Managing Supply Chain Uncertainty with Emerging Ethical Issues

1. Introduction

The globalisation of supply chains means that the production of many goods and services is now affected by a variety of infrastructures, climates and cultures, and by the interactions between them. As a result, there is potential for increased supply chain uncertainty, risk, and complexity (Bhatnagar & Sohal, 2005; Merschmann & Thonemann, 2011; Pilbeam *et al.*, 2012, Wiengarten *et al*., 2015). Identifying the major sources of uncertainty within supply chains, and developing strategies to manage them, is therefore an important challenge for industry. Although there is an emerging research literature on supply chain uncertainty and the associated fields, such as risk and complexity (e.g. van Donk & van der Vaart, 2005; Rodrigues *et al.*, 2008; Christopher & Holweg, 2011; Simangunsong *et al.*, 2012; Solomon *et al.*, 2012; Wiengarten *et al*., 2015), much of the work is theoretical or survey based. Given that the latter research approach tends to focus on a limited set of uncertainties and strategies (see, for example, Huang *et al*., 2014), there is a need to collect more in-depth empirical evidence using the case study method to further our understanding of multiple sources of supply chain uncertainty and of how they can be managed effectively in practice. In particular, there is a need for such evidence to be collected from emerging economies, given that they are key players in global supply chains and are under-represented in the literature to date (Huq *et al.*, 2014; Zorzini *et al.*, 2014 & 2015).

Against this backdrop, this paper presents an empirical study to investigate the effective management of supply chain uncertainty in the Indonesian food industry. In doing so, it investigates an example of an emerging economy and an industrial sector with inherent uncertainty, e.g. due to a reliance on crops at the upstream end of the supply chain. The model of supply chain uncertainty management proposed by Simangunsong *et al.,* (2012) from the extant literature was used as a starting point, as it is argued to be the most comprehensive model to date in terms of the number of sources of uncertainties considered and of associated management practices. Thus, for each of the 14 sources of uncertainty identified in this extant model, multi-case study evidence was collected to gain an in-depth understanding of the relevance of each source of uncertainty; the approaches used to manage that source of uncertainty; and the impact of that management approach on performance.

While this research did not initially set out to specifically identify ethical issues, several such issues emerged, and thus it is in this area that there is argued to be both a particular interest for industrial managers operating in global supply chains and a need for further research. These ethical issues either affect the level of uncertainty, e.g. by causing uncertainty, or are linked to strategies for managing uncertainty. The three ethical issues that are highlighted have not been discussed in the context of supply chain uncertainty in the prior literature. Thus whilst much of this research is of a deductive nature, thereby looking for new empirical evidence to support the existing literature (Simangunsong *et al.,* 2012), there is also an inductive element. In the context of the current literature and its debates on Corporate Social Responsibility (CSR), socially responsible leadership, and socially responsible sourcing (e.g. Roehrich *et al.*, 2014; Hoejmose *et al.*, 2014), the ethical issues that emerged are argued to be particularly topical.

The research gaps that this study seeks to address are further justified in the literature review in Section 2 below. In summary, this paper seeks to empirically investigate aligned management strategies for a more comprehensive set of sources of uncertainty than has been achieved in the prior literature – see for example Chen *et al*. (2013) and Huang *et al*. (2014); and to provide an in-depth understanding of the ethical issues that emerged in this context. Thus, a theory-building approach has been adopted, leading to new findings on how to manage supply chain uncertainty in practice; and the research is also theory-driven as the conceptual model of Simangunsong *et al*. (2012) is underpinned by contingency and alignment theory, as discussed in Section 3.2 below. The two research questions used are as follows:

Research Question 1: *How can multiple sources of uncertainty be effectively aligned with management strategies to improve overall supply chain performance in the Indonesian food industry?*

Research Question 2: *How and why do ethical issues emerge in the context of the management of supply chain uncertainty in the Indonesian food industry, and how can they be effectively addressed in practice?*

The remainder of the paper is organised as follows. Section 2 reviews the literature, while the multi-case study research method is described in Section 3. This is followed by a presentation of the case study evidence in sections 4 and 5, and a discussion of the findings in Section 6. Finally, the paper concludes in Section 7, which includes managerial and social implications, research limitations, and areas for future research.

2. Literature Review

This literature review begins with a discussion of prior research into supply chain uncertainty – focusing firstly on conceptual models and explaining why the model by Simangunsong *et al.* (2012) is used as the starting point for this research. Secondly, more recent survey research into aspects of supply chain uncertainty is then briefly discussed to justify the research gap to understand how multiple sources of uncertainty can be effectively managed (Research Question 1 above). Thirdly, the extant literature on ethical issues in the supply chain is reviewed to explain the need to investigate the impact of ethical issues on the effective management of supply chain uncertainty (Research Question 2 above).

2.1 Conceptual Models of Supply Chain Uncertainty

As a comprehensive review of the literature on supply chain uncertainty has recently been published in Simangunsong *et al.* (2012), the reader is referred to that paper for a detailed review of this area prior to 2012. Simangunsong *et al.* (2012) conclude with a conceptual model that identifies both a comprehensive set of sources of uncertainty and of associated uncertainty management strategies, as summarised in tables 1 and 2 below. Note that, within this theoretical model, the sources of uncertainty (U) are either: internal to the firm (U1-U6); internal to the supply chain of the firm (U7 to U12); or external sources of uncertainty (U13 & U14). In addition, the management strategies are divided into two categories: those that aim to reduce the uncertainty at its source (R1 to R10); and those that aim to cope with the uncertainty (C1- C11). Given that there are 14 sources of uncertainty and 21 management strategies, this conceptual model is more comprehensive than any of the available alternatives (e.g. Mason-Jones & Towill, 1998; Wilding, 1998; Geary *et al.* 2002; Prater, 2005; van Donk & van der Vaart, 2005; Merschmann & Thonemann, 2011; Solomon *et al.*, 2012). Thus, the model by Simangunsong *et al.* (2012) is used as a starting point for this research. Figure 1 illustrates this conceptual model, which is based on contingency and alignment theory as explained in Section 3.2 below. For the purposes of this study, the model has been revised to also include R11 – Joint Purchasing, as this management strategy emerged as this research progressed, as discussed in the findings in sections 4 to 6 below.

[Take in Tables 1 and 2; and Figure 1]

The prior literature on which this extant model is based is mostly theoretical, but does include some empirical studies. The empirical studies all consider the manufacturing sector,

with two studies also including evidence from the retail sector (van der Vorst *et al.*, 1998; van der Vorst & Beulens, 2002). The particular manufacturing sectors studied include the food industry, industrial machinery, and transportation & equipment (see, for example, van der Vorst & Beulens, 2002; Sawhney, 2006; and Bhatnagar & Sohal, 2005, respectively). As none of these prior studies considered a comprehensive set of sources of uncertainty and aligned management strategies, it is argued by Simangunsong *et al.* (2012) that there is scope to gather more comprehensive evidence from all manufacturing sectors. However, industries with inherent uncertainty and global supply chain networks may provide the richest sources of data, such as the food industry. This industry has only been the focus of two previous studies (van der Vorst *et al.*, 1998; van der Vorst & Beulens, 2002), with the context of this prior research being in developed economies. Thus emerging economies are under-represented in research into supply chain uncertainty in the food sector to date, and it can be argued that there is a research gap to investigate multiple sources of uncertainty in this context. However, to confirm this research gap, it is also important to consider more recent survey based empirical research – see Section 2.2 below.

It is also important to note the inclusion of supply chain performance within this extant model, as depicted in Figure 1. Simangunsong *et al.* (2012) include a brief review of the relevant literature on this topic and argue that there is a need for more research into the impact of specific supply chain uncertainty management strategies on specific performance measures. More recent authors, such as Grosvold *et al*. (2014) and Beske-Janssen *et al.* (2015), argue for the need to include the topical issue of sustainability in supply chain performance systems, where conventional systems have tended to focus on economic performance alone. Thus it is concluded that within the context of the management of supply chain uncertainty, further research is needed into appropriate supply chain performance measurement and management, as well as the specific links with certain facets of performance with specific uncertainty management strategies.

2.2 Recent Survey Research into Supply Chain Uncertainty

Recent survey papers have added to the empirical evidence available regarding the impact of supply chain uncertainty on particular management strategies. For example, supply chain integration and collaboration have been the focus of several studies, such as those by Huang *et al*. (2014), Chen *et al*. (2013), Wong *et al*. (2011) and Boon-itt & Wong (2011). Firstly, Huang *et al*. (2014) shows that whilst supply chain integration improves a supplier's performance, this effect is weakened under demand uncertainty but strengthened under

technological uncertainty. These results are found in a multi-industry context in Taiwan; and confirm the findings of Boon-itt & Wong (2011) using data from Thailand's automotive industry. Secondly, Chen *et al*. (2013) study the related concepts of demand, supply chain and process risk in Australian manufacturing companies. They found, for example, that supply risk does not have a direct impact on supply chain performance, but it does impact process risk and this has a direct impact on performance. Thirdly, the study by Wong *et al.* (2011) looks at the impact of environmental uncertainty in Thailand's automotive industry on supply chain integration, where environmental uncertainty is operationalised using four concepts: demand uncertainty, supply uncertainty, unpredictable competitor actions, and technological change. Thus, whilst Simangunsong *et al*. (2012) suggest 14 sources of uncertainty, studies of this type are much more limited in their exploration of this topic.

From the above, it follows that survey studies of this type all further advance our understanding of the impact of a particular management strategy on performance under certain defined uncertainties / risks. However, none of them fully consider all potential sources of uncertainty, and it is argued here that a more complex operationalisation of the concept of supply chain uncertainty could provide a much deeper understanding of the impact of broad concepts used in survey research, such as demand uncertainty and supply uncertainty, on performance. In addition, whilst supply chain integration and collaboration have received much attention in survey research, there is also a research gap to empirically investigate the impact of the other management strategies found in the literature, as summarised in the model by Simangunsong *et al*. (2012), given that much of the literature on which this model is based is theoretical. Finally, these survey studies are limited in terms of the facets of performance considered, for example limiting this to the supplier's performance in Huang *et al*. (2014).

Thus, the research presented in this paper addresses these research gaps by using an in-depth case study approach to consider multiple sources of uncertainty, allowing new management strategies to emerge and exploring the impact of all of these strategies on different facets of performance (Research Question 1 above). The Indonesian food industry is the research context, and no prior studies have looked at the food industry in an emerging economy context. In addition, none of these prior studies have considered the impact of ethical issues on supply chain uncertainty, and so this topic is separately reviewed below.

2.3 Ethical Issues in the Supply Chain

The focus of this section of the literature review is on the ethical issues that emerged as this research progressed. These were not included in the previous literature review of supply chain uncertainty by Simangunsong *et al.* (2012), as they have not been previously discussed in the literature in this context. They therefore warrant greater discussion here. This section begins with a general discussion of literature contributions on the role of ethics in business; its costs and benefits; definitions and different cultural understandings; and the role of power in the supply chain, before the particular research gaps to be addressed by this paper are identified.

The role of ethics in business has been debated by many authors (e.g. Friedman, 1970; Carroll, 1979; Phillips & Caldwell, 2005; Pilbeam *et al.,* 2012; Zorzini *et al.,* 2015). For example, Friedman (1970) argued that there is no urgency to act ethically, unless it serves the purposes of the company; whilst others stress the importance of ethics on moral grounds alone (e.g. Carroll, 1979). It has also been suggested that the relevance of business ethics depends on supply chain position and membership; for example, Phillips & Caldwell (2005) comment that smaller members of large, complex supply chains assume that ethical responsibilities lie with the larger, more powerful companies in the chain. Most recently, the Socially Responsible Sourcing (SRS) literature has posited that there is an inherent need to address a multitude of ethical issues, and that further research is needed to tackle this complex phenomenon (Zorzini *et al.,* 2015). Thus, many authors implicitly assume the importance of ethical issues, whilst others challenge this assumption.

Given this debate, several authors have sought to understand the costs and benefits of ethical behaviour (e.g. Cooper *et al.*, 2000; Carter, 2000; Carter & Rogers, 2008). For example, Carter & Rogers (2008) suggest that unethical business practices will increase tangible supply chain costs because of the investment in monitoring business transactions, difficulties in reaching contract agreements, and the costs of lobbying governments to update regulations. In terms of less tangible costs, authors such as Carter (2000) explain that unethical behaviour by sales people can result in dissatisfied customers while, if suppliers perceive the behaviour of buyers to be unethical, supplier performance may be negatively affected (e.g. lower customer service levels). The authors refer to Frazier *et al.* (1988) and Ellram (1991) in explaining that unethical behaviour may provide benefits for the firm but at the expense of the supply chain as a whole. Much of the recent Sustainable Supply Chain Management (SSCM) literature concurs with this view, by suggesting that supply chain longevity is best assured when social, environmental, and economic concerns are all addressed concurrently (Carter & Rogers, 2008; Carter & Easton, 2011). This literature looks

at issues such as ethical purchasing, which supports fair pricing strategies for all supply chain members (e.g. Carter, 2000; Maloni & Brown, 2006; Drake & Schlachter, 2008).

So it could be argued that there is broad agreement in the recent SSCM literature around the importance of being ethical. However, there is still a debate around what this means in practice. In broad terms, Husser *et al.* (2014: page 328) define ethics as "*a science of behaviour and decision-making, in the context of conscious and deliberate action to reach a goal. It is the basic principle of correct behaviour …. Thus, purchasing ethics may be viewed as an extension of the trade practices and rules which people in a society regard as important to maintain true and fair relationships*". While many would agree with this basic definition, it is important to note that there can be differences in perceptions of ethical issues between buyers and suppliers, as identified by Carter (2000) in the context of US buyers and non-US suppliers. Thus, while authors such as Carter (2000) and Maloni & Brown (2006) describe many unethical activities (including buying substandard supplies; favouritism/partiality in selecting suppliers; bribery; obscure contract terms; and rebidding past a deadline), it is important to note that these practices are more acceptable in some cultures than in others – with bribery being a key example.

On the assumption that unethical issues in the supply chain are problematic, there has also been research to investigate measures to combat the problem (e.g. Lin & Ho, 2009; Ho, 2012; Ntayi *et al.,* 2013; Husser *et al.,* 2014). For example, Ntayi *et al.* (2013) investigated the presence of corruption in public procurement in Uganda, exploring the effect of various influences on the behaviour of individuals, such as social identity, morals, legislation and religious beliefs. They conclude that there is a need for a further reduction in corruption and propose 'schemas' to achieve this. But further research is needed to explore the effectiveness of their proposals.

Another topic in the literature that is related to the issue of ethics and corruption is power in the supply chain. This has been discussed by authors such as Cox (1999), Shou *et al.* (2013) and He *et al.* (2013). For example, as argued by Cox (1999), a good understanding of power in the supply chain is an important precursor when devising strategies and operational practices to manage supply chains effectively. He *et al.* (2013) found that most research on power, and its relationship with different attributes of supply chain partnerships, is either conceptual or descriptive and hence found that more empirical research is still needed to develop generalisable conclusions. A key example of an empirical study in this area is that presented by Shou *et al.* (2013), who studied the Yangtze River Delta using a survey method that spanned many industrial sectors and found that strong financial resources and innovation

capabilities are major sources of power in the supply chain. Further empirical evidence is still needed in other contexts.

Given the on-going controversy over the importance of supply chain ethics at each tier in the chain; the need for further empirical evidence into the role of power; the differences in cultural perception of what practices are considered to be unethical; and, the relative infancy of research into appropriate management practices to combat this issue, it remains a ripe area for further research. This research is needed in other industrial settings and cultures than those studied to date to further understand where ethical issues arise; what causes them; and how they can be overcome. In particular, there is a gap to explore these issues in the context of supply chain uncertainty, given that no references that explore ethical issues in this context have been found in the extant literature. In addition, it has been argued by authors such as Zorzini *et al.* (2015) that it is particularly important to consider the context of developing economies as there is insufficient research in this context to date. These are the issues which are addressed by the second research question in this paper, as presented in Section 1 above.

3. Research Method

The case study method (see, e.g. Eisenhardt & Graebner, 2007) has been adopted in this research, using the four stages described by Stuart *et al.* (2002) of: setting the research questions; instrument development; data collection; and, data analysis. The remainder of this section follows this structure.

3.1 Research Questions & Justification of the Case Study Method

The first research question identified in Section 1 above was derived deductively from the literature review. The second research question was derived inductively after the data was collected, and was then used to inform the data analysis stage. Both questions are limited to the Indonesian food industry to show the context of the research.

The case study method was deemed appropriate given the need to ask 'how' and 'why' questions and to build theory on the effective management of supply chain uncertainty in practice (Voss, 2009). This choice was made after careful comparison with the survey method, which would have allowed the existing conceptual model to be validated. It was decided that the advantages of a case study approach outweighed the advantages of undertaking a survey, as the case method allows for more in-depth analysis of the issues around the questions of 'how' and 'why' as well as allowing for new issues to emerge inductively.

3.2 Instrument Development

In the second stage proposed by Stuart *et al.* (2002), the instrument development includes both case selection and the development of the interview protocol. The particular choice of the Indonesian food industry followed a theoretical sampling approach (Voss, 2009), whereby we choose an industry in which supply chain uncertainty is inherent, for example due to the reliance on crops at the upstream end of the supply chain; and an emerging economy from which new issues were more likely to arise given that most prior research had taken place in developed economies. Thus the case selection was felt to be appropriate for building theory on the effective management of supply chain uncertainty. In choosing the case study companies, a deliberate attempt was made to cover three different tiers of the supply chain, i.e. first-tier customers (retailers) and first-tier suppliers of focal manufacturing companies – hence both literal replication and theoretical replication was used by considering both multiple cases at the same tier and cases at different tiers, respectively (Voss, 2009).

A network of twelve companies in the food industry in Indonesia was identified that met these criteria. Figure 2 illustrates the structure of the network and shows that the set of cases is comprised of four suppliers (S1-S4), four manufacturers (M1-M4), and four retailers (Re1-Re4). The relationships between: the manufacturers; their active and potential suppliers; and their customers, is also indicated in Figure 2. The unit of analysis was the individual cases, and hence a multi-case study approach was adopted with 12 cases. In addition, Figure 2 indicates the number of employees and turnover of each of the case companies. Note that the turnover in Indonesian Rupiah has been converted to Pounds Sterling and then multiplied by 16 (based on the minimum wage in the UK being 16 times greater than in Indonesia) to give a better indication of the relative size of the companies in UK economic terms. All of the manufacturing companies operate using a mass production process, as is common in Indonesia.

[Take in Figure 2]

While there is no ideal number of cases, theoretical saturation – where improvement becomes small when further cases are added – was used to indicate when 'enough' cases had been studied (Eisenhardt & Graebner, 2007). In this study, initially, just nine of these companies were selected with a further three added later. The additional information gained from each interview became marginal after nine case companies and negligible at twelve companies, in that no further sources of uncertainty or management strategies were identified.

This suggested that studying twelve case companies was enough to meet the needs of the research and achieve theoretical saturation.

Given that the Simangunsong *et al.* (2012) theoretical model of the management of supply chain uncertainty was used as a starting point in this research, the 46 interview questions included in the interview protocol were organised around the sources of supply chain uncertainty identified in this prior study. Thus, the concept of supply chain uncertainty is operationalised in this study by using the definitions of the sources of uncertainty given in Table 1 above. Drawing on the manufacturing strategy literature (e.g. Swamidass & Newell, 1987; Ho, 1996), the theoretical foundation of the prior conceptual model was based on alignment and contingency theory, suggesting that the choice of supply chain uncertainty management strategy is contingent on the environmental context of the supply chain and that alignment is essential for a strategy to have a positive impact on performance. Thus, the instrument development was theory-driven as the interview questions probed these issues, asking about whether each uncertainty source was relevant to the case context; and, if relevant, how that uncertainty was managed and affected performance outcomes. The protocol was first trialled in a pilot study involving a large food manufacturer and a leading supermarket in the UK, leading to minor modifications to the clarity and structure of some of the interview questions.

3.3 Data Collection

In the data collection stage, a total of 23 semi-structured interviews were carried out with 32 top executives and departmental managers, taking an average of 88 minutes per interview. On some occasions, multiple interviewees were present at the same interview. All interviews were audio recorded and, in the majority of cases, video recording was also permitted. Interview notes were taken during the discussion and later finalised before being sent to each interviewee for validation. Where necessary, there was a follow-up telephone call or email to clarify vague or ambiguous responses. Additional supporting documents, e.g. company profile documents and reports, were also collected where available.

3.4 Data Analysis

In the data analysis stage, the practical content analysis approach proposed by Arksey & Knight (1999) was adopted. The first step was to convert all the raw data into an electronic format; Atlas.ti was used as the database. Furthermore, all relevant literature was added to the database to aid analysis – this included all the relevant literature relating to supply chain uncertainties, sources and management strategies that had been identified in the prior

Simangunsong *et al.* (2012) review. The second step involved creating indices based on themes/topics and categories derived both from the initial literature review and the data itself. The third step of the analysis was data retrieval, with Atlas.ti providing a powerful tool to speed up this process. Finally, the data was interpreted to provide rich information. Both within-case and cross-case analysis was used (Voss, 2009), though it is the latter which is the focus of the case study evidence presented and discussed in sections 4, 5 and 6 below. To illustrate the type of within-case analysis undertaken, the reader is referred to Appendix 1, which tabulates the within-case data used for M1, an ice-cream manufacturer, illustrating the sources of uncertainty identified; the management strategies employed and their perceived effect on company performance. Similar tables were constructed and analysis carried out for each case study company before undertaking cross-case analysis.

In summary, the quality of the research was assured through comprehensive and careful implementation of the stages described above to meet the four conditions of good quality case research (construct validity, internal validity, external validity, and reliability), as proposed by Yin (2009). Table 3 indicates how each of these four conditions was met.

[Take in Table 3]

4. Findings: The Multi-Case Study Evidence

Having completed the within-case analysis, as demonstrated in Appendix 1 and briefly described above in Section 3.4, the cross-case analysis was carried out for each of the sources of uncertainty. The first step in this analysis was to tabulate each source of uncertainty found, indicating all the cases in which it had been identified and whether this confirmed the extant literature or added a new dimension. Table 4 presents the material included in this type of table for 'Parallel Interaction', labelled as U10 in the Simangunsong *et al.* (2012) model, as defined in Table 1 above. This shows that one new dimension was identified for this source of uncertainty, and that for the other dimension, further empirical evidence is now available to support the existing literature. The second step was to consider all of the management strategies that had been identified as being effective ways to manage each source of uncertainty. This was also tabulated, as also demonstrated in Table 4 for Parallel Interaction. Again, the contribution to the literature was noted, this time by highlighting any new strategies identified; and the cases in which this data had been found was also noted on the right-hand side. A discussion of these particular new findings is presented in Section 5 below along with a discussion of the other findings that relate to ethical issues. A full set of

these tables for all the sources of uncertainty, along with other tables that cross-tabulate the data, and a detailed discussion of all of the data including quotes from the interviewees, is given in Simangunsong (2010).

[Take in Table 4]

This case study evidence is summarised in Table 5 below. As discussed in Section 3.2 above, the Simangunsong *et al.* (2012) conceptual model posits that appropriate alignment of the management strategies, as contingent upon the sources of uncertainty found within a particular context, will lead to improved supply chain performance. The alignments identified in this empirical evidence between individual sources of uncertainty and management strategies are illustrated in Table 5, which also indicates whether or not the new evidence confirms an alignment identified in the prior literature. Although it is noted that cause and effect are difficult to establish, new evidence of the alignments is only included in Table 5 if the case study findings suggested that the application of a particular strategy to manage a particular source of uncertainty led to improved performance in some way. It can be seen that a significant number of new alignments are identified here that had not been discussed in the prior literature. Therefore, Table 5 shows evidence, for example, that parallel interaction (U10) can be effectively managed through alignment with Collaboration (R5), Joint Purchasing (R11), or the use of Multiple Suppliers (C5), as further explained in Table 4. Table 5 also shows that some strategies, such as Collaboration (R5) and Lean Operations (R1), are being used to address several different sources of uncertainty at once, suggesting that these are important strategies in the Indonesian food industry. It also shows that, for some sources of uncertainty, many different strategies are adopted. For example, for end-customer demand (U7), a total of 12 strategies have been identified.

[Take in Table 5]

Space does not allow for a full discussion of all of the connections illustrated in Table 5, but such a discussion is available in Simangunsong (2010). For example, this discussion illustrates that U5 'Organisational/Behavioural issues' is made up of two dimensions: (i) 'General behavioural issues' e.g. risk taker versus risk adverse behaviour that can lead to supply chain disruption; and, (ii) 'political influence within an organisation'. The first dimension – *general behavioural issues* – was reported as being managed by two different strategies. The first strategy – *process performance measure (R3)* – was identified in the mini market (Re3). Here, a routine and frequent report of store performance, for example to

evaluate whether sales targets had been met, had helped to prevent misunderstanding between management and the store manager. This led to better customer service and hence more satisfied customers as well as more orders for suppliers – thus to an improvement across the supply chain. This finding provides new empirical support to the previous study by van der Vorst & Beulens (2002). The second strategy – *decision policy & procedures (R7)* – was identified in four case companies (S4, M1, M2 and M4). In particular, this led to the resolution of conflict between the marketing and production functions, leading to reduced costs and more satisfied customers. This strategy has been identified in the literature, supported with empirical analysis from secondary data, see Sheffi & Rice (2005). This paper, therefore, strengthens existing data by providing additional supporting evidence from primary data.

Previous studies have not explicitly identified strategies for managing the second dimension: *political influence in an organisation*. Analysis of the case study data, however, suggests two strategies. The first strategy – *ICT system (R8)* – was identified in the wholesaler (Re2). The purchasing manager of Re2 stated: *"Our ICT system facilitates centralized and transparent information access … this reduces conflicts between departments and unsupportive human behaviour."* The purchasing manager, who was young and a new employee at the time of the interview, explained that she faced many difficulties in performing her role and making decisions because of her weak political power compared with her peer managers. However, by utilising accessible information on facts and figures when presenting her proposal, e.g., sales performance and profit margins, she was able to reduce conflicts between departments and speed up decision making processes, increasing responsiveness to customers. The second strategy – *redesign of chain infrastructure (R10)* – was identified in the ice cream manufacturer (M1). The production manager of M1 stated: *"New machines were installed to replace old machines in the factory …this reduced dependency on labour and fewer workers are required …there are no labour related problems* [e.g. labour strikes] *anymore."* Here, factory modernization helped to reduce the political power of workers as the production process depends more on machines than workers; this, in turn, has increased productivity and reduced production cost.

Given that the case companies chose reducing uncertainty strategies over coping with uncertainty strategies, it is argued that it is important to solve 'Organisation/Behavioural issues' (U5). However, this is not the case for other sources of uncertainty. A summary of the broader prevalence of the various management strategies employed is presented in Table 6.

[Take in Table 6]

In terms of ways to manage uncertainty, Table 6 illustrates that reducing uncertainty strategies are more common for a firm's internal sources of uncertainty (U1 to U6 in Table 1); meanwhile, for sources that are external to the firm (U7 to U14), sometimes the only choice is to cope with the effects of the uncertainty. A total of 51 instances of the use of reducing strategies have been found for the firm level sources of uncertainty, compared with 15 instances of coping with uncertainty strategies. This is because of the tangible benefit of reducing uncertainty strategies in contrast to coping with uncertainty strategies, where the problems remain. On the other hand, a greater number of coping with uncertainty strategies were identified for managing external sources of uncertainty. This implies that reducing uncertainty strategies are more difficult to implement for these sources of uncertainty, given the breadth of the management and co-ordination that would be needed across the supply chain.

Table 6 also illustrates that 'Redesign of chain infrastructure' (R10) was identified as the most common reducing strategy, implying that a change or a redesign of supply chain structure or facilities may be needed to solve uncertainty problems. For example, M2 reconfigured its manufacturing process to use different packaging materials, so that it could change to a different packaging supplier that was able to deliver in a more timely fashion as it had warehouses nearby.

Finally, Table 6 shows that 'Collaboration' (R5 & C7) is the most common uncertainty management strategy in terms of the number of instances and the sources of uncertainty it has been used to manage, implying that a collaboration strategy is easily implemented in some contexts, and has provided effective results. However, the evidence also suggests that this is only effective when the suppliers or the customer are within easy reach of the focal organisation. Due to the geographical setting and communication issues, collaboration is not easy to implement among some supply chain partners across Indonesia. For example, M1 had difficulties in planning the production and distribution of its products because many of its customers (retailers) are located on islands outside of Java where the head office resides, making coordination and information exchange difficult. This also caused high variability in lead times from one-day delivery within Java Island to over one month to Papua Island in eastern Indonesia. Therefore, the benefits of collaboration are sometimes outweighed by the expense involved in maintaining an intense level of collaboration in the long term; and when this is the case, the companies would rather accept the knock-on effect of lower levels of

collaboration. Here, a contingency-based perspective aids in the explanation of the findings, and means that even strategies that are common will not always be appropriate in all contexts.

Having described the overall findings as related to Research Question 1 by: summarising the findings using Tables 5 & 6; discussing in detail the alignments related to U5 'Organisational/ Behavioural issues'; and describing some of the patterns in the data, the paper now considers the findings related to the emerging ethical issues to address Research Question 2.

5. Findings: The Emerging Ethical Issues

Three key unethical practices are evident in the case study data: collusion or parallel interaction between firms supplying the same type of product to customers; firms influencing government regulations in their favour; and, firms 'abusing' their power and leverage at the expense of other firms. These are described in turn below.

5.1 Parallel Interaction between Firms Supplying the Same Product

Only one type of parallel interaction (U10), which is caused by interaction across companies at the same tier of a supply network, has been identified in the relevant literature to date. For example, van der Vorst & Beulens (2002) identified this issue between firms in the same tier supplying different products in the supply chain for cheese, where the use of a shared truck led to delays at the cross-docking stage because other suppliers' products had not yet arrived. However, the case study data provides evidence of a second type, which is argued to be unethical and occurs between companies that supply the same materials to a firm. The empirical evidence suggests that suppliers sometimes collude by forming a cartel and withholding the supply of a material, thereby artificially claiming there is a scarcity in order to create hype for the product and increase the price customers are willing to pay. When the cartel suddenly releases the material, customers order in higher volume than normal and are prepared to pay a higher price; in other words, 'panic buying' ensues in case a scarcity reoccurs. This behaviour is common where there are only a few suppliers and they control the local market, e.g. where imported materials are prohibited.

This phenomenon is evident in 5 of the cases: the flour supplier (S4); the ice-cream manufacturer (M1); the drinks manufacturer (M2); the dairy manufacturer (M3); and, the traditional market store (Re4). It occurs for products such as wheat and sugar. For example, the production manager of the ice-cream manufacturer (M1) stated: "*... for sugar, we suspect there is collusion among suppliers*"; he went on to explain that it is difficult to control a

supplier's behaviour as they make excuses for supply shortages, such as a bad harvest season, and the government is trapped in its policy to protect the farmer. Similarly, the purchasing manager of the drinks manufacturer (M2) stated that: "*We recognise there are cartels in Indonesia. For example … supply and price games are played with one of our most important raw materials … few suppliers are available and they control the market.*" The purchasing manager explained that supply (and pricing) uncertainty had caused disruptions to supply chain processes in terms of an inability to meet production targets and variable production costs.

However, the empirical evidence also suggests that collusion does not succeed if the buying company has strong bargaining power. For example, the supply chain manager of the bakery manufacturer (M4) believed that, as the bakery buys in large quantities, suppliers are keen to obtain their business and hence suppliers compete to win orders (rather than collude). For firms that lack sufficient purchasing leverage, 'joint purchasing' can be an effective strategy for combating collusion. The purchasing manager of the drinks manufacturer (M2) stated that: "*A business cartel exists in Indonesia and has disrupted our plans … for example, one important raw material is only supplied by a few suppliers that control the market …this cartel speculates in the market, fixing the price and availability of raw materials …so we search for other companies that purchase the same materials and then contact their purchasing managers …our collective bargaining position increases with larger buying volume.*" Joint buying increases the order volume for one purchase and forces suppliers to break from the cartel because each cartel member wants to win the order. Firms within the joint purchasing agreement can also potentially share intelligence about cartels. Thus, 'joint purchasing' has been added to the conceptual model proposed by Simangunsong *et al.* (2012), given that this was not included in the original model.

Collusion is also ineffective if the buying company is able to source from a supplier outside of the cartel. For example, the purchasing manager of the dairy manufacturer (M3) stated that the company has been able to obtain permission from the government to import sugar – which is normally prohibited – for a temporary period. He stated that: "*I am a member of the industry association of sugar consumers …we work together and make proposals to the State Minister of agriculture to 'open the door' for imported sugar …sugar is normally a protected commodity product.*" This association is hence effective in persuading the government to allow sugar to be imported into the country; however, the effect is only temporary as strong protests from local farmers and sugar producers tend to lead the government to later reverse their decision. Similarly, cartels may be regional and it

may be possible to identify an alternative supplier from a different area of Indonesia. The store manager of Re4 stated: "*Suppliers may devise a scheme to increase the prices we have to pay because we are a small retailer and have weak bargaining power … However, if their offer is unacceptable, we may buy products from suppliers in a different region of Indonesia … The price may be different elsewhere because different suppliers supply different regions.*" The store manager explained that sourcing from suppliers in different regions increases transportation costs, and hence reduces prior profits; however, it at least means that the store is able to satisfy its customers at a greater profit than would have been possible through buying from the local supplier at that point in time.

Where neither joint purchasing nor alternative suppliers have been identified, the problems surrounding parallel interaction remain. Interviewees from the ice-cream manufacturer (M1) still consider collusion amongst suppliers to be a significant source of uncertainty. The production manager stated: "*We suspect collusion among our sugar suppliers … suppliers may hold stock in their warehouse and only limited amounts are made available in the market … this artificially increases the market price we have to pay.*" Hence, it is concluded that parallel interaction is a difficult source of uncertainty to manage and that combating it is likely to require an inter-firm response.

5.2 Influencing Environmental Uncertainty due to Government Regulations

One of the sources of uncertainty external to the supply chain is that of environmental uncertainty (U13), which includes uncertainty surrounding changes in government regulations, e.g. on food standards. Three government policy issues may give rise to this. First, there may be inconsistent government regulations; for example, the general manager of the drinks manufacturer (M2) stated: "*Government regulation is often unclear. For example, there may be an announcement that a particular raw material, which is important for us, is not 'good' for health, hence it is prohibited. But later they cancel that regulation … this disrupts our plans badly.*" The general manager also explained that the National Agency for Drug and Food Control may unexpectedly revoke permission for a product because they believe that the text and image used in packaging, labelling and promotion contravenes regulations. This revocation may require the final product to be returned from the market. Second, there can be administrative issues during customs clearance. As the purchasing manager of the dairy manufacturer (M3) stated: "*There is high uncertainty surrounding customs clearance in Indonesia. For example, to get raw materials through customs, we have to get official permission from various government agencies such as the Agricultural*

Department, the National Agency for Drug and Food Control, the Council of Indonesian Ulama and many more including quarantine requirements." It is hence often unclear how long it will take to obtain clearance, and this creates uncertainty for the production plans. The production manager of the ice cream manufacturer (M1) gave a range of one week to two months for the required time to gain customs clearance. Third, there can be unexpected changes in regulations regarding food standards and certification (e.g. relating to halal foods); for example, the ruling body that determines whether food products can carry the halal logo on the packaging may act inconsistently. The marketing manager of the bakery manufacturer (M4) stated: "*Regulation is an uncertain factor because of a lack of standardisation. For example,* [the ruling body] *has changed the halal logo several times in a short period.*" This had meant that additional time and cost was incurred in order to redesign the product packaging, and existing products had to be recalled from the market.

The above provides an insight into some of the uncertainties created that are external to the supply chain of a firm; however, it is the response to these issues (rather than the initial source) which are agued here to, at times, be unethical. For example, some firms have sought to reduce uncertainty surrounding government regulations by collaborating with the authorities on product compliance through consultation meetings and by lobbying for regulation changes. This issue was identified in the case of the flour supplier (S4) and confirmed by the bakery manufacturer (M4), one of S4's customers. The flour supplier (S4) is able to meet high production standards while its competitors are less able to do so; as the company lobbies the government to tighten national standards to disrupt the competition.

5.3 Competitor Behaviour and the 'Abuse' of Power

The effects of large supermarket chains on small independent competitors, and on the profitability and long-term sustainability of suppliers, is globally recognised (Robson & Rawnsley, 2001). This issue arose in the case study data in the context of U13: environmental uncertainty caused by competitor behaviour. For example, the smaller stores (Re3 and Re4) commented on the effects of large supermarkets, such as Re1 and Re2, encroaching on their territory. For example, high-volume product movements and an efficient logistics system have enabled Re2 to operate at significantly less cost than local retailers, enabling them to offer lower prices. This is partly because Re2 has redesigned its supply chain infrastructure – one way of reducing supply chain uncertainty proposed in the literature (e.g. Lee, 2002) – such as by introducing its own distribution network and cross-docking system, allowing it to undercut local retailers in provincial areas of Indonesia. Approaches such as this are argued

here to raise ethical issues, including promoting anti-competitive business practices, given that the smaller retailers are family-run businesses and that local communities may rely on these businesses for both their social and economic sustainability. Yet no solution has been identified by any of the case study companies affected by this issue in this research.

6. Discussion

The material presented in tables 5 and 6 above provide a summarised answer to Research Question 1, which asked how multiple sources of uncertainty can be effectively aligned with management strategies to improve overall supply chain performance. It is of course not always possible to address all sources of uncertainty simultaneously, but the research has shed further light into how more than one source of uncertainty can be addressed by the same management strategy, and highlights both chain redesign and collaboration as key management approaches. In terms of the positive effects on performance identified, these have included financial improvements (e.g. reduced production costs) and non-financial measures (e.g. increased customer satisfaction). However, all of these measures can be described as conventional measures as defined by authors such as Beske-Janssen *et al.* (2015), with no sustainability measures identified. This adds further evidence to the conclusion of Beske-Janssen *et al*. (2015) who suggest that sustainability performance is receiving more attention in the academic literature than corporate practice. It also adds evidence to the arguments of authors such as Ntayi *et al*. (2013) who claim that social and ethical issues are viewed differently in emerging economies – as it could be argued that this lack of referral to these performance measures is a cultural issue. Thus further research is needed into methods to embed sustainable performance measures and management systems across global supply chains.

The findings also suggest more avenues to explore from a survey point of view given the increased number of proposed links between sources of uncertainty and management strategies. As discussed in Section 2.2, to date, survey research in this field has looked at a limited number of management strategies, typically also considering a very limited number of sources of uncertainty, where these have been grouped into broad categories such as supply uncertainty or demand uncertainty in many prior studies (Huang *et al*., 2014, Chen *et al*., 2013, Wong *et al*., 2011 and Boon-itt & Wong, 2011). For example, collaboration and supply chain integration have been extensively studied, but always while examining just one or two dimensions of uncertainty on a limited set of performance measures. This research

suggests additional sources of uncertainty that could be explored, which are likely to be contingency factors that explain when a management strategy will have a positive effect on performance. For example, organisational behaviour, operationalised as conflict between the marketing and production functions, could be considered to be a moderating factor reducing the effectiveness of collaboration on supply/ demand/ process uncertainty. In addition, in terms of management strategies, this research suggests that the redesign of chain infrastructure deserves more attention from survey research, which could be operationalised in terms of finding new suppliers/ new packaging materials or introducing higher levels of automation. The findings also confirm the importance of collaboration, which was identified in Section 2.2 to be a main theme in prior survey research, and authors such as Soosay & Hyland (2015) suggest this continues to need further study. In particular, the findings presented here suggest that moderating effects such as the cost of collaboration and the geographical dispersion of collaborators could be further researched.

In answer to Research Question 2, which asked how and why ethical issues emerge in the context of supply chain uncertainty and how they can be effectively managed, three issues have been identified. The first issue of parallel interaction leads to a joint purchasing response to combat supply uncertainty caused by cartels which would otherwise artificially limit supply. In ethical terms, this raises several fair-trade issues, including the question of whether the price was 'fair' in the first place, both in terms of the cost of the final product for the consumer and the price paid to the farmer. In a supply chain management context, the key issue is to reduce costs across the whole supply network while also addressing these ethical concerns. This confirms the previous findings of Carter (2000) and others who have concluded that unethical behaviour may provide benefit to the firm, but at the expense of the chain as a whole.

The second issue related to Research Question 2 is attempts to influence government regulations in order to reduce environmental uncertainty. Lobbying for regulatory changes has helped some firms to influence regulations in a way that favours their own products and discriminates against those of a competitor (e.g. deliberately influencing new national product standards so the existing formulation of a competitor's product or packaging is no longer compliant with food standards and needs to be withdrawn from the market). This collaboration reduces uncertainty for the focal firm in terms of (understanding and anticipating) regulatory changes and increases uncertainty for competitors; moreover, changing regulations can increase the number of sourcing options available to a firm. Lobbying for changes to regulations supports the study by Miller (1992), which proposed the

approach but without providing any empirical evidence. This gives a rather different slant to the issue of influence through bribery identified by Cooper *et al.* (2000). It could be argued that, if bribes were not involved, the practices would be less questionable from an ethics point of view. However, this still raises the question of whether all firms are able to operate in a 'fair' environment, with fair-trade principles for all concerned.

The findings related to the third ethical issue of power in the supply chain confirm much of the previous literature on power in the supply chain, while also bringing much needed new empirical evidence to the debate. For example, the evidence above on the ability of Re2 to redesign its infrastructure further confirms the findings of Shou *et al.* (2013) who found that strong financial resources and innovation capabilities are major sources of power in the supply chain. More broadly, our empirical evidence is the first to confirm that this phenomenon occurs in the Indonesian food industry, thereby aiding this generalisation in an emerging economy. However, as argued by Cox (1999), the understanding of power in the supply chain is just a precursor (albeit an important one) when devising strategies and operational practices to manage supply chains effectively. Given that strategies to overcome this issue have not been found in this empirical evidence, more research is still needed to investigate appropriate strategies and operational practices to combat this issue.

Figure 3 illustrates that these emerging ethical issues can either be part of the contextual factors in which the supply chain seeks to operate, or they can be part of the management approach to gain an appropriate alignment for improved performance. Thus this research question is answered using a contingency theory perspective given that Figure 3 is based on the supply chain uncertainty model of Simangunsong *et al*. (2012), which posits that the contextual factors need to be aligned with appropriate management strategies in order to have a positive impact on performance. These elements of the model are discussed in turn below before the overall findings are generalised and propositions are then developed.

[Take in Figure 3]

Firstly, looking at the contextual factors in Figure 3, although these have been categorised as either environmental uncertainty (U13) or parallel interaction (U10), it is argued here that it is their ultimate effect on supply uncertainty and demand uncertainty that is key to understanding their impact on supply chain performance. For example, the parallel interaction issues identified lead to uncertainty regarding supply as there are temporary illusions of supply shortages. Similarly, the government policies can lead to demand

uncertainty when recipes are forced to change; or supply uncertainty when health warnings force a change of ingredients.

Secondly, the management strategies identified are mostly strategies for coping with the uncertainty – for example, the use of multiple suppliers (C5) and the arguably unethical practice of government lobbying are both strategies to cope with uncertainty. The exception to this is the Joint Purchasing (R11) strategy that reduces the uncertainty. This forces suppliers to break from the cartels that are artificially fixing the prices. The required raw materials then become available at a lower price than the buying firm would normally be able to achieve.

Thirdly, although alignment leads to increased performance, as argued by contingency theory, it is argued here that the performance is not necessarily optimal at the whole supply chain level. For example, using multiple suppliers to combat parallel interaction may sometimes mean using more expensive suppliers, or suppliers that are further away, leading to higher transportation costs. Thus the focal firm has found an effective strategy to cope with supply uncertainty, but the cost of procurement is higher than it would have been if this source of uncertainty could have been completely eradicated.

It can therefore be concluded that unethical practices lead to greater supply and demand uncertainty, which in turn lead to reduced supply chain performance unless they can be effectively combatted by a management strategy to reduce the uncertainty at its source. Figure 4 summarises these conclusions more broadly, using examples from the discussion of the ethical issues. This shows for example, that strategies used to cope with the uncertainty, such as the use of multiple suppliers as discussed above, lead to firm level improvements only; whilst strategies that reduce uncertainty, such as joint purchasing, will lead to overall supply chain performance improvement. The discussion on 'Organisational/ Behavioural Issues' could be argued to come to the same conclusion, as all of the strategies employed led to improvements that had potential benefits for the supply chain as a whole – for example resolving the conflict between marketing and production will have benefits for both suppliers and customers. Hence the research leads to the following propositions:

[Take in Figure 4]

Proposition 1: *Management strategies that only cope with supply chain uncertainty lessen the impact of the uncertainty on firm level performance, whilst the performance remains sub-optimal for the supply chain as a whole.*

Proposition 2: *Management strategies that lead to a reduction in supply chain uncertainty improve supply chain performance for the chain as a whole.*

Thus it is argued that this research leads to avenues for further research. In particular, it suggests that further survey research should distinguish between alignments for which management strategies seek to reduce uncertainty and alignments when the strategies aim to just cope with uncertainty. For example, supply chain integration/ collaboration is shown by this research to be both a reducing strategy – affecting 7 sources of uncertainty, as illustrated in Table 5 – as well as a coping with uncertainty strategy that can be used to effectively manage 3 sources of uncertainty, as shown in Table 5. It is only when it is used as a strategy to reduce uncertainty that it can be expected to have a positive impact on supply chain performance overall.

7. Conclusions

A comprehensive picture of the alignments between sources of uncertainty and effective ways of managing them in the context of twelve companies in the food supply chain in Indonesia has been developed, as summarised in Table 5. The data summarised in this table, along with Table 6, was then used to answer Research Question 1, which asked how multiple sources of uncertainty can be effectively aligned with management strategies to improve supply chain performance. Empirical evidence for the alignments included in Table 5 is only incorporated if the interviewees indicated that a particular strategy enabled them to either reduce or better cope with a given source of uncertainty, thus leading to improved performance for the firm and/or the supply chain as a whole. This data also adds further evidence to the debate on aspects of the broader supply chain management literature, such as the literature on collaboration and the contexts in which effective collaboration is more difficult to implement.

In answer to Research Question 2, which asked how and why ethical issues emerge in the context of the Indonesian food industry and how they can be overcome, the data analysis has identified a number of arguably unethical practices that have created supply chain uncertainty for other firms. First, collusion amongst suppliers of the same product – a form of parallel interaction – creates uncertainty for the purchasing organisation in terms of the timing and pricing of supplies. Second, firms may seek to influence regulations on product standards so that the products or packaging of competitors have to be recalled but the firm's own products or packaging remain within regulation. These first two examples demonstrate that some of

the supply and demand uncertainties experienced were deliberately created by other firms (for the 'good' of a firm but not the supply chain as a whole). Finally, anti-competition behaviour by large food retailers has been observed; for example, redesigning the chain infrastructure may help large firms to reduce uncertainty but makes it more difficult for smaller rivals to compete. In terms of strategies to manage these uncertainties, this research has identified three strategies for the first issue discussed above of collusion amongst suppliers: 'joint purchasing'; individual volume purchasing; and/or sourcing from alternative albeit often more expensive suppliers. For issues regarding government policy, government lobbying is found to be an effective strategy for the individual firm, but this in itself can be argued to be unethical. However, strategies to combat the third ethical issue were not found in the empirical evidence and hence it is argued that further research is needed to establish how to deal with this issue.

These findings were then generalised to propose that when a management strategy is aligned in such a way that it seeks to reduce the uncertainty at its source, this will lead to improved overall supply chain performance. However, where the strategy alignment just seeks to cope with the uncertainty, increased costs are generally implied and thus the alignment lessens the impact of the uncertainty but the uncertainty still has a negative impact on the overall performance of the supply chain.

7.1 Managerial and Social Implications

In terms of managerial implications, this research highlights the need to reduce uncertainty wherever possible, as this is likely to have the biggest impact on performance in the long run, whilst acknowledging that this is not always feasible and may also be prohibitively expensive in some cases. The empirical evidence particularly stresses the importance of considering chain redesign as a key management strategy for reducing uncertainty, where feasible. In addition, given that strategies such as collaboration could be used to tackle several uncertainties at once, the model may also suggest this as being the most effective management strategy, assuming there is an appropriate context in which to collaborate.

Given that many firms now operate within a global supply chain network, the ethical issues that have arisen in one culture may be of relevance to any other culture in the world. Therefore, although some of the issues may be spatial and contextual, i.e. particularly prevalent in the Indonesian food industry, it is argued that the findings are of international relevance – and hence have implications for managers operating within a global supply chain. Specifically, managers need to be aware that some of the sources of uncertainty can be

intentionally caused by unethical behaviour such as collusion amongst suppliers to ration supplies. The joint purchasing strategy has been shown to be an effective means to overcome this issue. This is a strategy that has been previously primarily associated with gaining a better price, i.e. that greater economies of scale allow. Thus this research brings a greater level of importance to this strategy.

The detailed discussion of the ethical issues also has social implications. There has long been a debate in the literature and amongst many charitable organisations on the issue of fairness. This paper adds further evidence for this debate, illustrating how unethical influence on government decisions; the dishonesty of cartels and the 'abuse' of power by large retailers can all have unwelcome consequences for other supply chain members. Thus this research further suggests that there may be a need for legislation, as well as more normative influences, to protect small family-run businesses that are often at the very end of the supply chain (including the small retailers in this research), and on which families/ individuals may be totally dependent for their survival.

7.2 Limitations and Further Research

This research is limited by the particular context studied, and the use of the case study method. Whilst these choices provided new insights, there is scope to extend the research to other industrial and country contexts, and to broaden the findings using the survey research method. Such research may lead to further refinements to the conceptual model presented here.

Having said that, a key contribution of this paper is in identifying the need for a link between research that studies the management of supply chain uncertainty and research into ethical behaviour in the supply chain. The analysis of the data above gives a partial answer to the second research question by identifying three key ethical issues, and indicating ways in which some of the case study companies have overcome them. However, further research is needed to explore these issues in more detail, and to identify further literature from other management disciplines, including marketing and economics, that may provide insights into this supply chain management concern. For example, the issue of power in the supply chain, and whether or not this is in fact an abuse of power at the expense of smaller, family-run firms, would benefit from further exploration in collaboration with the small firm/family business research communities.

Other further research opportunities include the development of a practical management tool that incorporates all of the uncertainties and their dimensions, aiding in the development of a hierarchy of issues and appropriate management strategies.

References

Arksey, H. & Knight, P. (1999). *Interviewing for social scientists*. Sage Publications Thousand Oaks, Calif.

Beske-Janssen P., Johnson M.P. & Schaltegger S. (2015). "20 years of performance measurement in sustainable supply chain management – what has been achieved?" *Supply Chain Management: An International Journal*, 20 (6), 664-680.

Bhatnagar, R. & Sohal, A.S. (2005). "Supply chain competitiveness: measuring the impact of location factors, uncertainty and manufacturing practices". *Technovation*, 25(5), 443–456.

Boon-itt, S. and Wong C.Y. (2011). "The moderating effects of technological and demand uncertainties on the relationship between supply chain integration and customer delivery performance". *International Journal of Physical Distribution & Logistics Management,* 41(3), 253-276.

Carroll, A.B. (1979). "A three-dimensional conceptual model of corporate performance". *Academy of Management Review,* 4(4), 497–505.

Carter, C.R. (2000). "Ethical issues in international buyer–supplier relationships: a dyadic examination". *Journal of Operations Management*, 18(2), 191–208.

Carter, C.R. & Rogers, D.S. (2008). "A framework of sustainable supply chain management: moving toward new theory". *International Journal of Physical Distribution & Logistics Management*, 38, 360–387.

Carter, C. R. and Easton, P. L. (2011). "Sustainable Supply Chain Management: Evolution and Future Directions", *International Journal of Physical Distribution & Logistics Management*, 41(1), 46-62.

Chen, J., Sohal, A.S. & Prajogo D.I. (2013). "Supply chain operational risk management: a collaborative approach". *International Journal of Production Research,* 51(7), 2186-2199.

Christopher, M. & Holweg, M. (2011). " "Supply Chain 2.0": managing supply chains in the era of turbulence". *International Journal of Physical Distribution & Logistics Management*, 41(1), 63–82.

Cooper, R.W., Frank, G.L. & Kemp, R.A. (2000). "A multinational comparison of key ethical issues, helps and challenges in the purchasing and supply management profession: the key implications for business and the professions". *Journal of Business Ethics*, 23, 83–100.

Cox, A. (1999). "Power, value and supply chain management". *Supply Chain Management: An International Journal*, 4(4), 167-175.

Drake, M. J. and Schlachter, J. T. (2008). "A Virtue-Ethics Analysis of Supply Chain Collaboration", *Journal of Business Ethics*, 82(4), 851-864.

Eisenhardt, K.M. & Graebner, M.E. (2007). "Theory Building From Cases: Opportunities and Challenges". *The Academy of Management Journal*, 50(1), 25–32.

Ellram, L.M. (1991). "Supply-chain management: the industrial organisation perspective". *International Journal of Physical Distribution & Logistics Management*, 21(1), 13–22.

Frazier, G.L., Spekman, R.E. & O'neal, C.R. (1988). "Just-in-time exchange relationships in industrial markets". *The Journal of Marketing*, 52–67.

Friedman, M. (1970). "A theoretical framework for monetary analysis". *The Journal of Political Economy*, 193–238.

Geary, S., Childerhouse, P. & Towill, D.R. (2002). "Uncertainty and the seamless supply chain". *Supply Chain Management Review*, 6(4), 52.

Grosvold J., Hoejmose S.U. & Roehrich J.K. (2014). "Squaring the circle: management, measurement and performance of sustainability in supply chains", *Supply Chain Management: An International Journal*, 19 (3), 292-305.

He, Q., Ghobadian, A. & Gallear, D. (2013). "Knowledge acquisition in supply chain partnerships: The role of power". *International Journal of Production Economics*, 141(2), 605–618.

Ho, C.F. (1996). "A contingency theoretical model of manufacturing strategy". *International Journal of Operations and Production Management*, 16(5), 74–98.

Ho, Y- H. (2012). A review of research on ethical decision-making of purchasing professionals. *Information Management and Business Review*, 4(2), 72–78.

Hoejmose S.U., Roehrich J.K. & Grosvold J. (2014). " Is doing more better? The relationship between responsible supply chain management and corporate reputation". *Industrial Marketing Management,* 43, 77-90.

Huang, M-C, Yen G-F & Lui T-Z. (2014). "Reexamining supply chain integration and the supplier's performance relationships under uncertainty", *Supply Chain Management: An International Journal,* 19(1), 64-78.

Husser, J., Gautier, L., Andre, J-M. & Lespinet-Najib, V. (2014). "Linking Purchasing to Ethical Decision-Making: An Empirical Investigation", *Journal of Business Ethics*, 123, 327–338.

Huq, F., Stevenson, M., and Zorzini, M. (2014). "Social sustainability in developing country suppliers: an exploratory study in the readymade garments industry of Bangladesh", *International Journal of Operations and Production Management*, 34(5), 610-638.

Lee, H. L. (2002). "Aligning Supply Chain Strategies with Product Uncertainties". *California Management Review,* 44**,** 105-119.

Lin, C-Y & Ho, Y- H. (2009). “Cultural influences on moral reasoning capacities of purchasing managers: A comparison across the Taiwan Strait”. *Social Behavior and Personality: An International Journal*, 37(2), 203–208.

Maloni, M. & Brown, M. (2006). “Corporate Social Responsibility in the Supply Chain: An Application in the Food Industry”. *Journal of Business Ethics*, 68(1), 35–52.

Mason-Jones, R. & Towill, D.R. (1998). "Shrinking the supply chain uncertainty circle". *IOM Control*, 24(7), 17–22.

Merschmann, U. & Thonemann, U.W. (2011). "Supply chain flexibility, uncertainty and firm performance: An empirical analysis of German manufacturing firms". *International Journal of Production Economics*, 130(1), 43–53.

Miller, K. D. (1992). “A Framework for Integrated Risk Management”. *Journal of International Business Studies*, 23, 311-331.

Ntayi, J.M., Ngoboka, P. & Kakooza, C.S. (2013). "Moral schemas and corruption in Ugandan public procurement". *Journal of Business Ethics*, 112(3), 417–436.

Phillips, R. & Caldwell, C.B. (2005). "Value Chain Responsibility: A Farewell to Arm’s Length" *Business and Society Review*, 110(4), 345–370.

Pilbeam, C., Alvarez, G. & Wilson, H. (2012). "The governance of supply networks: a systematic literature review". *Supply Chain Management: An International Journal*, 17(4), 358–376.

Prater, E. (2005). "A framework for understanding the interaction of uncertainty and information systems on supply chains". *International Journal of Physical Distribution & Logistics Management*, 35(7/8), 524.

Robson, I. & Rawnsley, V. (2001). "Co-operation or coercion? Supplier networks and relationships in the UK food industry". *Supply Chain Management: An International Journal*, 6(1), 39–48.

Rodrigues, V.S., Stantchev, D., Potter, A., Naim, M. & Whiteing, A. (2008). "Establishing a transport operation focused uncertainty model for the supply chain". *International Journal of Physical Distribution & Logistics Management*, 38(5), 388–411.

Roehrich J.K., Grosvold J. & Hoejmose S.U. (2014). “Reputational risks and sustainable supply chain management”. *International Journal of Operations & Production Management*, 34(5), 695-719.

Sawhney, R. (2006). “Interplay between uncertainty and flexibility across the value-chain: Towards a transformation model of manufacturing flexibility”. *Journal of Operations Management,* 24**,** 476-493.

Sheffi, Y. & Rice, J. (2005). “A Supply Chain View of the Resilient Enterprise”. *MIT Sloan Management Review,* 47**,** 41.

Shou, Y., Feng, Y., Zheng, J., Wang, G. & Yeboah, N.E. (2013). "Power source and its effect on customer–supplier relationships: An empirical study in Yangtze River Delta". *International Journal of Production Economics*, 146(1), 118-128.

Simangunsong, E. (2010). *Supply Chain Uncertainty: Linking sources of uncertainty and management practises*, Ph.D thesis (unpublished), Lancaster University, UK.

Simangunsong, E., Hendry, L.C. & Stevenson, M. (2012). "Supply-chain uncertainty: a review and theoretical foundation for future research". *International Journal of Production Research*, 50(16), 4493–4523.

Solomon, A., Ketikidis, P., Choudhary, A. & Tiwari, M. (2012). "A Knowledge Based Decision Support System for Supply Chain Risk Management". In: *European Decision Sciences Institute Conferenc*e EDSI 2012. Available at SSRN: http://ssrn.com/abstract=2126597.

Soosay C.A. & Hyland P. (2015). " A decade of supply chain collaboration and directions for future research". *Supply Chain Management: An International Journal,* 20 (6), 613-630.

Stuart, I., McCutcheon, D., Handfield, R., McLachlin, R. & Samson, D. (2002). "Effective case research in operations management: a process perspective". *Journal of Operations Management*, 20(5), 419–433.

Swamidass, P.M. and Newell, W.T. (1987). "Manufacturing strategy, environmental uncertainty and performance: a path analytic model". *Management Science*, 33(4), 509–524.

van der Vorst, J.G.A.J. & Beulens, A.J.M. (2002). "Identifying sources of uncertainty to generate supply chain redesign strategies". *International Journal of Physical Distribution & Logistics Management*, 32(6), 409.

van der Vorst, J.G.A.J., Beulens, A.J.M., Wit, W. de & Beek, P. van (1998). "Supply chain management in food chains: improving performance by reducing uncertainty". *International Transactions in Operational Research*, 5(6), 487–499.

van Donk, D.P. & van der Vaart, T. (2005). "A case of shared resources, uncertainty and supply chain integration in the process industry". *International Journal of Production Economics*, 96(1), 97–108.

Voss, C. (2009). "Case Research in Operations Management". In Karlsson, C. (Ed), *Researching Operations Management*, 1st ed., Routledge, New York, 162-195

Wiengarten, F., Humphreys, P., Gimenez, C. & McIvor, R. (2015). "Risk, risk management practices, and the success of supply chain integration". *International Journal of Production Economics*, http://dx.doi.org/10.1016/j.ijpe.2015.03.020i.

Wilding, R. (1998). "The supply chain complexity triangle". *International Journal of Physical Distribution & Logistics Management*, 28(8), 599-616.

Wong, C. Y., Boon-itt, S and Wong C.W.Y. (2011), "The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance". *Journal of Operations Management,* 29, 604-615.

Yin, R. (2009). *Case Study Research : Design and Methods*. 4th ed. Los Angeles Calif., Sage Publications.

Zorzini, M., Stevenson, M., and Hendry, L. (2014). "Coordinating offshored operations in emerging economies: a contingency-based study", *International Journal of Production Economics*, 153, 323-339.

Zorzini, M., Hendry L.C., Huq F.A. & Stevenson M. (2015). "Socially Responsible Sourcing: Reviewing the Literature and its use of Theory". *International Journal of Operations & Production Management*, 35(1), 60-109.

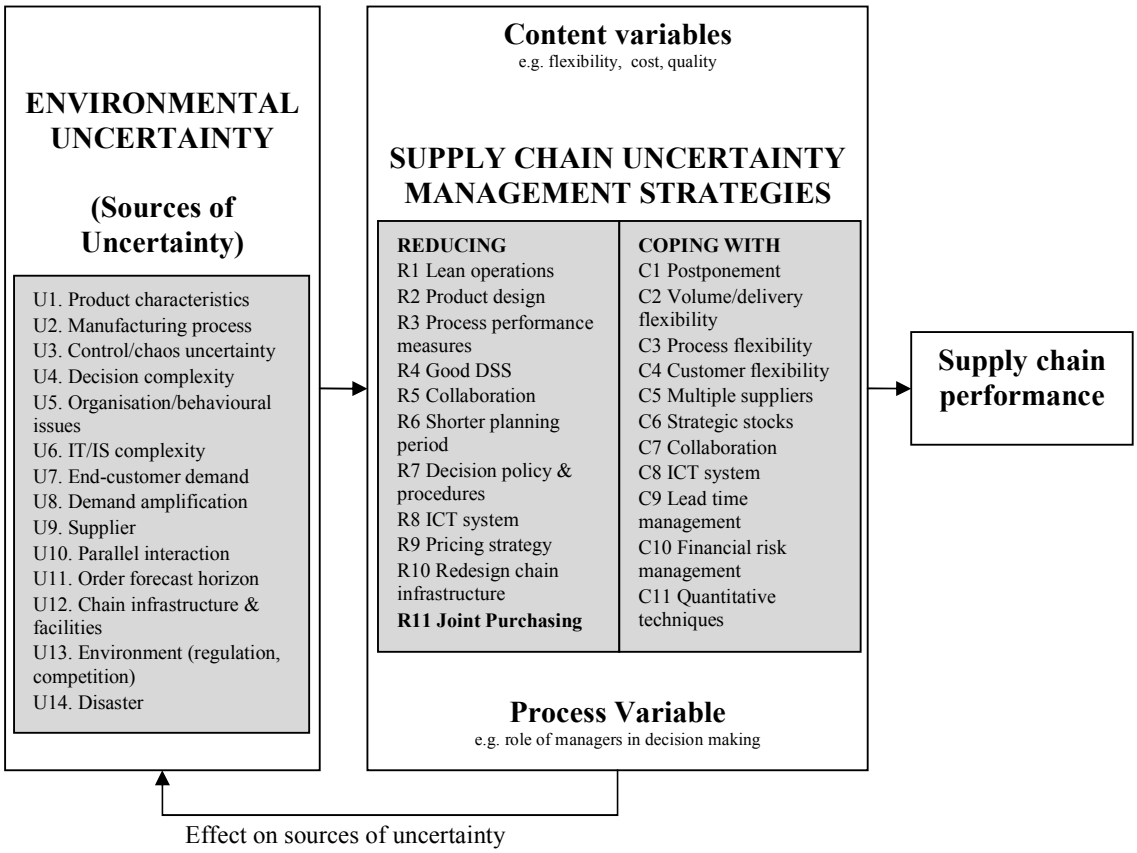


Figure 1: Theoretical Model of Supply Chain Uncertainty Management (adapted from Simangunsong et al., 2012)

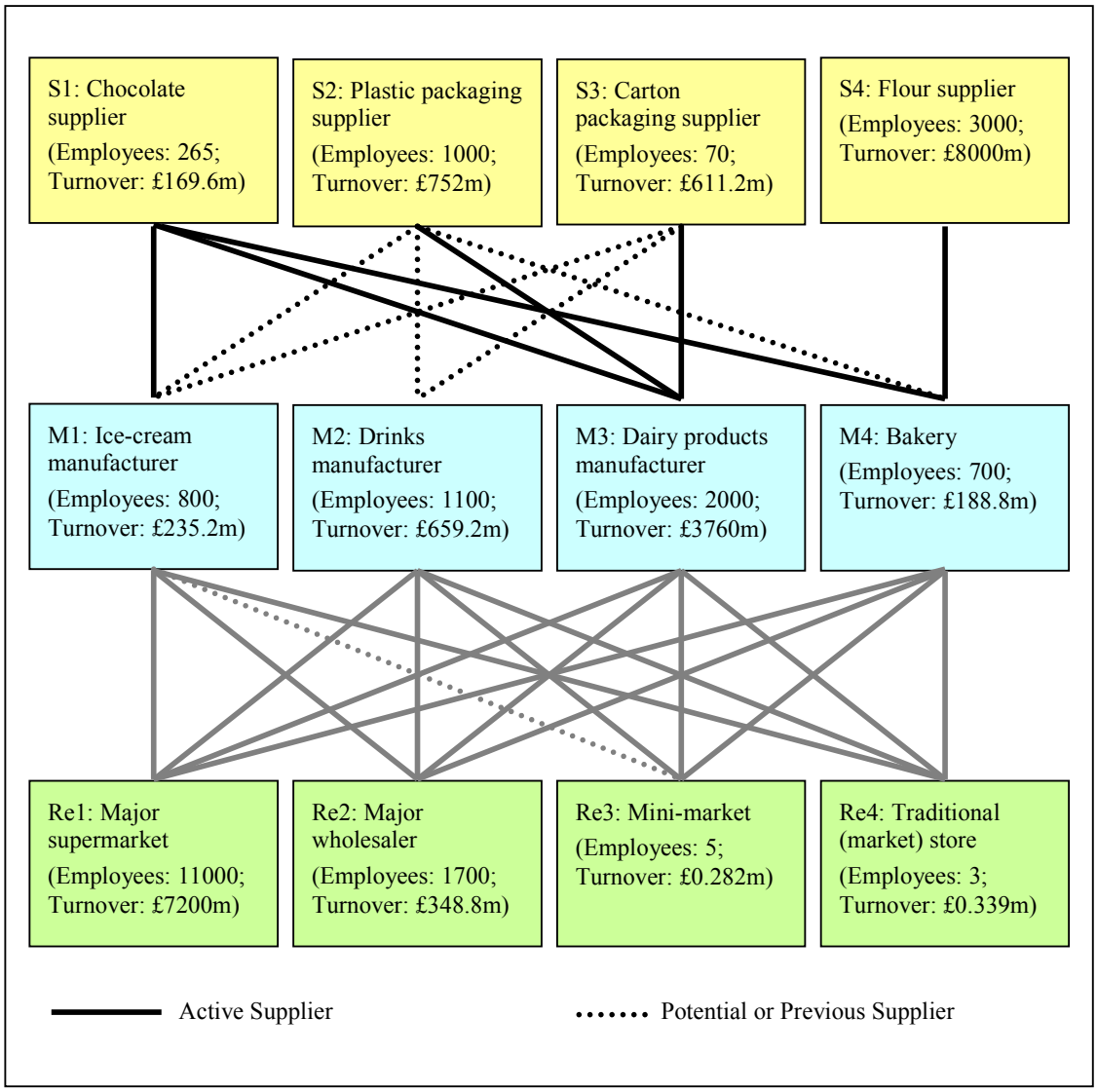
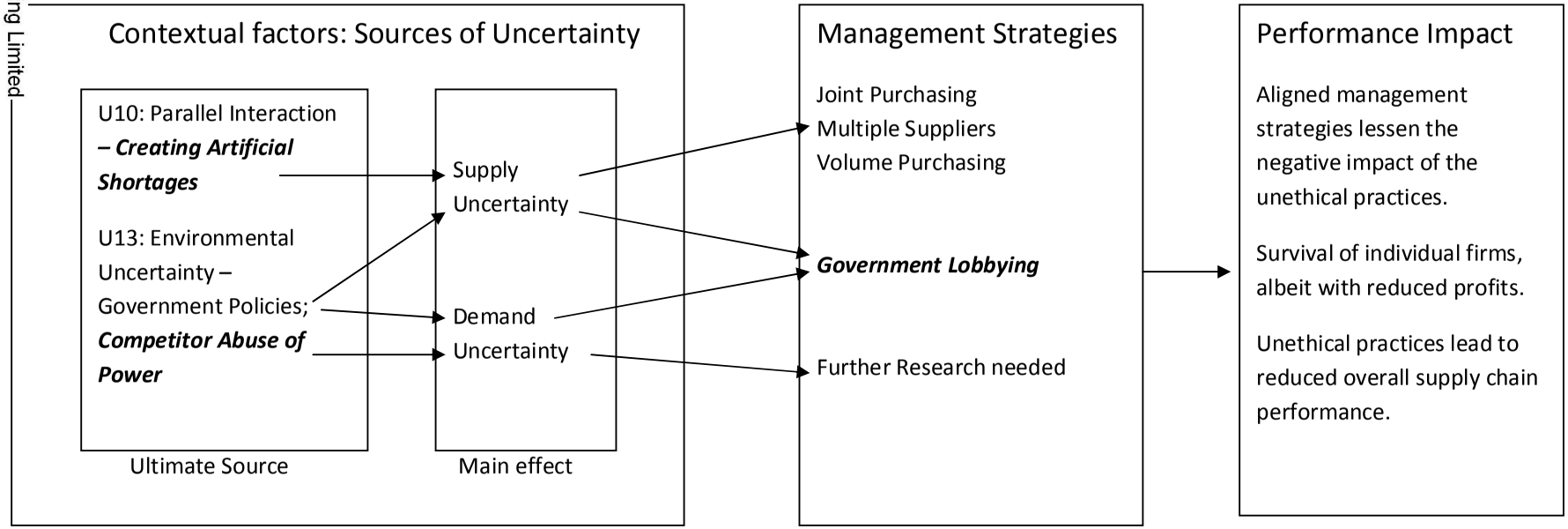


Figure 2: Network of Inter-Related Companies Studied



Key: Ethical issues are highlighted in bold italic text

Figure 3: The Emerging Ethical Issues

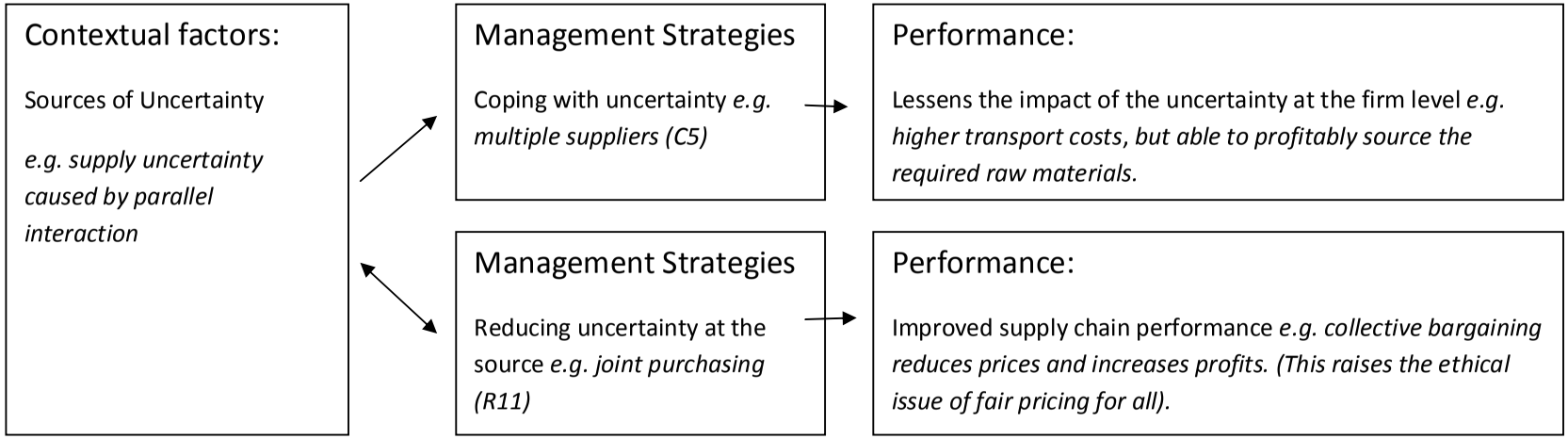


Figure 4: Linking Uncertainty Sources, Management Strategies and Supply Chain Performance

Table 1: Definitions of Sources of Uncertainty

Source of Uncertainty	Definition
U1. Product characteristics	The physical characteristics of a product e.g. colour, length, size, packaging, etc. and the product attributes e.g. perishability and product life cycle
U2. Process/manufacturing	Any issues in the process that affect an organization's internal ability to meet a production delivery target
U3. Control/chaos/response uncertainty	The chaos resulting from the implementation of the control systems in an organization, e.g. use of inappropriate rules when transforming customer orders into production plans and raw material requirements
U4. Decision complexity	Uncertainty that arises because of multiple dimensions in a decision-making process
U5. Organisation structure and human behaviour	Human behavioural issues that disrupt a supply chain process
U6. IT/IS complexity	The IT/IS issues including IT dependency e.g. due to the input of inaccurate data
U7. End-customer demand	Irregular changes in end-customer demand patterns
U8. Demand amplification	A phenomena where sales to the customer has lower variance than orders to the supplier, and this variance amplifies in the upstream chain
U9. Supplier	An uncertainty caused by a supplier's inability to meet its promises
U10. Parallel interaction	An uncertainty caused by interaction between channels of a supply chain in the same tier
U11. Order forecast horizon/ lead-time gap	An uncertainty caused by the requirement to forecast further ahead e.g. as supplier lead times are long or as companies order infrequently due to high costs of ordering.
U12. Chain configuration, infrastructure and facilities	Supply chain geographical coverage, communication infrastructure and transportation infrastructure
U13. Environment	An uncertainty related to factors, which are not directly associated with an organisation's supply chain, e.g. the actions of competitors or government regulatory changes
U14. Disruption/natural Uncertainties	An uncertainty related to natural causes e.g. earthquakes

(Adapted from: Simangunsong *et al.*, 2012).

Table 2: Uncertainty Management Strategies

REDUCING STRATEGY (R)	DESCRIPTION & EXAMPLE
R1. Lean operations	By making a process leaner, it becomes a simpler process with less inherent uncertainty.
R2. Product design	Changing the design of a product to enable a better and more robust manufacturing process.
R3. Process performance measurement	Using process performance measures, e.g., quality measures, machine performance indicators, and key performance indicators (KPIs), to detect and hence reduce uncertainty.
R4. Good Decision Support System (DSS)	Refers to the use of decision support systems as a problem solving strategy for complex decision making situations.
R5. Collaboration	Proactive initiatives, where people play a dominant role, to reduce uncertainty within the scope of the activities described below: ▪ Internal integration that provides synchronized decision and control functions in the organisation ▪ Vertical integration as a way to control supply or demand uncertainties ▪ Contractual agreements with suppliers or buyers to reduce uncertainty ▪ Voluntary restraint of competition by alliances, joint ventures, franchising agreements, technology licensing agreements, and participation in consortia ▪ Partnership programmes by working more closely with suppliers or customers, for example, in terms of collaborative planning, forecasting and replenishment (CPFR) initiatives to reduce uncertainty regarding problems of other members of the supply chain.
R6. Shorter planning period	Runs a planning system in a shorter period than the forecast horizon, thereby reducing the number of last minute changes to the schedule. For example, a manufacturer may carry out weekly production plans and product replenishment to retail outlets whereas retailers send monthly forecasts.
R7. Decision policy & procedures	Refers to the use of better decision policy & procedures to improve supply chain processes. For example, bureaucratic decision making policies require signatures from several people, making it a difficult and lengthy procedure. Therefore redesigning procedures to reduce the number of signatures will reduce inherent uncertainty.
R8. ICT System	A strategy to use application software, computer hardware and communication technology, e.g., virus-removing software and firewall software.
R9. Pricing Strategy	Refers to the use of pricing strategy or other incentives to reduce demand uncertainty.
R10. Redesign of chain infrastructure	Refers to the process of redesigning the supply chain infrastructure, i.e., the plants, distribution centres, transportation modes, and production processes, which will be used to satisfy customer demands.
COPING w. UNCERTAINTY STRATEGY (C)	DESCRIPTION & EXAMPLE
C1. Postponement	Delaying activities or processes until the latest possible point in time makes it possible to make things according to known rather than forecast demand.
C2. Volume/delivery flexibility	The ability to manufacture a product despite changes to volumes (capacity) and/or lead times.
C3. Process flexibility	The flexibility of the workforce, plant and equipment enable a company to cope with uncertainty caused by frequent product changeovers on the shop floor
C4. Customer flexibility	Exploiting relationships with customers that are less sensitive to uncertainty issues and are able to adapt their plans.
C5. Multiple suppliers	Exploiting the availability of potential suppliers and their willingness to help an organisation manage its sources of uncertainty.

C6. Strategic Stocks	Refers to the use of inventory to buffer against uncertainty.
C7. Collaboration	Basic/limited information sharing internally within an organisation or with chain partners (suppliers and customers) but, in contrast to the reducing strategy of R5, this is without affecting the source of uncertainty.
C8. ICT System	The availability of a computer based information system to provide information transparency between supply chain partners, which then enables better and faster information flow, but in contrast to R8, this is without reducing the source of uncertainty.
C9. Lead time management	Refers to the quoting of a longer lead time for customer orders compared with the expected manufacturing lead time, in order to increase flexibility to cope with uncertainty in manufacturing & delivery processes.
C10. Financial risk management	Refers to techniques of financial risk-mitigation such as purchasing insurance, and buying & selling financial instruments, e.g., forward contracts, futures contracts, swaps, and options, to cope with the financial impact of uncertainty.
C11. Quantitative Techniques	Employing operations research techniques, e.g. forecasting, simulation, and mathematical modelling, to reduce the impact caused by a source of uncertainty.

(Adapted from: Simangunsong *et al.*, 2012).

Table 3: Quality of Research Design

Conditions	Definition*	Research design used
Construct validity	Establishing correct operational measures for the concepts being studied	✓ Multiple sources of evidence with more than one interviewee for each case company ✓ Multiple sources of data (interview notes, company reports, company websites) ✓ Chain of evidence, enabling links among the case companies, which enable cross checking of data ✓ Interview notes sent to the interviewees for review
Internal validity	Establishing a causal relationship, whereby certain conditions are shown to lead to other conditions	✓ Developing a theoretical foundation and a summary of links between sources of uncertainty and uncertainty management strategies, and then comparing it with the empirical data
External validity	Establishing the domain to which a study's findings can be generalized	✓ Employing multiple case studies instead of a single case ✓ Replication logic applied to multiple case studies.
Reliability	Demonstrating that the operations of a study can be repeated, with the same results	✓ A case study protocol which is used in each case study ✓ A systematic case study database in Atlas.ti

*Adapted from Yin (2009)

Table 4: Summary of Parallel Interaction (U10): Sources of Uncertainty and Management Strategies

DIMENSION	NEW EMPIRICAL EVIDENCE OF PARALLEL INTERACTION	STRATEGY	CASE STUDY EVIDENCE	CASES
			Note: ▭ = new strategy identified *(text in italic)* = perceived impact on performance	
General parallel interaction issue among suppliers that supply different products to a company, e.g. cross docking issues	Parallel interaction among suppliers of different products, e.g. bottles & caps from one supplier cannot be delivered if the supplier of the boxes does not also deliver at the same time.	R5. Collaboration	Communication and reconfirmation with customers before daily product delivery to avoid parallel interaction issues (orders from their other suppliers), leading to cost reduction and satisfied demand. *(Reduction of inventory and transportation cost)*	S2
		R1. Lean operations, R8. ICT System, C6. Strategic Stocks are not identified		
Collusion among suppliers that supply similar products to a company *(New dimension)*	Supply availability and price games on a product where few suppliers available and they control the market.	R5. Collaboration	Vertical integration by buying some of supplier's company share, hence co-own it. This helps to overcome speculation in the wheat market and helps to guarantee raw material. Wheat procurement, a separate company within group, which specializes in futures trading, to overcome speculation in the wheat market; this helps to secure availability of raw material. *(Increased raw material availability)*	S4
			Collaboration with a trusted supplier to develop alternative material, which successfully eliminates parallel interaction issues. *(Reduction of purchasing cost and increased raw material availability)*	M2
		C5. Multiple suppliers	The likelihood to source from suppliers in different region helps to cope with parallel interaction issues. *(Increased supply availability)*	Re4
	Commodity products, e.g. wheat and sugar, where suppliers may hold back stock to create an illusion of scarcity and hence increase prices.	R5. Collaboration	Collaboration in Industry association to provide a liaison with the government and enable import of raw material e.g. sugar. *(Better raw material availability and reduction of purchasing cost)*	M3
		R11. Joint Purchasing	Good communication and joint buying with other companies in the Industrial area to increase volume buying and bargaining position with supplier; this reduces the parallel interaction problem, enabling the company to ask for a better price and service level e.g. delivery time from suppliers. *(Reduction of purchasing cost, increased raw material availability and delivery responsiveness)*	M2

Table 5: Alignment between Sources of Uncertainty and Uncertainty Management Strategies

■ Literature & Evidence ■ Literature & No Evidence ■ Evidence only	R1. Lean operations	R2. Product design	R3 Process performance measure	R4 Good DSS	R5 Collaboration	R6 Shorter planning period	R7 Decision policy & procedures	R8 ICT system	R9 Pricing strategy	R10 Redesign chain infrastructure	R11 Joint Purchasing	C1 Postponement	C2 Volume/delivery flexibility	C3 Process flexibility	C4 Customer flexibility	C5 Multiple suppliers	C6 Strategic stocks	C7 Collaboration	C8 ICT system	C9 Lead time management	C10 Financial risk management	C11 Quantitative techniques	TOTAL (with evidence only)
U1. Product characteristic																							3
U2. Manufacturing process																							7
U3. Control/Chaos uncertainty																							5
U4. Decision complexity																							5
U5. Organisation/behavioural issues																							3
U6. IT/IS complexity																							3
U7. End-customer demand																							12
U8. Demand amplification																							6
U9. Supplier																							11
U10. Parallel interaction																							3
U11. Order forecast horizon																							0
U12. Chain infrastructure & facilities																							3
U13. Environment																							5
U14. Disaster																							5
TOTAL (with evidence only)	6	5	3	2	7	3	4	5	3	3	2	1	3	3	4	5	4	3	1	1	1	2	

Table 6: Uncertainty Management Strategies for Firm Level and Supply Chain/External Sources of Uncertainty.

REDUCING UNCERTAINTY STRATEGY	Number of Case Companies		COPING WITH UNCERTAINTY STRATEGY	Number of Case Companies	
	Firm-level	S C & External		Firm-level	S C & External
R1 Lean operations	7	3	C1 Postponement	1	-
R2 Product design	4	5	C2 Volume/delivery flexibility	4	4
R3 Process performance measures	7	2	C3 Process flexibility	-	3
R4 Good DSS	4	-	C4 Customer flexibility	2	4
R5 Collaboration	11	9	C5 Multiple Suppliers	1	11
R6 Shorter planning period	-	4	C6 Strategic stocks	-	10
R7 Decision policy & procedures	10	-	C7 Collaboration	6	6
R8 ICT system	7	5	C8 ICT system	-	1
R9 Pricing strategy	-	4	C9 Lead time management	-	1
R10 Redesign of chain infrastructure	1	10	C10 Financial risk management	-	11
R11 Joint Purchasing	-	2	C11 Quantitative techniques	1	2
Total	**51**	**44**		**15**	**53**

Appendix 1: Example Case M1 (Ice Cream Manufacturer) – Sources of Uncertainty, Management Practices and Performance Impact

Table A1: Case M1 – Sources of Uncertainty

SOURCE OF UNCERTAINTY	UNCERTAINTY ISSUES	LEVEL
U1. Product characteristic	R&D uncertainty in creating future products that match market trends. For example, the Sales General Manager stated: *"Short product life, for example, if a new product promotion failed, we have to drop the product"* and *"Customers are not loyal, especially impulse goods"*.	High
U2. Manufacturing process	Electricity outage, Machine breakdown (before service maintenance), Variable process yield and scrap-rates for new products. For example, the Head of Production Planning stated: "*Indonesia (Surabaya City, where the factory is located) has not enough supply of electricity"*.	High
U3. Control/chaos uncertainty	Errors caused by inaccuracies of sales reports, e.g. stock level and sales, from traditional trading partners which is beyond the control of the organisation. For example, the Sales General Manager stated: "*Currently our salesmen have to visit around 2000 mini stores and check our remaining stocks. There is control uncertainty caused by human error in inputting data or laziness*".	High
U4. Decision complexity	Different goals between the marketing department and production. As stated by the General Manager for Production: *"Production department prefer less product variety and long production run to increase machine efficiency. Marketing department, however, insists on much more product variety because customers have their own different preferences"*	Medium
U5. Organisation/behavioural issues	High uncertainty before organisational restructuring e.g. labour strike, unsupportive human behaviour that resist changes in the organisation. As stated by the General Manager for Production: *"Serious human resource conflict before organisation regeneration occurred in 1995/1996 in the marketing department and in 1998/1999 in production department. At that time, the workers were on strike (and production was stopped)"*	Low
U6. IT/IS complexity	Technical failure, Unauthorized information access that creates information confusion and reduces information integrity e.g. marketing can access unauthorized factory operation data and may question official production report, inadequate IT/IS system performance leads to process unresponsiveness. For example, the Production General Manager stated that there can be: "*Technical failure and system down, for example leased line connection from Telkom is cut-off*"; and the Sales General Manager referred to: "*Unauthorized access, for example (an employee) printed company data and then gave it to other company*".	Low
U7. End-customer demand	Demand fluctuation in peak season, Incorrect weather forecast, No customer loyalty (unexpectedly change in customer taste). According to the Product Manager: "*There are three peak*	High

SOURCE OF UNCERTAINTY	UNCERTAINTY ISSUES	LEVEL
	seasons in Indonesia, such as school holiday, idul fitri, and Christmas-new year. In idul fitri for example, the normal sales volume for two months is sold out in two days".	
U8. Demand amplification	Exists, but is well managed such as: *"For modern trade we use planogram, where we set a specific volume or carton boxes for each store, for example five carton boxes of one item for one store, and set automatic reorder level, for example after three carton boxes were sold. This system is similar to the kanban system"(General Manager, Sales)* *"There is a plan to implement vendor managed inventory with Alphamart and Superindo this year. We are waiting for them to start the system"(Logistics Head)* *"The Sales Promotion Girl (who we installed in a store) can also submit purchase (replenishment) orders before official purchase order from the stores"(Logistics Head)*	Low
U9. Supplier	Quality issues/rejected order. "*The supplier sends raw material with incorrect specification*" (General Manager, Production)	Medium
U10. Parallel interaction	Exists e.g. sugar, packaging. As stated by the Production General Manager: "*For sugar (raw material), we suspect there is a cartel of suppliers*" and "*For cartons (packaging material), we use two to three suppliers that have different core businesses to prevent collusion among them*"	Medium
U11. Order forecast horizon	Potentially exists but considered low because: "*We provide production and procurement forecast (to suppliers). In terms of stocks, they know aggregate numbers such as 2 weeks or 1 week stock availability. We ask suppliers for their stock level and the supplier is willing to provide such information*"(Production Planning Head)	Low
U12. Chain infrastructure & facilities	The lack of dependable communication, e.g. fax and internet, leads to out of date sales data records; this caused inefficient distribution process. As stated by the General Managers for Sales and Production respectively: *"Information from traditional stores is hopeless and inaccurate, they are passive and we have to press them to provide information (albeit mostly inaccurate or outdated data was provided)"* and *"Technical failure and system down, for example leased line connection from Telkom is cut-off".*	Medium
U13. Environment (regulation, competition)	Government & local regulation such as: Unhelpful or changing regulation e.g. change of regulation when a new head of The National Agency of Drug and Food Control (referred to as BPOM in Indonesia) is appointed; Unnecessary new regulations; and Halal certification. For example, the Production General Manager stated: *"Another problem is fatwa and other rules related to halal certificate. The impact is serious, we just finish a management meeting with important decisions, then a new fatwa is published".* Competitors' behaviour e.g. new player, market leader that disturb market equilibrium i.e. new product, promotion activities etc. *"The market leader company is a source of uncertainty because they often do marketing activities that change market equilibrium. For example, promoting mini ice cream that influence customer taste and preference" (General Manager Sales).*	High

SOURCE OF UNCERTAINTY	UNCERTAINTY ISSUES	LEVEL
U14. Disaster	Bad Weather, High sea waves, Flooding, Fire/Accidents. For example, the Head of Logistics stated: "*Bad weather has caused delayed delivery to outer islands*" and *"Flooding disrupts land transportation"*.	High

Table A2: Case M1 - Uncertainty Management

STRATEGIES	EVIDENCE
R1 Lean operations	✓ *"For modern trade we use planogram, where we set a specific volume or carton boxes for each store, for example five carton boxes of one item for one store, and set automatic reorder level, for example after three carton boxes were sold. This system is similar to the kanban system"* (General Manager, Sales). This leads to reduction of inventory level and helps to reduce stock out in retail (U8-Demand Amplification)
R2 Product design	✓ The flexibility in terms of product design to retain end-customers by satisfying their expectation for new trends (U7-End-Customer demand). The General Manager for sales claimed that the company: "*Create similar products to the market leader, a riding the wave strategy, to match their competitive offering*".
R3 Process performance measure	✓ SPC in the process to control the manufacturing process within quality specifications (U2-Manufacturing Process). As stated by the Production General Manager, the company has a: "*Maintenance contract for machines to reduce manufacturing uncertainty*", and "*implements SPC because the company will never sacrifice quality*".
R4 Good DSS	No evidence of use
R5 Collaboration	✓ Internal collaboration to ensure product innovation that provides ability to follow and match competitor's product movement with own developed product (U1-Product characteristic, U13-Environment) ✓ Coordination with retailer e.g. as stated by the General Manager for Sales: *"In peak season, we proactively initiate communication with retailers, for example Indomaret (one of the major retail players) to set stock allocation using trend of historical data. This helps the production department to anticipate demand changes and reduce uncertainty"* (U3-Control/Chaos uncertainty). Intensive communication also helps decide the priority of production resources usage (U4-Decision complexity), and maintain product availability without excessive levels of stock (U8-Demand Amplification) ✓ Partnership with suppliers, especially with materials that have large variety, e.g. fruits and preserves, to reduce quality issues. The Production General Manager stated: "*We have strong partnership with our suppliers for many years, even at personal level, for example for fruit suppliers*" (U9-Supplier) ✓ Coordination with suppliers for space/capacity allocation to reduce possibility of raw material shortage (U9-Supplier) ✓ Communication and collaboration within Industry Association in negotiation with the National Agency of Drug and Food Control (referred to as BPOM in Indonesia) to speed up the registration process of new product and compliance with government regulation (U13-Environment).
R6 Shorter planning period	No evidence of use

STRATEGIES	EVIDENCE
R7 Decision policy & procedures	✓ Well defined procedure for planning system (annual, monthly, weekly planning) and clear responsibility. Hence this reduces discrepancies between departments (U4-Decision complexity), and unsupportive human/organisational behaviour toward changes in the organisation (U5-Organisation/behavioural issues) ✓ Security information handling policy where employee can only access data based on responsibility, The Production General Manager claimed that: "*In every branch office (employee) use dumb terminal so it is difficult to download unauthorised data. Every employee can only access data according to their user level or position in the company*" (U6- IT/IS Complexity)
R8 ICT system	✓ ERP provides online data transaction and communication internally and between the company and the branches/retailers, plus updated physical stock information (SPG in retailer) has helped to reduce demand amplification (U8). "*We ask retailers to open their sales per customer data, but not online. We update inventory stock at retailers through our supervisors placed in the stores*" (GM Sales) ✓ B2B server connection for real-time data sharing (under trial at present) with major retailer also helps to reduce inventory problems (U8-Demand amplification). "*Carrefour gives us real sales data (monthly data) every three months. We plan to connect our information system to their system using B2B or server to server connection*" (General Manager, Production).
R9 Pricing strategy	No evidence of use
R10 Redesign chain infrastructure	✓ Labour rationalisation, e.g., workers in the factory, as the result of factory modernisation; this reduces uncertainty related to human behaviours. The General Manager for Production asserted that: "*People (staff and factory workers) that cannot follow changes in the organisation are fired. But we do this in phases to avoid disruption in the production process. The company implements a regeneration strategy to reduce uncertainty from underperformed workers"* (U5-Organisation/behavioural issues) ✓ The use of third party logistics provider to optimize distribution especially to provincial regions and remote areas where they have capability and good service level (U12-Chain infrastructure & facilities). *"(We) use third party logistics provider to send product to remote areas so they responsible with transportation risk*"(General Manager Sales)
C1 Postponement	No evidence of use
C2 Volume/ delivery flexibility	✓ The usage of general purpose machines enables volume flexibility. As stated by the General Manager for Production: *"For example production capability in terms of volume flexibility and continue production in case of one machine problem using our general purpose machines",* (U2-Manufacturing process).
C3 Process flexibility	✓ Flexible in terms of production process to match the products offered by the market leader has helped to reduce the impact of strong competition in the market, as suggested by the Production General Manager: "*Product development is flexible because we use same machine with market leader. This machines are only used in large scale manufacturer like our company (and the market leader)"* (U13-Environment)
C4 Customer flexibility	No evidence of use
C5 Multiple suppliers	✓ *"(The company has) policy to use 2 suppliers to cope with quality issues of raw material"* (Production Planning Head) (U9-Supplier)
C6 Strategic	✓ "*Use buffer stock, especially for imported raw material and main raw materials*

STRATEGIES	EVIDENCE
stocks	*such as sugar*" (GM Production). This helps to cope with customs/ excise problems (U13-Environment)
C7 Collaboration	✓ Placing salesperson in retailer helps to facilitate intensive communication especially in peak season, hence this increases responsiveness to cope with end-customer demand fluctuation (U7-End-Customer demand) ✓ Coordination with distributor and retailer (partnership/working together) e.g. *"There is trading terms agreement with retailer, for example, Carrefour. We meet every three month to discuss market share, consumer requirements, promotion plan, and price reduction"* (General Manager Sales) to aid in the estimation of demand (U7-End-customer demand). ✓ The placement of sales personnel in retailers (customers) helps to manage the impact of demand amplification (U8), especially in period where retailers execute marketing or promotion activities, and the case company is unable to influence retailers' decision. As described by the Sales General manager: "*SPG (sales promotion girl) that we placed in big retail stores provide us with customer information (and feedback)"*
C8 ICT system	✓ The implementation of B2B server connection between the company and retailers for real-time data exchange; this enables direct access of sales data in retailers and leads to increase forecast accuracy to cope with demand uncertainty (U7) "*Carrefour gives us real sales data (monthly data) every three months. We plan to connect our information system to their system using B2B or server to server connection*" (General Manager, Production).
C9 Lead time management	No evidence of use
C10 Financial risk management	✓ Have insurance through the use of CIF (Cost, Insurance and Freight) transactions for imported material to avoid losses caused by natural disaster e.g. the Head of Logistics stated: "*We insure assets in retail stores such as freezers*" (U14-Disaster) ✓ Third party logistics are responsible for risk in transporting the product to the customer (U14- Disaster)
C11 Quantitative techniques	No evidence of use

Table A3: Case M1 - Impact on Performance

STRATEGIES	EVIDENCE
R1 Lean operations	✓ An electronic kanban system (planogram) has reduced inventory cost and helps to reduce stock out in retail, which means reduced complaints from consumers
R2 Product design	✓ Product design ability to match competitor offering helps to retain end-customers and satisfy their expectation of the new trend
R3 Process performance measure	✓ SPC in the process helps to produce more consistent product quality
R4 Good DSS	No evidence of use
R5 Collaboration	✓ Internal collaboration in product innovation helps to increase responsiveness to the changing trend of customer demand e.g. time to deliver new product to the market

STRATEGIES	EVIDENCE
	✓ Coordination with retailer e.g. place salesperson in customer site to facilitate intensive communication especially in peak season has increased responsiveness to customer demand, helped to increase production efficiency and volume flexibility as the major sales to the company comes during this peak season ✓ Partnership with supplier, especially with materials that have large variety e.g. fruits and preserves has helped to reduce quality issues or rejected material in order to ensure quality, and the quantity of final product produced ✓ Coordination with supplier for supply volume/capacity allocation has maintained continuity of production in case of raw material shortage and this ensures continuation of product quantity delivered to the customer ✓ Communication and collaboration within Industry Association has helped to speed up registration process to the National Agency of Drug and Food Control (referred to as BPOM in Indonesia) and compliance with government regulation; this also speeds up the delivery of the product to the end-customer
R6 Shorter planning period	No evidence of use
R7 Decision policy & procedures	✓ Well defined procedure for planning system has increased productivity in the company e.g. no labour strike, less conflicts between departments, increased information integrity and increased focus to satisfy customer and consumer demand
R8 ICT system	✓ The company claimed that the ERP (SAP) system has helped to reduce cost compared to the previous/manual system, helps to increase customer responsiveness e.g. delivery time, product availability and facilitates information to accommodate volume and schedule fluctuations from customers
R9 Pricing strategy	No evidence of use
R10 Redesign chain infrastructure	✓ Labour rationalisation has reduced cost as a result of increased productivity ✓ The use of a capable third party logistics provider has helped the company to maintain distribution and product availability in provincial regions and remote areas, hence ensures on time delivery to the remote areas
C1 Postponement	No evidence of use
C2 Volume/delivery flexibility	✓ The usage of general purpose machines helps to create volume flexibility in case of machine breakdown, hence this enables the company to keep continuation of product delivery as the customers have requested
C3 Process flexibility	✓ Machine & technology capability in terms of different configurations of products, e.g., mini vs. large ice cream, has enabled the company to satisfy its business customer needs and the consumers
C4 Customer flexibility	No evidence of use
C5 Multiple suppliers	✓ Multiple suppliers (> 2) helps to cope with sourcing problems, avoid delayed production caused by no raw material issues in order to ensure on time delivery to the customer