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Lappeenranta University of Technology

Industrial Engineering and Management
Master's Program: Global Management of Innovation and Technology

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**Ensuring Product Safety in the Global Supply Chain
Upstream: A Case Study**

Master's Thesis

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ABSTRACT

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<p>Organisations face intricate and more extended supply chain network shaped by the globalisation of value chain. This led to several instances of safety incidents, and product recalls attributed to poor design of components or supplies from the suppliers in low-cost locations. This single case-study-based research aims to assess the approaches and processes employed by the case organisation in the global supply chain upstream (GSCU) to mitigate the escalator product safety concerns.</p> <p>The case organisation is among the top five manufacturers in the escalator market and currently sourcing significant components of an escalator globally. In the recent time, the escalator market has seen some high-profile safety incidents, and escalator safety department at KONE decided to proactively improve its product safety to mitigate the probability of such instances on KONE's brand name. Therefore, this thesis materialised with the consideration for product development and global sourcing activities in the GSCU that have a high influence on product safety.</p> <p>This thesis utilised a theoretical framework based on agency theory, resource-based view and transaction cost economics to assess the gathered data through the interviews of business leaders, functional experts and organisation's records. The findings coded using content analysis and five emergent themes are identified, and then recommendations for identified challenges and opportunities are provided followed by managerial, societal and theoretical implications. Improving product safety in the GSCU decreases the probability of fatalities in societies and pecuniary aftermaths for organisations, and concurrently increases the public trust on the organisational brand.</p>	
Keywords: global supply chain, global sourcing, product development, product safety	

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"We all need people who will give us feedback. That's how we improve." – Bill Gates

Hyvinkää, 27th of April 2018

Vivek Prakash Nigam

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LIST OF ABBREVIATIONS

ASME	American Society of Mechanical Engineers
DSC	Domestic supply chain
EBIT	Earnings before interest and tax
EFTA	European Free Trade Association
ELA	European Lift Association
EU	European Union
FL	Frontline
GSC	Global supply chain
GSCU	Global supply chain upstream
GSP	Global sourcing process
IPR	Intellectual property rights
KSO	KONE supply organisation
NPD	New product development
PD	Product development
PDP	Product development process
R&D	Research and development
RBV	Resource-based view
SGM	Stage-gate model
SL	Supply line
SQM	Supplier quality management
TCE	Transaction cost economics

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1 INTRODUCTION

Eased trade regulations and easy access to the new market entrants place organisations under severe pressure to reduce the input costs for sustainable operations and remain competitive (Prasad and Sounderpandian 2003). Organisations have relocated their factory operations and material supplies near low-cost raw material and economical labour in the countries such as China or India (Ibrahim et al. 2015; Moe et al. 2014). Also, the organisation's supply chain, starting from the product design to order fulfilment, has become multifaceted with a presence in several geographies (Golini and Kalchschmidt 2015; Prasad and Sounderpandian 2003), especially sub-contractors and suppliers in the low-cost countries. This chain of events has made the organisations' processes challenging to comprehend and occasionally results in the quality issues because of the underestimation of intricacies involved in the processes (Steven et al. 2014) and presents various "risks and vulnerabilities" related to the product safety (Maruchek et al. 2011, 707).

Product safety denotes the decrease in the possibility that use of a product lead to a health hazard or cause detrimental results to product, infrastructure or people (Hora et al. 2011; Maruchek et al. 2011). Ensuring product safety is the utmost important factor in the global supply chain (GSC) since safety issues in the fields have significant societal and financial repercussions. The societal repercussions include the unfavourable effect on the families or section of societies, when end-user(s) or people involved in the supply chain getting injured, incapacitated or deceased. These incidents damage the image of the organisation involved along with the trust of customers and society that subsequently translates into financial repercussions. The aim of this case study based qualitative research is to empirically investigate the approaches employed and challenges experienced by the case organisation to mitigate the product safety issues in the GSC upstream (GSCU) for the escalator.

1.1 Research background

Product recalls related to product safety commonly stun the customers and question the ability of the organisations to manufacture reliable and safe products (Gallup 2008). With increasing globalisation, Maruchek (1987) argued that even a single safety issue can have substantial consequences around the globe. Historically, these safety issues mostly ascribed to the inherent errors in product design, inefficient quality control in a production process, sub-standard raw material or insufficient operating instructions (Hora et al. 2011). Sanchanta and Takahasi (2010) provided the example of Toyota recalls in 2009 and 2010 that led to not only fines and legal expenses but also losses due to lost sales worldwide and additional expenditures by the organisation to re-establish the brand. Such issues not only put the end-users life in danger but also carry potential disastrous financial consequences for organisations (Wowak and Boone 2015).

The case organisation for this thesis, KONE Corporation, is operational in the elevator and escalator market. The escalator market has experienced considerable growth in the last decade, and so does the escalator deliveries made by KONE. During the same time, the escalator market has seen some high-profile safety incidents that questioned the passengers' safety on the product. This thesis initiated as a part of KONE's escalator safety department's initiative to proactively improve its product safety and mitigate the probability of safety instances on KONE supplied escalators. Zhou *et al.* (2017) contend that addressing any product related issue in the upstream of supply chain helps the organisation to save cost and maintain reputations. Therefore, this thesis assesses the current approaches and practices involved in the GSCU and provides recommendations for making respective processes more robust from the perspective of product safety. The thesis utilises literature from industry practitioners and academic scholars for the assessment and benchmarking purposes and provides recommendations and implications for consideration.

The area of product safety and its relationship with product development (Pyke and Tang 2010; Zhu et al. 2016) and global sourcing (Steven et al. 2014) in a GSC is an evolving topic in the risk management literature and has experienced the augmented scholars' consideration in the preceding years (Christopher et al. 2011; Lyles et al. 2008; Maruchek et al. 2011; Pyke and Tang 2010; Stanczyk et al. 2017; Steven et al. 2014; Wowak and Boone 2015). However, considerable literature is in the area of risk management of supply chain and focuses on product flow and defect or quality of products majorly in retail, food and pharmaceutical sectors. To the best of author's knowledge, the study specifically on the organisational approaches and processes to mitigate the product safety-related problems especially in the GSCU (i.e. product development and global sourcing) in the escalator industry is not available. This study fills this research gap by focusing on the GSCU and assess product development process (PDP) and global sourcing process (GSP) for the case organisation in the context of escalator product safety.

1.2 Objective and research questions

The globalisation of organisations is one of the critical drivers for the inclusion of GSC in the organisational strategy. Gereffi et al. (2005) illustrated that a GSC could be assessed through the concept of the global value chain. The concept of value chain denotes the set of activities (e.g. research and development, purchasing or sourcing, operations or production, sales, and service) undertaken by an organisation to produce a valued product or service that can be retailed in the market (Porter, 1985). Addressing any product related issue in the supply chain upstream helps the organisation to save cost and maintain reputation (Zhou et al. 2017). Thus, this thesis work considers two principal activities: global sourcing and product development (PD) in the GSCU.

PD signifies the set of activities and processes to realise an original product, product modifications or improvements, and brand building through the efforts of R&D function (Kotler and Armstrong 2010). Global sourcing is a broad strategic concept in the larger organisations, encompassing international procurements from the inside and

outside the organisational boundaries with some intersections with production and PD (Schneider et al. 2013).

Organisations in the western world are actively sourcing products from the low-cost countries such as China in a bid to remain competitive. However, such supplies accompany with the intricacies that possibly affect the product performance or safety (Subramanian et al. 2015). In 2017, European Union (EU)'s Rapid Alert System for dangerous non-food products (RAPEX) issued 2201 notifications, an increase of 7.7% from 2016, related to products present a safety risk to end users, and a significant number of the items originated from outside Europe (RAPEX 2017; 2018). These recurring issues can be attributed to the challenges faced by organisations to create global sourcing strategies to mitigate product operational or safety issues (Subramanian et al. 2015; Stanczyk et al. 2017).

The objective of this thesis is to explore the successful approaches and practices in PD and global sourcing developed and implemented by the case organisation keeping product safety in focus. Additionally, identification of the improvement opportunities along with the potential solutions. To meet the objective of this thesis following research questions (RQs) are framed:

RQ1. How is safety ensured in the product development process of an escalator?

RQ1.1. What are the parameters that affect safety in product design?

RQ2. How is an escalator manufacturing organisation mitigate the safety issues while sourcing globally?

RQ2.1. What are the approaches and parameters affect product safety in global sourcing setting?

RQ3. What are the challenges in product safety mitigation in the upstream of a global supply chain?

1.3 Research scope and delimitations

This thesis work aims to investigate the approaches and practices employed by an escalator manufacturer in the GSCU from the perspective of product safety. The concept of a GSC is considered as the global networking of internal functions within an organisation and with external suppliers (Prasad and Sounderpandian 2003). The flow of material and information in these networked firms can also visualise as the creation of value that termed as the value chain (Holweg and Helo 2014). The principal activities in the value chain are research and development (R&D), purchasing or sourcing, operations or production, sales, and service (Porter 1985). This thesis focusses on the upstream of this value chain and takes into consideration specifically product development and global sourcing activities. The other activities in the value chain are delimited out of the scope.

This thesis introduces and utilises a theoretical framework based on agency theory, resource-based view (RBV), transaction cost economics (TCE), PD, global sourcing, and product safety. The research is carried out from the case organisation's viewpoint with a focus on escalator product safety, to comprehend the approaches and viewpoints of organisational leaders, experts and organisational processes. Then, findings are critically analysed in the light of literature reviewed, and recommendations including managerial implications are made that suited the case organisation. The case organisation also manufactures elevators, but this study limits the scope to only escalators.

Product safety encompasses health hazard or detrimental effect on product, infrastructure or people (Hora et al. 2011; Marucheck et al. 2011). The different type of escalators' accidents involving people comprises: falling over, entrapment between step and side panel or comb, and step breaking or missing (Escalator Accidents 2009). Nicolson (2008) claimed that escalators accidents mostly originates either from the product itself or a passenger (e.g. drunk people, people with buggies or heavy luggage,

toddler or kid without adult supervision). The scope of this research is restricted to the product aspect only with consideration to PDP and GSP.

1.4 Theoretical framework

A precise theoretical framework provides the basis for excellent research and offers a setting or perspective through which academician can evaluate actions and articulate clarifications of their findings (Flynn and Zhao 2014). The theoretical foundation for this thesis is based on the “integrative organisational framework” developed by Tan and Mahoney (2006, 458). This framework was founded on the agency theory, RBV and TCE. The complementary nature of these three theories enables comprehension of several organisational strategic approaches, and thus these are increasingly employed by researchers (Tan and Mahoney 2006).

1.4.1 Agency theory

Agency theory emphasises on investigating the inherent conflicts in shared objectives between actors involved in a contract. A contract is the focal point of this emphasis that concluded between a principal and an agent, to carry out a set of activities by the agent for the principal under the agreed terms. Agency theory addresses the two potential challenges that may appear in this contractual relationship. The first emerges when there is a conflict between the objectives of principal and agent and the difficulty faced by the principal in verifying the actual work being performed by the agent. The second is concerned with the attitude of both the parties towards risk; each actor may favour different actions driven by their different perception of the risk. (Eisenhardt 1989; Zsidisin and Ellram 2003)

Perrow (1986) proposed three assumptions, fundamental to agency theory: actors capitalising their gains, focus on analysing the organisation internally, and societal life is derived from the contractual relationships based on competitive personal gains or

exchanges. Cheating or unscrupulousness emerges due to the expensive and futile monitoring of contracts in the organisations. (Perrow 1986)

Criticism of agency theory recognises it, to be radical with a sound basis (Jensen and Meckling 1979), based on contextual assumptions (Eisenhardt 1989), and defines motivational model narrowly with little cognisance for further research and subsequently undervalues work ethics (Donaldson and Davis 1991). Dyer and Chu (2000) observed the close working relationship between Japanese organisations and their suppliers and long-term commitments for purchase led to a higher level of trust and reduced conflicts, reflecting ineffectiveness of agency theory assumptions.

1.4.2 Resource-based view

The pioneering work of Wernerfelt (1984) on RBV of the firm has provided a new perspective on the literature of strategic management. Strategic management is based on the central theme of competitive advantage that an organisation tries to accomplish to perform better than its competitors. In the traditional RBV literature, an organisation's competitive advantage is illustrated by its excellent in-house resources and processes such as human capital, financial, intellectual capital, tangible and intangible established processes.

RBV theoretical framework maintained that the faultily imitable, non-replaceable, rare and valuable competencies and resources are the primary drivers for the sustainable competitive advantage of an organisation (Augusto and de Souza 2015). Barney (1991) argued that the organisational processes be also part of resources that contribute to its efficiency and effectiveness that finally drive competitive advantages. Disregarding the fact that resources are perfectly mobile and stern inside-out emphasis are some criticisms RBV has received along with limited literature on inter-organisation relationships, i.e. buyers-suppliers associations (Steinle and Schiele 2008).

RBV has an origin to understand the organisations' performance, however it has been extended to understand the intricate processes such as product development (Kleinschmidt et al. 2007; Verona 1999), sourcing (Barney 1999; Espino-Rodríguez and Padrón-Robaina 2006), decisions within an organisation (Augusto and de Souza 2015), and outside its legal borders, such as suppliers (Rungtusanatham et al. 2003; Steinle and Schiele 2008).

1.4.3 Transaction cost economics

TCE is another theoretical framework utilised by scholars to examine the supply chain's mechanisms (Espino-Rodríguez and Padrón-Robaina 2006; Hobbs 1996; Lojacono et al. 2017; Schneider et al. 2013; Williamson 2008) or relationship between customers and suppliers (Augusto and de Souza 2015). There are three prevalent dimensions to illustrate transactions: asset specificity, frequency, and uncertainty (Schneider et al. 2013). Asset specificity denotes the extent to which an auxiliary asset of a transaction can be shifted beyond the exchange relationship to a different transaction (Schneider et al. 2013). Frequency signifies the amount of recurrence of a transaction and the uncertainty illustrates the degree of disturbances subjected to a transaction (Schneider et al. 2013).

Transaction cost encompasses costs and efforts invested in an economic exchange including expenditure on searching a lowest priced product from the market, negotiation costs with shortlisted parties, and the monitoring and controlling costs post contract (Augusto and de Souza 2015). The TCE is focused on the decisions connected to in-house production vs procurement from outside suppliers that driven by the organisation's transaction cost of contract management in the marketplace or the cost of in-house production (Coase 1937). When the cost associated with a monetary transaction in a marketplace surpasses the in-house coordination costs, the organisation will manufacture the goods and grow in size. Whereas, if the marketplace transaction cost is lower than the in-house production cost, the organisation will trim its operations through outsourcing.

Several aspects influence global sourcing, but transaction cost, which represents the 35-40% of economic activity costs, savings is the central driving force especially in the manufacturing industries. Often later in the GSP, organisations may realise that they failed to estimate precisely accompanying costs, often originated from unexpected coordination activities. The organisations later discover that they failed to meet the sourcing objectives. These failures can negatively affect organisation performance and can originate from deteriorating or unreliable product quality. (Schneider et al. 2013)

1.4.4 Complementary facets of theories

Agency theory possesses some similarities to TCE, as both the theories share common assumptions of bounded rationality and self-interest, and depend on similar variables: hierarchies roughly correspond to behaviour based contracts and markets correspond to outcome-based contracts (Eisenhardt 1989). Agency theory complements the TCE (emphasise on “*ex-post* contractual” issues) by providing a theoretical lens for examining “*ex-ante* contractual” issues (Tan and Mahoney 2006, 457). The RBV also balances the TCE by considering the role of organisation’s resources in generating returns and guiding organisational decisions (Tan and Mahoney 2006). The latest literature base on the boundaries of firms using TCE is consistent with the RBV. The complementarity of the RBV and TCE turn out to be distinct when discussing asset specificity, from RBV perspective, the strategic resources of the firm can be construed as specific assets and, therefore, analysed from the TCE context (Augusto and de Souza 2015). Therefore, scholars have progressively been assimilating these three theoretical frameworks to provide a deeper understanding of several organisational strategic approaches (Tan and Mahoney 2006).

1.4.5 A research framework for the thesis

Figure 1 illustrates the research framework for this thesis work; the product development is mainly led by the R&D function, which is a differentiating resource

for an organisation. Similarly, approaches, practices and decision-making employed during the global sourcing are organisational capabilities. Hence, RBV used to complement agency theory and TCE in GSCU setting. Organisation’s global sourcing approach and practices define the components to outsource in a GSC and influenced by both RBV and TCE (shown through blue arrows). Agency theory concerns with the contracting scenario when an entity (termed as principal) transfers work to another party (termed as agent) and hence useful in analysing the supplier management in GSP. This research work utilises agency theory, RBV and TCE to analyse the case organisation’s PDP and GSP in the GSCU.

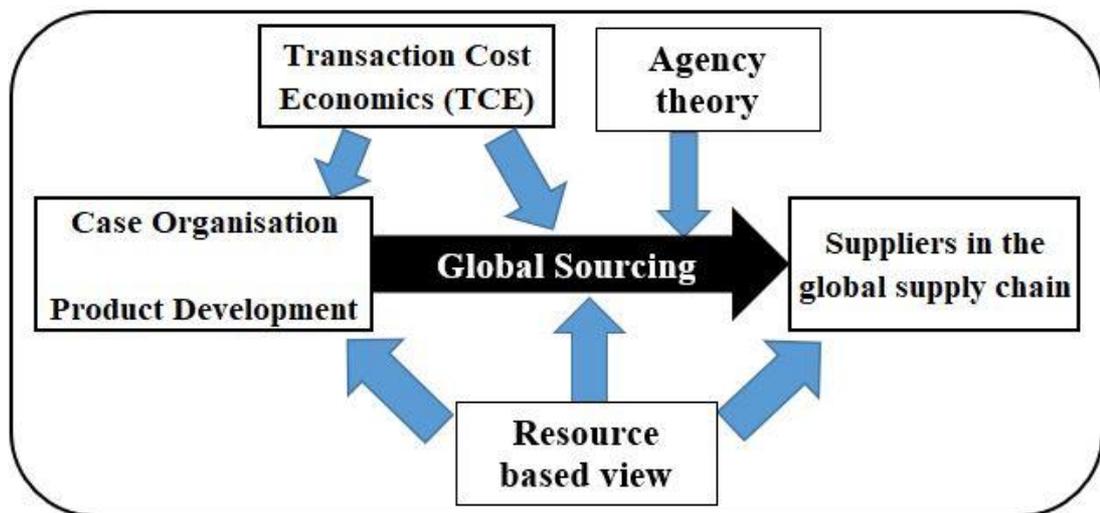


Figure 1. Research framework for the thesis

1.5 Structure of the report

The research background, scope, limitations, and research questions are presented in this chapter. The structure of rest of the thesis is described as follows. Figure 2 summarises the chapters titles with respective inputs and outputs.

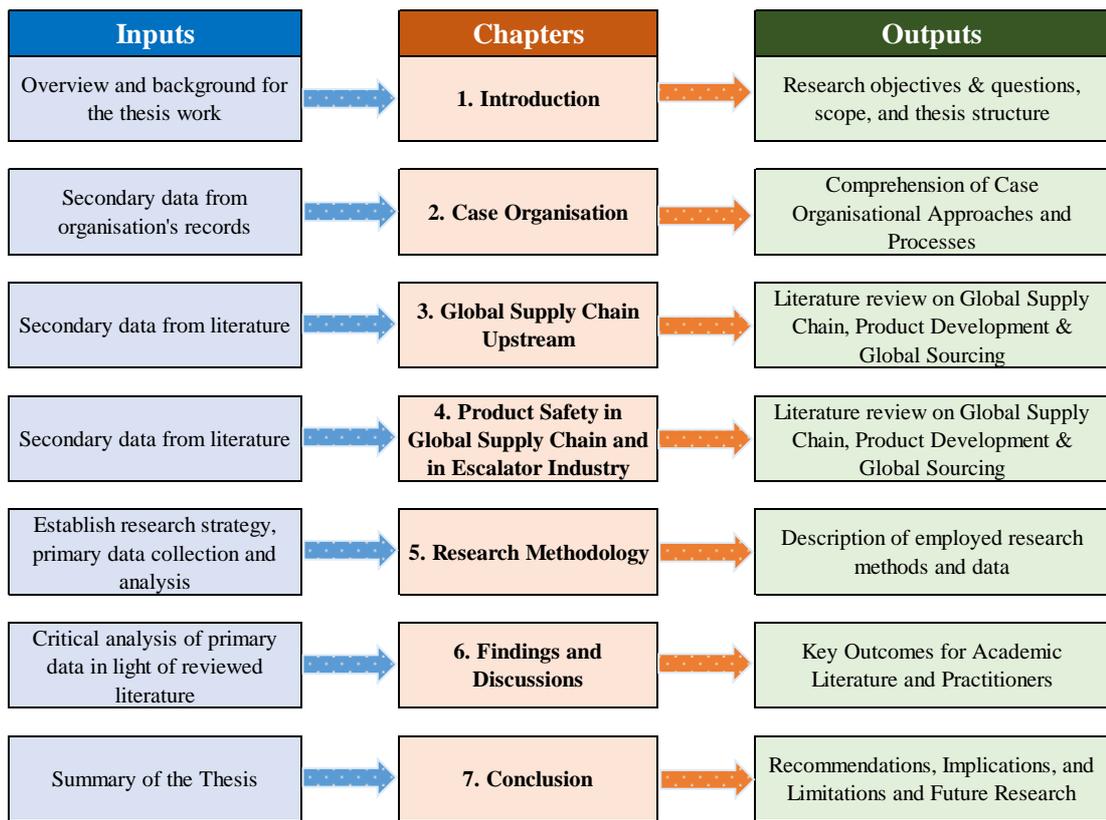


Figure 2. Structure of the thesis

The first chapter on *Introduction* presents the research background, clarify scope, and introduces the research questions with an outline of the thesis. Second chapter *Case organisation* utilises the secondary data sources available within the organisation to set the foundation for the literature review and primary data for analytical purposes. Chapter three *Global supply chain upstream* critically review the literature in global supply chain and upstream activities product development and global sourcing. Fourth chapter *Product safety in global supply chain and escalator global* sets the research context by collecting the secondary data available in scholarly and practitioners literature on product safety risks in the GSC and product in focus. Based on identified literature gap and research questions, fifth chapter *Research methodology* provides the choice of a case study based qualitative research and data collection and analysis strategy. The result of this chapter gives the detailed information on research methods and data samples. The chapter six *Findings and discussions* utilises the results from

previous chapters and presents the results and discussions of the data analysis. Finally, chapter seven *Conclusion* appraises the study, presents recommendations for case organisation and implications for academics, industry and society along with the limitations and opportunities for future research.

2 CASE ORGANISATION

This chapter introduces the case organisation: KONE corporation, founded in Finland and now operating worldwide. The company key offerings include elevator, escalators and service or maintenance. The sub-sections provide the brief introduction of KONE and its product offerings, company history, information on GSC, and operational strategy with a focus on safety.

2.1 KONE Corporation

KONE was started as a machine shop and christened in 1910 at Helsinki, Finland. ‘Kone’ is a Finnish word, which means ‘machine’ (KONE 2018b). Almost a century later, KONE is a market leader in elevator and among the top five escalator businesses around the globe. The net annual sales in 2017 stand at EUR 8.9 billion with earnings before interest and tax (EBIT) at EUR 1.22 billion, with operations in over 60 countries and a global workforce of more than 55,000 (KONE 2018a; 2018c). In 2017, the significant portion of revenues comes from the sales of new product (53%) followed by maintenance (32%), and rest from modernization (14%), in terms of geography, EMEA (41%) and Asia-Pacific (39%) leading the contributions followed by Americas (20%) (KONE 2018c).

The company’s vision is “to delivers the best People Flow[®] experience” that means by offering products and services to facilitate an appropriate, dependable and safe people movement within high rise buildings and commercial centres (e.g. airports, shopping malls). KONE delivering this experience to approximately 0.45 million customers worldwide comprised construction companies and owners, facility executives and real estate developers. The extended stakeholders also include architects or civil engineers, governmental authorities and property consultants that influence the KONE’s operations. (KONE 2018c)

2.2 KONE's strategy and processes

The company has realised the megatrends 'urbanisation' driving the effective people flow solution and 'technological disruptions' have permanently upgraded the customers' and users' expectations. Thus, KONE enters into the next phase of strategy "Winning with Customers" for 2017-2020, with an underlying motive to lead the change instead of being forced to change. The strategy is based on the four core values: delighting the customer, energy for renewal, passion for performance and winning together, supported by a strong cultural focus on safety and quality. The strategy will be realised through the 'KONE Way', which refers to the set of processes that defines pathways to achieve established goals. The identified ways to win are: collaborative innovation and new competencies, customer-centric solutions and services, fast and smart execution, and true service mindset. Figure 3 summarises and communicates the organisational strategy very effectively. (KONE SharePoint 2017b)

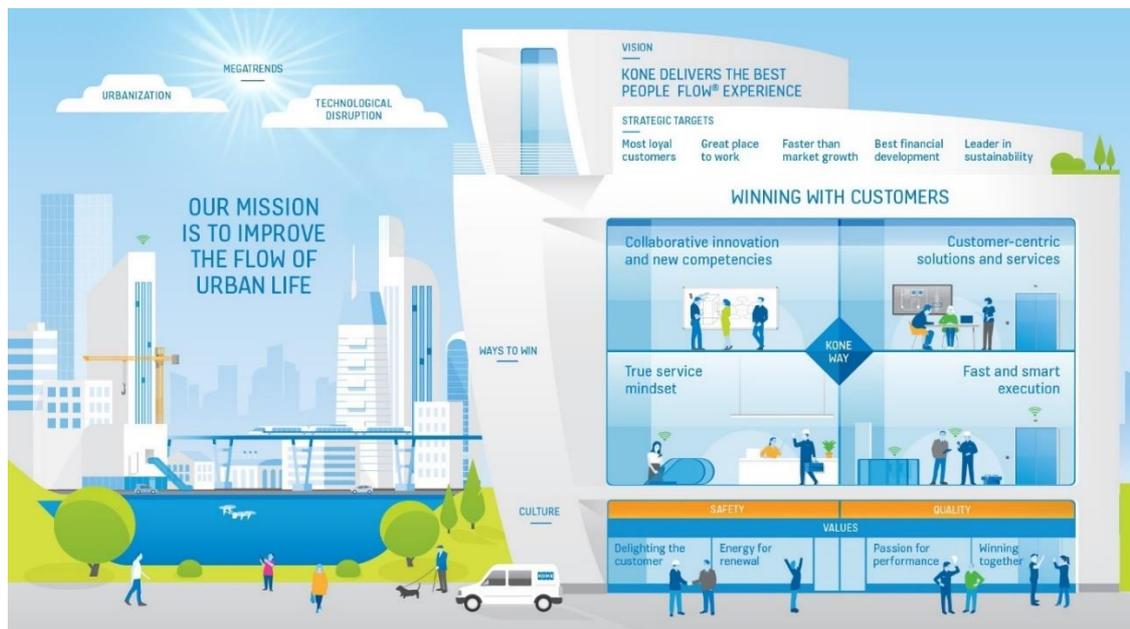


Figure 3. KONE's 2017-2020 strategy (Source: KONE SharePoint 2017b)

KONE Way defines the how business being run to offer speed and consistency to customers. It outlines the how organisational strategy being implemented fast and in a

standard way. Its purpose is to improve customer service experience, employee satisfaction and business performance. It describes the five elements to run the business: (KONE SharePoint 2017e)

- Defined roles in which organisation work
- An organisation that supports KONE business
- Processes that enable working commonly:
 - Manage the relationship with the customers
 - Deliver products and services
 - Conduct maintenance
 - Create new solutions
 - Manage and support KONE business
- IT tools that make organisation's work more efficient
- Data that allows managing KONE by providing insights.

To bring KONE strategy to life, the organisation has introduced four “Ways to Win” with the customers. Each of ways to win has some customer-centric programs within them. The programs and projects underneath them are the practical way to make advancement in daily work in the organisation. (KONE SharePoint 2017e)

2.3 Global operations and supply base

KONE has thirteen manufacturing facilities located in seven countries and nine global R&D units (figure 4). KONE supply base comprised approximately 2000 components suppliers and thousands of installation suppliers. KONE purchases most of its raw materials, components and systems supply from external suppliers located in vicinity to the KONE facilities and job sites. Supplier base is consists of component manufacturers, contract manufacturers, raw-material providers, as well as subcontractors in the installation phase. (KONE 2018c)

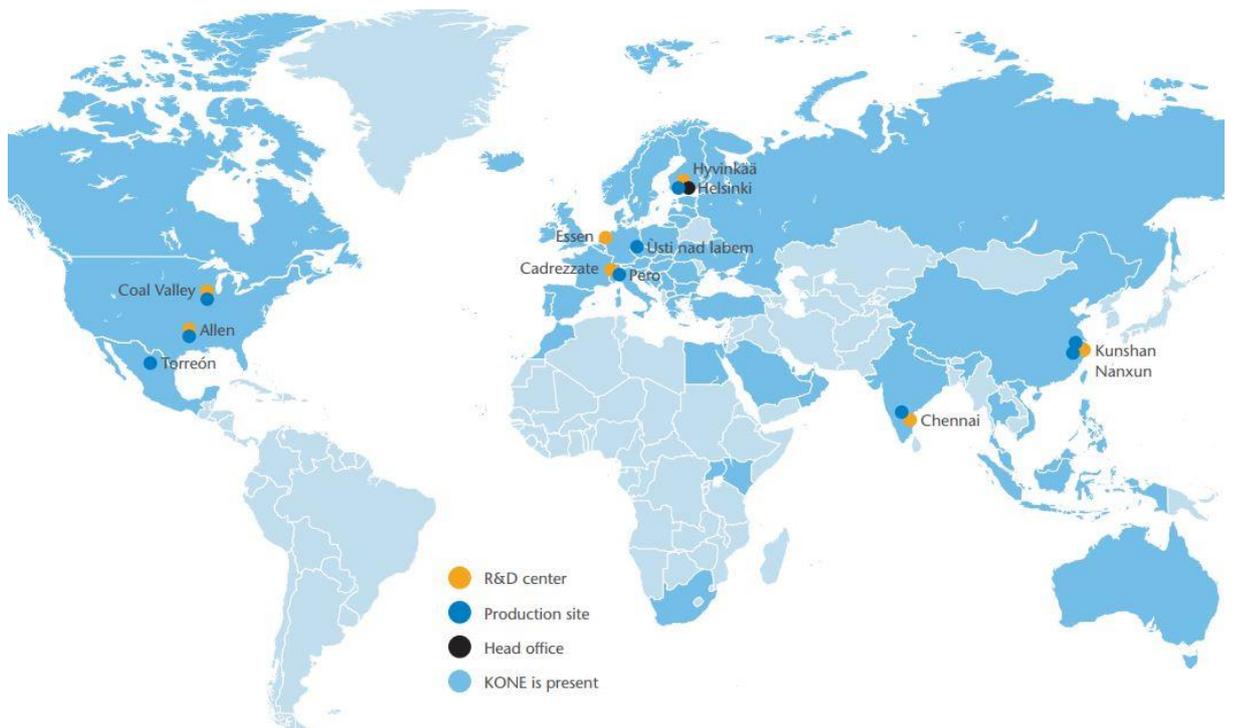


Figure 4. KONE's global locations (Source: KONE SharePoint 2017b)

KONE global supply base plays a vital role in delivering good quality and safe solutions to customers. To fulfil the customer's needs efficiently, KONE has developed a global supply base reinforced by augmented supply operations, managed by the KONE Supply Unit (KSU) organisation (KONE SharePoint 2017a). The supply chain aims to transport the KONE products directly to the construction sites in the most efficient and sustainable means to fulfil the time and quality requirements in alignment with the KONE sustainability goals (KONE 2018c). Although, The case company places a high emphasis on developing a global outlook, its supply chain, predominantly in the installation business, is vastly localised or served by global spares supply function.

The functionality of KONE's supply organisation is shown in figure 5. Supply operations includes the Supply Line (SL) order management, engineering, procurement, manufacturing and logistics activities related to supplying the KONE products/materials needed in the customer delivery projects. This is managed by the

KSU organisation, consisting of the supply operations units across the globe, and the related global functions. In each of the supply units, the KONE supply service team provides tendering support for non-standard people flow solutions and manages the SL side of the ordering process for KONE products, consequently providing the main contact interface for the Front Lines (FLs). Dedicated supply managers are appointed to manage the SL side of larger projects. Supply Units order escalators' components from KONE factories and external first-tier suppliers, and after relevant listing and engineering activities the components are manufactured and shipped to the distribution centres, where they are consolidated into escalator deliveries waiting for the installation supervisors to call them off to the job sites. To support all of this, the planning teams in the Supply Units work together with the delivery chain planning team (part of KONE operations development) to warrant sufficient delivery competence. (KONE SharePoint 2017a)

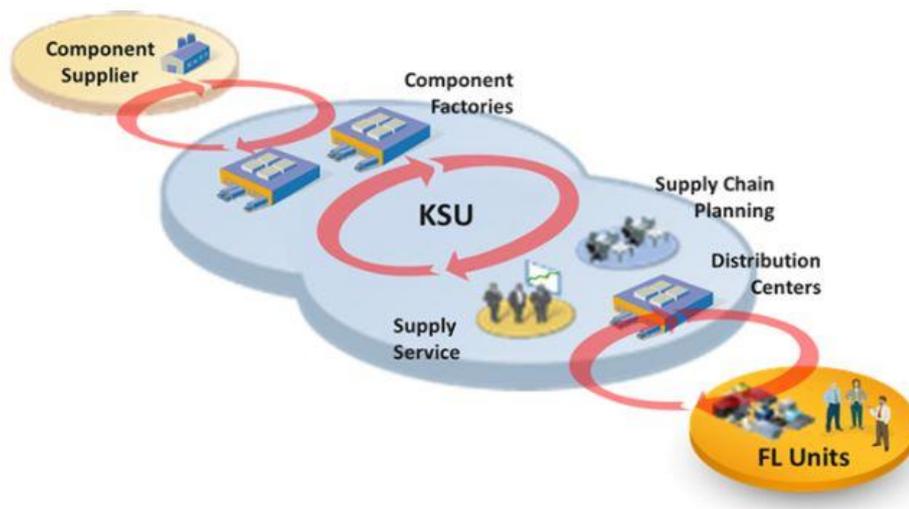


Figure 5. Supply operations of KONE (Source: KONE SharePoint 2017a)

2.3.1 KONE product development

The R&D leads the product development in KONE that consists of two teams under the technology and innovation unit. The product R&D focuses on new products and modernisation solutions, whereas the services and solutions R&D focuses on services

and people flow intelligence solutions. Product R&D focuses on global product platforms for new equipment and modernisation solutions, presence in local markets and energy-efficient products. Also, product R&D involves in original concept development and experiments. The unit consists of global teams and country R&D units. The escalator technology development and continuous product improvements managed by the escalator technology team at the global level. (KONE SharePoint 2017c)

The product development process at KONE splits into two processes: concepts development process and solution development process. The concepts development process studies and develops new concepts and technologies, fosters and tests new ideas and develops innovative new concepts to enable fast and efficient solution development to maximise the value to customers and the organisation. In the practical level, the objective of the process is to introduce new and well-evaluated project proposals for the develop solution process. The develop concept process consists of two phases (front-end innovation and blue boxing) and formalised steps to develop mature concepts. (KONE SharePoint 2017c)

The starting point of the concepts development process is the Front End Innovation (FEI) phase. In this phase new ideas are generated, pre-concepts and proposals of new applications and technological solutions are created. The idea may originate from insight into a customer, or user need forming a clear value proposal or business opportunity. These new ideas and pre-concepts are further developed and evaluated during the FEI and blue boxing phases. The second phase of blue boxing reduces uncertainties and ensures technology and solution readiness required to start a project according to solution development process. Uncertainties are reduced through blue box steps finding answers to specific questions defined for the project and accepted by the stakeholders. The final objective is to reduce the uncertainty of the concept to the maturity level that is acceptable before the decision to develop the complete solution. (KONE SharePoint 2017c)

Solution development process commercialises the technologies and concepts to create new business opportunities and strengthen KONE's competitive edge. The develop solution process starts with a concept with verified technology, completes the requirement collection of the concept, validates the concept, specifies and finalises the design and implements the design to all the KONE Way processes. The product development is executed in projects. The develop solutions process applies to all projects that aim for developing a new solution for a customer. A solution can refer to the product (platforms), components, or services and their combination. (KONE SharePoint 2017c)

The solution development process is divided into seven phases between the gates:

1. Initiate project
2. Validate concept against requirements
3. Specify
4. Finalise product design
5. Prepare processes
6. Validate processes
7. Close project

Initiate project phase's purpose is to prepare the business case of the developed concept, and check that the technology is mature enough for the concept and that there are resources that are committed to delivering the project. The second phase will gather all the requirements to the project and its product. During this phase, the project core team should decide which requirements they can fulfil with the concept and which not. In the specify phase the project team will develop a detailed specification for the developed solution along with a detailed project plan. The finalise product design phase will finalise the product design. In this phase, the final design is proposed by the design team and verified by the project core team. The production, installation and maintenance processes need to be known on such a level that the design can be frozen. The freezing is done to enable a smooth and efficient ramp-up of the processes. The fifth phase prepares the processes (e.g. tools, systems, people, documentation) to a

level that a readiness to sell, deliver and maintain the product at selected customers is reached. The sixth phase of validation of the core processes is done either by piloting or in-house validation. The product is ready, with all processes and documents. The project has achieved its objectives and responsibility of the product, and other deliverables are handed over to the product owner. The last phase of project closure once it has been verified that project has met all the objectives. (KONE SharePoint 2017c)

2.3.2 KONE sourcing

Sourcing function at KONE is responsible for managing the cost of goods and services expenditures and supplier relationship management, in enterprise-wide association with internal business partners, to deliver exceptional value for KONE. The main component of KONE Sourcing is the idea of category management, illustrated as a complete and integrated approach to manage expenditure (categories) areas recognised by comparable material characteristics or supply marketplace's features. The category management method permits a team formation in a cross-functional environment, and alignment across the enterprise. Sourcing category managers, sourcing unit managers and SQM (supplier quality management) managers are required to work in close partnership to develop and execute sourcing plans and ensure timely, quality and cost competitive supply of products and services. Sourcing category managers must continuously interface with sourcing unit managers. The KONE supply organisation (KSO) follows an annual budget process in which sourcing projects and savings targets for the coming year are planned and followed-up against the plan. (KONE SharePoint 2017d)

The processes applied in KONE to conduct strategic sourcing and SQM processes are described as part of the KONE WAY processes. All KSO employees are expected to follow these processes in their dealings with suppliers and all other defined KONE processes, policies or procedures in their businesses in general. KONE's sourcing process is consists of five stages with first two clubbed together. Figure 6 shows the

summary of the key activities in the sourcing process at KONE. (KONE SharePoint, 2017e)



Figure 6. KONE's sourcing process

The sourcing legal council maintains global contract templates and communicates to KSO teams and relevant SL/FL units and their legal councils for any changes made to these templates. The communication about changes comprises the direction of whether updates are to be revised to existing contracts immediately or if they can be revised into existing contracts as part of the next upcoming contract renewal. KSO drives the supplier segmentation to define one methodology for managing supplier relationships based on the strategic objectives of KONE, the supplier's capability and role in meeting those requirements and the supplier's impact on KONE differentiates suppliers according to specific criteria and defines the building blocks for managing the supplier relationship. Suppliers are divided into five segments according to the strategic priorities and their importance and criticality to KONE. The segments are

global partner, global strategic, unit strategic, validated, and selected use. (KONE SharePoint 2017e)

KSO nominates a single point of contact (contract owner) for all main suppliers (at least global partner, global strategic and unit strategic suppliers). For suppliers used cross-regionally KSO may nominate a dedicated area based contract support. All KONE employees align with the area based contract support or the contract owner on any supplier related issue. The KONE commodity team is responsible for budgeting and forecasting the prices of key commodities purchased by KONE directly or indirectly. This team meets periodically to review and validate current and future price assumptions. (KONE SharePoint 2017e)

The other sub-functions within KSO that play an important role in supplier management are SQM and supplier development. SQM continuously work with suppliers to assess and follow-up their quality. This function check and report suppliers' key performance indicators, conduct audits at suppliers, initiate and follow-up correct actions with suppliers and ensure that suppliers back-report about special initiatives. Supplier development develops and initiates special improvement programs that rolled-out to most important suppliers. This function also administers the KONE certification (gold/silver/bronze) of key suppliers. (KONE SharePoint 2017f)

3 GLOBAL SUPPLY CHAIN UPSTREAM

This chapter begins with the systematic review of the articles by scholars and practitioners that facilitate understandings of global supply chain and its upstream activities. Literature review in qualitative research settings facilitates in exploring the phenomenon and the research methodology (Yin, 2015).

3.1 Global supply chain

Over the past two decades, GSC has been a conversant fragment for practitioners at global businesses and scholars (Ibrahim et al. 2015). A supply chain is defined by Mentzer et al. (2001) as the group of actors ensured movements (upstream and downstream) of products (or services) from a source to the end customers. The upstream reflects the supply to a sourcing organisation, and downstream reflects the distribution (sales channel, movement of goods from factory to retailers/customers). In the last few decades, companies have experienced a rapid expansion of their supply chain into different geographies driven by globalisation and competitive pressure of cutting costs (Golini and Kalchschmidt 2015; Ibrahim et al. 2015). These expansions lead to the concept of a GSC. GSC is defined as the global networking of internal functions within an organisation and with external suppliers to achieve competitive advantage (Prasad and Sounderpandian 2003). The flow of material and information in these networked firms can also visualise as the creation of value that termed as the value chain (Holweg and Helo 2014).

Michael Porter in 1985 introduced the concept of the value chain in his book “Competitive Advantage: Creating and Sustaining Superior Performance”. The concept is defined as the set of activities (figure 7) undertaken by an organisation to produce a valued product or service that can be retailed in the market. The organisations employ numerous activities right from acquiring the material or inputs to the distribution of the final product or service to customer till service after sales.

The principal activities are R&D, purchasing or sourcing, operations or production, sales, and service. (Porter 1985)

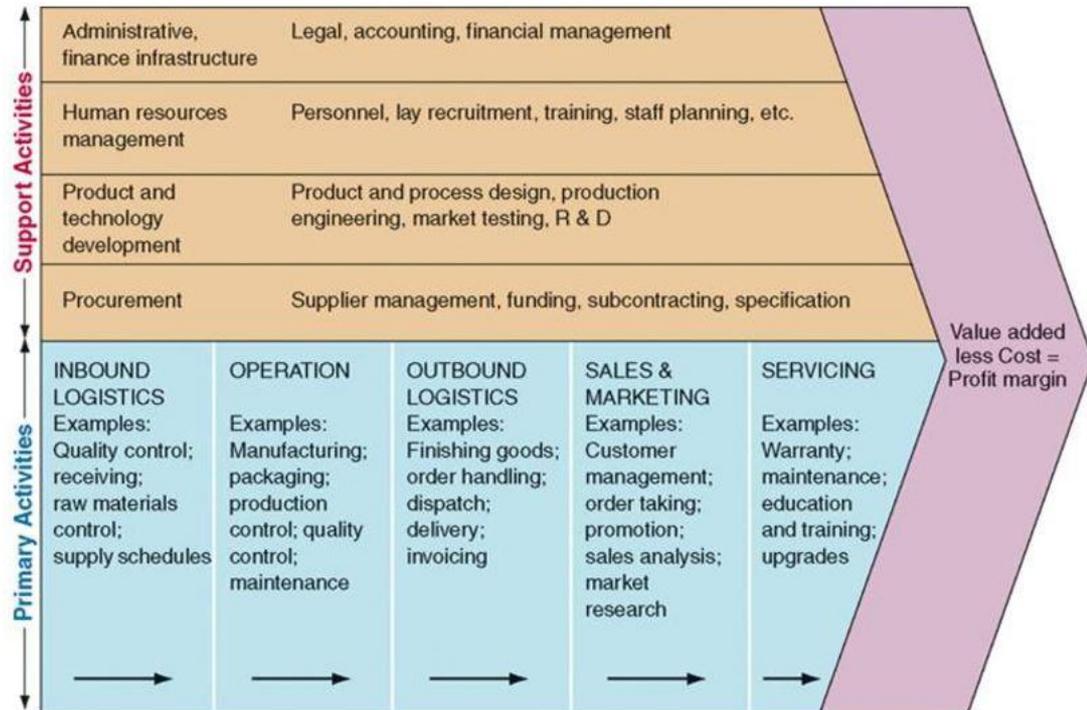


Figure 7. Value chain (Porter 1985; Image Source: Baker University 2018)

Several business leaders identified and acted swiftly on the opportunity to generate more value by global integration of upstream of organisation’s supply chain started to emerge due to globalisation (Trent and Monczka 2002). Within the defined scope, this research explicitly focusses on the two support activities (i.e. product and technology development and global sourcing under procurement) in the upstream (i.e. inbound logistics and operations) of value chain shown in figure 3 with an emphasis on the safe product for end users. In supply chain domain, the opportunities for incremental improvements for some organisations are considerable (Trent and Monczka 2002), however an organisation have first to identify the necessities: to outline its strategy for supply chain aligning with its core strategy and competence. An organisation’s core competence is the key to compete and influence its competitive gain in the international market (Prahalad and Hamel 2003). The motivation behind establishing

a GSC is to concentrate on core competencies and simultaneously to address the requirements of the customers. This leads to the integration of business functions starting from early material procurements to the delivery of final product and associated services to the customers (Porter 1985).

3.2 Product development

The academic literature uses new product development (NPD) and PD interchangeably. However, this thesis will use the term PD to illustrate NPD or existing product improvements. PD traditionally have seen as the territory of R&D function within organisations. The globalisation of markets and PD are two certainties influencing the capability of organisations to accomplish success in the current volatile business situation (Kleinschmidt et al. 2007). Especially, firms concerned with technological products, the firm with the most innovative solution supplemented by cutting-edge product have better chances in the market to survive or lead (Conway and McGuinness 1986). Additionally, customers are more informed and demanding on the requirements, and thus customer requirement management turns out to be the crucial factor for the success of product development (Jiao and Chen 2006). Therefore, organisations aim to have a robust PDP that is effective and efficient by integrating various functions within as well as supply chains into the process.

PD can be interpreted in different ways, i.e. it concerns the conception of a novel product (Kotler and Armstrong 2010). Still, significant efforts of R&D personnel are not focused in this direction (Conway and McGuinness 1986; Kotler and Armstrong 2010). Most of the efforts are intended to improve or modify the existing product offerings (Kotler and Armstrong 2010). PD denotes the set of activities and processes to realise an original product, product modifications or improvements, and brand building through the efforts of R&D function (Kotler and Armstrong 2010). Mital et al. (2014) define product development as a wide-ranging set of activities encompassing product ideation and design, production, and finally selling it to customers. PD definitions and literature shows a degree of fragmentation and the

concept has been studied from the viewpoints of several disciplines encompassing marketing (Kotler and Armstrong 2010), operations (Mital et al. 2014; Ulrich and Eppinger 2012), organisational behaviour and strategy (Clark and Fujimoto 1991; Müller-Stewens and Möller 2017). A theory unifying different viewpoints of PD is not available in the reviewed literature. Considering the research focus of this thesis, the main contributions of theories are referenced from the operations and partially from the marketing literature.

Organisations approach PD as a time-bound project. Approved PD projects can be classified into following four typologies for product design and development initiatives or projects (Ulrich and Eppinger 2012):

1. New product platforms
2. Variants in existing product platforms
3. Continuous improvements in existing products
4. Primarily fresh product

The first projects classification (new product platforms) comprises intellectual development activities to develop a new product's family founded on a novel and common platform for an acquainted marketplace. The second classification (variants in existing product platforms) of PD projects involve the addition of new products in an existing product platform and thereby extending its scope to cater the emerging needs of the customers. The third classification deals with the ongoing or gradual changes in the features of current products to address the market feedback or make them more competitive. The last classification involves risky projects that focus on radical, innovative PD for the new or unfamiliar customers. (Ulrich and Eppinger 2012)

Strategic orientation of an organisation drives the PDP that results in alignment of the organisation's PD activities with the fundamental strategic requirements of that organisation (Hargadon 2003). Once materialised, the PDP leads the development of

products, complying with the strategic purposes of the organisation while utilising strategic competencies of the organisation (Tzokas et al. 2004). The task of harmonising organisation's capability and strategy with markets' needs is challenging for any organisation. Therefore, many organisations have adopted a similar or derivative of renown stage-gate model (SGM) proposed by Cooper (1990). The SGM breakdowns the PDP into predefined stages with a defined set of activities (Kahn et al. 2012).

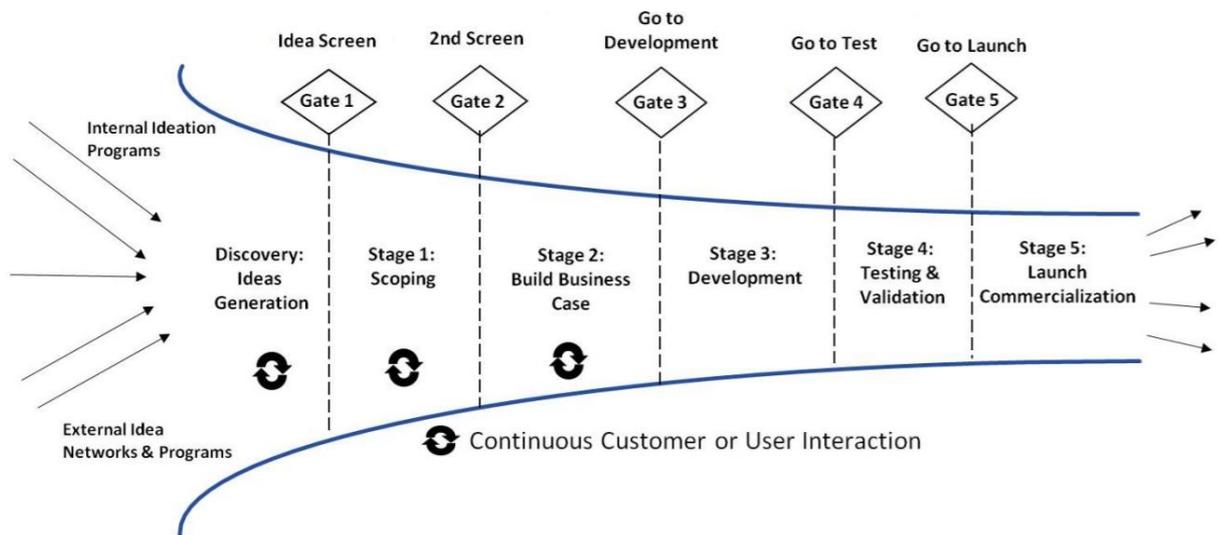


Figure 8. Stage-gate process (Edgett 2015, 3)

Organisations employ various nomenclature for the in-house stage-gate processes with a unique structure, however fundamentally they are based on the process shown in figure 8 (Edgett 2015; Kahn et al. 2012). Primarily, the purpose of these process models is to guide the PD activities in a structured way to ensure a consistent and reliable output. The activities or value-added work performed in stages, whereas gates are used as a checkpoint to decide whether to continue this project or not (Edgett 2015). A stage review is performed at the consecutive gate to validate the performance of the previous stage. In case of a positive outcome, the project transcends to next stage. Alternatively, it stays in the same stage until all the identified issues resolved. (Edgett 2015)

Table 1. The generic PDP and vital responsibilities of crucial departments (adopted from Ulrich and Eppinger 2012)

Planning	Concept Development	System-Level Design	Detail Design	Testing & Refinement	Production Ramp-Up
Marketing					
<ul style="list-style-type: none"> •Articulate market opportunity. •Define market segments. 	<ul style="list-style-type: none"> •Collect customer needs. •Identify lead users •Identify competitive products 	<ul style="list-style-type: none"> •Develop plan for product options & extended product family. 	<ul style="list-style-type: none"> •Develop marketing plan. 	<ul style="list-style-type: none"> •Develop promotion & launch materials. •Facilitate field testing. 	<ul style="list-style-type: none"> •Place early production with key customers.
Design					
<ul style="list-style-type: none"> •Consider product platform & architecture. 	<ul style="list-style-type: none"> •Investigate feasibility of product concepts. •Develop industrial design concepts. •Build & test experimental prototypes. 	<ul style="list-style-type: none"> •Develop product architecture. •Define major sub-systems & interfaces. •Refine industrial design. •Preliminary component engineering. 	<ul style="list-style-type: none"> •Define part geometry. •Choose materials. •Assign tolerances. •Complete industrial design control documentation. 	<ul style="list-style-type: none"> •Test overall performance, reliability, & durability. •Obtain regulatory approvals. •Assess environmental impact. •Implement design changes. 	<ul style="list-style-type: none"> •Evaluate early production output.
Manufacturing					
<ul style="list-style-type: none"> •Identify production constraints. •Set supply chain strategy. 	<ul style="list-style-type: none"> •Estimate manufacturing cost. •Assess production feasibility. 	<ul style="list-style-type: none"> •Identify suppliers for key components. •Perform makebuy analysis. •Define final assembly scheme. 	<ul style="list-style-type: none"> •Define piece part production processes. •Design tooling. •Define quality assurance processes. •Begin procurement of long-lead tooling. 	<ul style="list-style-type: none"> •Facilitate supplier ramp-up. •Refine fabrication & assembly processes. •Train workforce. •Refine quality assurance processes. 	<ul style="list-style-type: none"> •Begin full operation of production system.
Other Functions					
<ul style="list-style-type: none"> •Research: Demonstrate available technologies. •Finance: Provide planning goals. •General Management: Allocate project resources. 	<ul style="list-style-type: none"> •Finance: Facilitate economic analysis. •Legal: Investigate patent issues. 	<ul style="list-style-type: none"> •Finance: Facilitate makebuy analysis. •Service: Identify service issues. 		<ul style="list-style-type: none"> •Sales: Develop sales plan. 	<ul style="list-style-type: none"> •General Management: Conduct postproject review.

Ulrich and Eppinger (2012) proposed an integrated six phase generic PDP used by organisations to develop and commercialise a given product. Different phases with a set of essential activities for critical business functions are summarised in table 1. The

first phase “Planning” is also termed as “phase zero” since it precedes the approval and commences of actual PDP. This phase starts with the identification of suitable opportunity in line with organisation’s competence and strategy. This phase provides information on business objectives, the target market for the product, main assumptions and limitations that acts as input for next phase “Concept Development”. There is also a decision or review point between each phase as shown in figure 9 to provide a go-ahead or a rework of project activities. (Ulrich and Eppinger 2012)

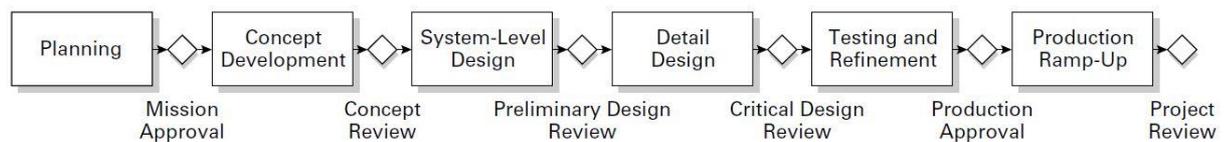


Figure 9. Generic PDP (Source: Ulrich and Eppinger 2012, 22)

Scholars have also probed the soundness of a structured PDP such as SGM. Du Preez and Louw (2008) argued that the original SGM is rigid in early phases and the integrated sequential approach inhibits the opportunity for learning. Wind and Mahajan (1988) proposed that there is a need to reinvestigate the entire PDP basing on the fact that the fraction of efficacious new product introductions has not enhanced considerably despite employing sophisticated PDPs. Wind and Mahajan (1988) found that the modern organisations are facing challenges that are difficult to handle with the existing PDP. Notwithstanding the critique, structured PDP is widely adopted by organisations. Edgett (2015) argued that approximately 80% of US-based organisations use SGM. According to a survey based study by PDMA, 60% of the organisation reported using a stage-gate PDP (Kahn et al. 2012).

3.3 Global sourcing

Sourcing or outsourcing is an essential activity in modern organisations characterising purchasing of goods and services through reliable and economical sources or suppliers to sustain or improve organisation’s competitiveness. With increasing market

dynamics and competitiveness, organisations are required to pursue global opportunities through sourcing, to offer products at competitive price with desired quality in shortest possible lead time. Therefore, global sourcing emerged as one of the important strategies for organisational leaders seeking to internationalise by focusing on their core competencies and simultaneously reducing input costs. Golini and Kalchschmidt (2015) contended that the global sourcing facilitates entree to new markets with a focus on organisational core capabilities, improves supply chain agility, and utilises foreign suppliers to manage competitive advantage.

Daniel Hefler (i.e. Hefler 1981) is among the early scholars who introduced the term 'Global sourcing' in the academic literature. Later, different synonyms of word 'Global' such as 'international', 'worldwide' and 'offshore' used interchangeably to reflect the internationalisation of sourcing process. Since then, the concept of global sourcing has been researched broadly by academics and practitioners. Global sourcing refers to the organisational strategy to outsource the raw material beyond the national boundaries of origin to improve competitiveness (Golini and Kalchschmidt 2015). Moreover, global sourcing enables a swift entry into the newer markets and a rapid NPIs (Kumar et al. 2011). While cost reduction is frequently quoted goal for the global sourcing, this strategy possibly has an inadvertent significance, for instance, the likelihood for issues related to product safety and subsequent recalls (Steven et al. 2014).

Global sourcing is a strategic move with long-term in focus and substantially varies from the foreign purchases or international procurements (Monczka and Trent 1991). One of the most broadly recognised explanations of global sourcing is "integration and coordination of procurement requirements across worldwide business units, looking at common items, processes, technologies, and suppliers" (Monczka and Trent 1991, 3). Kotabe (1998) asserted that the global sourcing is a strategic blend of domestic and abroad sourcing to realise long-term competitiveness. Hence, this research uses the definition of global sourcing as the standardised set of activities within a multinational

organisation to search and acquire material or resources from suppliers based at global locations.

Lojacono et al. (2017) reasoned that the organisations' participation in the overseas market provides experience or learning in several forms. These experiences become the foundation for subsequent changes in organisational practices or structure. The practice of global sourcing is an integral part of modern corporations organisation strategy, and this practice continues to grow, encompassing different functions in the value chain. (Lojacono et al. 2017)

Steven et al. (2014) cautioned business leaders about planning preventive measures when engaging in global sourcing to control product failures that may lead to expensive recall exercise. Obloj and Zemsky (2015) argued that the selection of supplier should be based on the advantages of productive efficiency compared to possible expenses of contracting. Organisational managers must ensure the completeness of contracts regarding ethical threats, exploitations and minimising appropriations, particularly in the nations with weak legal establishments and market.

Economic downturns in developed economies have led to anti-global sourcing protests and consecutive legislation as a populist measure by political outfits. Business leaders of multinational organisations faced severe pressure to retain the jobs in home countries. Still, the representatives involved in sourcing decisions favoured the cost savings and improved flexibility offered by global sourcing, and most of them do not have a defined plan to change the current sourced locations. (Lacity et al. 2017)

Global sourcing studied extensively from the strategic perspective whereas studies from process design and management perspectives are limited. It is observed that there is an agreement among practitioners about the general process presented in the literature. The GSP comprises five stages: (i) investigation and tendering, (ii) evaluation, (iii) supplier selection and development, (iv) implementation and (v)

performance measurement and continuous improvement. Figure 6 summarises the key activities under each stage. (Zeng 2003)

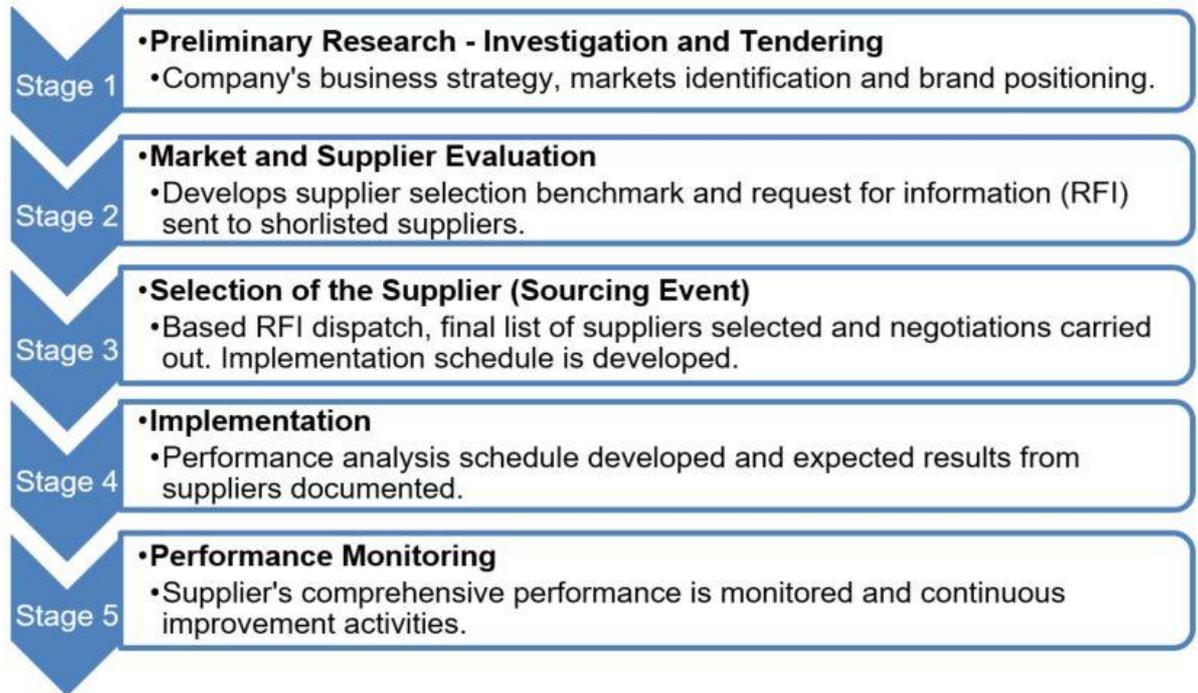


Figure 10. General GSP (Based on Agrawal 2015)

Figure 10 summarises the stages and critical activities involved in a GSP. The first stage involves planning before setting up global sourcing strategy. Organisation's core, non-core, profile, target customer segment, and competitors are analysed to determine the scope of sourcing strategy. In the second stage, criteria to select suppliers are established and sourcing strategy refined along with an analysis of economic and operating advantages of sourcing project. The third stage begins with final supplier selection and contract finalisation. Technical and cost saving analysis for the selected supplier is performed then an implementation timeline is established. In the fourth stage, an implementation team is formed with the publication of strategy and timelines. Supply and logistics terms involving resources to be shared are agreed, and projected results are established in-house and with the supplier, these results measured regularly and reported as performance indicators. The fifth stage involves

ongoing performance monitoring of supplier independently and in concurrence to the shared resources utilised by it. Collaborative partnership with supplier assessed for effectiveness and opportunities for continuous improvement is identified. (Zeng 2003)

Agrawal (2015) asserted that an active GSP considers and defines: cost (consignment, duties, insurance apart from cheap labour or material prices), currency, culture and language (to circumvent misinterpretations), laws (contractual agreement validity), lead time, logistics and methods of payment.

4 PRODUCT SAFETY IN GLOBAL SUPPLY CHAIN AND IN ESCALATOR INDUSTRY

This chapter holistically presents the literature review utilising the critical summary and analysis of multifaceted articles in the focus areas and theoretical models that concern the product safety in PD and global sourcing. This chapter also introduces the case product escalator, its safety features and escalator industry.

4.1 Product safety in the GSC

The theme of product safety in a GSC is an evolving topic in the supply chain risk management. The area of risk management in the supply chain has attracted considerable attention from practitioners and scholars (Christopher et al. 2011; Giunipero and Aly Eltantawy 2004; Zsidisin and Ellram 2003). GSCs are riskier compared to domestic supply chains (DSCs) due to several interconnected links of companies in different geographies. Each node of this networked companies is susceptible to a variety of possible failures such as economic and political influences, sustained resources and capability availability, and location-based issues. Risks in supply chains are severe challenges since their inept management possibly degrades organisations' performance and competitive advantage (Stanczyk et al. 2017).

Supply chain risk is broadly defined as the possibility to not meet the customer demand related to quantity and quality of a product or service within the defined costs and time and possibly an adverse impact on the safety of customers (Christopher et al. 2011). This thesis focuses on supply safety risks that emphasise the probability by which an organisation failed to meet the safety requirements expected from the product in the PDP and GSP.

4.1.1 Safety risks in product development

A successful product development characterised by product quality, product cost, development time, development cost, and development capability. These are considered as the main ingredients of economic success of a product. Development team's members are mostly interested in making a fundamentally exciting product. However, the members of society where the product is manufactured or consumed relying on the development team for the required product safety irrespective of product profitability. (Ulrich and Eppinger 2012)

The classical example of Ford Pinto safety issue of fuel tank design showcases the impact of product safety ignorance during PDP that led to several litigations against company, reported deaths in the range of 27 to 180, and brand value deterioration. The flawed design of fuel tank placement behind the rear axle instead of above the axle causes the fuel tank to rupture in low-speed crashes from the rear side of the car, leading to a significant fuel leak followed by a risk of fire. The company management was aware of the problem, however, neglected it on account of a cost-benefit analysis, which shows fixing the problem is costlier than the potential damage pay-outs. (Ford Pinto 2011) This example can be visualised through the transaction cost economics, where management's short-sightedness on immediate gains of development time and development cost against the long-term impact on organisation's reputation and future sales lost.

The organisations continuously face challenges in balancing the innovation with safety in the PDP. There are some safety risks presented by sophisticated new technologies that may be difficult to predict during development and may realise once the product is necessarily in use. Moreover, these different safety risks may appear at different phases of product lifecycle, e.g. manufacturing, packaging, handling and transportation, storage, and commissioning. (Maruchek et al. 2011) Pyke and Tang (2010) proposed a 3R (readiness, responsiveness, and recovery) strategy that defines the guideline for PD. To mitigate safety risks, the strategy advises integrating safety

and traceability characteristics in the early phases of PD utilising the lessons learned from earlier PD programs.

4.1.2 Safety risks in global sourcing

Although cost advantage is the most quoted reason for the global sourcing, such a short-sighted strategy of cost-cutting often leads to inadvertent consequences, such as the possibility of product recalls or retrofits to resolve safety glitches (Steven et al. 2014). The concept of global sourcing adopted by several organisations, however many sourcing initiatives did not perform as expected (Stanczyk et al. 2017). The most recurring reasons for dismissing the outsourcing contracts are cost saving estimates, protection of intellectual asset and severe quality issues (Moe et al. 2014). In these studies, authors revealed that regardless of the increasing outsourcing adoption, clients and suppliers experienced the below-average performance of the outsourcing project due to complications and problems.

Dachs and Zanker (2015) through a survey of the 3000 European manufacturing organisations observed recurrent top three concerns for outsourced products are: unacceptable product quality, low flexibility in tackling market demands and underutilisation of in-house capacity. Additionally, defective products pose safety issues to end-customers and severely affect organisation's brand in front of the general public (Maruchek et al. 2011). Handley and Benton Jr (2013) observed that the product recalls incidents due to safety issues originated from global suppliers are growing and recognise a necessity to enhance the practices of quality assurance for the products outsourced globally. Kinkel (2014) contended that the minimising labour cost is the most leading factor for global sourcing followed by the vicinity to main customers and entry into the foreign market. While global sourcing offers several benefits, it can also expose an organisation to product safety issues that may result in substantial financial losses.

Niranjan and Rao (2011) reasoned that although outsourcing has been a historical practice and have been adopted considerably, it is still an argumentative subject due to actual cost savings. A significant risk for organisation engaging in subcontracting is the opportunistic conduct of an established supplier, who possibly take advantage of the organisation, which divested its resources of the outsourced department. Subsequently, the subcontracting organisation loses the intellectual and physical assets that make it highly dependent on the supplier and susceptible to strong-arm tactics of the supplier. Outsourcing organisation tend to show considerable cost benefits. However these benefits may vanish, and the shown benefits become inflated when considering total transaction costs and potential quality issues. (Niranjan and Rao, 2011)

Series of product recalls with a concern for end-user safety that originated from food items to toxic toys to automobiles highlight the exposure of organisations and customers identical to safety risks in a GSC. GSC have less visibility that leads to slow decision making in response to an interruption caused by a safety issue. Marucheck et al. (2011, 707) argued that the globalisation has commanded increased alertness for the “risks and vulnerabilities” in goods as they transit within the GSC. The GSCs are lengthy and intricate, and with a considerable number of suppliers based in developing economies, such as China, supplies some of the critical components for a product through their borders that present risks associated with product safety (Marucheck et al. 2011). To substantiate the argument that the Chinese goods potentially increases the safety risks, the report for 2017 on recalls known as Rapid Alert System in European Commission, concluded that significant fraction of the non-food products that pose safety or health risk to EU consumers are traced to China (RAPEX 2018). RAPEX, was established in 2003, is the EU information exchange system for dangerous non-food goods such as chemicals, cosmetics, machines, toys and other products within EU nations and assembled approximate 25000 alerts till date (RAPEX 2017; 2018). According to the RAPEX 2017 report, China (including Hong Kong) made products generated 53% of the 2201 consumer products alerts in the EU (RAPEX 2018). Marucheck et al. (2011) recognised that the low visibility of products’

defects worsened the problems associated with safety, which are frequently concealed in the production methods, a network of supply, or the incoming material.

4.2 Escalator industry, product and safety

In the past, developed geographies such as Western Europe and North America were the most lucrative and profitable markets for the escalator industry. The recent surge in urbanisation and infrastructure development in populous developing nations such as China and India fuelled a tremendous growth in the escalator industry. The escalator industry comprised three businesses: new product, maintenance and modernisation. The developed geographies remain attractive for the premium new product, maintenance and modernisation due to ageing, whereas developing markets pushed sales number of new products especially with a low price tag along with maintenance. This led to a highly competitive market among the top five key players (based on revenue): United Technologies (Otis), Mitsubishi Electric, Schindler, Kone and ThyssenKrupp. The global elevator and escalator market is projected to grow to the size of \$125.22 billion in 2021 from \$88.78 in 2015. (Statista 2018a; 2018b)

The escalator is considered as the most effective mode to move large numbers of persons between building's floors and defined as "a moving staircase for transporting people between floors of a building" (KONE 2018d). Some of the typical components of a standard escalator are shown in figure 11. The components can be broadly classified into three categories: Balustrade, Truss, and Steps.

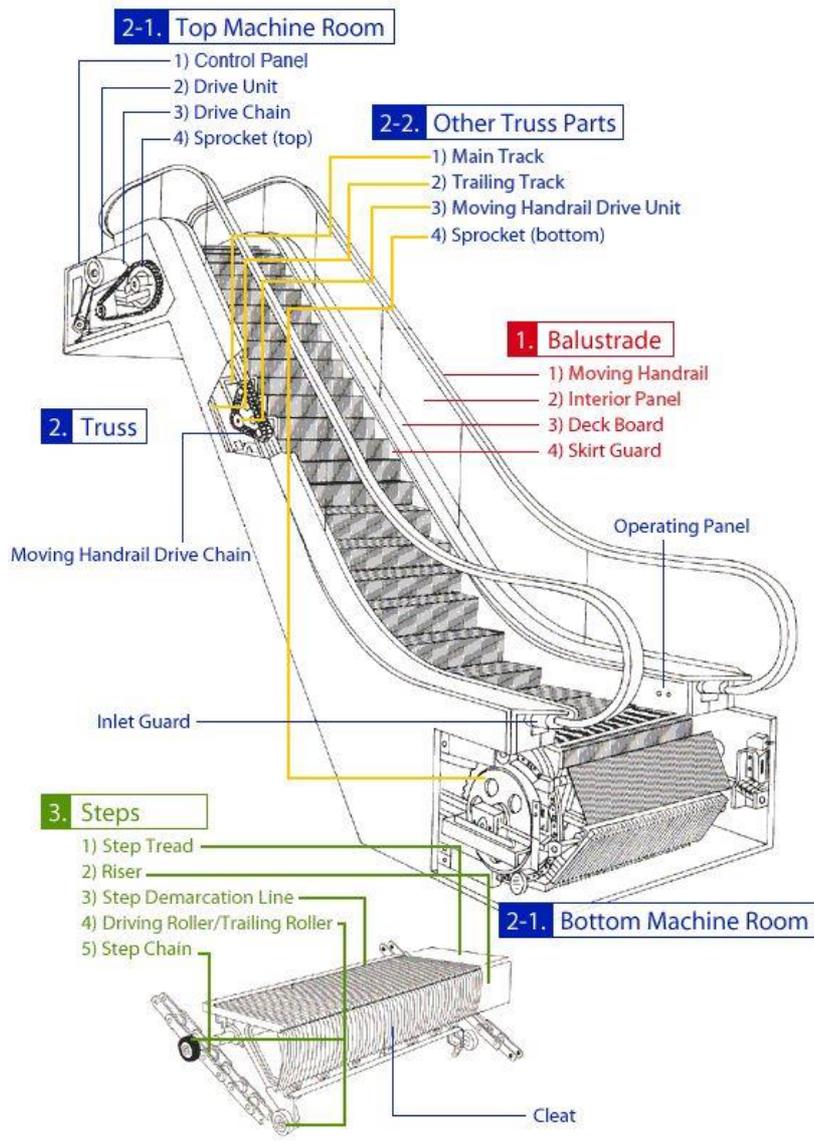


Figure 11. Escalator components (Source: Mitsubishi 2018)

The different categories of components including the one shown in figure 11 and their child parts are illustrated as follows.

4.2.1 Balustrade

The balustrade is the side panels of an escalator ranging over the steps and comprises deck board, interior panel, moving handrails and skirt guard. Deck board is an aesthetic

cover that remains in the moving direction. An interior panel is made up of glass (or sometimes solid material such as steel, wood) and constituent the main panel share. A moving handrail is a supportive structure for passengers that move in synchronisation with the steps. A skirt guard is the lowest panel in a balustrade, precisely below the inner deck and next to the Steps with a clearance gap. (Mitsubishi 2018) A balustrade unit prevents the passengers from falling over and provides holding support when riding an escalator.

4.2.2 Truss

A truss is a mechanical structure made up of steep that holds the load and weight of as escalator and passengers. It comprises a control panel, drive units for running the steps and handrails and other parts contained in the construction. A control panel as the name suggests controls the power supply to drive unit and manage start and stop operations. A drive unit consists of an electric motor, electromagnetic brakes, decelerator, V-belt, sprocket and other parts. A drive chain transmits the power from drive unit to the sprocket. Set of sprockets at top and bottom are installed to run the steps. The other truss components are main track (guiding rail for driving rollers), trailing track (guiding rail for trailing rollers) and moving handrail drive unit (indirectly run the handrail in synchronisation with steps through the moving handrail drive chain). (Mitsubishi 2018)

4.2.3 Step

The step is the passenger's platform that transport people between floors. The nomenclature of a Step is shown in figure 7. Tread is the top horizontal phase where a traveller stands. The riser is the vertical front phase of the step. Step demarcation line is the yellow borders to mark safe standing region, thus guide travellers to avoid an accident with the skirt guard. Steps are connected to the step chains using pins and rollers, front roller is known as the driving roller and the rear roller as trailing roller. Placed on either side of the escalator, a step chain links the steps to step chain sprocket, which ensures the movement of steps. (Mitsubishi, 2018)

4.2.4 Miscellaneous

At the entry and exit points of escalators, a removable steel-plate with anti-skid top known as floor plate usually installed above the truss. The section of floor plate where combs are installed known as comb plate. A comb is a teathed plate that mesh with step cleats at the entry and exit points to prevent any foreign object or passengers getting caught between floor plate and moving steps. Figure 12 shows the layout of the floor plate, comb plate and comb on a typical escalator. (Mitsubishi, 2018) This area has experienced considerable number of safety incidents in the past.

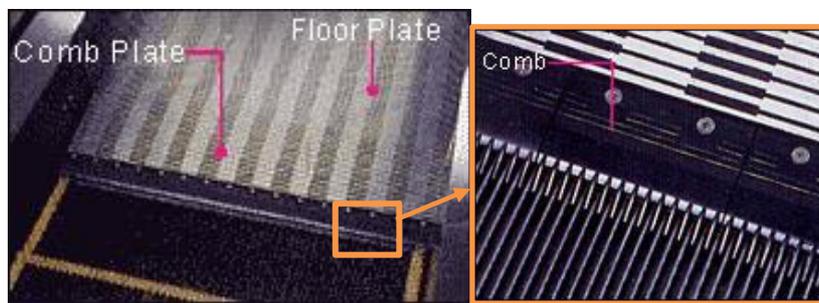


Figure 12: Floorplate, comb plate and comb (Source: Mitsubishi, 2018)

4.3 Escalator product safety

The safety-related incidents on escalators are on the rise since the early 90s. However only a limited statistics are available (Schminke et al. 2013). In the US each year approximately three persons get killed, and 6,800 get seriously injured on escalators (McCann 2013). In China, a mother got killed while saving her child on an escalator, after a floor plate breakage (Corsley Law 2016). This accident flashed an amplified coverage of accidents on escalators throughout China. In 2014, China experienced 34 deaths that were linked to escalators (Corsley Law 2016). The role of design is

significant in these accidents and is recognised by individuals working with escalator manufacturers (Safety Research 2011).

The safe structural design, safety features and safe installations of an escalator are primarily defined by the government standards such as European standard EN115 and Machinery Directive (98/37/EC), and North American standard of American Society of Mechanical Engineers (ASME) ASME A17.1-2013/CSA B44-13. These codes or standards provide guidelines and specification tools when planning an escalator or moving walkway as part of an infrastructure project. These codes give due consideration to the safe use of an escalator and provide inputs on free spaces, balustrade height, and overhead and safety clearances (KONE 2018d). However, the critical aspect to understand that these codes define the necessary level of acceptable safety requirements that need to be fused into the product for a particular market, which recognises these codes. Additionally, these codes are upgraded or revised periodically looking at the market needs and product safety performance. This exercise is consistent with Pyke and Tang (2010) 3R strategy 'recovery' mitigation action under PD. In a study conducted by IBAF for KONE, it is found that the structural design aspect of EN 13001 (design standard for cranes) is more comprehensive than EN 115, and hence ensures better design for safety (IBAF 2017).

European Lift Association (ELA) denotes the group of associations, related to the lifts, escalators and moving walks, operating in EU or European Free Trade Association (EFTA). ELA identified that there are more than 75000 escalators and moving walkways operating in EU, and more than 50% were produced before at least two decades or more. Therefore, there are escalators with different safety standards and present considerable safety risks. ELA published a brochure enlisting twenty potential safety issues in escalators and moving walks. (ELA 2010)

Griffin (2008) argued that the expansions of airports and their terminals lead to considerable increase in the number of escalators in the facility along with the number of safety incidents on these products. Airports are outsourcing the maintenance

activities to external suppliers and attempt to transfer the accident liabilities to the suppliers through contract terms. The typical safety incidents include caught-between moving parts or entrapments (e.g. between step and skirt or step and comb), electrical shocks, people falling over and property damage. (Griffin 2008)

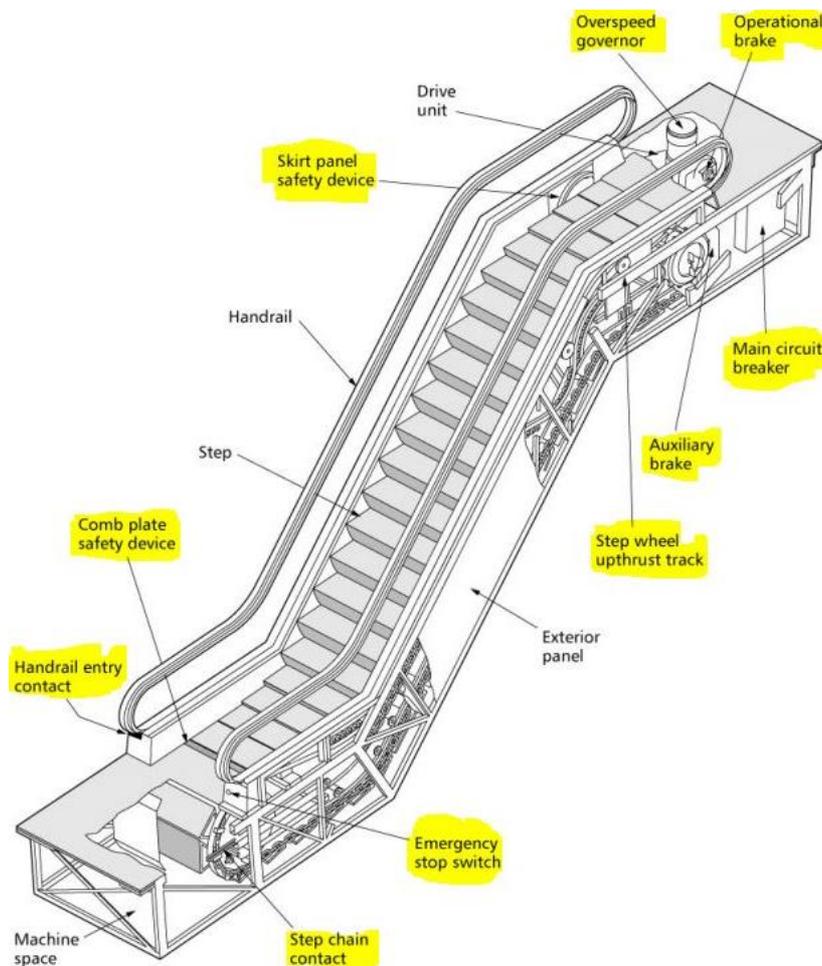


Figure 13. Typical safety devices (highlighted in YELLOW) on an escalator (Source: SAF 2011)

Figure 13 summarises some of the commercial and compelled by governmental standards or codes safety devices available in an escalator. Standards prescribe basic safety devices that are included in retail price and manufacturers have developed some upgraded and add-on safety features, which customer can choose when ordering the

product. For example, emergency stop switch, handrail entry contact and comb plate safety device is required by the codes and others are offered as per the safety requirements of the customers at added cost. (KONE 2018e)

5 RESEARCH METHODOLOGY

A research methodology is an integral part of research work; methodology guides the researcher for research methods to consider, data collection and analysis approaches that will be utilised in the course of research (Saunders et al. 2009). This section introduces the methodology of research utilised in this thesis work along with data collection strategy and analysis.

5.1 Research design

This section explores the available alternatives for research design in literature and evaluates the applicability in the scope of this thesis work.

5.1.1 Research approach

According to Polsa (2013), there are three research approaches: deductive, inductive and abductive that are distinguished regarding the beginning of research from a hypothesis derived from the theories or an observation in the real-life setup. The deductive approach also termed as the hypothesis-testing approach. Novel hypotheses are derived from the theories, and then these resultant hypotheses are validated using empirical data as true or false. Quantitative studies find this approach useful, utilising surveys or questionnaires as a tool for data collection. The shortcoming of deductive approach is that it only tests the hypotheses based on cognitive beliefs of the researcher and it is highly probable to overlook the innovative facts during the process. (Polsa 2013)

The inductive approach starts with no initial theoretical frame of reference. Instead, patterns and structures are observed that led to the development of a theory. The advantage of this approach in exploring the new scientific phenomenon, usually there is no theories, to begin with, and new theories are proposed based on the observations. Consequently, the drawback with this approach is difficulty in collecting the data

without biases and influence of previous knowledge. (Polsa 2013; Saunders et al. 2009)

The abductive approach is a balanced technique between deductive and inductive approaches. This approach utilises an iterative process, in which researcher examine the existing theoretical base and empirical situation simultaneously to create a situation dependent theory or find a theory that fits the empirical situation. (Polsa 2013) Therefore, this approach requires considerable experience from researcher's part on similar exercises because of its iterative nature and no structured method.

This thesis principally utilises inductive approach for studying the product safety assurance in the upstream of GSC. To the best of author's knowledge, there are no previous studies about escalator industry; this research began from the existing studies in product safety domain in food, health and pharmaceutical, automotive, and toys. The organisation approached in escalator business has to be examined through observations. Thus, the inductive approach becomes the natural choice.

5.1.2 Research strategy

A case study method is reasonable and classically employed when these circumstances present: 1) research questions are based on "how" and "why", 2) researcher has minute control over proceedings, and 3) the investigation focusses on a modern day concept with real-life perspective (Yin 2017). Yin (2017) asserted that in a single case study, the person conducting the study concentrates on a given problem, defines the boundary and digs into the thorough clarification of the problem. The case study provides the opportunity to assess and explore the issue under consideration from different contexts and improves the learning of a researcher (Yin 2017). Thus, A single case study is a preferred approach in this investigation and a perfect fit in addressing the founding questions of this thesis on organisational approaches and processes to mitigate product safety issues in the escalator product in the GSCU.

Typically a case study approach and the results of this study are not generalizable. This thesis work focusses on investigating the current approaches and processes in a particular real-life setting, in the GSCU. The findings and recommendations are made using existing literature and interviews with the case organisation's business leaders and experts.

5.1.3 Methodological choices

The author considered three choices for research methodology: quantitative, qualitative, and mixed methods (Khaldi 2017). Golafshani (2003) argued that researcher must understand the philosophical and theoretical assumptions and their implications for research. One primary difference between quantitative and qualitative research is that quantitative research validates a hypothesis as true or false, whereas qualitative research generates a hypothesis (Golafshani 2003; Khaldi 2017). The qualitative approach permits in-depth exploration of a phenomenon utilising interviews, observations, and documents with a high degree of details compared to a quantitative approach (Yin 2015). A qualitative approach in this study maximises the understanding of successful business experiences in mitigating the safety issues in a GSC (Wowak and Boone 2015).

Qualitative research offers the possibility to capture the perceptions and perspectives of the research's participants (Yin 2015). According to Saunders et al. (2009), ensuring research data from diverse sources is the key to conducting good quality research. Therefore, this study provides a prospect to develop new insights by involving case organisation's business leaders and sourcing and design domain experts as participants.

5.2 Data collection

Saunders et al. (2009) noted that qualitative research comprises different data collection methods: group or individual interviews, observations, and textual and

visual analysis of books, presentations, videos and organisation's documents, website and investor's reports. This thesis utilises triangulation technique to gather data from multiple primary and secondary sources. Triangulation denotes the utilisation of differing techniques for data collection to confirm the thinking line of a researcher (Saunders et al. 2009). The primary data were collected using semi-structured interviews, and organisation's documents and information available on the intranet and public website, while secondary data was collected using literature review of scholarly articles and trade journals.

5.2.1 Interviews

Interviews and observations are most predominant methods for data collection in qualitative research (Golafshani 2003). Qualitative research typically includes three approaches of interviews: structured, semi-structured, and unstructured (Yin 2015). Structured interviews are set of questions managed orally in which the researcher enquires pre-established questions with the slight opportunity to add any supplement queries. Equally, there is slight or no organised approach in administering the unstructured interviews. There is non-existence of pre-established questions in unstructured interviews due to which these are time-consuming and offer small control. Semi-structured interviews are compiled from numerous crucial questions that describe exploratory domains while permitting researchers to dive deeper to pursue a response (Saunders et al. 2009). Yin (2015) argued that the in-depth semi-structured interviews be the most common interview approaches in qualitative research and permit researchers to dig deeper into the research focus area.

Therefore, to capture the overall perspective and more profound understanding of business leaders and experts experiences, this study utilises semi-structured interviews consist of open-ended questions (Appendix 1). The mode of interviews was planned based on geographic availability (China, Germany and Finland) of identified interviewees. Some interviews were conducted in person (researcher travelled to Germany) and other over the Skype calls, which allow screen sharing for further

clarification or information sharing. The length of interviews was in the range of 45 to 60 minutes and followed by the summary of interview discussion. The interview conducted with more of an interactive approach to dig deeper into the stimulating area and the actual questions asked were going beyond the list of predetermined questions (Appendix 1). Post-interviews and summary sharing, interviewees were given the flexibility to supplement the provided information at any point through a call or e-mail. The case organisation's requirement to keep data confidential and interviewees reluctance for recording, the study utilised the note-taking to capture the vital information.

The selected case organisation is a leader in escalator industry, and the objective was to arrange at least one business leader and two experts from each sourcing and product development functions along with access to internal documents. In qualitative research, selecting participant is decisive that necessitates searching the participants who are best informed on the research questions driven by their interests, and their comprehension of the study results (Saunders et al. 2009). Identification of appropriate participants is the most crucial task in the research design phase (Yin 2015). Thus, seven participants identified that are involved in PDP, GSP and product safety areas and a target of at least one interview with each participant is planned. Table 2 presents the summary of an actual number of interviews and modes with each of the identified participant.

Table 2. Summary of participants' background and interviews conducted

Business Area	Participants	Interviews	Skype	In-person
Product Development	Business Leader	1		x
Product Development	Expert 1	2	x	x
Product Development	Expert 2	1		x
Global Sourcing	Business Leader	1	x	
Global Sourcing	Expert 1	1	x	
Global Sourcing	Expert 2	1	x	
Escalator Product Safety	Business Leader	2		x

5.2.2 Case organisation's records

Case organisation sponsored this thesis as a part of an initiative to identify the opportunities for improving product safety and accesses were granted for internal company documents (policies and procedures) and intranet pages. The chapter four utilises the information from these accesses and presents relevant information in this thesis.

5.2.3 Literature review

Secondary data most typically gathered through the literature review, which provides foundational theories and references for improving the researcher's understanding of problem in-hand. This thesis attempts to cover classic as well as latest scholarly contributions in the area of GSC, global sourcing, PD, and product safety. The references are cited within the text and provided in the 'References' chapter. The primary sources were printed books, scientific articles from leading journals, and practitioners articles from trade journals. The combinations of keywords from the scope of this thesis were used to search scientific literature on platforms and databases such as Google Scholar, Scopus, Springer, and Web of Science.

5.3 Data analysis

The objective of data analysis is to consolidate and construct the research's findings to maximise the understanding of results. This thesis primarily utilises textual coding from content analysis to identify the categories exists in the data. Content analysis can be used for analysis of textual data resulting from interviews and can build a coherent explanation for the phenomenon under research consideration. Later, the results can be consolidated or merged with a broader context that comprises other results aligning with the similar phenomena. The content analysis can be done quantitatively or qualitatively. In the quantitative content analysis, the data was measured or specified in quantitative terms such as frequency of occurrence of any word in the given data.

In the qualitative analysis, verbal explanation of the content is examined to identify the themes. (Krippendorff 2012)

There are three discrete approaches to begun content analysis: deductive, inductive and abductive. The deductive approach utilises existing theories to prepare a theoretical foundation for codes creation from the content. Whereas, an inductive approach first identify the codes in data and later utilises it for the theoretical foundation. Abductive approach is a hybrid combining both deductive and inductive that includes comparisons and counting of for example keywords and using these findings to construe the content. (Krippendorff 2012)

This thesis work utilises triangulation of qualitative content analysis and exploratory research method to investigate the current processes and strategies of case organisation, in the GSCU to mitigate product safety issues. The first phase of analysis begins with the review of participants answers in interview notes and identification of interesting themes emerged from the collected data. The whole thesis-work tails two principal themes, first to investigate approaches of case company to mitigate the product safety issues in global sourcing and product development. Secondly, to identify the challenges in mitigating the product safety in focused areas. These critical themes utilised as a beginning point for the content analysis of interview data. Subsequently, the results from the interview data have been restructured and organised through an iterative approach.

The second phase of analysis followed a thorough review of case organisation's processes, policies and practices to establish the relationship with emerging themes from the interviews and aid as a triangulation method (Saunders et al. 2009).

5.4 Research's findings credibility

Two universal concepts ensure the credibility of qualitative research: reliability and validity that conceived as trustworthiness, thoroughness and accuracy in qualitative

method (Golafshani 2003; Sanders et al. 2009). The credibility of the research in a qualitative study is ensured by a thorough explanation of the research methodology and eliminating biases (Saunders et al. 2009). In this thesis work, the research methodology is introduced and authenticated within the running chapter. Moreover, the interview questions utilised in data collection are presented in Appendix 1. To eliminate the biases, data sources and analysis are triangulated to consider the different viewpoints (Golafshani 2003).

Reliability denotes the degree to which data collection or analysis methods will produce the dependable results. Reliability of qualitative research indicates the trust of participants on the results and repeatedly getting the same result by other researchers. (Sanders et al. 2009) Reliability of a qualitative case study can be improved by utilising the chain of evidence that confirms construct validity (Yin 2017). This thesis's chain of evidence comprises interviews and company records, and theoretically supported through the literature review.

Validity conceptually denotes the vast array of terminologies in qualitative research and represent the accuracy of a perceived result. The concepts of reliability and validity also equated to the trustworthiness of research and can be enhanced when employing several methods and contexts. (Golafshani 2003)

However, it should be taken into account that this thesis work includes results from only a single case organisation from the escalator industry and hence results are not generalizable until supported by additional research. The interview conditions were particular circumstances, and both individual characteristics and skill-sets of the participants and the researcher can influence the results. Moreover, it must be noted that the participants represented individual's expertise and are not necessarily able to comment on organisation strategy as a whole. The interview questions were shared with the participants in advance, and they were asked if they are not conversant with any particular question theme and provided alternate contacts for an interview.

6 FINDINGS AND DISCUSSIONS

The central thesis questions presented in chapter 1 guided the progress of this thesis. To investigate the answers to those questions, the collected data was validated through cross-corroboration utilising several sources. Golafshani (2003) noted that the use of several sources enhances the trustworthiness of research. The collected data and substantiation were: (i) semi-structured exhaustive interviews of two business leaders and four experts at the case organisation and (ii) review of organisation's documents (especially, GSP and PDP). Data analysis reported five themes, categorised two each under PD and global sourcing, and one standard theme for product safety challenges in the GSCU. These themes demonstrated the approaches and challenges for case organisation in mitigating the product safety issues in the GSCU.

These emerging themes established a foundation that sets the direction to investigate the strategies used by case organisation to curtail product safety issues effectively. The themes under product development are: (i) parameters affecting safe product design and (ii) ensuring safety in product development. Global sourcing comprised themes are: (iii) parameters influencing the suppliers' selection and relationship and (iv) approach for curtailing product safety issues. The identified challenges related to product safety are categorised in the theme (v) product safety challenges in the GSCU. Collectively, these themes outlined pragmatic approaches that other organisations might consider to improve product safety in the GSC.

6.1 Parameters affecting safe product design

The first theme that appeared in developing a safe product is the parameters that affect the product design. This theme comprises two sub-themes: (a) customer and market requirements, and (b) codes and standards. The gathered data under this theme was found in alignment with the tenets of RBV that an organisation require possessing exceptional capabilities and resources to succeed in a competitive market (Ferreira and

Fernandes 2017). Under this theme, a proposal is made to consider an emerging dimension of TCE framework in product design trade-offs between cost and safety.

6.1.1 Customer and market requirements

This sub-theme emerged as the most recited parameter influencing the product design and subsequently product safety. The escalator is a highly customer focused product with considerable configurations and optionality. The findings are in-line with the findings of Tseng and Piller (2011) and Jiao and Chen (2006) that organisations follow a strategy of retailing customer-focused products possessing a considerable degree of distinctiveness. Participant leader 1 from NPD organisation quoted the example of world's first arched escalators developed by case organisation for Elbphilharmonie concert hall in Hamburg, Germany that shows the complexities involved in PD.

To meet such distinctive customer requirements, an organisation require some unique skillsets and processes. As answered by PD expert "*we need to have considerable experience and ability to understand the scenarios in which escalator will be used or misused*", this statement shows the importance of RBV in understanding the PD, as noted by Kleinschmidt et al. (2007). The organisational resources and PDP capabilities affect the PD performance and contribute to organisational competitive advantage (Kleinschmidt et al. 2007). The viewpoint of TCE can be understood when reviewing the effect of cost reduction strategy on PD and product safety, and the PD expert 1 responded "*there is always a struggle between safety and cost, and we need to balance both in such a way that our product can compete in the market with the price customer intended to pay*". PD expert 2 agreed with the view and quoted that "*in such compromising situation, the codes and standards guide the product design and define the final product base machine and options*". McCann et al. (2005) argued that the public policies should be evaluated from the perspective of transaction costs through a broader framework comprising benefits and total costs.

6.1.2 Codes and standards

This sub-theme is another vital parameter emerged during a discussion with PD participants. On the one hand, these guidelines standardise the features and functionality of escalator industry as discussed in literature review. On the other hand, it poses a dilemma, should a product developed with all possible safety options which increase its costs or develop a product with essential safety options as defined by codes and standards. PD business leader noted, *“These codes and standards are defined by based on inputs from industry body, which consists of small and big players. Many small players thrive in the market because of low cost and product development with minimum resources, hence introducing any change in the standards that increase the product cost significantly or require considerable resources investment for a new capability development without the substantial backing of a recurring safety issue be challenging. Therefore, these codes and standards defined only basic safety features and functionalities and discussed periodically among industry players for any update or change.”*. This observation discussed in detail under the theme of challenges.

6.2 Ensuring safety in product development

This is the third theme emerged during the data analysis and focused on the strategies and approaches to ensure product safety in PD. To address the cost challenges associated in PD, business leader responded: *“We have identified the potential areas for product safety improvement and developed safety and condition monitoring devices that are offered in the market as add-ons or accessories to new product and modernisation businesses’ customers”*. PD expert 2 added, *“these offerings act as an additional layer of safety for the escalators products in the fields, for the abnormal situations not considered in codes and standards”*. The organisation’s strategy of balancing profits and cost drivers through offerings differentiation for product safety is in alignment with the findings as noted by Desai et al. (2001). From the perspective of RBV, an organisational strategy can be considered as the unique for the given set

of firm-specific resources, aiming to generate rent using those resources (Augusto and de Souza 2015).

To understand the approaches to ensure product safety, PD expert 1 replied “*to create safety culture with built-in safety in our products; we ensured safety culture embodiment into product development projects and KONE WAY process. This is achieved through the introduction of tracking of safety-critical tasks in product development process and addressing open tasks before entering the gate of phase 5 and 6*”. The case organisation has adopted the modified version of the stage-gate PDP, which was proposed by Cooper (1990). In this SGM, PDP breakdowns into predefined stages with a defined set of activities (Kahn et al. 2012), and these set of activities identified for safety criticality and reviewed for completion before piloting and full production. From the context of RBV, the case organisation’s PDP is an established set of routines that ensure the involvement of right resources and information from appropriate sources in a time bound manner (Kleinschmidt et al. 2007).

6.3 Parameters influencing the suppliers’ selection and relationship

This is the first theme on global sourcing that emerged during the analysis of data. This theme comprised two sub-themes: (a) design ownership and capability, and (b) cost of sourced product and product safety. The part of findings is aligned with the views of RBV and TCE. However, some findings diverged particularly from the assumptions of agency theory. The agency theory is founded on the ground that an agent tries to maximise own return by obeying the commercial purposes of the principal (Jensen & Meckling 1979). Agency theory supports a researcher in contemplating situations between a principal and an agent, where interest misalignment and information unevenness occurred (Eisenhardt 1989). The agency theory is based on the assumption that the procuring organisation has insufficient knowledge about the motives and efforts of the supplier at the transaction’s start. This assumption generates distrust concerning likely opportunism in the minds of the procuring organisation’s managers (Steven et al. 2014). Steven et al. (2014)

emphasised that from the perspective of agency theory, sourcing is a strategic move to reduce costs by an organisation by assigning responsibilities to other firms. In a global context, it may lead to substandard products finally leading to recalls (Steven et al. 2014). The analysis of collected data from a business leader and a sourcing expert unexpectedly yielded different considerations in supplier's selection.

6.3.1 Design ownership and capability

This emerged sub-theme shows the findings in the light of RBV and TCE, and in alignment to the tenets of agency theory in the context of selecting a supplier as asserted by Steven et al. (2014). Agency theory utilises lens of moral hazard to review the supplier selection when it is difficult or expensive for procuring organisation to monitor the activities of the supplier, that leads to a possible incentive for the supplier to deliver a substandard product or cheat, to gain more profits (Steven et al. 2014).

The response of sourcing leader, *“when we think of third-party relationship, the first thing comes to mind who is going to own the design (intellectual property right or IPR) and certifications for the product, does it belong to our organisation or supplier's and the answer decides the way supplier will be selected and later managed in the future. For a supplier who is manufacturing on ours organisation's specification, then our focus is fundamentally into the quality throughout the manufacturing plant. Suppliers need to have capability and resources, and we need to have the expertise to validate those”*, was in alignment with the agency theory, RBV and TCE. Sourcing expert stated *“First mapping of components (e.g. sensors, drive stations), which are defined as critical to safety component. High attention is given to these components.”*. This point further elaborated by business leader, *“the planning for sourcing starts with the considerations, how much the component is critical for us, how much we need to invest in the technology, we are not familiar with, and how much supplier landscape is for that particular product”*. The findings show that both supplier and procuring organisation need to have some specific skills to enable a successful partnership. In the supplier's selection phase validating the potential supplier's capability and ensuring

that it has sufficient resources to fulfil the material demand is coherent with the agency theory's framework.

6.3.2 Cost of global sourced product and product safety

The findings from the cost of the global sourced product and product safety in this thesis again diverged from the central assumptions of agency theory and TCE. The sourcing business leader and expert, both were similarly attentive to the requirements of product safety, and there was no trade-off situation with cost-benefit in global sourcing. Sourcing expert noted, *“In our organisation, product safety and quality considered first, and there is no compromise on those against cost.”*. Business leader's views were similar, and he further added *“safety mostly comes from design... moreover, we are not compromising on safety intentionally. So there is no direct link between cost reduction and safety”*. These viewpoints contradicted the agency theory in a theoretical framework and diverged from the discussed scientific literature during literature review that the cost-benefit is the primary driver for global sourcing.

6.4 Approaches for curtailing product safety issues

The most important theme appeared in the dataset from global sourcing was the strategies to curtail product safety issues. This theme consists of two sub-themes: (a) organisational internal practices and goals, and (b) supplier relationship management. The various strategies employed by case organisation to mitigate the product safety issues are consistent with the context of agency theory, RBV and TCE. Procuring organisations implement several administrative procedures to mitigate the substandard supplies from a supplier and minimise the possibility of an unfavourable incident (Zsidisin and Ellram 2003).

6.4.1 Organisational internal practices and goals

This subtheme is consistent with the framework of RBV and demonstrates how the organisation specific internal practices and goals for future provide an edge in the

market to provide a safe product. To highlight a similar practice, sourcing expert asserted, “*For components identified as safety-critical are extensively tested during product development as per defined standards. Sourcing collaborates with R&D to ensure the safe functioning of the sourced product.*”. Gomes et al. (2003) argued that functional integration within organisations, especially in the early phases of PDP, improve the quality of end product. Verona (1999) asserted that the cross-functional integrations inside an organisation could be assessed using the framework of RBV since those are exclusive capabilities with the given set of resources.

The sourcing leader provided useful insights about the practices and future goals by adding, “*we currently use VDA 6.3, which is an automotive standard. Our some practices are aligned with this standard, and we wanted to comply 100% to automotive standards, and once we are there, we will aim for aerospace standards to further improve our processes and final products.*”. VDA 6.3 is a standard for process-based auditing that evaluates and improves controls in a manufacturing and PD processes (QSE 2018). The decisions within organisations fit in the context of RBV (Augusto and de Souza 2015), for case organisation to follow a particular standard and implement it in its internal practices to develop knowledge resources. Once established, setting up future direction for more stringent standard demonstrates the approach of developing niche competencies and capabilities within the escalator industry.

6.4.2 Supplier relationship management

This subtheme includes the lifecycle of interactions with suppliers in the case organisation and is coherently relates to the principles of agency theory, RBV and TCE. The case organisation is highly focused on quality and safety of its product as established in its strategic framework (KONE SharePoint 2017b) discussed in the previous chapter and committed to developing its supplier to be competitive in the market (sourcing leader). The strategy to mitigate issues about product safety starts in early phases of supplier relationship lifecycle, as stated by sourcing expert, “*In the*

sourcing process when qualifying new suppliers – consideration was given to safety factors (through SQM audits). Existing suppliers assessed and managed through periodic (a year or two) recertification considering these safety factors”. These approaches ensure that supplier has necessary capacity and capabilities to meet the product specifications and safety requirements. Sourcing leader further added to this context, *“For a product for which we have an IPR, we preselect supplier from existing supply base and evaluates them on the basis of three dimensions: (i) a solid control plan in place indicating critical to safety and critical to quality indications, (ii) manufacturing process audits, first asking supplier’s evaluation and then utilising our auditing expertise to assess the manufacturing capabilities yearly, and (iii) the quality systems suppliers have in place, and very often we utilise external consultants to assess the capabilities of suppliers in different business processes”.* The established practices of case organisation are comparable to Japanese automotive manufacturers such as Honda, Kawasaki, and Toyota as noted by Jin et al. (2013). Gould (2003) asserted that periodic suppliers’ certification and facility visits strengthen the supply chain and ensure the active relationship with suppliers, that is critical to organisational success.

Both agency theory and TCE concern the challenges with conflicts of interests and power conflicts between principal and agent that possibly lead to safety issues in the final product. These challenges may be alleviated by introducing the instruments of incentivising and monitoring that limit the opportunistic conducts of actors (Oviatt 1988) and finally positively affect the product safety. Sourcing leader briefs this approach of case organisation, *“we need to drive a DNA and people’s mindset change at suppliers towards the quality and safety. It is about the keeping the message repeating consistently, punishing when we find some non-conformities and also reward when we have a good performance displayed by supplier”.* Some specific examples added by sourcing expert, *“penalty clause in contracts against safety issues, product insurance to cover the safety risks, and supplier risk assessment process to evaluate the potential safety issues”.*

6.5 Product safety challenges in the GSCU

This theme presents the challenges experienced by case organisations on product safety in the GSCU. This theme is categorised into two sub-themes based on the areas of focus of this thesis.

6.5.1 Challenges for product safety in PD

This is the second theme of PD that includes the challenges faced by case organisation in mitigating the product safety. As discussed in the previous section, insufficiency of codes and standards in meeting all product safety requirements came up frequently during discussions. PD expert 1 explained, *“the codes do not consider all possible dynamic loading situations and go with static analysis most of the time”*. PD expert 2 had a similar view too and added: *“we need to visualise possible loading scenarios based on our experiences”*. PD business leader stated, *“the current EN115 codes still have some opportunities to improve from a safety point of view if compared to similar codes for other industrial products”*. The supporting document (IBAF 2017) shared by the PD business leader on the comparison of EN 115 with cranes’ design standard EN 13001 validated the concern. The concern from product safety business leader was similar and further elaborated *“to keep up with the competitive market the product was designed keeping the specifications in codes, and since we do not know to what abnormal loads or conditions an escalator is subjected to, and it may affect the product safety”*. It has been observed that the case organisation utilises external consultants and engineering experts such as IBAF time to time to validate the product design.

Another challenge as concurred by PD business leader *“The current escalator industry landscape is highly competitive, and in last 20 years, the retail product price has dropped considerably due to competition among industry players.”*. PD expert 2 added, *“in the product development the cost is a major driving factor, and there is always a risk when reducing cost it may affect the quality of final product and subsequently product safety”*. PD expert 1 quoted *“we have the vision to become the*

safest company in the world and to enable product safety we are inventing and offering new monitoring and safety devices as options in our product portfolio". To cope up with dropping margins in the product and growing product demand in China market, the case organisation has shifted most of the escalators manufacturing operations to China, whereas retaining the product conceptualisation and testing capabilities, and some assembly operations in original locations such as Finland and Germany. The assessment and monitoring of total costs incurred in the supply chain are critical in coping up with the amplified competition globally (Nita 2014).

6.5.2 Product safety challenges in global sourcing

This theme incorporates significant challenges emerged during the interviews with the participants from sourcing function. The first challenge as stated by sourcing expert, "monitoring the variations in the output of the process at the suppliers" and the further added by sourcing leader "*consistency and sustainability... consistency in the supplies as per specification and sustainability of tools and processes in place to ensure the consistency, for example how frequently quality manager at supplier changes and what kind of resources does he has, and how much we instruct and specify is already part of their process DNA, and how much sustained by the supplier when you are not monitoring*". These observed challenges are reasonable with the agency theory's framework that is procuring organisation has less visibility to the internal process of suppliers and the possibility of getting the supplies, which are not compliant with the product safety. Business leader from product safety aligned with the views and further added: "*certainly there is a good focus on improving suppliers' processes and the quality of supplies. However, there is still an opportunity to engage with suppliers from product safety perspective*". It has been observed that one dedicated resource manages the department of escalator product safety currently and it limits the opportunity to work with suppliers in a global setting. Fernández-Muñiz et al. (2007) asserted that organisational safety performance profoundly influenced by the role of individuals.

Another, challenge as noted by sourcing leader, “*when working with the new suppliers, the major gap is how much supplier understands the system level of an escalator. Suppose, you buy an escalator step, how do you make sure that the supplier designed and delivered the product considering all aspects (e.g. life, speed, load, salty environment) of usage of it in an escalator. How much they contextualise the product, they deliver to make a right design for performance. Moreover, it is rather difficult to evaluate the suppliers or business partners understanding of the full functionality of an escalator*”. From the RBV perspective, suppliers are unique resources for an organisation that helps in gaining competitive advantage (Espino-Rodríguez and Padrón-Robaina 2006), whereas from the lens of moral hazard in the framework of agency theory (Steven et al. 2014), the irregularity in supplier’s effort in gaining the understanding of overall escalator functionality and using it to develop a product for unforeseen situation may negatively affect product safety.

7 CONCLUSIONS

This single case-study-based qualitative research aimed to examine the challenges experienced and approaches employed by an escalator manufacturer in mitigating the product safety issues in the GSCU. Although several parameters act as drivers for an organisation to operate in a GSC, the scientific literature founded on TCE more or less agrees on the cost saving as the primary driver. The RBV approach offers other insights such as retaining core competencies and using GSC for competitive advantage. Despite the increase in the numbers of organisations engaging in GSC, individuals in the supply chain acknowledge concerns with product safety. The alarming rate of recalls and safety notifications in GSC demand investigation of approaches and strategies to mitigate the issues deteriorating product safety.

The findings reveal that the case organisation relies on parameters such as customer requirements, codes and standards along with competence of its R&D workforce and suppliers to ensure the product safety in the PDP. When sourcing globally, a good understanding of in-house capabilities taken into account with an attitude of no compromise on safety. The internal organisational functions and their processes are guiding the interactions with suppliers and their management. The significant challenges identified in the PDP are concerned with the insufficiency of codes and standards, whereas in global sourcing its concerns with the supplier's understanding of an escalator system as a whole. This chapter of the thesis concludes the research followed by recommendations for case organisation, implications, and limitations and future research opportunities.

7.1 Recommendations for case organisation

This section presents some actionable recommendations that can help case organisation in improving the product safety. These recommendations are classified into three categories and explained as follows.

7.1.1 Upgradation of codes and standards

The first challenge identified in the context of product development is that the codes and standards only provide guidelines for basic safety. Moreover, the escalator market is highly competitive with many customers preferred minimum purchase price. This drives case organisation to offer safety features as an add-on and not in the primary product. Hence, there is a necessity to upgrade the current design standard EN 115 that still have several opportunities for safety consideration improvements when compared to design standards of other industrial products (IBAF 2017). Additionally, there is an opportunity to standardise safety signs on the escalators (Griffin 2008) across all manufacturers. The case organisation can communicate these findings in the EN 115 review meetings and coordinate with concern authorities to introduce the changes.

7.1.2 Capability development for digital analysis of the escalator system

This challenge or opportunity was not explicitly stated but emerged when analysing the data from multiple sources. The case organisation is involved in the full value chain of escalator manufacturing and upstream supply chain activities especially product development from the perspective of RBV is critical for organisational success (Verona 1999). Considering supply risk factors, product technology and security (Giunipero and Aly Eltantawy 2004), it is recommended that the case organisation consider developing capabilities on digital analysis of escalator system in-house to improve the product safety in PD and potentially cut total PD time.

7.1.3 Escalator academy

Another challenge emerged from the perspective of global sourcing is that suppliers lack understanding of escalator system as a whole. To overcome this challenge, this thesis recommends establishing an escalator academy for the suppliers that offer capability building program to crucial supplier personnel. This could be developed using a web-based platform and supplemented with a classroom-based curriculum covering the system level functionality of an escalator. This practice of supplier

capability building needs to be sustained by ensuring that it becomes the part of yearly certifications that will be then driven by the organisational processes.

7.1.4 Actualisation of a safety management system

This opportunity emerged when reviewing the company internal documents and discussions with a business leader in product safety. The case organisation utilises a safety policy worldwide, and have only one full-time resource for driving product safety in global escalator business. The development of product safety organisation and related processes were struggling to keep up with the growth that escalator business has experienced. Thus, this thesis recommends actualisation of a comprehensive global safety management system replacing existing safety policy within the organisation that enables efficient allocation of resources for safety initiatives within organisation and influences personnel's attitudes and behaviour related to safety (Fernández-Muñiz et al. 2007).

7.2 Implications

The findings of this thesis provide several implications for the different actors in the society. This section categorises and presents those implications for academics (theoretical), manager and society as follows.

7.2.1 Theoretical implications

On the theoretical front, this research enriched the growing literature integrating three theories, i.e. agency, RBV, and TCE (Tan and Mahoney 2006) forming the central theoretical framework of this thesis. Additionally, it provided some new viewpoints such as extending TCE to contextualise the PD in trade-offs decision between product cost and product safety. This research offered unexpected perceptions about the potential inappropriateness of agency theory in specific business settings and challenged some underlying assumptions that again shows contextual (Eisenhardt 1989) nature of agency theory. The prevailing belief that an organisation principally

engaged in global sourcing to lower cost (Ibrahim et al. 2015; Moe et al. 2014) from a TCE perspective is challenged in this study. The findings show that the product safety and not the product cost was the most crucial decision parameter in a GSC. The use of RBV complemented TCE by providing the viewpoint on organisational capabilities that affect the strategies in the GSC (Barney 1999).

7.2.2 Managerial implications

The findings of this thesis provide actionable and detailed references for an escalator or similar industrial product manufacturers, operating in a GSC, may benchmark to mitigate the product safety issues in the GSCU. Considering inadequacy in codes and standards for escalators manufacturers, a broader framework encompassing the safety benefits and overall costs need to be incorporated for measurement of transaction costs when making trade-offs between safety, development time and cost. The learning from Ford Pinto case is an important takeaway for poor corporate decisions about product safety.

7.2.3 Societal implications

This thesis work also presented some historical cases about product safety and their effect on the organisations and society as a whole. The motive is to create awareness and drive a viewpoint change towards the product safety. The issues related to product safety not only put the end-users life in danger but also carry potential disastrous financial and trust consequences for the organisations involved (Wowak and Boone 2015). Additionally, this research aims to highlight the prerequisite for organisations engaged in a GSC to fulfil the requirements of government legislation and regulations and be accountable for their products. The implication for societal change is that societies will face decreased safety risks from products manufactured in a GSC and subsequently reduce the incidents with disastrous mortalities and financial consequence for organisations.

7.3 Limitations and future research

This case study based research has some limitations regarding generalizability. First, the reported findings and recommendations are sector or organisation size and operations specific. The study focuses on capturing the practices and processes in GSC environment where the organisation has a specific set of suppliers that are from a different cultural background with different capabilities. This may affect the generalizability. To establish the generalisation, future studies can consider other players in escalator industry and segregate the suppliers based on cultural and capabilities settings.

The central research theme is based on the supply chain upstream with a focus on PD and global sourcing. Considering the escalator product life, which varies 50-80 years, it would be interesting in future to study the product safety in supply chain downstream. Especially, understanding the influence of installation and ongoing maintenance in establishing the product safety would be valuable from the academics' and practitioners' standpoint.

The PD has been researched from various perspectives such as marketing (Kotler and Armstrong 2010), operations (Mital et al. 2014; Ulrich and Eppinger 2012), organisational behaviour and strategy (Clark and Fujimoto 1991; Müller-Stewens and Möller 2017) and considered to include a wide-ranging set of activities: product ideation and design, production, and finally selling it to customers (Kotler and Armstrong 2010; Mital et al. 2014). The thesis is focussed on the upstream activities of the supply chain, and hence the sales and marketing aspect of PD is not considered in the scope. In future studies, the PD can be contextualised from the aspects of sales and marketing to assess the impact on product safety.

Regarding research method, the availability of time with organisational leaders and experts were limited, and there is a possibility that not all information captured. The other possibility in this category would be unease from participants to disclose the

information on organisation's internal practices, which is recognised as trade secrets. Future research studies can utilise the longitudinal settings and ongoing interactions to observe complete PDP and total supplier management within global sourcing to enrich the findings of this study.

With consideration to product safety, Nicolson (2008) argued that the most of the safety incidents on escalators be originated due to errors of passengers or end-users (Nicolson 2008). The future studies can incorporate the human behavioural frameworks building upon the findings of Fernández-Muñiz et al. (2007) that human factor takes the central role in safety performance. This framework can be used to comprehend the passenger's viewpoint and research escalator's product design to improve product safety.

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APPENDICES

Appendix 1: Interview questions

Interview Questions – Product Development

1. What factors or parameters are considered to decide escalator and its components product development strategy?
2. How do these factors or parameters for product development affect the product safety?
3. How does the cost reduction strategy or targets affect the capability to mitigate safety issues in your products?
4. What are your key challenges in product development process to mitigate the product safety problems?
5. What approaches or strategies are you employing to counter the product safety challenges in product development?
6. What are your practices and standards to evaluate the product safety in product development process?

Interview Questions – Global Sourcing

1. What factors or parameters are considered to decide your escalator and its components sourcing strategy?
2. How do these factors or parameters for product sourcing affect the product safety?
3. How does the cost reduction strategy affect the capability to mitigate safety issues in the products?
4. What are the key challenges you experience when working with suppliers in the global supply chain to mitigate the product safety concerns?
5. What approaches or strategies are you employing to counter the product safety challenges in the global supply chain?

6. What are your practices and standards to evaluate the capability of different suppliers in the global supply chain to comply with your product safety specifications?

Interview Questions – Product Safety

1. What are your key challenges in the global supply chain upstream to mitigate the product safety concerns?
2. What approaches or strategies are you employing to counter the product safety challenges in global supply chain upstream?
3. What are your practices and standards to evaluate the product safety in global supply chain upstream?