothaman Mahesh Babu

Date observation protocol Sheet Produced:

27 September 2017

Project Title

Improving business processes through enhanced understanding of the interactions of Lean, waste and cognitive factors in workplaces.

Safety Protocol.

- ***In what ways might the researchers be at risk***?
  Since the study is in business process, manufacturing and services the industrial risks are potential. The interview may be at a public nearby.
- ***How will this be managed?***

  The researcher will read and understand safety protocol, practice all safety instructions in the organisation and take suggestions from coordinator/ participant on safety while observation***.***
  The interview will be held in public place like a coffee shop.

- ***What will be done by the researcher to ensure risks are mitigated?***

Before the case study

- Check with the organization for the need of any specific personal protection equipment
- Arrange for the personal protection equipment if needed.
- Accept interview only in a safe public place or place of participant work.

During the case study (observation Phase)

- Check for safety update and training needs from the organisation.
- Undergo the safety update and training.
- Understand the emergency evacuation procedures and safe assembly point in the organisation.
- Follow the instructions given during the training.
- Before the observation of the activity, check with the operator for the safe place stand and observe.
- Follow the instructions given by the operator.

After the Case study

- Thank the operator and safety trainer.
- Inform the problems faced verbally if any.

Appendix 8: Semi-structured Interview questioner

Participating Operator/ workmen / employee

- May I know your level in the organisation and your overall experience?
- Can you please explain what you do with making the product/ service?
- How did you improve the process in the past and what were the issues while improving the process?
- What are the current issues in the process?
- What are the waste, in terms of human effort, material and time in the process?
- What improvements are needed to increase your productivity and ease your workload?
- What sort of interruptions do you have while working? What are your ideas to overcome difficulties?
- Do the new technologies bring improvement to process and do they help you?
- Have you been given suggestions for improvement from your peers, supervisors, and managers?
- Can you give some examples of improvements you implemented and those you rejected?
- Why did you accept or reject the suggestions?
- What are the assumptions you made in accepting or rejecting the suggestions?
- Do you have anything else that you want to add?

Participating Staff / Manager

- May I know your level in the organisation and your overall experience?
- Can you please explain what you do with making the product/ service?
- How did you improve the process in the past and what were the issues while improving the process?
- What are the current issues in the process?
- Did you have any failures during the improvement phase and what caused the failures?

- What are the waste, in terms of human effort, material, time in the process?
- What improvements are needed to increase productivity and ease your workload?
- What sort of interruptions do you have while working?
- What are your ideas to overcome difficulties?
- Do the new technologies bring improvement to process and does the technologies help you?
- Have you been given suggestions for improvement from your peers, supervisors, subordinates, and managers?
- Can you give some examples for those which you implemented and those which you rejected?
- Why did you accept or reject the suggestions?
- What are the assumptions you made in accepting or rejecting the suggestions?
- Was there an external agency like auditors, certifiers or consultants involved in the process, if so what were the advantages and drawbacks of involving them?
- Do you have anything else that you want to add?

Minimum questions for Participating Top Management:

- May I know your overall experience?
- Do you see any issues or problems in the ------- process done at ----------*(Will word the process taken for study at the particular plant)?.*
- How did you improve the process in the past and what were the issues while improving the process?
- What are the current issues in the process?
- Did you have any failures during the Improvement phase and what caused those failures?
- Was there an external agency like auditors, certifiers or consultants involved in the process, if so what were the advantages and drawbacks of including them?
- Do you have anything else that you want to add?

Appendix 9: Consent Form

Project title: ***Improving business processes through enhanced understanding of the interactions of Lean, waste and cognitive factors in workplaces***

Project Supervisor: ***Dr Jeff Seadon***

Researcher: ***Purushothaman Mahesh Babu***

- ○ I have read and understood the information provided about this research project in the Information Sheet dated 14 November 2017.
- ○ I have had an opportunity to ask questions and to have them answered.
- ○ I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- ○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.
- ○ I understand that if I withdraw from the study then I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.
- ○ I agree to take part in this research.
- ○ I wish to receive a summary of the research findings (please tick one): Yes○ No○
- ○ I understand that I may be identified in the report to the employer.
- ○ I understand that I will be observed doing the activity in my workplace.

Participant's signature:

....……………………………………………………………

Participant's name:

....……………………………………………………………

Participant's Contact Details (if appropriate):

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………………………………………………………………………………………..

………………………………………………………………………………………..

Date:

Approved by the Auckland University of Technology Ethics Committee on 6 December 2017 AUTEC Reference number 17/351

Note: The Participant should retain a copy of this form.

Appendix 10: Consent Form- focus group

Project title: ***Improving business processes through enhanced understanding of the interactions of Lean, waste and cognitive factors in workplaces***

Project Supervisor: ***Dr Jeff Seadon***

Researcher: ***Purushothaman Mahesh Babu***

○ I have read and understood the information provided about this research project in the Information Sheet dated 14 November 2017.

○ I have had an opportunity to ask questions and to have them answered.

○ I understand that identity of my fellow participants and our discussions in the focus group are confidential to the group and I agree to keep this information confidential.

○ I understand that notes will be taken during the focus group and that it will also be audio-taped and transcribed.

○ I understand that taking part in this study is voluntary (my choice) and that I may withdraw from the study at any time without being disadvantaged in any way.

○ I understand that if I withdraw from the study then, while it may not be possible to destroy all records of the focus group discussion of which I was a part, I will be offered the choice between having any data that is identifiable as belonging to me removed or allowing it to continue to be used. However, once the findings have been produced, removal of my data may not be possible.

○ I agree to take part in this research.

○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

○ I understand that I may be identified in the report to the employer.

○ I understand that I will be observed doing the activity in my workplace.

Participant's signature:

....……………………………………………………………

Participant's name:

....……………………………………………………………

Participant's Contact Details (if appropriate):

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

………………………………………………………………………………………..

Date:

Approved by the Auckland University of Technology Ethics Committee on 6 December 2017 AUTEC Reference number 17/351

Note: The Participant should retain a copy of this focus group participant form.

Appendix 11: Permission for researchers to invite organisation employees/ staff.

Project title: ***Improving business processes through enhanced understanding of the interactions of Lean, waste and cognitive factors in work places***

Project Supervisor: ***Dr Jeff Seadon***

Researcher: ***Purushothaman Mahesh Babu***

○ I have read and understood the information provided about this research project in the Information Sheet dated 27 September 2017.

○ I give permission for the researcher to undertake research within ___________________________________

○ I give permission for the researcher to invite the staff / employees of ________________________________

○ I give permission for the researcher to observe the process, and staff / employees of ____________________

○ I agree to participate in the study (please tick one): Yes○ No○____________________

○ I wish to receive a summary of the research findings (please tick one): Yes○ No○

CEO's / Authorities signature: ....

CEO's / Authorities name: ....

CEO's Contact Details (if consent to participate in the study):

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

……………………………………………………………………………………..

Date:

Approved by the Auckland University of Technology Ethics Committee on 6 December 2017 AUTEC Reference number 17/351

Note: The head of the organisation should retain a copy of this form.

Appendix 12: Ethics Approval

6 December 2017

Jeff Seadon

Faculty of Design and Creative Technologies

Dear Jeff

Ethics Application: 17/351 **Improving business processes through enhanced understanding of the interactions of Lean, waste and cognitive factors in work places**

I wish to advise you that the Auckland University of Technology Ethics Committee (AUTEC) has **approved** your ethics application at its meeting of 4 December 2017.

This approval is for three years, expiring 4 December 2020.

Standard Conditions of Approval

1. A progress report is due annually on the anniversary of the approval date, using form EA2, which is available online through http://www.aut.ac.nz/researchethics.
2. A final report is due at the expiration of the approval period, or, upon completion of project, using form EA3, which is available online through http://www.aut.ac.nz/researchethics.
3. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form: http://www.aut.ac.nz/researchethics.
4. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
5. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.

Non-Standard Conditions of Approval

1. Reconsideration of the contact person in the organisation. AUTEC suggests that it should be someone other than the potential participants manager;
2. In the Information Sheet for the organisation, remove the reference to 'group interviews. Alternatively, if they are taking place information about these needs to be provided.
3. AUTEC suggests that the Information Sheet is proof read by the supervisor for clarity of expression.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to be submitted to or reviewed by AUTEC before commencing your study.

Please quote the application number and title on all future correspondence related to this project.

AUTEC grants ethical approval only. If you require management approval for access for your research from another institution or organisation then you are responsible for obtaining it. You are reminded that it is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard.

For any enquiries please contact ethics@aut.ac.nz

Yours sincerely,

Kate O'Connor

Executive Manager

Auckland University of Technology Ethics Committee