building 4.0 crc

PROJECT #25: OPERATIONAL EXCELLENCE FRAMEWORK OF STEEL FABRICATION AND PROCESSING IN THE OFF-SITE MANUFACTURING AND PREFABRICATION SECTORS (PHASE 1)

FINAL REPORT

FLEETWOOD AUSTRALIA · BlueScope · YNOMIA · The University of Melbourne · Monash University

Australian Government Department of Industry, Science and Resources | Cooperative Research Centres Program

CONTENTS

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Author of this report:	Felix Kin Peng Hui, Siddhesh Godbole, Mizan Ahmed, Omar Castrejon Campos
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Partners:	• Fleetwood • BlueScope Steel • Ynomia
Project team members:	• A/Prof. Felix Hui • Prof. Prakash Singh • Prof. Danny Samson • A/ Prof. Sherah Kurnia • Dr Guilherme Tortorella • Dr Robert Moehler • Dr Jenny Zhou • Dr Mizan Ahmed • Dr Siddhesh Godbole • Dr Omar Castrejon Campos • Shubham Agrawal
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Disclaimer

1. EXECUTIVE SUMMARY

This project aims to develop an operationally excellent steel-based product platform and production system that suits low- and medium-rise building development up to 8 stories. Phase 1 of this project involved understanding the current operations and supply chain of Fleetwood, BlueScope Steel and their distributors, and Ynomia, and facilitating bi-directional feedback that will allow product and design development coordination with an emphasis on Design for Manufacturing and Assembly (DfMA) in the future phase of this project.

We conducted a detailed literature review on the business and competitive consideration, sustainability, and the application of technology and automation in the steel supply chain. We analysed the current operations and supply chains of Fleetwood, BlueScope Steel and their distributors, and Ynomia, using the Supply Chain Operations Reference model (SCOR) methodology and interviewing key personnel. We identified pain points in different parts of the supply chain and suggested best practices recommended by the SCOR model. We also identified future research directions and proposed recommendations for Phase 2.

This report excludes confidential information about industry partner operations.

2. PROJECT OVERVIEW

2.1 Introduction

The opportunities for steel fabrication in offsite manufacturing (OSM) and the prefabricated building sector is rapidly growing due to the ease of construction. These segments include prefabricated building modules for health care, mining, and residential and commercial buildings. Like all general steel fabrication, steel fabrication in the manufacture of prefabricated modules offsite often comes with many challenges:

- Certainty and reliability of the supply chain from mill to the factory to site, with issues around traceability and supply clarity
- The need to lower costs to improve production efficiency e.g., using automation, reducing inventory via just in time (JIT) production, streamlining the design to the factory to site, and shortening the time to customers
- Improved existing methods of production for both the steel producer and modular manufacturer/builder
- The trade-off between standardisation and flexibility in product design.

In a competitive landscape, it is imperative to seek out new methods of efficient production and new ways to collaborate in the supply chain. New and innovative ways to collaborate will help foster closer working relationships through ordering mechanisms, more optimal stocking levels, better forecasting for demand and supply, and intelligent software that helps predict demand.

This project aims to develop an operationally excellent steel-based product platform and production system that suits low- and medium-rise building development up to 8 stories. Phase 1 of this project involved understanding the current operations and supply chains of Fleetwood, BlueScope Steel and their distributors, and Ynomia, and facilitating bi-directional feedback that will allow product and design development coordination with an emphasis on Design for Manufacturing and Assembly (DfMA) in the future phase of this project.

2.2 Literature review

a. Steel supply chain

Like many other countries, Australia's offsite manufacturing (OSM) and the prefabricated building sector have experienced a massive boom. A report published in IBISWorld in 2021 cited the 'prefabricated metal building manufacturing' industry's contribution to the overall economy is expected to grow by annualised 3.3% over the next 10 years. This result outperforms real gross domestic product (GDP) growth over the same period, which is forecasted to grow by 2.2% annually (Figure 1).[1] The number of establishments in the industry is expected to grow by 2.6% and its share of the economy is expected to grow by 0.9%. At the same time, similar figures for the 'wooden prefabricated building manufacturing industry' were 3.0% and 3.1% respectively. As demand rises, the certainty and reliability of the supply chain becomes an important factor.

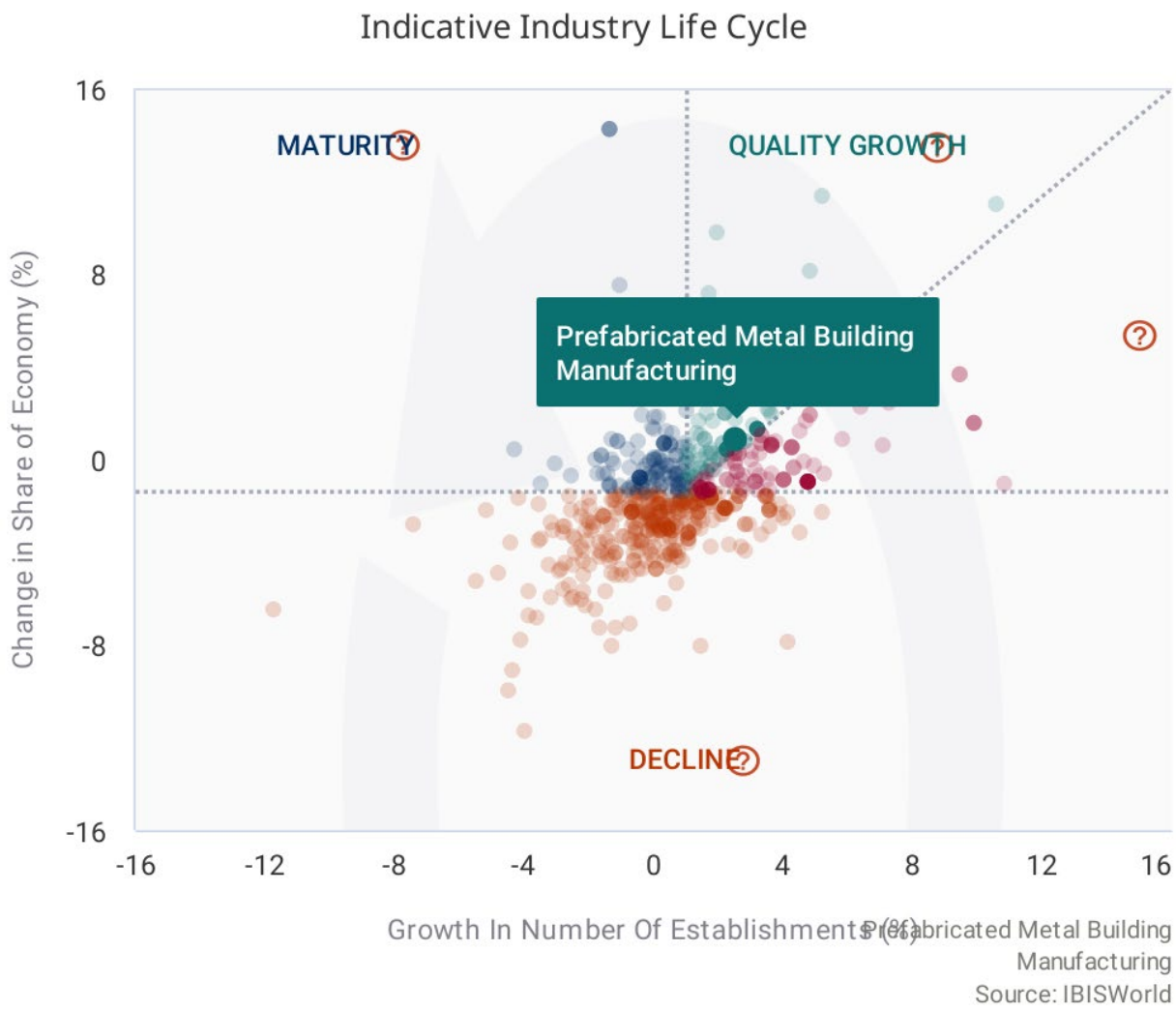

Figure 1. Industry placement of prefabricated metal building manufacturing (Source: https://my.ibisworld.com/au/en/industry/c2222/industry-outlook)

A typical supply chain includes customers, manufacturers, distributors and suppliers. Optimum management of the supply chain could: (i) improve throughput by increasing inventory utilisation, (ii) reduce cycle time via sufficient alternatives, (iii) reduce inventory cost via accurate customer demands and optimised procurements, (iv) optimise transportation, (v) increase order fill-rate by real-time visibility across the supply chain, and (vi) enhance customer responsiveness.[2] Figure 2 shows the typical supply chain for steel products. Generally, steel products are supplied to clients directly by steel producers such as BlueScope subjected to meet the minimum volume order requirement or through distribution partners.

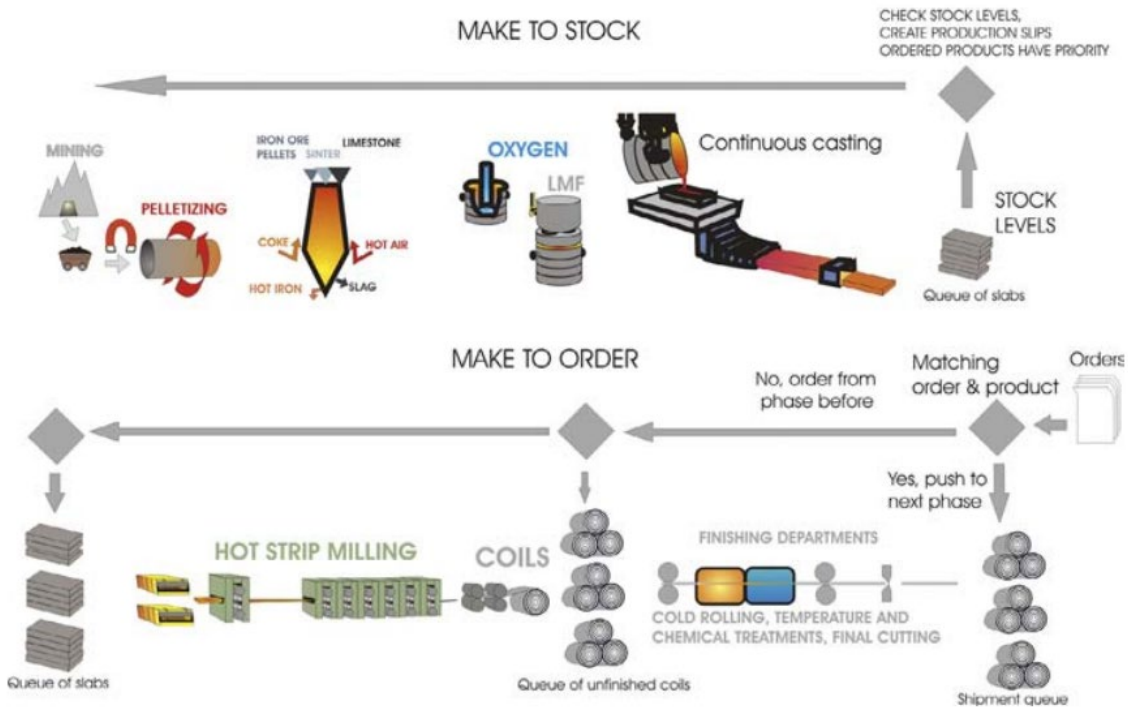

Figure 2. Steel supply chain (image source: [2])

The 2022 statistics for institutional building construction highlight the segmentation, as shown in Figure 3.[3] Reconciling the Australian institutional building construction with Fleetwood's business segmentation, we can see Fleetwood is well placed to capitalise on its 10.5% market share.[4]

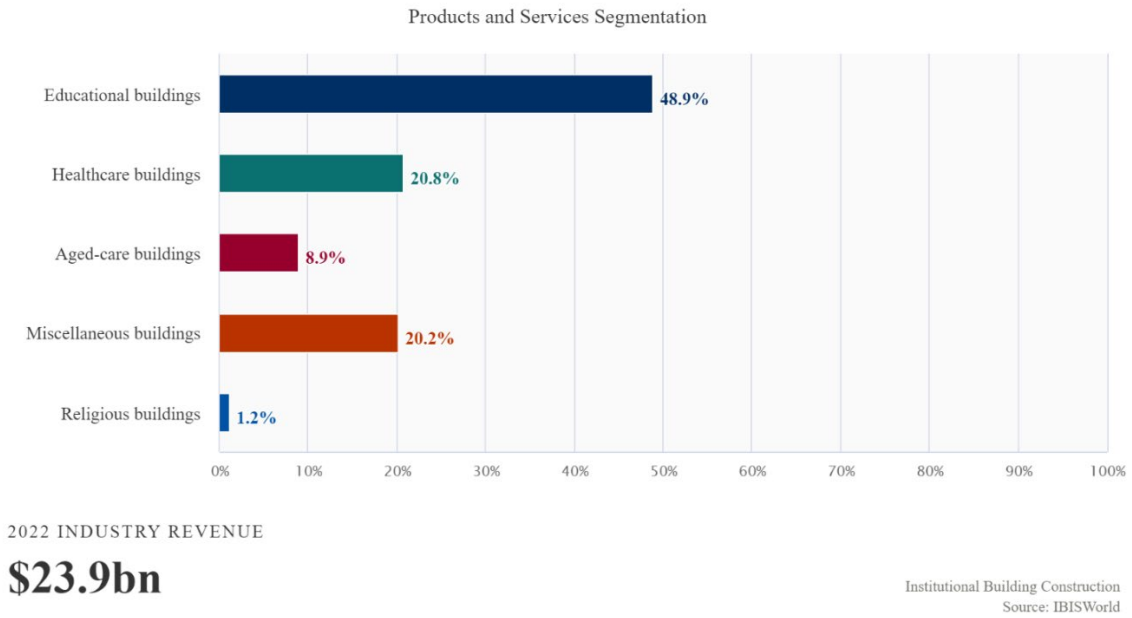

Figure 3. Institutional building construction, Australia, 2022
(Source: https://my.ibisworld.com/au/en/industry/e3022/products-and-markets)

With a stimulus to immigration post COVID–19, Australian residential and non-residential construction may witness a strong surge in demand for fabricated steel products. Because the industry has much growth potential before reaching maturation, we may see strong capacity build up in the Australian context. This would drive both steel fabrication demand and prefabricated house building demand in the positive direction.

b. Operational excellence in supply chain management

The term 'Operational Excellence' (OE) is widely used by modern organisations, and it has been researched across a range of disciplinary fields.[5] Although the meaning of OE is ill-defined depending on the context of the enquiry,[6] the core theme of OE is achieving excellence, sustenance and continuous improvement to attain greater cost efficiencies and reduce risks.[7] OE aims to improve the supply chain in terms of economic and operational efficiency through optimisation, while escalating social and environmental benefits. Several (sometimes contested) factors such productivity, reliability, quality, safety and cost optimisation must be managed in an integrated way to make the business competitive as well as sustainable.[7] Striving to attain OE in the steel industry is one of the most important contributors to the industry's sustainable performance and growth. Since the steel industry presents significant operational challenges and risks (e.g., price volatility, overcapacity and large variations in input quality characteristics of raw materials), achieving efficiency and effectiveness by driving excellence across the steel value chain is crucial for sustainable growth.

Based on a brainstorming session with industry personnel and academics, the requirement in the building industry for achieving and maintaining OE is identified as:

- Introducing culture, tools and methods in the business/ organisation to see the impact on users and employees for business growth. Examples include obtaining feedback, capturing and sharing knowledge, bringing in new people, training and pathways. (Develop a matrix in the building industry that will help to measure OE.)
- Implementing a new source of energy in the manufacturing and processing of any product to reduce waste in an organisation
- Reducing waste by improving cycles, optimising operations, reducing carbon emissions
- Implementing a socio-technical strategy
- Ensuring stable supply of and demand for the product
- Recognising safety as an important matrix in OE in the building industry
- Recognising OE in the building industry is most inclined towards the manufacturing side and supply chain.

c. Technology and automation

In recent years, industries are seeking to reach high levels of OE by developing or adopting emerging digital technologies for Industry 4.0 (I4.0) such as cloud computing, Internet of Things (IoT), Internet of Services (IoS), big data and cyber-physical systems (CPS).[8] I4.0 technologies may bring several benefits to operations management such as reducing manufacturing costs, lowering a product's processing time, increasing process flexibility, allowing for higher product customisation, improving customer service and upgrading value chain coordination, among many others.[8, 9] These technologies may improve interactions among suppliers, manufacturers and customers by enabling the integration of physical objects, intelligent machines, processes, production lines and human interactions, to develop a smart, connected and efficient value chain.[9] Table 1 categorises I4.0 technologies, based on their functionality.

Table 1. Emerging technologies related to Industry 4.0[9]

Technologies related to I4.0	Objective	Examples
Data analytics and processing	Information processing	Advanced algorithms for process optimisation, analytic tools like machine learning, data mining, big data and authentication and fraud detection
Augmented and virtual reality	To capture objects by visual sensors, to process and find out the context hidden in them	Virtual objects in the physical environment which are shown to the user in real-time with the support of some technological device
Cloud computing	Model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable resources that can be rapidly provisioned and released with minimal management effort or service provider interaction	Technologies for remotely processing data, incorporation servers, big data storage systems, applications and services
Mobile devices	Portability	Use of mobile terminals such as smartphones, tablets smart glasses
IoT/IoS	To communicate and present information	Use of intelligent sensors, middleware, location detection technologies, IoT applications, wireless networks, radio frequency identifiers (RFID)
Additive manufacturing	To reduce time and cost for product development and manufacturing, and enable mass customisation of goods on a large scale by using 3D printers	Various raw materials can be used by 3D printing methods including polymers, epoxy resins, titanium, sterling silver, sandstone and stainless steel
CPS	Robotisation, automation, and advanced use of human-machine interface and machine-machine interface, contributing to the automation and control of processes	Machines are used in manufacturing, transportation, robots and automatic guided vehicles (AGV)

The steel industry in highly developed countries like Australia foresees the integration and implementation of diverse I4.0 technologies to improve competitiveness while protecting the environment.[10] Integrating I4.0 technologies in the steel industry supply chain may bring important opportunities for development such as quick access to data, full communication, digitalisation and differentiation of production, deep automation, robotisation, customisation and improvement of value creation processes.

With significant challenges in the steel industry (e.g., heterogeneous product portfolio, process complexity and flexibility, shorter product life cycles in the downstream business, shorter innovation cycles), technology development and implementation will be a game-changer and will reshape market competition over the next decade. Thus, technological developments and innovation processes are expected to increase efficiency, reduce costs and enhance sustainability, while reducing the resource and labour intensity of industrial activities.[10]

Incremental technological progress will play a key role in the ongoing transformation of the steel industry and may be accompanied by changes in the skills of the workforce (e.g., upgrading skills focused on digitalisation, automation, real-time data processing, and technological innovation).[11] However, selecting 'optimal' technology solutions is challenging due to the technological heterogeneity presented throughout the supply chain (e.g., technological maturity levels may vary among companies) and the evolving aspect of socio-technical transformational processes (e.g., industry digital transformation).[12, 13] Thus, investigating new business models supported by innovative value chain management practices has been recently advocated to achieve OE.[6]

2.3 Overview of supply chain structure

a. Supply chain policies and arrangements

In the 21st century, competitive advantage could be achieved by those who can maintain robust supply chains and the same goes for steel. With high-quality demand and ever-increasing competition in the global market, an increasing number of supplier companies are moving from mere physical products to products offered as services.[14] In the past, IBM switched from offering hard products to products with services based on customer demand, giving them a competitive advantage in the market[15] The new version of the supply chain that emerged was known as service supply chain management, which included managing information, processes, capacity, service performance and funds from the originating supplier to the ultimate customer.[16] From a service supply chain point of view, the relationship between the buyer and the supplier is not just buy–sell, but a process of value co-creation and coordination. It becomes necessary for the supplier to know the product demand, where the value is created, and how the value is perceived by the customer.[17] Figure 4 shows the supply chain partners in prefabricated steel building. In a prefabricated building production value chain between Fleetwood and BlueScope, where BlueScope is the principal supplier and Fleetwood is the manufacturer of the finished product to the customer, there is scope for value co-creation by looking at the steel supply chain from a service supply chain perspective.

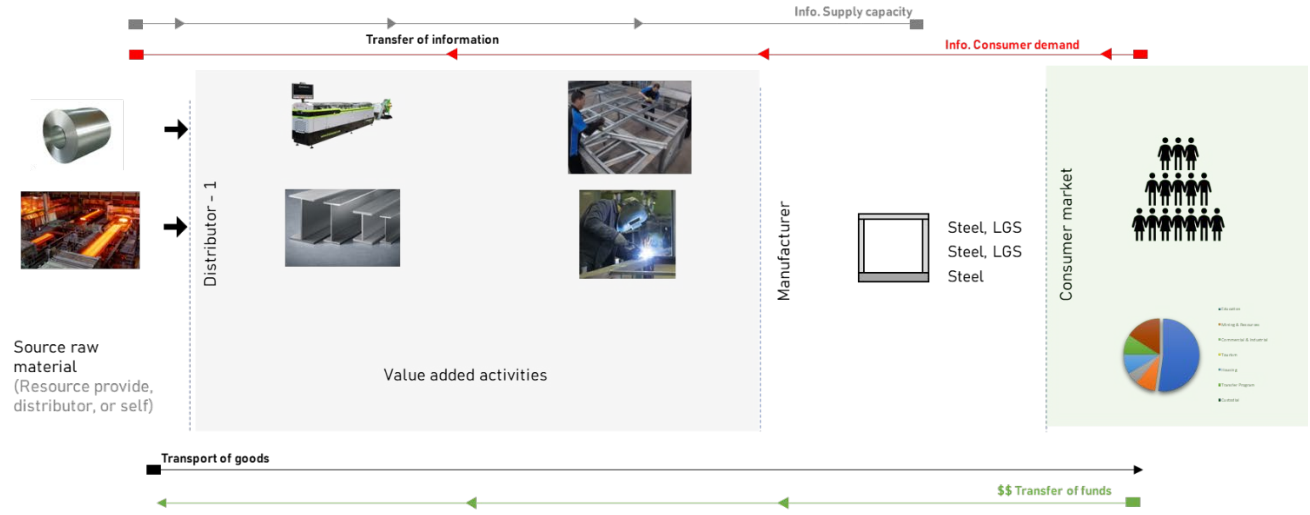

Figure 4. Supply chain partners in prefabricated steel building

b. Supply chain risks and mitigation

World steel prices have soared, reflecting constrained global supply chains due to the COVID-19 pandemic and geo-political tensions. The challenges in steel supply shortages are often traced back to supply chain mismanagement rather than to capacity. The global steel market suffered heavily after China's heavy influx of cheap steel between 2000 and 2014.[18] South Korea's POSCO managed not only to survive this wave of market penetration but thrived. The key lessons behind POSCO's growth were: (i) fostering international collaboration through upgrading companies' IT and ERP systems, (ii) collaborating with customers by sending their engineers to customers to understand customer-specific needs and driving the product R&D, (iii) innovating through sustainable steel production and other technology solutions, and (iv) forming strategic partnerships with key global innovators.[19]

c. Supply chain forecasting

Forecasting plays a crucial role in the smooth functioning of the end-to-end supply chain. However, fluctuating demand and supply volatility have made accurate demand forecasting even more challenging. For instance, using last year's sales data as a base for forecasts may be inaccurate, because demand fluctuations skew the data (e.g., due to the pandemic). Without consistent and

reliable demand data, it is difficult to generate a baseline forecast. In addition, customer behaviour has shifted significantly, making it hard to base assumptions on consumer trends. Accurate demand forecasts are essential, and forecasting problems lead to numerous other supply chain problems such as the higher risk of stock-outs, excess and obsolete stock, harder to manage supplier lead times, and damaged customer satisfaction and reputation. Thus, developing an optimal forecasting model by combining diverse statistical and machine learning forecasting techniques may help stakeholders improve forecasting accuracy.

d. Competitors in steel supply chain (main players)

BlueScope Steel (predominantly flat steel products), Liberty Primary steel (mostly hot-rolled steel and rail products), Molycorp (niche forging) and InfraBuild (reinforcing products) are Australia's top steel producers.[20] The Australian steel market could be classified into various segments – dwellings, non-dwellings, engineering, manufacturing, agriculture and mining, transport and automotive. A 2017 report to the commissioner of the anti-dumping commission identified the threats posed by global excess steel capacity and demand imbalance.[21] In Australia, steel fabricating industry revenue is expected to increase at an annualised 0.3% to total $6.3 billion through 2021-22. This trend has been influenced by expected growth in domestic demand for structural steel products of 0.9% (annualised) over the same period. The economic fallout from the COVID-19 pandemic contributed to a slump in investment in high-rise apartment and non-residential building projects, which led to a projected 9.3% decline in revenue during 2021-22. However, some industry operators benefited from government spending on public infrastructure projects, ongoing work on several landmark road and rail projects, and the short-term stimulus to new housing construction from the Australian Government's Home Builder scheme.[22] Figure 5 captures the essential characteristics of the Australian steel fabrication industry, retrieved from IBISWorld data. Although Australia exported $153 billion worth of crude metal in 2021-22,[23] its fabricated steel exports are dim compared with its imports. Almost two-thirds of fabricated steel products in Australia are currently sourced from China.

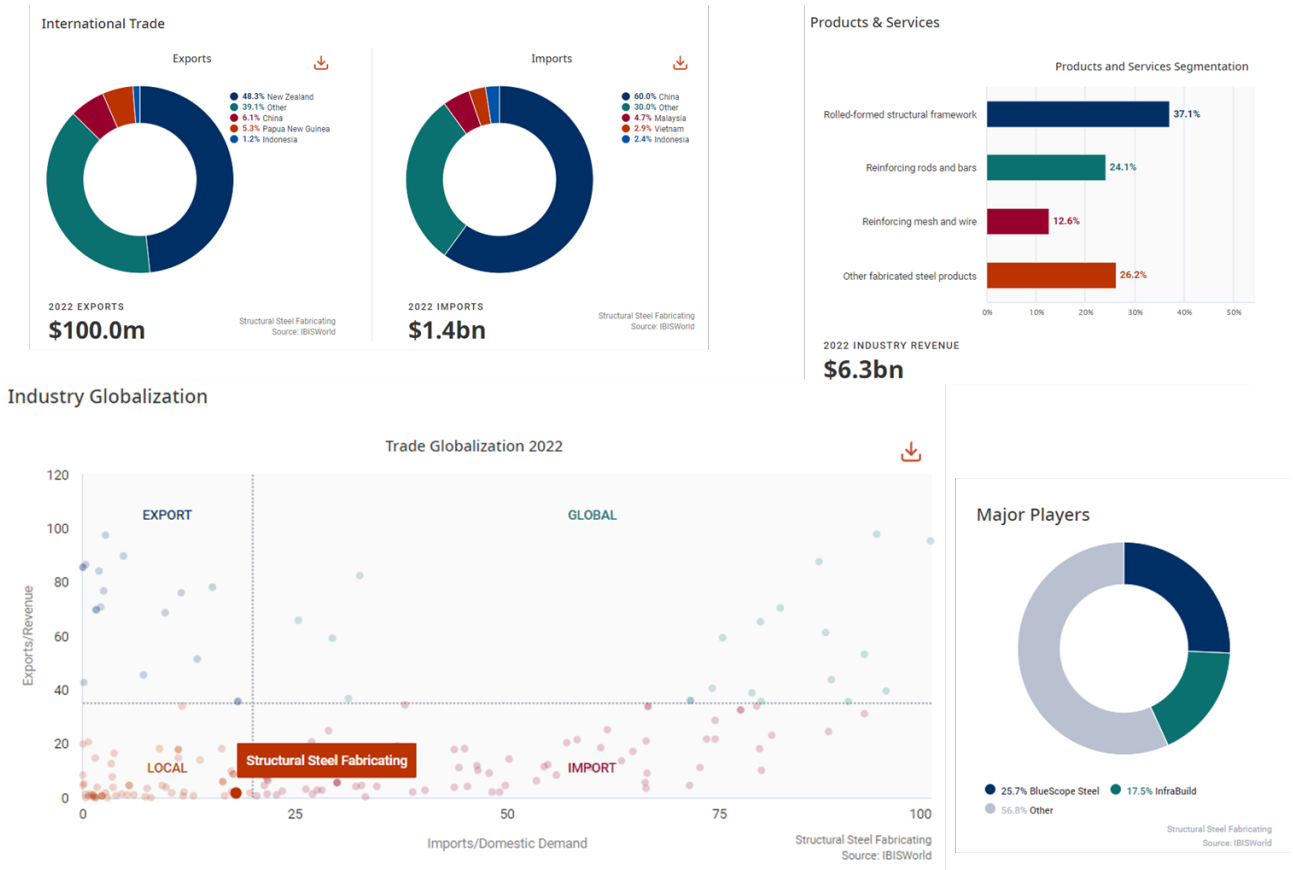

Figure 5. Structural steel manufacturing industry, Australia, 2022
(Source: https://my.ibisworld.com/au/en/industry/c2221/industry-at-a-glance)

e. Sustainability in supply chain

Sustainability is an integral part of supply chain management. Sustainability in supply chain management can be defined as "a wise balance among economic development, environmental stewardship, and social equity".[24] Ansari and Qureshi[25] stated "a sustainable supply chain management can be understood as maintaining a balance among social responsibility, environmental stewardship and economic viability along the entire supply chain, improving the long-term economic performance of an individual and the company and also meeting the customers' need competitively throughout the life cycle of goods and services". Sustainability in the supply chain aims to maintain the long-term growth of all the stakeholders involved in a specific ~~market~~ segment providing service to the clients. Improving sustainability in supply chain management will provide benefits like optimal inventory, flexibility, supply chain cost and supply lead time, client satisfaction, supplier innovation capacity, quality, trust and supply risk management.[26]

Table 2 shows the key differences between traditional supply chain management and sustainable supply chain management.[27] Even reputable firms with excellent supply chain management and supply chain risk management processes may encounter serious problems stemming from sustainability risks in their supply chain operations. For example, Apple suffered from damage induced by unsustainable practices (due to negative working conditions that were discovered at one of its supplier's factories in China) in their supply chains.[28] Hofmann et al.[29] analysed how sustainability-related issues materialise as supply chain risks and create loss and how these risks are integrated into the existing supply chain risk management literature as well as how can firms tackle these risks. They concluded supply chain risk management should not focus only on disruptive events but also possible stakeholder reactions. Giannakis and Papadopoulos[30] identified specific sustainability-related risks in the supply chain and proposed a risk management framework to treat these risks. Further, developing effective relationships with suppliers is a key factor in maintaining a company's sustainable operation. Companies are often vulnerable to various disruptions and risks in the supply chain that affect their business performance.

Table 2. Key differences between traditional supply chain management and sustainable supply chain management[27]

Traditional supply chain management	Sustainable supply chain management
Focus is only on elements connecting from the point of origin to the point of consumption (i.e., from supplier to consumer)	Social, environmental and economic issues are also considered along the supply chain
Purchasing does not consider the environmental issues	Incorporates green purchasing strategies and environmental purchasing
No significance given to marketing of product or service to protect the environment	Green marketing, environmental marketing and environmental marketing management of the product or service
ISO certification is not an integral part	Includes ISO-14000 certification
Reverse logistics is not an integral part of the supply chain	Reverse logistics is an integral part of the supply chain
No importance given to reducing the waste during manufacturing	Emphasises reduction of waste during manufacturing

Treleven and Bergman Schweikhart[31] identified 5 risk categories associated with purchasing and sourcing: disruption of supply risk, price risk, stock and schedule risk, technology risk and quality risk. However, information flow risks such as accuracy, system security and knowledge leaks have received less attention in studies of sustainability in supply chain management, even though most value-adding activities in a supply chain are triggered by information flow.[32] The usual way to manage risks in terms of sustainable purchasing and supply are the buffer activities like developing and maintaining multiple sources for strategic items, holding safety stock, and maintaining a well-stocked

supply pipeline.[33] Hallikas and Lintukangas[34] investigated the influence of supplier orientation, supplier dependency, customer orientation and integrated systemic buying on the performance of a company's supply risk management. They found the highest correlation between supply risk performance and supplier orientation, characterised as collaboration with suppliers, which is connected with measurement, common goals, new areas of collaboration, joint business process development and error handling.

2.4 Overview of the steel supply chain and research partners

Fleetwood and BlueScope Steel (including their distributors), the 2 principal industry partners in this project, are the main stakeholders in the offsite manufacturing (OSM) of prefabricated steel buildings (with Fleetwood being the builder and BlueScope the steel materials producer and supplier). The third partner Ynomia is an expert in the tracking and control of materials and has offered to bring this knowledge to the project. A brief description of these industry partners is presented below.

a. Fleetwood

Founded as a caravan business in 1964 in Australia, Fleetwood has rapidly grown into a globally recognised brand as a volumetric modular building solution provider. Fleetwood Australia has 3 business units: building solutions, RV solutions and community solutions. Fleetwood Australia is a wholly-owned subsidiary of ASX-listed Fleetwood Limited (FWD). Fleetwood has a nationwide footprint as depicted in Figure 6. Figure 7 shows the market share of Fleetwood in 2022.

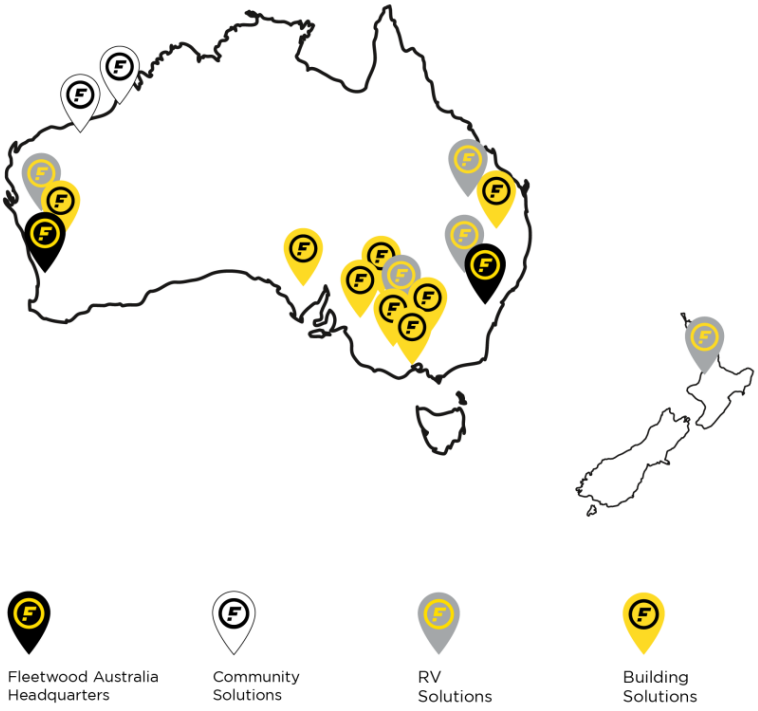

Figure 6. Fleetwood business locations
(Source: Fleetwood Australia website)

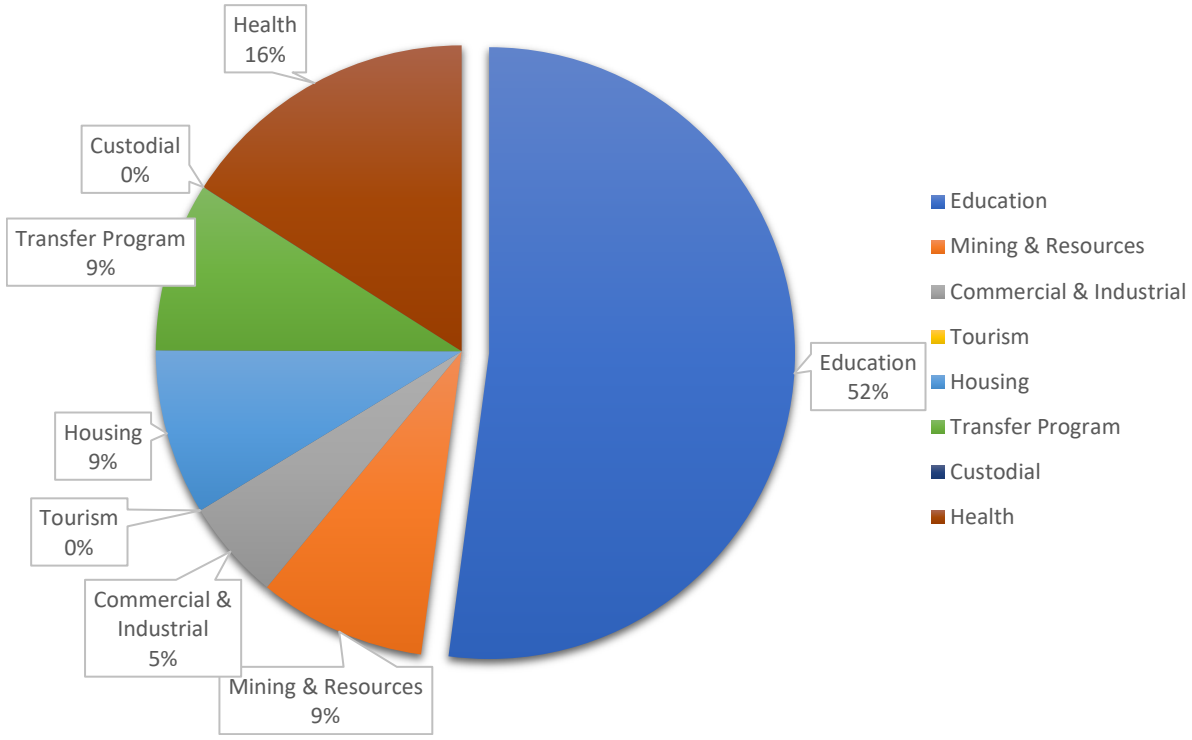

Figure 7. Fleetwood Building Solutions market segmentation as of 2022
(Source: Fleetwood)

b. BlueScope Steel

BlueScope Steel is a key global steel manufacturer, operating in many countries around the world including Australia, the USA, China and India. BlueScope Steel manufactures a range of products for building and construction industries, white goods and manufacturing applications, including steel slab, plate, hot and cold rolled coil, coated and painted strip products through to roof and wall cladding, purlins and house framing, and engineered building solutions. The company's major Australian manufacturing facility is in Port Kembla (NSW), while the distribution centres are located around the country. In Australia, the company employs around 6,000 people in more than 50 facilities and 50 distribution centres.

Generally, finished products are transported to distribution centres around the country using roads, rails and ships. The Pacific National is a key freight partner in distributing steel to Victoria, South Australia and Western Australia.

c. BlueScope Distribution

BlueScope Distribution is part of the broader BlueScope group of businesses, servicing a wide range of industries in Australia. They are an industry-leading steel and aluminium distributor and solutions provider. With a national network of 16 branches across metro locations and major regional towns, BlueScope Distribution aims to provide a diversified range of products, high-quality processing capability, and a broad range of services based on customer needs.

BlueScope Distribution serves diverse industries such as residential building, non-residential building, infrastructure, transport, farming, manufacturing, defence, renewable energy, and mining, oil and gas. Product range includes a wide variety of steel and coil plate products, pre-painted strip products, metallic coated steel products, cold and hot-rolled steel products, reinforcing steel, structural steel, merchant bar products, welded beam and columns, farming products (e.g., irrigation

systems, speed tillers, livestock transport and shedding), aluminium sheet, aluminium plate, aluminium extrusion, and aluminium coil products, as well as pipes, valves and fittings.

BlueScope Distribution can help coordinate a full suite of product, processing and project management requirements.

Products: BlueScope Distribution provides access to a full suite of steel and aluminium products as well as the ability to produce specially designed steel grades outside of the standard product range, through the BlueScope mill. The company helps reduce compliance risk through their ISO 9001 quality management system and ensures full compliance via their material test certificates. Some of the key products they offer are COLORBOND® steel, TRUECORE® steel, ZINACLUME® steel, GALVABOND® steel, ZINCFORM® steel, XLERPLATE® steel, TRU-SPEC® steel and REDCOR® weathering steel.

Processing: The company provides high quality processing capabilities. Key services include steel plate plasma cutting, drilling, etching and bevelling; steel sheet shearing and coil slitting; aluminium routing, sheet shearing and coil slitting; and aluminium PE film application for surface protection.

Solutions: The company provides end-to-end steel and aluminium project management solutions, delivering personalised supply chain coordination by coordinating material from multiple suppliers, managing production schedules, transport and delivery to provide one seamless point of contact. Key solutions include B2B digital system integration, consignment solutions, kitting and product labelling, and product identification for ease of installation (e.g., steel and aluminium surface etching).

BlueScope Distribution has been collaborating with Fleetwood for more than a decade (11–12 years). Figure 8 shows the supply chain of steel product from BlueScope to Fleetwood.

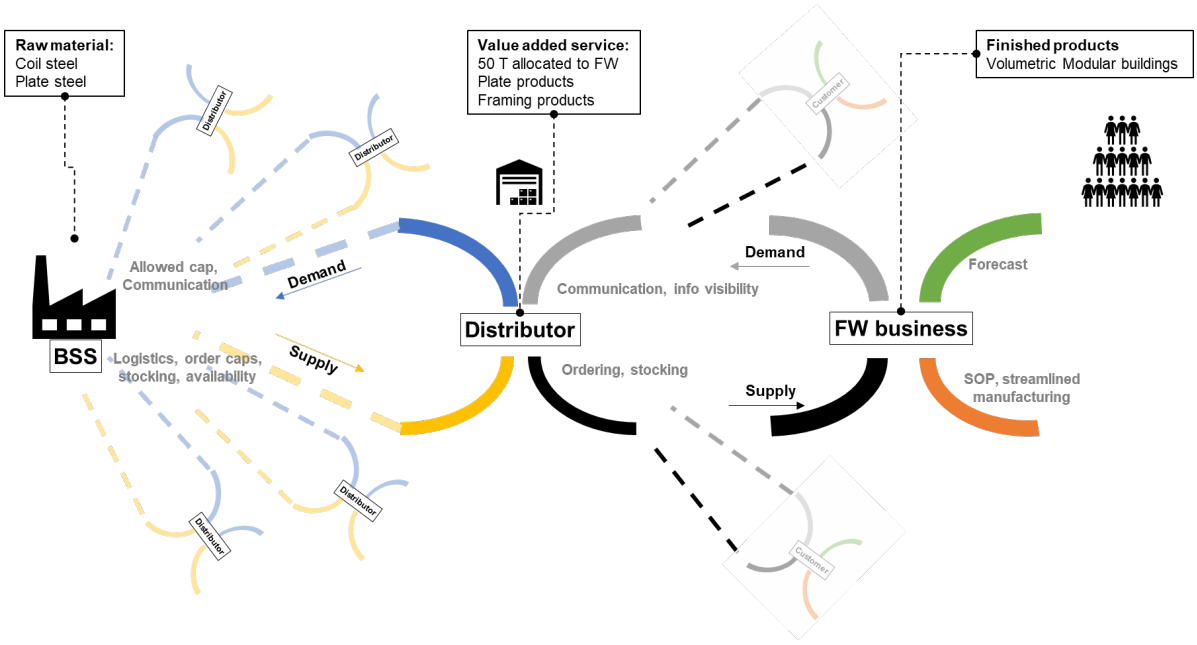

Figure 8. Schematic of steel supply chain for BlueScope – Distributor – Fleetwood

d. Ynomia

Ynomia is a Melbourne-based technology company that develops and applies cutting edge digital solutions to solve some of construction's most complex problems. Ynomia specialises in sensors that provide location and environmental monitoring services in difficult and complex environments where network connectivity is challenged. Thus, Ynomia offers a simple end-to-end technology solution that creates a Connected Jobsite IoT Digital Twin.

Ynomia developed a technology solution that utilises CSIRO-developed Bluetooth Low Energy Aware Tracking (BLEAT) technology to monitor the status of the screens and hatches in real-time in a global first for the construction industry. Ynomia BLEAT technology is uniquely developed for construction and is the basis to drive productivity improvements in the industry.

BLEAT is an indoor localisation and tracking system for objects and people improve productivity, health and safety, and knowledge of infrastructure utilisation through analytics. BLEAT is a first-of-its-kind system, leveraging Bluetooth Low Energy (BLE) for on-device location tracking and relaying (room-level) location through battery-powered BLE-LoRaWAN enabled beacons (BLEAcons). Devices can compute and use their own location and communicate information through to the cloud even in environments where there may be no GPS, cellular or WiFi available.

2.5 Methodology

This study analysed the current operations and the supply chain of Fleetwood, BlueScope Steel and their distributors using the methodology specified by the Supply Chain Operations Reference model (SCOR). It involved interviewing key personnel of the research partners. The SCOR model is organised around the 6 primary management processes called Plan, Source, Make, Deliver, Return and Enable, as shown in Figure 9. A common set of definitions were used to analyse the activities of different organisations in the overall supply chain, by which disparate industries can be linked.

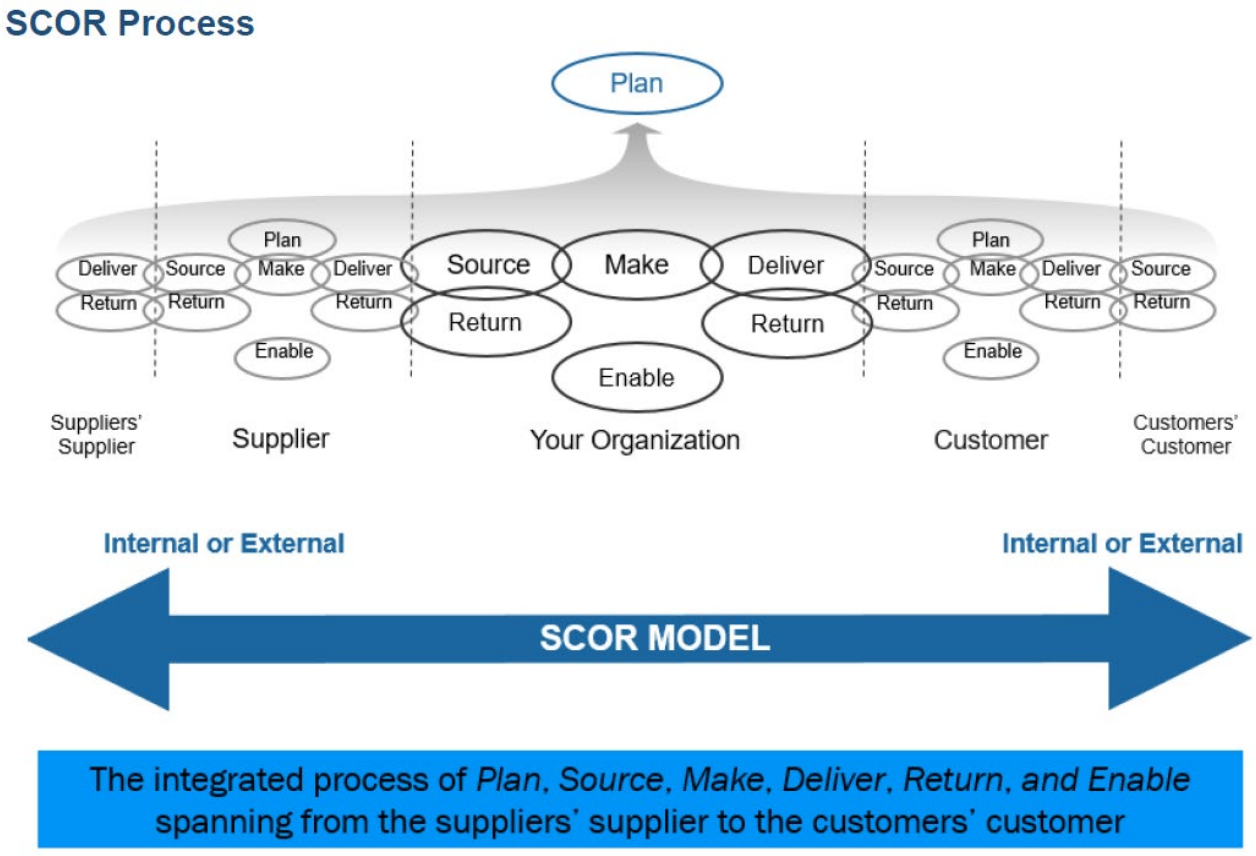

Figure 9. The supply chain operations reference (SCOR) model

The SCOR model can be used to analyse the supply chain at multiple levels, as shown in Figure 10. However, the top 3 process levels are industry neutral. Appendix 1 presents the SCOR model with questionnaires used to interview key personnel of research partners. We analysed the responses to identify pain points and improvement opportunities in the supply chain.

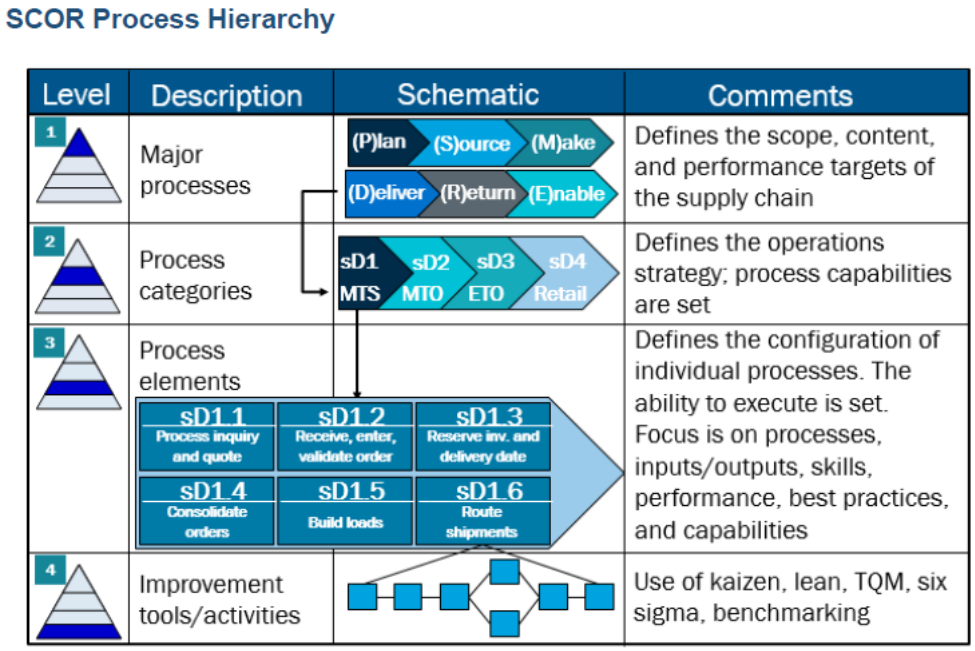

Figure 10. The multiple levels used for the analysis in the SCOR model

3. PROJECT FINDINGS AND OUTCOMES

3.1 Scope for improvement

Category	Improvement opportunity
Forecasting	Using the moving average method for forecasting creating reliability issues with forecasts
	Sudden spikes in certain stock keeping units (SKUs) causing supply chain issues
	Usage statistics from steel distributors and consumers not shared with suppliers
Asset tracking	Communication gap between the 2 ends of the supply chain
	Supply chain lacks asset tracking mechanisms are lacking during transit
Natural disaster	Centralised distribution partners affected during weather incidents such as floods, bushfires
Procurement	Lack of national footprint for material procurement leading to vulnerability in price fluctuations
Factory management	Manual interfaces between material tracking and warehouse management ERP (enterprise resource planning) software
	Manual conversion of architectural/engineering drawings to fabrication drawings
	Analogous manufacturing, lack of industrialised manufacturing equipment
Process optimisation	Scope for manufacturing process optimisation
	Scope for higher process automation starting from the design
	Scope for product optimisation for logistics and delivery

3.2 Prospects

I. Track and chase system for real-time monitoring

Partners would like to improve traceability and real-time monitoring. Generally, finished products from BlueScope Steel are transported to distribution centres around the country using roads, rails and ships. The Pacific National is a key freight partner in distributing steel to Victoria, South Australia and Western Australia. For traceability and quality checking, each coil has a unique barcode that can be traced back to the production; however, the lack of e-track means it is common to lose track of products during shipment. For example, cargo goes to a third party during shipment – e.g. Pacific National or another freight partner – and carriages are swapped or interchanged with other trains. Items generally turn up 4 to 12 days later.

Feasibility

Real-time e-tracking is an opportunity to update the client or the distributors with a more accurate timeframe regarding delivery. It will also give clients more accurate information about product times. This improves the information flow between the clients and BlueScope Steel. Organisations like

Ynomia can help develop an e-tracking system using either BLE, Bluetooth or low-energy wear tracking attached to cargo.

II. Decarbonisation and sustainability efforts

BlueScope's decarbonisation pathway outlines the steps it plans to take to meet its 2030 GHG targets and net zero 2050 goal. BlueScope is continuing to optimise current operating assets across its footprint, including energy and process efficiencies across steel making assets, low carbon energy sources and increased scrap use. BlueScope is also investigating accelerated technology developments in Direct Reduced Iron (DRI) using natural gas as a transitional pathway to using green hydrogen to produce lower emissions steel.

BlueScope is aware of the critical and global importance of climate change to our business and our stakeholders. We have embedded climate action into our corporate strategy, recognising it is crucial to our long-term success, and we have publicly stated our commitment to taking action to reduce our greenhouse gas emissions.

Read more here: https://www.bluescope.com/sustainable-steel/climate-action/

There is significant scope for Fleetwood to improve their sustainability.

Feasibility

Having a sustainable supply chain aims to maintain the long-term growth of all stakeholders. Fleetwood can claim a green star rating based on its sustainability approach. Further, taking a significant step to be environmentally sustainable (e.g., setting a goal to be carbon-free) will help to improve the company's reputation. Established life cycle assessment (LCA) models can be used to benchmark Fleetwood's sustainability performance and develop a framework to improve the company's sustainability performance. Standardising steel products will reduce handling of multiple parts, allow Fleetwood to consistently stock certain standardised products, and improve productivity.

Performing a comparative LCA of cost vs environmental effects for a different design using standardised steel products will help Fleetwood decide this matter. Fleetwood could assess its green star rating via a case study with sufficient structural details for a modular building. The LCA/LCC model can be based on best-known standards and guidelines (e.g., ISO 14044 LCA, BS 8001 circular economy, ISO 20915 LCI steel, etc.) and inventory databases (e.g., NGER, Ecoinvent, EPIC, etc.).

III. Platforms and markets/ modularity of product design / innovations in manufacturing and automation

Platforms and markets

Product platforms are a form of design standardisation that allow for greater manufacturing efficiency at scale. The automotive industry, aircraft industry and ship manufacturing use product platforms for high-volume production. The concept of standardisation is being introduced to the construction industry in a growing effort to view modern construction as manufacturing. The balance between bespoke client demand and a standardised product portfolio is the key to achieving client satisfaction and manufacturing efficiency. Product platforms may benefit building manufacturers by introducing standardised, pre-designed, structurally compliant components that can be assembled to form a building asset. Limiting the component variations for manufacturing could have an easing effect on related supply chain robustness and could lead to better forecasting. Delaying the introduction of product platforms could incur an opportunity cost in the targeted segments, where the demand for housing is increasing, material supply is uncertain, material wastage is costly, sustainability is paramount, and the margins are thin.

Figure 11 depicts conceptual development of a product platform. The platform approach introduces a certain amount of standardisation in product design, which may be unfavourable in some situations. However, the platform approach also facilitates process automation which in turn could create wide array of bespoke products and solutions. With well-defined market segments, manufacturers can take advantage of process as well as product standardisations to maximise efficiency and productivity. A deep understanding is required to answer the following questions and develop an efficient product platform:

1. What is the optimal product platform?
2. What is the number of SKUs in the optimal stock level?
3. What is the optimal technology configuration to be applied in the supply chain?
4. What communications systems could be integrated to improve operational efficiency?
5. Where is the customer order decoupling point?
6. What are the SKUs at different stages of the supply chain?
7. What is the optimal SKU range?

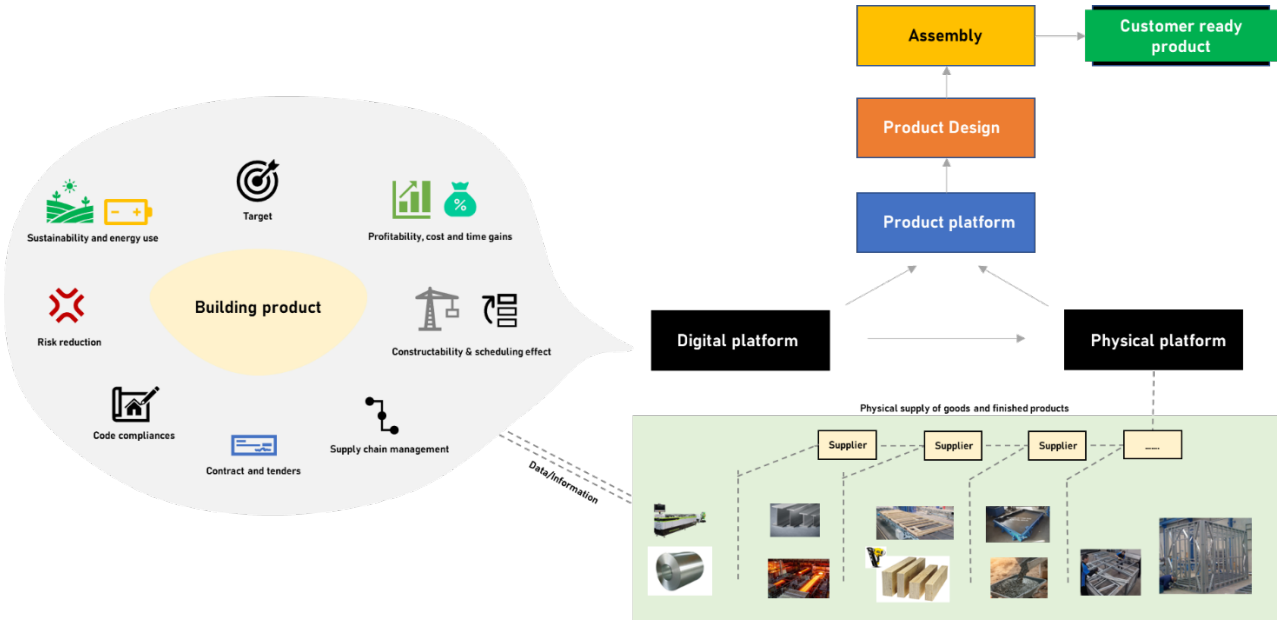

Figure 11. Platform benefits to production and business value chain for volumetric modular company

Feasibility

Introducing product platforms would need an in-depth understanding of a building manufacturer's product offerings and prospective markets. The extent of product standardisation would depend on the nature of the components making up the product, compliance code requirements, council requirements, material availability, supplier network, and the willingness to alter the business value proposition from flexibility to efficiency.

Developing a digital and physical platform of products would allow a manufacturer like Fleetwood to incorporate parameters like sustainability, supplier network, contracts and tenders, productivity and cost etc. into the design process (see Figure 7). The platform could reduce the burden on bespoke manufacturing line design and could increase emphasis on design for assembly. The physical platform could be influenced by the digital platform, which would be based on real-world product information from the supply chain network.

A platform approach could fast track:

a. project quotation at the time of tendering
b. project quantification for sustainability, cost, cost-risk, time, time-risk
c. availability of materials, requirement for ordering
d. forecast demand and maintain transparency in the supply chain.

IV. Innovations in manufacturing

Fleetwood expressed interest in redesigning its production technologies as well as a need for greater standardisation of operating procedures for manufacturing prefabricated units. The implications of design for manufacturing and assembly (DfMA)-led product design for the supply chain and productivity are proposed as a research direction for the upcoming phase.

Feasibility

The principles of DfMA are heavily tied to product design, product offering and manufacturing capability. DfMA is also influenced by the business value proposition and available supplier network. The proposed outcome could be achieved by carefully understanding Fleetwood's current manufacturing setup, product offerings and current design methods. The research would benefit from closer interaction with Fleetwood's design and manufacturing teams, numerical simulations for structural compliances, and prototype creation.

V. Transportation (logistics management)

Transporting prefabricated building units is limited by the maximum gross weight of the cargo and the maximum allowable dimensions. The transportation-related compliances may change with each jurisdiction. In Victoria, the maximum gross weight of the truck is limited to 43.0 tonnes and the maximum dimensions are limited to 5m x 5m x 30m. The load being carried must also satisfy the load restraint mechanisms stipulated by the National Transport Commission. Some truck dimensions also require a pilot or escort vehicle, which can add to transportation costs. Understanding different transportation requirements may help plan heavy haulage transportation.

Feasibility

Creating a parametric model of road transport logistics may be useful in understanding the efficacy and feasibility of product platforms. It may also help illustrate the entire supply chain from raw materials to finished goods. This model can also help better locate distribution centres/warehouses.

VI. Integration of communication systems to improve data interoperability

BlueScope Steel (BSS), BSS Distribution and Fleetwood need to share a great amount of information during their interactions. Communicating this information is key to supply chain success. Enterprise resource planning (ERP) systems may help facilitate information exchange between these organisations. Selecting, implementing and effectively using a suitable ERP system are crucial for managing data and informed decision-making processes.

Using different business management software and ERP systems can limit data interoperability. Although ERP systems help automate business functions for BlueScope Steel and Fleetwood, integrating diverse ERP systems faces numerous challenges. Efficiently integrating ERP systems is needed to improve information flow across the supply chain.

Perceived benefits

- Improve interoperability and interchange of data and information flow by using complementary data environments and/or digital tools.

- Reduce man hours (i.e., physical labour) throughout the supply chain by minimising the number of human interactions to capture and integrate information. (e.g., reducing the use of emails going back and forth, manual data entry of orders and face-to-face meetings to track and integrate information among stakeholders).
- Better predict customer demand, quickly adjust to changes in the market, accelerate the engineer-to-order process, and communicate more effectively.
- Create value by understanding how organisations can interact more effectively, particularly from a 'systems talking to one another' perspective.
- Speed up the digitalisation process.

Feasibility

Different communication systems can integrated using cloud-based tools such as Integration Platform as a Service (iPaaS) solutions, which make integrations easier and address ERP integration challenges. iPaaS solutions are typically built on the cloud and are used for application integration, data integration, B2B ecosystem integration, on-premises integration, application programming interface (API) publishing and other scenarios. iPaaS solutions are generally based on an API integration platform that provides connectivity, workflow design, data mapping and transformation, and an integration life cycle.

However, BlueScope Steel and Fleetwood have unique requirements, making integrating all functionalities across the supply chain challenging. Also, behavioural issues (e.g., resistance to change) may affect the integration/implementation time.

VII. Improving forecasting accuracy

As mentioned earlier, forecasting is important for an end-to-end supply chain. Currently, BlueScope uses, among other processes, a 13-week moving average to forecast the next order, including arranging resources such as sourcing materials (e.g., iron ore, coking coal etc.) from different parts of the country. The company uses this approach because the detailed demand visibility is clouded due to the indirect supply method to downstream customers. However, the accuracy of this approach can be affected by average usage of items for large projects. Similarly, the lead time to deliver non-standard products is up to 13 weeks. In addition, a sudden spike in construction projects can cause supply issues. Therefore, developing an optimal forecasting model by combining diverse statistical and machine learning forecasting techniques can improve forecasting accuracy. Analysis on improving forecasting accuracy will answer the following questions:

1. Where is the optimal push–pull point?
2. What is the 'best' model formulation for supply/demand forecasting?
3. What is the optimal time for updates?

Perceived benefits:

- Improve manufacturing and procurement planning to ensure minimum stock-out and excessive inventory build-up situations.
- Provide organisations with intelligent and smarter forecasts with fast forecast runtime without compromising accuracy.
- Use machine learning techniques to detect unusual patterns in the data, categorise data into different classes of time series, and match a time series to specific methods.
- Combine the strengths of statistical and machine learning algorithms to improve forecasting accuracy (e.g., sometimes a class of time series matches well with machine learning forecast methods, while others match well statistical methods).

Feasibility

Machine learning methods, especially Neural Networks, have been proposed in the academic literature as alternatives to statistical ones to improve time series predictions, suggesting methodological advances and accuracy improvements. However, integrated methods may be computationally more demanding than simple statistical ones, requiring greater dependence on computer science to be implemented.

4. FUTURE RESEARCH PLANS

4.1 Conclusions

This report provides an overview of the current operations and supply chain of Fleetwood, BlueScope Steel and their distributors, and Ynomia. The aim is to facilitate bi-directional feedback that will allow product and design development coordination that emphasises DfMA in developing an operationally-excellent steel-based product platform and production system that suits low and medium-rise buildings up to 8 stories. We conducted a detailed literature review on the business and competitive considerations, sustainability and application of technology and automation in the steel supply chain. Then, we analysed current operations and the supply chain of Fleetwood, BlueScope Steel and their distributors, and Ynomia using the methodology specified by the Supply Chain Operations Reference model (SCOR), interviewing key personnel from research partners. From their responses, we identified pain points in different parts of the supply chain and recommended best practices suggested by the SCOR model. We also identified and recommended future research directions for Phase 2.

4.2 Recommendation for Phase 2

We proposed the following projects for Phase 2. Figure 13 shows the potential value vs feasibility of the proposed projects.

1. **Project:** Development of real-time e-tracking of construction materials
2. **Project:** Developing a framework to visualize/assess/improve the sustainability performance
3. **Project:** Comparative LCA of environmental impact vs cost benefits by standardising steel products for modular construction
4. **Project:** Product platforms implementation and its effect on Fleetwood's prefabricated buildings supply chain
5. **Project:** DfMA-led design and production setup improvements to achieve higher production efficiency
6. **Project:** Transportation model development for logistic cost and compliance optimisation
7. **Project:** Strategies for productivity improvement in power imbalanced supply chains
8. **Project:** Integration of communication systems to improve data interoperability
9. **Project:** Development and implementation of an integrated forecasting model to improve forecasting accuracy

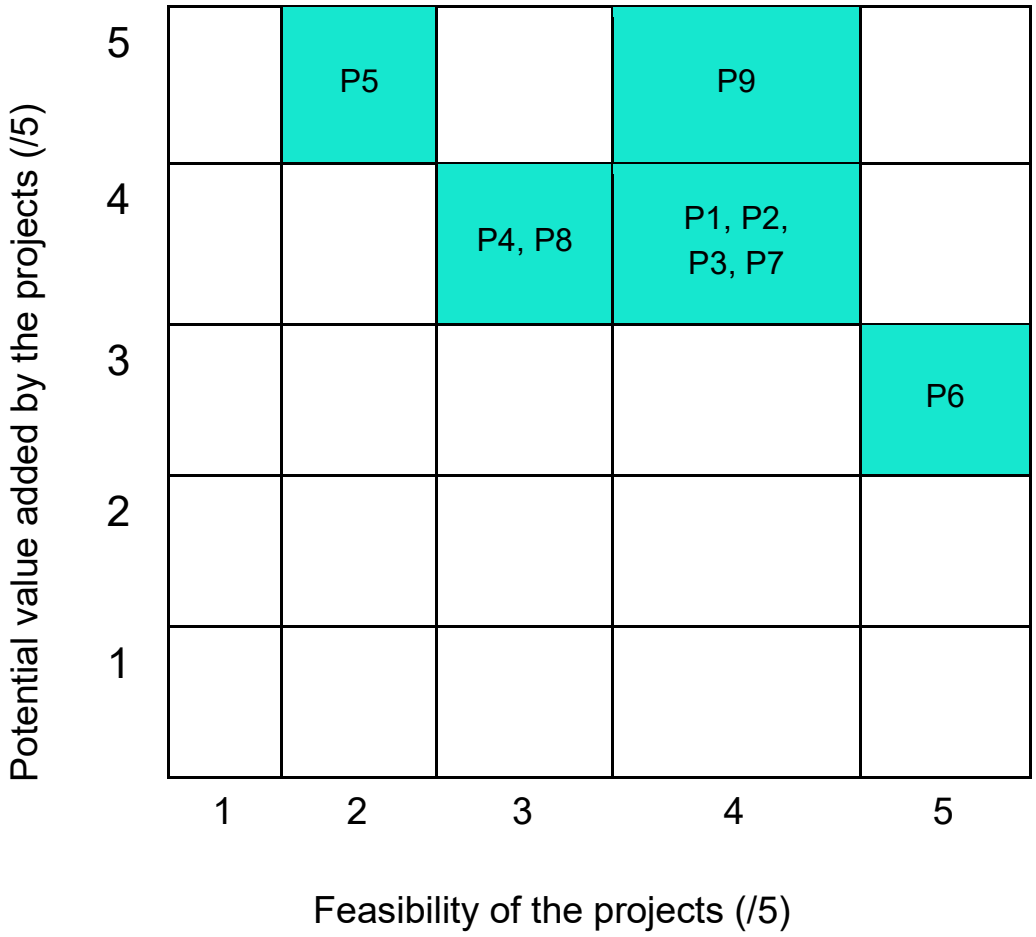

Figure 13 Potential value vs feasibility of proposed projects. (scale out of 5)

5. REFERENCES

1. Disha, J., *Prefabricated Metal Building Manufacturing in Australia*. 2021: IBISWorld. Retrieved from: https://my.ibisworld.com/au/en/industry/c2222/industry-outlook.
2. Sandhu, M.A., P. Helo, and Y. Kristianto, *Steel supply chain management by simulation modelling.* Benchmarking: An International Journal, 2013.
3. Kelly, A., *Institutional Building Construction in Australia*. 2022: IBISWorld. Retrieved from: https://my.ibisworld.com/au/en/industry/e3022/products-and-markets.
4. Disha, J., *Fleetwood Limited*. 2021: IBISWorld. Retrieved from: https://my.ibisworld.com/au/en/company-reports/5688/company-details.
5. Found, P., et al., *Towards a theory of operational excellence.* Total Quality Management & Business Excellence, 2018. **29**(9-10): p. 1012-1024.
6. Luz Tortorella, G., et al., *What does operational excellence mean in the Fourth Industrial Revolution era?* International Journal of Production Research, 2022. **60**(9): p. 2901-2917.
7. Malsinghe, M., et al., *Sustainable Supply Chains of Sri Lankan Manufacturing Organizations: A Study on Operational Excellence Models During the COVID-19 Pandemic.* Operations and Supply Chain Management: An International Journal, 2022. **15**(2): p. 228-239.
8. Dev, N.K., R. Shankar, and F.H. Qaiser, *Industry 4.0 and circular economy: Operational excellence for sustainable reverse supply chain performance.* Resources, Conservation and Recycling, 2020. **153**: p. 104583.
9. Fettermann, D.C., et al., *How does Industry 4.0 contribute to operations management?* Journal of Industrial and Production Engineering, 2018. **35**(4): p. 255-268.
10. Gajdzik, B. and R. Wolniak, *Transitioning of steel producers to the steelworks 4.0—Literature review with case studies.* Energies, 2021. **14**(14): p. 4109.
11. *Ensuring a sustainable steel industry in the 2020s and beyond*. 2020: Australian Steel Institute.
12. Pérez-Lara, M., et al., *Vertical and horizontal integration systems in Industry 4.0.* Wireless Networks, 2020. **26**(7): p. 4767-4775.
13. Tortorella, G.L., et al., *Organizational learning paths based upon industry 4.0 adoption: An empirical study with Brazilian manufacturers.* International Journal of Production Economics, 2020. **219**: p. 284-294.
14. Hua, S., S.R. Chatterjee, and C. Jingliang, *Achieving competitive advantage in service supply chain: evidence from the Chinese steel industry.* Chinese Management Studies, 2011. **5**(1): p. 68-81.
15. Reinartz, W. and W. Ulaga, *How to sell services more profitably.* Harvard business review, 2008. **86**(5): p. 90-6, 129.
16. Ellram, L.M., W.L. Tate, and C. Billington, *Understanding and managing the services supply chain.* Journal of supply chain management, 2004. **40**(3): p. 17-32.
17. Cova, B. and R. Salle, *Marketing solutions in accordance with the SD logic: Co-creating value with customer network actors.* Industrial marketing management, 2008. **37**(3): p. 270-277.
18. Gibson, T.J. and C. Schmitt, *The crisis facing the US steel industry.* CNN. Recuperado el Enero de, 2019.
19. Blitz, A., *Lessons from the steel industry: if you can't compete on price, innovate your way to value-added differentiation.* Strategy & Leadership, 2017.
20. Cairns, I., *Capabilities of the Australian steel industry to supply major projects in Australia.* Australian Steel Institute, 2010. **4**.
21. *Analysis of Steel and Aluminium markets report to the Commissioner of the Anti Dumping Commission*. 2016: Australian Anti-dumping Commission, Melbourne, Australia.
22. Kelly, A., *Structural steel fabricating in Australia.* 2022: IBISWorld. Retrieved from: https://my.ibisworld.com/au/en/industry/c2221/products-and-markets.
23. *Iron Ore, Resources and Energy Quarterly June 2022.* Access : Energy-Quarterly-June-2022-Iron-Ore.pdf.
24. Sikdar, S.K., *Sustainable development and sustainability metrics.* AIChE journal, 2003. **49**(8): p. 1928-1932.
25. Ansari, Z. and M. Qureshi, *Sustainability in supply chain management: An overview.* IUP Journal of Supply Chain Management, 2015. **12**(2).
26. Ageron, B., A. Gunasekaran, and A. Spalanzani, *Sustainable supply management: An empirical study.* International journal of production economics, 2012. **140**(1): p. 168-182.
27. Svensson, G., *Supply chain management versus sustainable chain management.* Esic Market, 2008. **129**: p. 219-237.
28. Cellan-Jones, R. *Apple factories to face independent inspections*. BBC News Technology 2012 July, 2022)]; Available from: http://www.bbc.co.uk/news/technology-1701582.

29. Hofmann, H., et al., *Sustainability-related supply chain risks: Conceptualization and management.* Business Strategy and the Environment, 2014. **23**(3): p. 160-172.
30. Giannakis, M. and T. Papadopoulos, *Supply chain sustainability: A risk management approach.* International Journal of Production Economics, 2016. **171**: p. 455-470.
31. Treleven, M. and S. Bergman Schweikhart, *A risk/benefit analysis of sourcing strategies: single vs. multiple sourcing.* Journal of operations management, 1988. **7**(3-4): p. 93-114.
32. Tang, O. and S.N. Musa, *Identifying risk issues and research advancements in supply chain risk management.* International journal of production economics, 2011. **133**(1): p. 25-34.
33. Zsidisin, G.A., A. Panelli, and R. Upton, *Purchasing organization involvement in risk assessments, contingency plans, and risk management: an exploratory study.* Supply Chain Management: an international journal, 2000.
34. Hallikas, J. and K. Lintukangas, *Purchasing and supply: An investigation of risk management performance.* International Journal of Production Economics, 2016. **171**: p. 487-494.

APPENDIX 1

SCOR MODEL

	Process category	Questions	Answers	KPIs	Best practices	Scor KPIs	Gaps and pain points
Plan supply chain	P1.1 Identify, prioritise and aggregate supply chain requirements	How do you plan to identify and prioritise your requirements?			Environmental impacts are considered		
					Digital links (XML-based, Electronic Data Interchange (EDI), etc.) among supply chain members		
					Collaborative planning system		
					Push-based forecast replaced by pull-based with customer replenishment [standard (RosettaNet, eBXML,Open Applications Group (OAG), etc.) business-to-business (B2B) integration tools/system]		
					Visibility of full stream demand requirements and priorities (supply chain management software, advanced planning and scheduling system)		
					Collaboration among strategy and operation teams		
					Supply chain advance planning system		
		How do you plan to forecast your requirements accurately in time?					
	P1.2 Identify, prioritise and aggregate supply chain resources	How do you plan to identify and prioritise your resources?			Environmental impacts are considered		
					Collaborative planning system		
					Digital links (XML-based, EDI, etc.) among supply chain members		
					Review of product profitability		
					Lead times updated monthly		
		How do you plan to forecast your resources accurately in time?					
	P1.3 Balancing resources and requirements	How do you plan to balance your resources vs requirements?			Balance environmental requirements		
					Customer relationship management		
					Demand planning and demand flow leadership		
					Business intelligence		
		How do you plan to prioritise the gap between resources and requirements?					
		How do you plan to forecast accurately imbalance between resources and requirements?					
	P1.4 Establish and communicate supply chain plan	How do you plan to communicate to meet your requirements vs projected resources in time?			Collaboration among operations strategy team		
					Digital links (XML-based, EDI, etc.) among supply chain members		
					Communicate environmental requirements		

					Supply chain advance planning system		
					System supporting online visibility of full stream demand requirements and priorities as well as resource utilisation and availability		
					Collaborative planning system		
					Collaborate with supply chain partners		
Plan source	P2.1	How do you identify and prioritise your product requirements?			Master production scheduling reflecting management of capacity and supply constraints		
					Provision for short-term flexibility in sales and operations		
					Update of demand plan to reflect customer forecast/consumption		
					Capacities are balanced against the demands during planning		
					Categorisation of 100% of total inventory		
	P2.2	How do you identify, evaluate and aggregate your product resources in time?			Inventory performance is measured at the dollar and unit levels		
					Capacity and supply constraints are balanced against demand during planning		
					Identify recyclables		
					Identify green products		
					Categorisation of 100% of total inventory		
					Minimise packaging		
					Inventory is planned at the part level, based on supply and demand		
					Inventory targets reviewed and adjusted often		
	P2.3	How do you balance your product resources vs product requirements in time?			Suppliers share responsibility for balancing supply and demand through collaborative planning system		
	P2.4	How do you communicate and establish your actions for your projected supply resources meeting sourcing plan requirements?			Digital links (XML-based, EDI, etc.) among supply chain members		
					Blanket purchase orders cover period requirements		
Plan make	P3.1	How do you identify and priortise your production requirements in time?			Consideration of supplier's material availability in company's supply resources (including supplier's production plan and capability, inventory and delivery plans)		
	P3.2	How do you identify, evaluate and aggregate your production resources in time?			Obsolete inventory is reviewed at part number level		
					Inventory targets reviewed and adjusted often		
					Environmental production constraints are considered		
	P3.3				Balance environmental requirements		

		How do you balance your production resources vs production requirements in time?			Inventory targets reviewed and adjusted often		
	P3.4	How do you communicate and establish your production plans representing your projected supply resources meeting production and operating requirements?			Minimise usage of energy		
					Minimise make emissions		
					Unplanned orders are accepted and scheduled only when there is no detrimental impact on overall product delivery plan		
Plan deliver	P4.1	How do you identify and prioritise your delivery requirements in time?			Customer relationship and digital linkages (XML, EDI, etc.) Provide accurate visibility into actual demand		
					Vendor managed inventory (VMI)		
					Ideal stock position based on days/weeks of supply		
					Flexibility for the seasonal and promotional changes		
					Electronic matching of POS data and store inventory		
					Eliminate ‘special deals’ sales		
					RFID and other tagging		
					Unplanned orders are accepted and scheduled only when there is no detrimental impact on overall product delivery plan		
					Forecasts are replaced with actual customer replenishment and orders where possible		
					Match shelf stock to expectations		
					Aggregate requirements to minimise transportation		
	P4.2	How do you identify, evaluate and aggregate your delivery resources in time?			Use reusable packaging		
	P4.3	How do you balance your delivery resources vs delivery requirements in time?			Demand priority reflecting default scheduling priority		
					Maximise loads and minimise transportation runs		
	P4.4	How do you communicate and establish your delivery plans representing your delivery resources meeting your			Address conditions that can't be satisfied during planning and recommend subsequent planning period		
					Plans not violating business rules are communicated openly for execution		

		delivery requirements?			Specified changes to the plan are agreed as per defined business rules		
					Minimise transport and maximise loads		
					Plans that violate the business rules are addressed cross functionally		
Plan return	P5.1	How do you identify, assess and aggregate your return requirements?			Use historical-based return rate forecasts		
					Real-time return anticipation		
					Identify items to return		
					Identify take back programs		
	P5.2	How do you identify, evaluate and aggregate your return resources?			Allow source suppliers full visibility into the current return situations and the forecasted return activity		
					Joint service agreements with the source suppliers to share responsibility and the costs of return		
					Rapid configuration of return capacity		
		How do you balance your return resources vs return requirements?			Advance planning applied to returns		
					Cost accounting system to determine the best return process to follow from a cost-of-business perspective		
	P5.3				Dynamic return restocking management		
	P5.4	How do you communicate and establish your return plans representing your required return resources meeting your return process requirements?			Rapid dynamic reconfiguration of return process to meet demand		
					Full internal visibility to return plans		
Source stocked product	S1.1	How do you schedule and manage the individual product deliveries against the contract or purchase order?			Bundle deliveries		
					Minimising the frequent shipment		
					Electronic Kanban support		
					VMI allow suppliers to manage inventory		
					Utilise EDI transactions to reduce cycle time and costs		
					Consignment inventory management		
					Advance ship notices allow for tight synchronisation between source and make processes		
	S1.2	What are the process and the associated activities of receiving product			Deliveries are balanced daily		
					VMI		
					Supplier delivers directly to point of use		

		to contract requirements?			Bar coding is used to minimise handling time and maximise data accuracy		
					Supplier certification programs are used		
					Carrier agreement		
	S1.3	How do you determine the product is conforming to the requirements and criteria?			Replacement of defective products with good products by supplier at customer's facility		
					Supplier's certification program		
					Deliveries are balanced daily		
					Supplier delivers directly to point of use		
					Bar coding is used to minimise handling time and maximise data accuracy		
	S1.4	How do you transfer product to the appropriate stocking location within supply chain?			Drive deliveries directly to the stock or point of use in manufacturing		
					Implement pollution prevention program		
					Utilise alternative fuel vehicles		
					Utilise high efficiency vehicles		
					Capability transfer to organisation.		
	S1.5	How do you manage the invoice collection, invoice matching and the issuance of checks to suppliers for product and services?					
Source make to order product	S2.1	How do you schedule and manage the individual deliveries of product against the contract?			Utilise EDI transactions to reduce cycle time and costs.		
					Electronic kanban support		
					Minimising the need for frequent shipment.		
		How do you make the detailed source plan including all aspects of managing the contract schedule including service deployment?			Consignment management inventory		
					Bundle deliveries		
					Advance ship notices allow for tight synchronisation between source and make processes		
					VMI		
	S2.2	How do you schedule and manage the individual deliveries of product against the contract?			Utilise EDI transactions to reduce cycle time and costs		
					Electronic kanban support		
					Minimise the need for frequent shipment		
		How do you make the detailed source plan including all aspects of managing the contract schedule including service deployment?			Consignment management inventory		
					Bundle deliveries		
					Advance ship notices allow for tight synchronisation between source and make processes		
					VMI		

	S2.3	How do you verify product meeting compliance, criteria and requirements?			Deliveries are balanced daily		
					Product compliance is met		
					Supplier delivers directly to point of use		
					Bar coding is used to minimise handling time and maximise data accuracy		
					Supplier certification programs are used		
					Carrier agreement		
	S2.4	How do you transfer product to the appropriate stocking location within the supply chain?			Implement pollution prevention		
					Utilise high energy vehicles		
					Drive deliveries to stock or point of manufacturing		
					Capability transfer to customer		
					Utilise alternative vehicles		
	S2.5	How do you authorise and manage the invoice collection, invoice matching and the issuance of checks to suppliers for product and services?					
Source engineer to order product	S3.1	How do you identify and qualify suppliers capable of designing and delivering product meeting required product specification?			Product data management and document management		
					Electronic data communication		
					Purchase recycle products		
					Purchase used suppliers		
					Electronics		
	S3.2	How do you identify final supplier/s and negotiate final contract?			Select firms with Electronics Manufacturing Services (EMS)		
					The use of concurrent engineering		
					The use of ISO standards		
					Automated supplier approval and document management		
					Electronic data transfer		
					Supplier certification programs		
					Cloud-based data management, supplier financials and life cycle		
	S3.3	How do you schedule and manage the execution of individual deliveries of product against the contract?			Electric kanban support		
					Minimise frequent shipment		
					Bundle deliveries		
					Advance ship notices allow for tight synchronisation between source and make processes		
					Consignment agreement		
	S3.4	What processes and activities are involved in receiving product to contract requirements?			Carrier agreement		
					Supplier's certification program		
					Deliveries are balanced daily		
					Supplier delivers directly to point of use or destination		

					Bar coding is used to minimise handling time and maximise data accuracy		
	S3.5	How do you verify product meeting compliance, criteria and requirements?			Deliveries are balanced daily		
					Product compliance is met		
					Supplier delivers directly to point of use		
					Bar coding is used to minimise handling time and maximise data accuracy		
					Supplier certification programs are used		
					Replacement of defective materials		
	S3.6	How do you transfer product to the appropriate stocking location within supply chain?			Drive deliveries directly to the stock or point of use in manufacturing		
					Implement pollution prevention program		
					Utilise alternative fuel vehicles		
					Utilise high efficiency vehicles		
					Capability transfer to organisation		
	S3.7	How do you authorise and manage the invoice collection, invoice matching and the issuance of checks to suppliers for product and services?					
Make to stock	M1.1	How do you schedule production activities?			Cross training/certification		
					Real-time feedback		
					Additional capacity for overflow demand		
					Maintain data and system integrity		
					Schedule minimises changeover costs between products		
					Utilise off-peak shifts		
					Schedule high energy consumption at night		
					Schedule air emissions after sunset		
					Preventive maintenance program		
	M1.2	How do you issue material?			Strategic safety stock of selected materials, items or sub-assemblies to decouple sourced product issuance cycle time from supplier lead time		
					Utilise off-peak shifts		
					Utilise high efficiency vehicles		
					Complete lot history		
					Supplier delivers directly to point of use		
					Demand pull mechanism		
					Preventive maintenance program		
					Back flush material at order completion		
					Electronic material move transaction		
	M1.3	How do you do you product and test your product			Batch history information		
					Real-time quality control		

		meeting compliance?			Design/upgrade production equipment		
					Pollution prevention program		
					Measuring process metrics		
					Benchmark practices		
					Provide environmental training		
					Training employees		
					Paperless production control		
					Accurate and approved process plans specifications		
					Minimise errors		
	M1.4	How do you do package?			Retrieve packaging after installation		
					Postponement and pre-kitting of accessories into modular packages		
					Up-to-date shop packet/ specification for each unique production event/ demand		
					Accurate and low-cost batch/ configuration records for warranty and regular tracking		
					Minimise operator induced errors		
					Maximise container loading		
					Bulk packaging		
					Accurate and approved process plans specifications		
					Reduce non-value added paperwork while still measuring process metrics		
					Design/ upgrade production equipment		
					Packaging operation		
					Automatic label and seal verification		
					Use multi-purpose packaging		
					Use recyclable packaging		
	M1.5	How do you move the product (stage product)?			Electronic material move transaction		
					Direct ship from factory to customer/channel		
	M1.6	How do you release product to deliver?			Accurate and low-cost batch records for regulatory compliance		
					Ensure environmental documentation		
					Review batch records by exception		
					Implement HAZMAT pharmacy system		
					Include supplier environmental information		
					Automated notification of laboratory regarding sample availability		
					Implement an EMS		
	M1.7	How do you dispose waste?			Daily HAZMAT inspection		
					Waste accumulation EMS		

					Stormwater prevention plans		
Make to order	M2.1	How do you schedule production activities?			Cross training/certification		
					Schedule optimisation		
					Produce products to unique customer requirements		
					Demand pull manufacturing		
					Drum buffer rope scheduling techniques		
					Maintain data and system integrity		
					Schedule high energy consumption at night		
					Schedule air emissions after sunset		
					Demand pull mechanism		
	M2.2	How do you issue material?			Complete lot history		
					Supplier delivery to production process		
					Utilise maintenance-free batteries		
					Implement pollution prevention program		
					Utilise alternative fuel vehicles		
					Electronic material move transaction		
					Demand pull mechanism		
					Utilise high efficiency vehicles		
					Back flush material at order completion		
	M2.3	How do you produce your product and test your product to meet compliance?			Batch history information		
					Real-time quality control		
					Design/upgrade production equipment		
					Pollution prevention program		
					Measure process metrics		
					Benchmark practices		
					Provide environmental training		
					Training employees		
					Paperless production control		
					Accurate and approved process plans specifications		
					Minimise errors		
	M2.4	How do you package your products?			Retrieve packaging after installation		
					Postponement and pre-kitting of accessories into modular packages		
					Up-to-date shop packet/ specification for each unique production event/ demand		

					Accurate and low-cost batch/ configuration records for warranty and regular tracking		
					Minimise operator induced errors		
					Maximise container loading		
					Bulk packaging		
					Accurate and approved process plans specifications		
					Reduce non-value added paperwork while still measuring process metrics		
					Design/ upgrade production equipment		
					Packaging operation		
					Automatic label and seal verification		
					Use multi-purpose packaging		
					Use recyclable packaging		
	M2.5	How do you move the product (stage product)?			Electronic material move transaction		
					Direct ship from factory to customer/channel		
	M2.6	How do you release product to deliver?			Accurate and low-cost batch records for regulatory compliance		
					Review batch records by exception		
					Implement HAZMAT pharmacy system		
					Automated notification of laboratory regarding sample availability		
					Implement an EMS		
	M2.7	How do you dispose waste?			Daily HAZMAT inspection		
					Waste accumulation EMS		
					Implement pollution prevention program		
Engineer to order	M3.1	How do you finalise production engineering?			Automated conversion of engineering drawings into product specifications		
					Automated configuration management		
	M3.2	How do you schedule production activities?			Additional capacity for overflow demand		
					Utilise off-peak shifts		
					Schedule minimises changeover costs between products		
					Design/ upgrade production equipment		
					Maximise data integrity and system accuracy		
					Cellular manufacturing		
					Build sub-assemblies to forecast at highest generic level in bill of material		

					Schedule includes preventive maintenance program		
					Schedule air emissions after sunset		
					Schedule reflects current plant status		
					Demand pull mechanism		
					Cross-training/certification		
					Schedule high energy consumption at night		
	M3.3	How do you issue material?			Utilise alternative fuel vehicles		
					Demand pull mechanism		
					Electronic material move transaction.		
					Back flush material at order completion		
					Utilise high efficiency vehicles		
					Supplier delivery to production process		
					Implement pollution prevention program		
	M3.4	How do you produce you product and test your product to meet compliance?			Link individual performance to organisational and divisional goals		
					Real-time quality and statistical control		
					Design/upgrade production equipment		
					Pollution prevention program		
					Measure process metrics		
					Benchmark practices		
					Provide environmental training		
					Train employees		
					Paperless production control		
					Accurate and approved process plans specifications		
					Maintain accurate let/batch history information		
					Up-to-date shop packet/ specifications		
					Reduce non-value added activities including queue, move, set-up times		
					Minimise errors		
	M3.5	How do you package your products?			Retrieve packaging after installation		
					Postponement and pre-kitting of accessories into modular packages		

					Up-to-date shop packet/ specification for each unique production event/ demand		
					Accurate and low-cost batch/ configuration records for warranty and regular tracking		
					Minimise operator induced errors		
					Maximise container loading		
					Bulk packaging		
					Accurate and approved process plans specifications		
					Design/ upgrade production equipment		
					Packaging operation		
					Automatic label and seal verification		
					Use multi-purpose packaging		
					Use recyclable packaging		
	M3.6	How do you move the product (stage product)?			Electronic material move transaction		
					Direct ship from factory to customer/channel		
	M3.7	How do you release product to deliver?			Accurate and low-cost batch records for regulatory compliance		
					Review batch records by exception		
					Implement HAZMAT pharmacy system		
					Automated notification of laboratory regarding sample availability		
					Implement an EMS		
	M3.8	How do you dispose waste?			Daily HAZMAT inspection		
					Waste accumulation EMS		
					Stormwater prevention plans		
Deliver stocked product	D1.1	How do you receive and respond to general customer inquiries and requests for quote?			Quote capability, without reserving inventory, which can be converted into an order in a single step		
					Single point of contact for all order inquiries (including order entry)		
	D1.2	How do you receive, enter and validate orders?			Remote order entry capability		
					Enable real-time visibility into backlog, order status, shipments, scheduled material receipts, customer credit history and current inventory position		
					Value pricing based on ‘cost-to-serve’; everyday low price (EDLP); cost-plus pricing		
					Automatic credit checking		

					Continuous replenishment programs		
					Electronic commerce, automatic stock check and reservation of inventory		
	D1.3	How do you reserve inventory and determine delivery date?			Include environment costs		
					Inventory allocation		
					Priority-based inventory reservations		
					Automatic reservation of inventory and dynamic sourcing		
					Establish spill controls		
					EDI links between manufacturing and distributor		
	D1.4	How do you analyse orders to determine the groupings that result in least cost/best service fulfillment and transportation?			Consolidate orders by customer, source, traffic lane, carrier etc.		
					Consolidate to minimise energy consumption		
					Combine consolidation needs with other products/companies		
	D1.5	How do you select transportation mode and build efficient loads?			Consolidation of inbound and outbound requirements		
					VMI		
					Build load in stop sequence		
					Select carriers with good records		
					Select carriers with EMS		
					Continuous replenishment program (CRP) and vendor managed inventory (VMI) loads optimised for utilisation		
	D1.6	How are loads consolidated and routed by mode, lane and location?			VMI		
					Shipment tracking and tracing		
					Consolidation of carriers		
					CRP/VMI		
					Route to minimise fuel consumption		
	D1.7	How do you select carriers and rate and tender shipments?			Carriers with EMS		
					Select compliant carriers		
					Select carriers using refurbished tires		
					Select carriers that are cheapest per shipment		
	D1.7	How do you select carriers and rate and tender shipments?			Carriers with EMS		
					Select compliant carriers.		
					Select carriers using refurbished tires		
					Select carriers that are cheapest per shipment		
	D1.8	How are activities such as receiving product, verifying, recording product receipt, determining put way location, putting away and recording location including inspection carried out at your company?			Automatic identification		
					Cross-docking		
					Merge in transit		
					Automatic receiving and put away		
	D1.9				Dynamic simulation of picking		

		How do you retrieve orders to pick, determine inventory availability, pick the product, record the pick and deliver product to shipping in response to an order?			Automated handling		
					Merge in transit		
					Automatic receiving and put away		
	D1.10	How do you pack the product?					
	D.11	How do you load the product and generate shipping documentation?			Shipment tracking		
					Full visibility of credit history by shipping personnel		
					Advanced shipping notices and container labelling		
					Carrier agreement		
					Automatic generation of documents		
					Integrated credit checking		
					Cross-docking		
	D1.12	How do you ship the product to the container site?			Shipment tracking		
					Cross-docking		
					Retrieve packaging after installation		
	D1.13	How do you receive and verify product by customer?			Advanced shipping notices and container labelling		
	D1.14	How do you install products?			Joint service agreement to document acceptable service levels		
	D1.15	What is the procedure for invoicing in your company?			Electronic transfer of shipment information		
					Provide visibility to and quickly escalate delinquent accounts		
					Using EDI and file transfer protocol (FTP)		
Deliver make to order product	D2.1	How do you process and respond to general customer inquiries and requests for quotes?			Quote capability without reserving inventory		
					Single point of contact for all orders		
	D2.2	How do you receive, configure, enter and validate orders?			Remote order entry capability		
					Enable real-time visibility into backlog, order status, shipments, scheduled material receipts, customer credit history and current inventory position		
					Value pricing based on ‘cost to serve’; EDLP; cost-plus pricing		
					Automatic credit checking		
					Continuous replenishment programs		
					Electronic commerce, automatic stock check and reservation of inventory		
	D2.3				Include environment costs		

		How do you reserve inventory and determine delivery date?			Inventory allocation		
					Priority-based inventory reservations		
					Automatic reservation of inventory and dynamic sourcing		
					Establish spill controls		
					EDI links between manufacturing and distributor		
	D2.4	How do you analyse orders to determine the groupings that result in least cost/best service fulfillment and transportation?			Consolidate orders by customer, source, traffic lane, carrier etc.		
					Consolidate to minimise energy consumption		
					Combine consolidation needs with other products/companies		
	D2.5	How do you select transportation mode and build efficient loads?			Consolidation of inbound and outbound requirements		
					VMI		
					Build load in stop sequence		
					Select carriers with good records		
					Select carriers with EMS		
					CRP and VMI loads optimised for utilisation		
	D2.6	How are loads consolidated and routed by mode, lane and location?			VMI		
					Shipment tracking and tracing		
					Consolidation of carriers		
					CRP/VMI		
					Route to minimise fuel consumption		
	D2.7	How do you select carriers and rate and tender shipments?			Carriers with EMS		
					Select compliant carriers		
					Select carriers using refurbished tires		
					Select carriers that are cheapest per shipment		
	D2.8	How are activities such as receiving product, verifying, recording product receipt, determining put way location, putting away and recording location including inspection carried out at your company?			Automatic identification		
					Cross-docking		
					Merge in transit		
					Automatic receiving and put away		
	D2.9	How do you retrieve orders to pick, determine inventory availability, pick the product, record the pick and deliver product to shipping in response to an order?			Dynamic simulation of picking		
					Automated handling		
					Merge in transit		
					Automatic receiving and put away		
	D2.10	How do you pack the product?					
	D2.11	How do you load the product and generate shipping documentation?			Shipment tracking		
					Full visibility of credit history by shipping personnel		

					Advanced shipping notices and container labelling		
					Carrier agreement		
					Automatic generation of documents		
					Integrated credit checking		
					Cross-docking		
	D2.12	How do you ship the product to the container site?			Shipment tracking		
					Cross-docking		
					Retrieve packaging after installation		
	D2.13	How do you receive and verify product by customer?			Advanced shipping notices and container labelling		
	D2.14	How do you install products?			Joint service agreement to document acceptable service levels		
	D2.15	What is the procedure for invoicing in your company?			Electronic transfer of shipment information		
					Provide visibility to and quickly escalate delinquent accounts		
					Use EDI and FTI		
Deliver engineer to order product	D3.1	How do you obtain and respond to potential customer inquiries and requests for quotes?			Partnership with outside design firm		
					Use of computer-aided design/computer-aided engineering (CAD/CAE) applications		
	D3.2	How do you negotiate and receive contracts?					
	D3.3	How do you enter orders, commit resources and launch programs?					
	D3.4	How do you schedule installation?					
	D3.5	How do you select transportation mode and build efficient loads?			Consolidation of inbound and outbound requirements		
					VMI		
					Build load in stop sequence		
					Select carriers with good records		
					Select carriers with EMS		
					CRP and VMI loads optimised for utilisation		
	D3.6	How are loads consolidated and routed by mode, lane and location?			VMI		
					Shipment tracking and tracing		
					Consolidation of carriers		
					CRP/VMI		
					Route to minimise fuel consumption		
	D3.7	How do you select carriers and rate and tender shipments?			Carriers with EMS		
					Select compliant carriers		
					Select carriers using refurbished tires		
					Select carriers that are cheapest per shipment		
	D3.8	How are activities such as receiving product, verifying, recording product receipt,			Automatic identification		
					Cross-docking		
					Merge in transit		

		determining put way location, putting away and recording location including inspection carried out at your company?			Automatic receiving and put away		
	D3.9	How do you retrieve orders to pick, determine inventory availability, pick the product, record the pick and deliver product to shipping in response to an order?			Dynamic simulation of picking		
					Automated handling		
					Merge in transit		
					Automatic receiving and put away		
	D3.10	How do you pack the product?					
	D3.11	How do you load the product and generate shipping documentation?			Shipment tracking		
					Full visibility of credit history by shipping personnel		
					Advanced shipping notices and container labelling		
					Carrier agreement		
					Automatic generation of documents		
					Integrated credit checking		
					Cross-docking		
	D3.12	How do you ship the product to the container site?			Shipment tracking		
					Cross-docking		
					Retrieve packaging after installation		
	D3.13	How do you receive and verify product by customer?			Advanced shipping notices and container labelling		
	D3.14	How do you install products?			Joint service agreement to document acceptable service levels		
	D3.15	What is the procedure for invoicing in your company?			Electronic transfer of shipment information		
					Provide visibility to and quickly escalate delinquent accounts		
					Use EDI and FTI		
Deliver retail product	D4.1	How do you generate stocking schedule?			Automatic pick list		
					Labour scheduling that matches product flow		
					Push product on trailer arrival		
	D4.2	How do you receive product at the store?			Push product on trailer arrival		
					Automatic pick list		
					Labour scheduling that matches product flow		
					Push product on trailer arrival		
	D4.3	How do you pick product from backroom?			Staging based on in-store zones		
					Automated directed picking		
					Automated replenishment of back stock		
					Defined stocking levels and criteria		
	D4.4				Proof of performance		

		How do you stock shelf? For example as per merchandise plans, recording inventory transactions etc.			Scan displays for promotion conformance		
					Off-peak stocking		
					item/shelf scanning		
	D4.5	How do you fill shopping cart?			Multiple locations throughout store		
					Up- and cross-selling		
					Substitution		
					Loyalty card data		
	D4.6	How do you checkout ?			Notification of exiting		
					Automatic customer payment		
	D4.7	What is your procedure for preparing and installing the product at the customer site?			Goals/performance plans		
					Measurement, monitoring and adjustment		
					Stage product or service adoption		
Enable supply chain business rule	E1.1	How do you gather business rules requirements? That includes collecting, organising, prioritising and scheduling policies and directives requiring new supply chain business rules, changes to business rules or discontinuation of business rules.			Business rule management		
					Workflow automation		
					Documentation management		
					Controls and compliances		
	E1.2	How do you interpret business rule requirements such as determining how the policy or directive impacts supply chain processes, technology and business rules?			Workflow automation		
					Documentation management		
					Controls and compliances		
	E1.3	What is your current process of writing the business rule in the appropriate system of record?			Workflow automation		
					Documentation management		
					Controls and compliances		
					Environmental health and safety (EHS) regulations		
					Import/export regulations		
					Intellectual property/proprietary data		
					International trade		
					Legislation and standards		
					Total quality management (TQM)		
					Warranty process and policy		
	E1.4	How do you communicate business rules?			Document management system		
					Workflow automation		
	E1.5	How do you release and publish business rules?			Document management system		
					Workflow automation		
	E1.6				Document management system		

		How do you retire or deactivate business rules?			Workflow automation		
Manage supply chain performance	E2.1	How do you initiate reporting?					
	E2.2	How do you review/analyse the reported performance?			Performance management		
					Supply chain performance measurements		
	E2.3	How do you find the root cause i.e., gap in the performance?			Performance management		
					Supply chain performance measurements		
					Trouble shooting		
	E2.4	How do you prioritise root causes?			Performance management		
	E2.5	How do you identify, document and test corrective actions to address the root cause to close the performance gap?			Performance management		
	E2.6	How do you obtain approve, prioritise, communicate and launch the corrective actions?			Performance management		
Manage data and information	E3.1	What is your process of receiving, validating and logging the request for information, configuration or system functionality maintenance?					
	E3.2	How you determine the activities required to perform the requested maintenance?					
	E3.3	How do you maintain and code, i.e., the process of formatting, entering, loading, editing or deleting the information, software updates and code changes are updated?			ERP system		
	E3.4	What is the current process of establishing, changing or removing access rights for users?					
	E3.5	How do you publish information that includes the process of activating the changes to information, configuration and/or code and populating the information to dependent					

		systems, where applicable?					
	E3.6	What is your current process of verifying the information is properly recorded in the system of record and populated to dependent systems?					
Manage supply chain human resources	E4.1	How do you identify skills and resource requirements?					
	E4.2	How do you identify available skills and resources?					
	E4.3	How do you match skills or resource demand with the available skills/resources?					
	E4.4	How do you identify the sources of new hires or sources and destinations for redeployment?					
	E4.5	How do you identify training and education programs to ensure existing (and newly hired) employees will have the appropriate skills to perform the work allocated to each individual employee?					
	E4.6	How do you approve hiring, redeployment, training and education plans, and prioritise and execute these plans?					
Manage supply chain assets	E5.1	How do you schedule asset management activities?			Predictive maintenance		
					Total preventative maintenance program		
	E5.2	How do you take an asset offline i.e., needs to be stopped or put into maintenance mode?					
	E5.3	How do you perform standard inspection and detailed troubleshooting if required?					
	E5.4	How do you install new hardware, software or functionality (equipment/ assets)?					
	E5.5	How do you clean, maintain and repair your assets?					

	E5.6	How do you decommission and dispose of existing hardware, software or functionality (equipment/ assets)?					
	E5.7	How do you inspect maintenance?					
	E5.8	How do you complete maintenance work and prepare an asset to be brought online?					
Manage supply chain contracts / agreements	E6.1	How do you receive contracts and execute agreement updates?					
	E6.2	How do you enter and distribute contracts in your company?					
	E6.3	How do you activate and archive contracts?					
	E6.4	How do you review contractual performance?					
	E6.5	How do you identify and prioritise key performance issues or areas of ongoing process improvement?					
	E6.6	How do you identify resolution and improvements?					
	E6.7	How do you select, prioritise and distribute issue resolutions?					
Manage supply chain network	E7.1	How do you select scope and organisation? Note that organisation selection includes identification and securing availability of sponsor, stakeholders and data/information providers as well as selecting project team members.					
	E7.2	How do you gather input and data for the supply chain?					
	E7.3	How do you develop scenarios ('what if') in support of different strategies and projections?					

	E7.4	How do you develop models and/or simulate models to run 'what if' scenarios through a validation process?					
	E7.5	How do you estimate the effort, risks and results of implementing the scenario? Effort includes estimating the risks and duration and the funding, staffing and skills required to implement the scenario.					
	E7.6	How do you select and approve supply chain network/ configuration changes?					
	E7.7	How do you develop a roadmap for a change? This includes identifying the steps (or projects) required to implement changes to facilities, contracted parties, staffing, automation and process.					
	E7.8	How do you launch a change program?					
Manage regulatory and voluntary compliance	E8.1	How do you identify regulatory publications, subscribe to publications, receive and register publications of relevant regulatory entities?					
	E8.2	How do you read, interpret and research policies, laws, rules and regulations?					
	E8.3	How do you identify regulatory deficiencies, keeping in view your past, current and future regulatory requirements that are not or cannot be met in the prevailing business rules?					
	E8.4	How do you define remediation for any deficiency ?					
	E8.5	How do you verify the remediation strategy with controlling entities and/or obtain a licence certifying compliance by the controlling entity?					

	E8.6	How do you publish remediations?					
Manage supply chain risk	E9	How do you define and document the objectives and scope (internal and external) for managing risk?					
	E9.2	How do you identify risk events?					
	E9.3	How do you quantify risks?					
	E9.4	How do you evaluate risks?					
	E9.5	How do you mitigate risk ?					
Manage supply chain procurement	E10.1	What is your process of developing a strategy and plan to procure the products and services?					
	E10.2	How do you the market test and market engagement in pre-procurement condition?					
	E10.3	How do you develop procurement documentation (pricing, product and quality (ppq)/ detailed spec.)?					
	E10.4	How do you select suppliers to participate in invitation to tender (ITT) and request for quotation (RFQ) negotiation?					
	E10.5	How do you issue invitation to tender (ITT) and request for quotation (RFQ)?					
	E10.6	How are bids and/or proposals evaluated and validated to select the preferred supplier(s)?					
	E10.7	How is contract award and implementation executed in your company? Note: Once the supplier has been selected, a contract is typically developed that allows both parties to fully understand their obligations and key success criteria as part of the agreement.					
	E11.1						

Manage supply chain technology		How do you define supply chain technology requirements? This can involve internal and external research to develop robust requirements.					
	E11.2	How do you identify technology solution alternatives ?					
	E11.3	How do you define and update a supply chain technology roadmap?					
	E11.4	How do you select technology solution?					
	E11.5	How do you deploy technology solution?					
	E11.6	How do you maintain and improve technology solution?					
	E11.7	How do you remove or retire a supply chain technology solution from active use?					

building 4.0 crc

info@building40crc.org
www.building4pointzero.org
/building-4-0-crc