A Study to Examine the Importance of Forecast Accuracy to Supply Chain Performance, the Contributing Factors and the Improvement Enablers in Practice

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ABSTRACT

Forecast accuracy plays a critical role in supply chain performance. Various researches have studied this topic from different angles, inspired by these studies, objectives are set up to investigate the recognition of the importance of forecast accuracy in supply chain performance in practice, identify the contributing factors and improvement enablers recognised in practice. This research attempts to comprehensively examine the findings and conclusions that are drawn from literatures in the real supply chain environment, at the same time aims to discover good practices as well as issues from the supply chain practice for future studies, and provides recommendations to the practitioners based on findings and conclusions from both literature review and this research.

An exploratory research approach utilizing a combined quantitative and qualitative method has been taken. The research starts with an on-line questionnaire, then complemented by follow up telephone interviews subject to the candidates' willingness to participate. Information collected through the survey and interviews are analysed using different Excel tools and methods, conclusions and recommendations are then drawn based on the findings and discussions.

It has been concluded that the importance of forecast accuracy for supply chain performance has been well recognized in practice. The contributing factors and improvement enablers identified from the literature review have been commonly acknowledged by the practitioners, however, the level of understanding on these subjects varied among these businesses, and different opinions and approaches have also been discovered. In some cases, actions taken to seek improvement are well lagging behind. Furthermore, new views, fresh ideas, good practices, issues and constraints are also revealed through this research. Recommendation based on both literature review and the research findings are then made to the practitioners. At the same time, suggestions are given for future studies.

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Chapter 1 – Introduction

1.1 Introduction

Supply chain and supply chain management have been developing rapidly in the last two decades as a result of the economic globalization, technology development, growing consumer power and an increasing global focus on sustainability. Among various supply chain focuses and processes, supply chain forecast and its accuracy has been one of the major focus areas drawing attention from both researchers and practitioners. Numerous studies have investigated forecast accuracy from different angles, and best practices from real business world have also emerged and been spreading.

However, most academic studies are based on models with certain assumptions which are either simple or ideal, though they provide a theoretical insight to supply chain issues and performance evaluation, they do not suffice as true practical solutions (Zhao & Xie 2002, p313, Acar, Yavuz & Gardner, 2012, p842), and quite often, focusing on single subject or a limited areas, these studies do not provide highly practical guidance in the real supply chain field. There appears to be a lack of review based on real world practice, where the theories and conclusions from the academic studies can be investigated and examined in a live environment extensively.

1.2 Research Goals and Objectives

Originated from the researcher's previous supply chain working experience and inspired by the relevant academic literatures, a project has been set up to pursue an exploratory study on the subject of supply chain forecast accuracy. The research aims to examine the findings and conclusions drawn from related literatures in the real supply chain environment. Three objectives have been defined as below.

- To evaluate the development of supply chain management and the recognition of the important role forecast accuracy plays in supply chain performance in the real business world.

- To identify the contributing factors to forecast accuracy recognized in the real business world and the related good practices.
- To discover the improvement enablers for forecast accuracy recognized in the real business world and the related good practices.

Top supply chain performers are the best resource to test these objectives and learn new ideas. However, as a student research, with limited time, budget and experience, obtaining access to top supply chain performers worldwide is not an easy task. It has thus been decided realistically, approaching well known businesses locally in the New Zealand market is more feasible. The research hence is designed with this in mind.

The goal of this research is first to explore the views, opinions and practices held in the real business world on the three set up objectives; then attempt to identify good practices as well as issues for future research and study; at the same time, bring recommendations to the practitioners based on the findings and conclusions from both the literature review and this particular research.

1.3 Thesis Structure

This thesis is structured into five chapters.

It starts with the introduction chapter which briefly describes the background from which this research is initiated, the defining of the objectives and goals of this research as well as the structure of this thesis.

Chapter 2 contains the literature review for this research. It covers the review on the development of supply chain and supply chain management, the importance of forecast accuracy in supply chain management, the impacts of forecast accuracy, the contributing factors and the improvement enablers.

Chapter 3 illustrates the research design process. In this chapter, the research method, data collection method and process, data analysis method are explained and justified respectively.

Chapter 4 presents the findings and discussions based on the survey and interview results.

Chapter 5 draws conclusions on the objectives of this research, provides recommendations to the practitioners, suggests future research topics and declares the limitation of this research.

Chapter 2 - Literature Review

2.1 Introduction

The literature review is going to give a comprehensive review on studies in this area, summarizing the development to date, the importance of forecast accuracy to supply chain performance, the contributing factors and the improvement enablers. This will form the base for the following research on same subjects in the real business world.

2.2 Overview of the Development of Supply Chain and Supply Chain Management

2.2.1 Introduction

Supply chain and supply chain management are not completely new concepts but rather re-defined terminologies. They are referring to the activities, processes and relationships that have been presenting since long time ago in the whole process from material sourcing, product making, warehousing, through logistics and distribution and finally delivering the finished goods or service to the end consumer (Lambert, Stock & Ellram, 1998). The idea was described by Henry Ford (Corominas, 2013, p6829) in as early as 1922 where he "clearly designed the system for producing and distributing his cars as a whole, instead of considering the assembly plant or the parts of the system separately, as if they were independent". The definite expression of the terms of supply chain and supply chain management has emerged quietly in the 1980's with Oliver and Webber first put forward the terminology of supply chain management in 1982 (Corominas, 2013, p6828). Since then, supply chain and supply chain management has gradually drawn the attention from both practitioners and researchers. Practices and studies on this subject have been developing rapidly since mid 1990's especially through the last two decades (Corominas, 2013, p6828). Several major drivers have been considered to lead to the rapid development in the supply chain and supply chain management field.

2.2.2 Development of Technology

On one hand, science and engineering technology has been developing faster than ever in all aspects, this has made developing new products and improving products performance more accessible and product life cycle shortened significantly. Therefore, competition is becoming fiercer and time now plays a fundamental role for a business's success, that means with similar product type and quality, who can deliver the product to the final customer in the shortest time will win the business. In the logistics and transportation field, science and technology has seen transportation especially international shipping undertaking dramatic transformation, new generations of super container ships are built to suit the rapid growing international shipping demand, new technologies are not only making vast vessel capacity possible, but also has successfully reduced the fuel consumption rate, at the same time cargo quality assurance has been increased with better container designs and temperature control technologies. Same happens in the warehousing and land transportation fields as well.

On the other hand, information technology is now taking center stage all over the world, be it for personal life experience or inside the business world. Business tools, software and systems are all the advantages provided by the fast developing information technology. They are transforming the business world by assisting with daily operational work, enabling fast and accurate information sharing and transmission to support analysis, reporting, planning, efficient communication and decision making.

2.2.3 Globalization

The much more capable and efficient transportation network has provided a platform for global sourcing of materials, outsourcing manufacturing and developing new markets globally, contributing in cost reduction and revenue gain. The advanced information technology supports the globalization through system implementation and internet transaction which have made sharing and exchanging information more efficiently without time and/or geographic boundaries. Great numbers of business are "taking strategy initiatives in terms of mergers and acquisitions to achieve reorganization of distributions for greater effectiveness in a global market" and "the development of supply chains and their

management is, to an important extent, driven by such change" (Mattsson, 2003, p416 & 424).

2.2.4 Consumer Power

Today's market is more consumer driven than ever, customers are always looking for better product with lowest possible price, best service and instant availability (Quayle, 2003, p80). Businesses are then forced to find solutions to be most cost effective, develop better product and make it accessible to the customer as fast and as easy as possible. Supply chain being the carrier of the product or service from their provider to the consumer has become the focal point when achieving this goal. How to reduce the lead time, how to deliver the right product in the right time at the right place, how to get the information flow faster and more accurate and how to get the support from participants within the supply chain to achieve the goal are some of the key elements of a business's competitive edge (Tracey, Lim & Vonderembse, 2005, p179; Quayle, 2003, p80; Ellinger, Shin, Northington & Adams, 2012).

2.2.5 Focus on Social Responsibility and Environmental Sustainability

Aesthetic forms part of a product or service quality dimension, in today's world, it is weighing more on a company's image in consumers and other stakeholders' eyes. A company taking social responsibility seriously and contributing positively and passionately to achieve environment sustainability receives positive perception from their customers and their business partners. With such perception, a customer is more inclined to buy product or service from these companies and seeing himself supporting the concept of making a better world for future generations, a business partner similarly sees himself contributing to this concept as well. To take on more social responsibility and contribute to environment sustainability, a business needs to focus on reducing waste, optimizing resource utilization and recycling. Reducing waste is a form of reducing cost which is a focal point of supply chain management, optimizing resource utilization relates to outsourcing manufacturing activities which means lower labor cost, higher productivity and efficiency, and often because outsourcing intends to happen in the developing countries, it also supports these countries' economy growth, improves people's living conditions which is closely related to

social responsibility. Recycling is a major factor to environment sustainability, reversed supply chain management plays a significant role in this process. It is correctly stated that 'Supply chain management (SCM) is highly relevant in addressing responsible behavior at all stages of the supply chain. It represents a potentially important discipline for establishing how to integrate environmental and social considerations and practices, to achieve the goal of sustainability' (Ashby, Leat & Hudson-Smith 2012, p497).

2.2.6 Summary

Driven by these forces discussed above, the concept of supply chain and supply chain management has emerged and developed in the last two decades. During this time, not only big sized businesses but also many small and medium sized businesses and entities are starting to realize that supply chain management is playing an increasingly fundamental role enabling a business to gain competitive advantage to survive and succeed (Tracey et al., , 2005, p180; Voss & Woodruff, 2006, p1). In other words, supply chain management brings focus, knowledge, expertise, collaboration to a business to respond to consumer needs, grow stronger in the process of globalization, take full advantage of technology and contribute to a better world for future generations.

2.3 The Importance of Forecast Accuracy in Supply Chain Performance and Its Impacts

2.3.1 Introduction

Forecast is a statement or an act to make a statement that predicts business activities for a future period of time based on information available at the time (Cambridge dictionary and business dictionary on line, 2014). A supply chain is a combination of processes and relationships interacting with each other to produce and deliver a product or service to the final customer, and quite often it is not a single line of activities one after the other but rather a complex network of all these processes, activities and relationships. Or in a simple version, Supply Chain Council has defined supply chain with five simple words, 'Plan, Source,

Make, Deliver, and Return' (Jusko, 2009, p28). Forecast is the blue print for these five components, it is presented in almost every stage of the supply chain network, acting as an indication and guidance for upcoming business activities, it is the foundation of all planning activities and a crucial link between the upstream and downstream processes. In short, 'a sound forecast is the first and most critical step in running a supply chain effectively' (Singh, 2014, p5).

Depending on the functions and focuses, there are different types of forecasts in a supply chain environment, such as demand forecast, supply forecast, sales forecast, production forecast, shipping capacity forecast, warehouse packing capacity forecast, backflow forecast etc. and all these forecasts can happen at all three management levels namely the strategic level, the tactical level and the operational level, where forecast at the strategic level provides long term overall guidance, then cascades into more detailed operational short term specific forecasts (Klatch, 2007, p23). All of these forecasts are making predictions based on information available at the time of the forecasting activity and are forming a critical foundation for the future upstream or downstream planning activities, i.e. Forecasting and planning activities are sequential to each other (Lancioni, 2000, p3). Forecasts can be seen as critical joints connecting upstream and downstream supply chain processes and activities to deliver the ultimate results. Forecast and its degree of accuracy are making various impacts on supply chain performance.

2.3.2 Forecast Accuracy's Impacts on Production Decision, Pricing Decision and Inventory Level

- **Production Decision**

Generally speaking, production decisions are made based on demand forecast. However, there's always a time gap between the earlier forecast and the receipt of the final firm order. A manufacturer can choose to begin production as soon as he receives the earliest forecast or wait till the last minute to begin production when the firm order comes through. The decision making on when to begin production and how much to produce is largely dependent on the forecast accuracy and cost associated with these decisions (LeBlanc, Hill,

Harder & Greenwell 2009, p20&29) i.e. early production usually is based on initial forecast which often contains more uncertainties hence offers a lower accuracy level, such decision with the advantage of longer lead time, will take advantage of cheaper material cost and labour cost but may risk in over producing and high inventory level; later production usually is based on more firmed forecast, but due to the short lead time, it demands higher cost to obtain materials and to produce with a tight capacity and schedule. In an ideal situation, an early forecast with a high level accuracy will give the production process a lot of advantages, it allows longer lead time to source materials and plan production, it also gives more confidence to the production decision makers that chances of over production and high level of inventory are minimized. The end result is a more comfortable and structured production process and a controllable low cost.

- **Pricing Decision**

Forecast accuracy also impacts pricing decisions (Mishra, Raghunathan & Yue, 2009, p152). In Mishra et al.'s study, both make-to-order and make-to-stock scenarios are examined on the relationship between forecast accuracy and pricing decision, it is found that sharing information will increase forecast accuracy and consequently assist the manufacturer with his pricing decision, such more informative pricing decision brings more benefits to not only the manufacturer but also the retailer with support of some suggested contract enforcement and incentives.

- **Inventory status**

Following the impacts on production and pricing decision, comes the impact on the downstream segment which is the inventory. Forecast, production decision and inventory happen in sequence, inaccurate or inadequate forecast has a significant impact on the inventory through its impact on the production decision. This is recognized in both literature and practice as the bullwhip effect. In a study carried out by Thomassey in 2010 on the sales forecast in the apparel industry, simulations run based on his proposed model clearly indicated that forecast errors lead to the increase of the orders from the retailer to the manufacturer while the actual sales remain unchanged, such fake 'demand' resulted in unnecessary production delay and shipment delay which in the end increased the inventory level and lost sales. Trapero, Kourentzes & Fildes, (2012, p739) drew the same conclusion in

his case study that forecast accuracy has a direct impact on inventory management. The higher the forecast accuracy, the lower the inventory level, Dr. Gardner (2014, www.bauer.uh.edu) in his presentation quantified the impact of forecast accuracy on safety stock at a 1 to 3 ratio, i.e. when standard deviation of forecast error is cut by $1, safety stock will be cut by $3, a very straight forward justification on the importance of improved forecast accuracy. By increasing forecast accuracy, not only inventory level is reduced, at the same time, customer service level can still be maintained and often improved with correctly stocked products at the right volume.

2.3.3 Impact on the Overall Supply Chain Performance

In a technology characterised, consumer driven and globalized business environment, supply chain performance directly determines a business's success. Service, revenue, inventories, expenses and cash are forming the new metrics for supply chain performance (Smith & Smith, 2013, p29). Smith & Smith (2013, p28) emphasised that today's supply chains are not linear chain but rather a complex network or system of flows of materials and information. They acclaimed 'flow comes first' as no.1 principle when understanding today's supply chain system, as a form and outcome of information flow and presented in every stage of the supply chain, forecast links upstream and downstream supply chain processes and activities, it is without doubt one of the key factors that determine the quality of overall supply chain performance (Zhao & Xie, 2002, p312, Trapero, Fildes & Davydenko, 2011, p490, Fildes, Goodwin, Lawerence & Nikolopoulos 2009, p4).

Demand driven supply chain concept is now prevailing in the research field as well as the practice with world top 25 supply chains demonstrating the same (Hofman & Aronow, 2012, p55). The demand driven framework implies an outside-in approach to drive supply, demand and product management (Hofman & Aronow, 2012, p58). Along this process, forecast takes on a critical role to not only pass on but also translate correctly the information from customer through the upstream supply chain functions to support the supply management, demand management and product management.

Closed loop or reverse supply chain is also gaining growing attention along the recognition of sustainability as a key component of supply chain success. Recycled products provide secondary raw materials that substitute a portion of primary materials, this process not only contributes to protecting the environment but also saves the total cost of sourcing raw materials, consequently strengthens a business's sustainability (Krapp, Nebel & Sahamie, 2013, p976/977). Krapp,et al. (2013, p1001) demonstrated with his generic forecasting framework that accurate return forecast will contribute to a more accurate decision making and at the same time present the decision makers with the impact of forecasting errors on the economic value added. Furthermore, Krapp et al. (2013, p1002) called for more research to be done on the forecasting methods and models that increase the accuracy on the return product quantity, timing and quality, these will improve the close loop supply chain performance hence the overall supply chain performance.

2.3.4 Summary

Furthermore, other researches done for different industries or supply chain characters all lead to the same conclusion discussed above. Thomassey's study on the sales forecasts in clothing industry revealed that increased forecast accuracy leads to better performance for both the retailers and the manufacturer (Thomassey, 2010, p481). Zhao, Xie & Wei, (2002, p251 & 278) investigated the relationship between forecast errors and the early order commitment in the supply chain, findings indicate that for supply chains utilizing early order commitment to improve supply chain efficiency and reduce cost, forecast accuracy plays a fundamental role. Simulations are performed with different scenarios where different forecast errors interact with the cost structure, number of retailers, capacity utilization and capacity policies, findings are consistently showing that forecast accuracy adds value to the early order commitment approach, as a consequence, improves overall supply chain efficiency and reduces overall supply chain cost. Aviv (2001, p1339) carried out a research that focused on collaborative forecasting in a supply chain environment that delivers long life cycle product with relatively low demand uncertainty, results on the impact on the cost of inventory on hand and back orders proved that collaborative forecasting enhances forecast accuracy and consequently brings substantial benefit to the supply chain. There

are also some other studies that have given evidence from the opposite angle, for example, Trapero et al. (2012, p739) has found through their study that forecasting errors can cause an increase of up to 30% of the organization cost which means a substantial damage to the business's performance.

Concluded from all these researches and studies, it is without doubt that forecast accuracy plays a critical role on various aspects of supply chain performance.

2.4 The Key Contributing Factors to Forecast Accuracy

2.4.1 Introduction

As pointed out by Thomassey (201, p482), the existence, relevance and reliability of data contained in the information system are the key factors that influence the forecast accuracy. These three elements can be translated as the following, existence is related to the availability of data which comes from the share of information and the range of such information; relevance is related to the range of information; and reliability of data is related to the quality of information. Aside from data related factors, there are other factors such as human and technology factors contributing to forecast accuracy as well. A large number of researches have studied these various factors that impact the supply chain forecast accuracy. Though most of them have been focusing on certain aspects with in depth investigations, these studies together can lead to the following summary of the key contributors to forecast accuracy.

2.4.2 Sharing of Information

- **Information Sharing Minimizes Uncertainties**

Demand, supply and manufacture are three base functions of most supply chains, they bring a lot of uncertainties along with their unique natures especially in today's globalized supply chain environment (Hung, Lin, & Ho, 2014, p48, Baumann, 2010, p21). Demand uncertainties are caused by customer preferences, competition activities, seasonality, special events etc. Supply uncertainties can be caused by upstream raw materials supply, suppliers' on time delivery ability, quality of the delivered supply etc. And manufacture

uncertainties are influenced by manufacture capacity, down time frequency, repair time etc. (Hung et al., 2014, p48). Traditionally in practice, holding a 'safe' level of inventory is the most common way of coping with supply chain uncertainties, however, such approach is a no turning back option. When the uncertainties do not turn up, those 'safety stock' will become waste or loss (Liao & Chang, 2010, p527). Since forecasts are done based on available information at the time of the forecasting activity, with so many uncertainties presenting among the demand, supply and manufacture processes, it is apparent that a forecast could easily become inaccurate as soon as it is done with upcoming uncertainties along the supply chain. Gathering the latest information and sharing with the relevant parties will minimize the impact of uncertainties, increase the chances of adjusting the forecast close to a real time manner to reflect the most current situation, hence increase the forecast accuracy. It is thus a much better way of minimizing the impact of uncertainties through information sharing to improve forecast accuracy, such a proactive approach will reduce much more uncertainties at the early stage, therefore avoiding unnecessary product to be physically made, hence achieving a more desirable inventory status.

- **Information Sharing Improves Responsiveness to Demand**

Yan & Wang found through their study that sharing information increases forecast accuracy which enables firms to respond to customer and competitive demands in a real time manner, their model has demonstrated that by sharing information in a franchiser and franchisee supply chain environment, forecast accuracy is significantly increased and both parties benefit from such improvement (Yan & Wang, 2012, 1171).

- **Information Sharing Contributes Significantly in Reducing the Bull Whip Effect**

Bull whip effect has been recognized as a major issue that causes inefficiency and excessive inventory waste in supply chain (Ali & Boylan, 2010, p5). Without sharing much information between supply chain participants but only passing through individual forecast from downstream customers to upstream customers, adjustments are done at each hand over of the forecast based on safety concerns and assumptions, forecast quickly loses its accuracy and becomes a total different picture from its original version which was supposed to reflect the true demand from the end consumer. Sharing information creates transparency in the forecasting process, with more firsthand information available, confidence in the

downstream forecast is built up for all supply chain participants; with more trust in its partners, supply chain participants can turn their focus from self-protection to ensure a more accurate forecast passed upstream without any artificial adjustment, forecast accuracy is thus increased and supply chain performance is improved eventually.

- **Information Sharing Improves Profitability.**

Zhu, Mukhopadhyay & Yue (2011) developed a model that simulated the relationship between forecast effort and supply chain profitability under several different information sharing scenarios, it's been found that the improved profitability by sharing information between supply chain partners is a direct result of improved forecast accuracy. In another case study carried out by Trapero et al. (2012), evidence also showed that sharing market information between the retailer and the supplier significantly increases forecast accuracy, it leads to direct monetary gain for the supplier and indirect benefit for the retailer in the aspects of improved customer service level and possibly reduced wholesale price in future (Trapero et al., 2012, p746).

However, sharing information is easy said than done. Different participants in the supply chain may come from different culture background; have different operational processes; possess varied abilities in sharing information; using different systems and tools collecting, storing and analyzing data and show different levels of willingness to collaborate in the information sharing process. All of these are possible obstacles of sharing information (Hung et al., 2014, p48). In this aspect, studies have been carried out to investigate the coordination mechanisms of information sharing and their impacts on reducing the supply chain uncertainties. Datta & Christopher (2011, p795) examined different combinations of information sharing and coordination mechanism in their simulation tests in a make-to-stock supply chain, findings suggest that information sharing alone or coordination alone does not suffice to increase forecast accuracy and reduce supply chain uncertainties; the right coordination mechanism together with widely shared information is the foundation for accurate forecasts.

2.4.3 Quality of Information

Further to sharing information, the quality of information plays a critical role in the final level of forecast accuracy as well, i.e. data quality affects decision quality (Chen & Wolfe, 2011, p70, Ramanathan, 2012, p691). In a study led by Choi, Li & Wei (2013, p136), results have shown that poor quality information reduces the accuracy of the forecasts that are drawn from those information.

Forslund & Jonsson (2007, p93) has also done a research with a focus on the forecast information quality and its impact on supply chain performance. They (Forslund & Jonsson, 2007, p104) tested relationship between supply chain performance and forecast information quality with four variables namely in time, accurate, access convenience and reliability (Forslund & Jonsson, 2007, p94). In time refers to information is provided in the right time horizon when the forecast is produced; accurate means the information is true or with the lowest degree of errors; convenient to access refers to the format of the information is easy to adapt and requires little reformatting or reprocessing; reliability refers to how long these information will remain valid, or in other words, the information does not expire or change too soon. The findings through Forslund & Jonsson's study supported previous researches in the conclusion that forecast information quality has a positive impact on supply chain performance as a result of improved forecast accuracy.

Information quality is affected by the number of relays and handlings from its origin to its destination, i.e. exchange directly between two parties ensures a higher quality, while if handled multiple times along several parties, the quality tends to decrease due to the handling or manipulation along the way such as format change, data conversion and inappropriate interpretation and communication that make the information less visible or more difficult to understand (Chen & Wolfe, 2011, p70 and Klatch, 2007, p28).

The quality of information also depends on the credibility of the relevant parties and how they want to provide the information, should there be an incentive to do so, such as to protect their own interests, they may provide artificial information and hide the true picture hence jeopardize the quality of information which will at the end impact the degree of accuracy of the forecasts generated from those information (Cachon & Lairiviere, 2001, p629).

2.4.4 Range of Information

The type of information to be shared, i.e. 'what to share' is the 3rd factor contributing to the forecast accuracy (Ramanathan, 2012, p678).

The type of information shared should include a good range of both internal and external data as well as direct and indirect data. Studied in a MRP framework, Viswanathan et al. compared the outcome on inventory level and total cost by sharing end user demand information and sharing only the immediate downstream customer's information, results have shown that sharing information from end user comes with the lowest total cost (Viswanathan, Widiarta & Piplani, 2007, p5072), i.e. best overall supply chain performance in terms of cost. In an 'order forecast competition' study led by Williams & Waller (2010), competition of forecast accuracy between forecasts drawn from POC (Point of Sale) data and from DC (Distribution Centre) order data was facilitated, results confirmed that generally the accuracy of the forecast based on POS data over performed those drawn from DC order historical data. However, DC order data may contain certain information that POS data does not reflect such as non-turn volume order which is usually related to promotion programs from the supplier itself (Williams & Waller, 2010, p247-248). Ramanathan's case study (2012, p690) also suggested that a combination of both internal and external data will result in a better forecast than either alone.

Seasonal and weather information is another type of data that consists of a range of information to be shared. Seasonal factor is usually on the annual horizon and has impact on agriculture productions such as milk, meat, seafood, fruit and vegetables etc. It also has a linkage with consumer behavior in terms of consumption of seasonal products such as sun screen, ice cream, beer, swimwear for summer and other type of apparel for each different season of the year. Weather information is often in a short term horizon consists of information of temperature, sunshine, rain etc. in the next 7 to 10 days, longer period than this will see a significant decrease of information accuracy. The weather information has a particular impact on fast consuming seasonal goods forecasts. In a case study based on a major brewer in UK, it is proved that short term weather information improves forecast

accuracy by 2.3% in average and 6.2% in the summer season where more sales are allocated (Nikolopoulos & Fildes, 2013, p86).

It must be pointed out that no single set of data is perfect or sufficient, it is then paramount that the most available data range including direct/indirect data, internal and external data, seasonal and weather data, and other type of customer, product, market related data is shared among supply chain members to achieve higher forecast accuracy therefor better supply chain performance.

2.4.5 Forecasting Capability – Human Factor and Tools and Systems

Sharing the right and relative information in a wide range with the highest possible quality does not automatically lead to an accurate forecast outcome, how to analyze this information, how to interpret it and how to utilize it are some of the crucial determinants in producing an accurate forecast. Traditionally, forecasting capability is mainly depending on the forecaster's competence, such as their experience, their skills and even their personalities. With information technology becoming an essential part of today's businesses, various tools and systems are now consisting a major part of forecasting capability (Fildes & Hastings, 1994, p1&16). As correctly stated by Wang & Pervaiz (2007, p27), a business's capability to best utilize its human resource and information technology resource creates competitive edge for the entity.

- **Human Factors**

The forecaster is the leader in the forecasting process (Singh, 2014, p5), to make the right adjustment and the right decisions, they need to possess a good set of skills and capabilities. As Singh (2014) summarized, first of all a good forecaster should have a comprehensive understanding of the business about its products, customers, markets and competition environment; then comes the good understanding of the data that is being fed into and processed by the forecasting systems, such as their meanings, validities and alignment. Secondly, a good forecaster should be highly capable of producing accurate forecast at different aggregation level by correctly utilizing the tools, systems and his knowledge, knowing when and how to change and make sound adjustment. Thirdly, a good forecaster

should always deliver meaningful forecasts with the right metrics to the right audience, and promote single set of forecast numbers to be used throughout the organization. Last but not least, a good forecaster should also be a good communicator with exceptional interpersonal skills to convey the forecasts correctly among the business functions, negotiate and obtain agreement when necessary, as well as educate the business when required. All of these skills and capabilities from the forecasters make significant impact on the forecast accuracy, as the forecasts are after all generated by the forecasters with the support of information technology tools and systems.

Managerial adjustment or judgmental adjustment has been recognized recently as a major factor that influences forecast accuracy with increased studies focusing on this aspect (Onkal, Zeynep & Lawerence, 2012, p693, Trapero et al., 2011, p506, Fildes et al., 2009, p20). Judgmental adjustment is usually taken as a supplement to complete or polish forecasts produced by tools and systems, taking into consideration the factors that are hard to be modeled into systems, such as strategy, special events, competition environment, short term or one off problems etc. (Onkal et al., 2012, p695, Trapero et al., 2011, p490/491). Various studies have come up with mixed findings with some suggesting that management adjustment improves forecast accuracy while others reached the opposite conclusion (Franses & Legerstee, 2011, p537). Franses & Legerstee (2011) examined the impact of managerial adjustment on forecast accuracy at the SKU level over different horizons, and found out that managerial adjustment tend to over manipulate the pure model based forecast, and the shorter the horizon, the worse the impact. It is then recommended when applying managerial or expert adjustment, extra caution needs to be taken to ensure they do add value not the opposite. Franses & Legerstee (2011) also pointed out that expert training in this aspect is essential for managerial adjustment to add true value to forecast accuracy. From another angle, judgmental adjustment can be done by individual forecasters or with a group of experts representing different functions of the supply chain in a collaborative manner. Onkal et al.'s (2012) research on role playing group forecasting showed that no significant difference on forecast accuracy is found between the role playing group and non-role playing group. However, the non-role playing group does make less adjustment over the initial forecast, and the role playing group showed a stronger commitment to their own roles and less agreement on the consensus forecast (Onkal et al.,

2012, p693/698). This result highlighted a potential issue with group forecasting approach, that the forecast accuracy can be affected by individual group members when they have a stronger commitment to their own roles and possess stronger influence abilities over the other group members. The higher level of disagreement between group members may also impact negatively on efficiently delivering a forecast result. Oliva & Watson (2009, p140) highlighted this as intentional bias caused by incentive misalignment and disposition of power. Here, choosing the right people with competencies not only on expertise but also with the right attitude and mindset to put the global objective on top of individual interest is key to ensure a more accurate and efficient forecast delivery.

- **Tools and Systems**

With the rapid development of information technology, various tools and systems are being applied in almost every part of the business to assist with analysis and decision making, forecast is one of the major areas that tools and systems are involved. Tools and systems make it possible to store and exchange large amount of information, enable fast and complex analysis, and produce forecast in a more efficient manner. However, the impact of tools and systems on forecast accuracy are twofold. On one hand, as expected, tools and systems can process large volume of data more efficiently and accurate than human being; on the other hand, not utilized or programmed properly, tools and systems can become obstacles to forecast accuracy, they may produce totally useless or misleading result (Singh, 2014, p5, Morlidge, 2014, p35). Based on Morlidge's (2014, p35&36) analysis on M3-forecast competition, it is noted that sophisticated systems do not necessarily guarantee an accurate forecast outcome; however, combined methods usually produce better forecast than the single ones.

2.4.6 Forecasting Methods and Approaches

Forecasting methods or approaches is the fifth factor that influences forecast accuracy.

In terms of how to aggregate data, Boylan (2010, p9-13) explained several approaches namely the top-down approach, the bottom-up approach, and the middle-out approach that starts from the tactical level then combines top-down and bottom-up, the hybrid forecast

that mixes the previous method with more refined techniques, and last but not least aggregation over time. No single method is perfect, he emphasized that a close look at own data and a long term view at the strategic level helps with choosing the best method that suits a specific supply chain.

In relation to time horizon, rolling forecast is widely adopted in practice as a way of sharing demand forecast between customers and their suppliers and has seen success with several top business performers (Huang, Hsieh & Farn, 2011, p397). This method bases itself on a forecast over several consecutive periods in future in a set time interval and updates with a certain frequency as time proceeds. As time comes closer for one period, the forecast becomes more accurate compared to the actual order. This is actually a technique of sharing customer's forecast with the supplier in a timely manner with a constant adjustment to ensure the forecast is getting as accurate as possible to the firm order (Huang et al., 2011, p399). However, such technique itself does not guarantee a high level of forecast accuracy, the customer may be tempted to artificially make up the rolling forecast numbers in favor of his own interest. Hence it requires other techniques to bring out the full value of rolling forecast. One solution is to put penalty or incentive terms in the contract to discourage high deviation between forecast and actual order and encourage minimizing the gap (Huang et al., 2011, p398). Another solution lies with the supplier or the forecast receiver to identify the deviation manner of the forecast vs. actual orders, then apply different adjustment techniques to get an improved accuracy from the original rolling forecast provided by the customer. Huang et al. (2011, p408) have conducted simulations on those scenarios and recommended AVG (adjusted by average) for adjusting upside estimation bias and RMSE (root mean squared error) for downside estimation bias.

In terms of techniques, ordering quantity, lead time and coordination mechanism are three elements that determine forecast accuracy as pointed out by Song, Hui & Luo, (2011, p1). Through their models, the relationship between the maximum supply chain profit and ordering decisions on quantity and lead time have been examined, it is then concluded that optimal ordering quantity and lead time will reduce demand forecast uncertainty in both centralized and decentralized supply chain.

2.4.7 Summary

The contributing factors to forecast accuracy can be categorized into three dimensions as data, forecasting capabilities, and, method and techniques. They are associated with two types of biases, the intentional one is caused by incentive misalignment and disposition of power, as well as the forecasters' skills and capabilities. The unintentional one is introduced by blind spots existing in the tools, systems, methods and techniques that are used in sharing, analyzing and processing data, which cause deficiency in the data quality, the range of data collected and the efficiency of data sharing and processing (Oliva & Watson, 2009, p140). Eliminating these biases, enhancing forecaster's skills and capabilities and choosing the right tools and systems are the keys to improving forecast accuracy, they are discussed in the following section as improvement enablers.

2.5 The Improvement Enablers for Forecast Accuracy

2.5.1 Introduction

Having identified the contributing factors to forecast accuracy, solutions need to be established based on these elements to improve forecast accuracy, as the end goal is to improve supply chain performance and increase a business's competitive edge through the improved forecast accuracy. Coordination and collaboration approaches in sharing information, obtaining a sufficient range of information as well as increasing information quality are summarized in this section. Reviews are also done in regards to how to enhance forecaster's skills and capabilities, how to build trust as the foundation for collaboration, how to choose forecast methods and mechanisms and how to best utilize tools and systems.

2.5.2 Cross Functional and Collaborative Programs

Although information sharing is essential to forecast accuracy, simply sharing information is not enough at all. How to share information and how to best utilize the shared information are the key to the most optimal result. With shared information, if each individual party in the supply chain still does their own forecast with a focus to maximize their own benefit, sharing information adds no value to the overall forecast accuracy and the overall supply

chain performance. The only way to bring out the value in sharing information is to draw a unified focus from all supply chain participants onto one single goal that is to collaboratively work on a single forecast process with shared information, and aim to achieve the best for the whole supply chain (Viswanathan et al., 2007, p5059).

- **Sales & Operations Planning (S&OP) – What is the Process**

Stahl & Wallace (2012, p29) have claimed S&OP process is "one of the most performance-enhancing activities an organization can undertake." So what is S&OP? Thome, Scavarda, Fernandez & Scavarda, (2012, p360) described S&OP as a process of integrating all functional plans into a unified tactical plan over a time horizon from less than 3 months to 18-24months to strategically direct a firm's operational planning and related activities to achieve a better performance of the business. The positive connection between S&OP and firm performance has been emphasized by various researches (Thomé et al., 2012, Olhager, 2013, Reed, 2012, Dooley & Higgins, 2006, Phillips, 2011). At the same time, both literature and practice have called for collaboration to improve supply chain forecast accuracy which in the end improves the overall supply chain performance (Ramanathan, 2012, p692, Aviv, 2001, p1337, Jusko, 2009, p26, Jonsson & Gustavsson, 2008, p292). For maximum collaboration and coordination to take place, S&OP appears to be an essential platform.

As pointed out by Affonso, Marcotte & Grabot, (2008), S&OP process is a powerful method to integrate different functions within a firm or a supply chain, and to combine, balance and unify different objectives, interests and constraints. Among those functions, operation and planning are often the major participants, however, it needs to be pointed out that the "S" in S&OP stands for sales, who are at the frontier of the market facing the customers directly. Chase & Charles (2013, p6) has urged to include marketing in this term to raise the focus on this side of the supply chain where sales and marketing are the forces to bring the first hand customer demand information into the S&OP process. This is directly linked to the range of information and the quality of information that is needed for improving forecast accuracy. Also as per Chase & Charles, (2013, p10), companies focus on demand sensing through sales and marketing, tend to improve their forecast accuracy substantially.

- **S&OP Provides a Collaborative Environment, Promoting Trust for Better Information Sharing**

Collaboration is one of the major benefits that S&OP can bring in the process of improving forecast accuracy. Sharing information obviously needs to be based on willingness and actions of collaboration. Following this prerequisite, comes the range of information and quality of information. What information is needed and what information can be provided are the key questions that need to be discussed and agreed between the forecasters and the information providers. S&OP process is a cross-functional one that offers such opportunity for relevant parties to raise questions, carry out discussions, reach conclusions and draw up action plans on how to share information and what information is needed and can be shared. Information quality issues can be raised in the S&OP process meetings to be discussed and solutions can then be found and taken place.

Trust between business partners is valuable; it enhances cooperation and itself is also strengthened through the S&OP process. Cachon & Lairiviere (2001) claimed credibility is key in sharing information. One of the lessons learned from Hung et al.'s (2014, p59) case study has highlighted the importance of trust in information sharing, it reduces uncertainties and risks, increases forecast accuracy and consequently improves the overall supply chain performance, the end results are beneficial to all participants within the supply chain, this in turn, will build a stronger trust between these parties creating a healthy and positive cycle. Similarly, Ebrahim-Khanjari, Hopp & Iravani, (2012, p456) studied how trust levels influence the forecast information sharing between a manufactures' salesperson and the retailer, it has been identified that trust and forecast accuracy are enhancing each other in the relationship, i.e. higher forecast accuracy enables the salesperson to give more accurate recommendations on the retailer's order quantity, usually the retailer will later realize an improved profit based on the earlier order recommended by the salesperson, he then puts more trust into this salesperson and the manufacturer's forecast, and will be less tempted to make any further adjustment on the future forecasts. Here forecast accuracy builds trust between the retailer and the manufacturer, in turn trust makes the retailer more willing to corporate with the manufacturer as well as sharing relevant information with the manufacturer to achieve higher forecast accuracy, this is all because the retailer is confident that he will benefit from this process.

However as Ali and Boylan (2010, p8) pointed out, trust between business partners is not easy to achieve, it takes years to build. Ebrahim-Khanjari et al. (2012, p463) also emphasized that a long-term relationship is essential to build and maintain high level of trust. Before the long-term relationship and trust are established, Ali and Boylan (2010, p8) suggested the use of obligation contracts to enforce information sharing.

- **S&OP Needs Management Involvement to Work Effectively**

S&OP is a process that requires management involvement at all three levels of the business, namely the strategic level, the tactical level and the operational level. Senior management engagement is key to a successful S&OP process, and Stahl and Wallace (2012, p29 - 33) pointed out 10 principles for the success of S&OP at the senior executive management level. They ensure a united focus from top down, maximum alignment between strategic planning, tactical planning and day to day operational planning and encourage high level commitment from all parties in the whole planning process. Such focus and involvement relayed down to the entire management team will no doubt develop a unified approach and create a platform for proactive information sharing with the most available information and the best information quality. Together with justified investment on relevant forecasting tools and systems, as well as the most capable forecasters, accurate forecasts can be delivered. These high quality forecasts in turn will assist with correct decision making which will contribute to the overall supply chain performance therefor achieving the business goal. Boylan (2010, p9 & 13) echoed the same in his review on recent development of supply chain forecast method, addressing that no matter what forecast approach is chosen, top management involvement on setting the context and strategy is essential.

In short, S&OP process combines some of the major contributing factors and improvement enablers for forecast accuracy; it brings all relevant parties onto the same table, generates a high level of collaboration and provides the single platform for exchange of information and joint decision making on improving forecast accuracy. S&OP process usually delivers an approved forecast together with a financial plan and a supply plan (Bower, 2012, p21). The approved forecast then is supposed to be disaggregated into tactical and operational forecast/planning. To ensure a correct translation of the baseline forecast, Bower (2012)

urged the need to include different scenarios of potential variations into the baseline forecast, i.e. to ask the 'what if' questions and prepare the contingency plans for several possible scenarios (Reed, 2012, p56, Galluci, 2008), so that in the followed forecasting and planning activities, guidelines and directions are provided proactively to mitigate impact on the sub forecast accuracy.

- **Other Cross Functional Collaboration Approaches - CPFR, ECR, QR, VMI, CRP and More**

In practice, apart from S&OP process, other cross functional collaboration and coordination approaches such as Collaborative Planning, Forecasting and Replenishment (CPFR) and Vendor Managed Inventory (VMI) have gained considerable success as well (Ali & Boylan, 2010, p14). Similar initiatives and approaches such as Efficient Customer Response (ECR), Quick Response (QR), and Continuous Replenishment Program (CRP) etc. are also being practiced in the real supply chain world (Vlčková, 2008, p336).

- **CPFR**

CPFR is an approach based on strong collaboration environment, it brings all concerned parties in the supply chain together to create a shared information system and manage a single shared planning, forecasting and replenishment process in their supply chains (Vlčková, 2008, p337). The first pilot on this approach was done in 1966 between Wal-Mart and Warner-Lambert on the Listerine products, where relevant data was exchanged timely and adequately to support the single co-managed planning, forecasting and replenishment process, success from this pilot has seen increased sales, better fill rates and reduced inventory investment. Since then, a considerable number of other similar pilots on CPFR have gained success for leading businesses from different industries such as P&G, Heineken USA and Levi Strauss (Aviv, 2001, p1327). Aviv (2001, p1327) also pointed out that to achieve a successful CPFR, high level of collaboration, willingness to share adequate information and strong technical support are crucial.

- **VMI**

VMI is a mechanism of sharing information that the supplier monitors the customer's inventory and takes the responsibility to maintain an optimal inventory level. Such solution effectively let the supplier lead the demand forecast process hence give the supplier access

to the true inventory data from the customer further down the supply chain. Hung et al.'s study (2014, p61) has concluded that this approach can significantly reduce risks and uncertainties, improve collaboration between parties, increase forecast accuracy, reduce bull whip effects and consequently improve overall supply chain performance.

- **QR**

QR originated from within the apparel industry. With an attempt to reduce lead time and inventory cost as well as to serve the customer quickly, the supplier and the retailer collaborate with each other by sharing information especially point of sale information to improve supplier forecast accuracy and production scheduling (Derrouiche, Neubert & Bouras, 2008, p429).

- **ECR**

ECR was developed in the grocery industry and is a similar approach to QR. The producers, manufacturers, wholesalers and retailers work together to build a highly collaborative supply chain to serve consumer in a more efficient way which provides the consumer with high quality fresh product at the same time reduces inventory cost, assets investment and over all supply chain cost (Derrouiche et al., 2008, p429).

- **CRP**

CRP focuses on the replenishment process between the supplier and the distribution center. With a pre-setup standard of stock level for various products, the supplier sends full load of a mixture of these products to maintain the stock level respectively (Derrouiche et al., 2008, p429), i.e. product is replenished for the sold amount in a real time manner (www.leanmanufacturingjapan, 2014). Here 'full load' and 'real time' are two unique characters of this program.

Apart from above mentioned collaborative strategies, other versions and similar approaches are presenting in the supply chain world as well. These various collaboration approaches have the same core target which is to enhance collaboration between supply chain partners for sharing information, in order to improve forecast accuracy which will eventually help to reduce cost, improve customer service level and overall supply chain performance.

However they do have varied advantages, limits and focuses. Choosing the right collaborative strategy needs to be based on evaluation in the specific business context and according to the respective supply chain structure (Derrouiche et al., 2008, p438).

2.5.3 People Talent and Training

As early as 1994, Fildes and Hastings's study on forecast improvement highlighted the importance of people talent and training in all aspects of the forecasting process, including: forecast system design and implementation; forecasting procedure set up; forecasting system and procedure evaluation; monitoring and review; and, forecasting data management. In a later study led by Fildes in 2009 (Fildes et al., 2009, p15&16), emphasis has been given again to motivations and trainings for forecasters as to the improvement of forecast accuracy. Stahl & Wallace (2012, p32) quoted a researcher Lora Cecere's finding that S&OP success is determined 60% by behavior change which is people and training related. As quoted by Jusko (2009, p27), talent is one of the five pillars of excellence for a successful supply chain. Talented people encouraged to think with a big picture in mind, or in Smith & Smith's word (2013, p33), think systematically, is the driving force for true collaboration and trust. In doing so, they are demonstrating the high willingness to share and work together.

To directly obtain talented people or have the talented people readily available is an ideal condition that hardly exists. So there comes the question of how to improve the capabilities of currently available forecasting personnel to deliver a high quality forecast result. Recommended by Fildes & Goodwin (2007), the forecasting principles developed by 40 leading forecasting professionals and 123 reviewers (www.forecastingprinciples.com, 2014) is a good framework for forecasters training and practice. And based on Morlidge's (2014) summary of the required skills and capabilities of forecasters, efforts should be made in the following areas for improvement.

- First, forecasters should be given opportunities to have exposure to all business functions including: production; logistics; the customers; and, the market, to gain that comprehensive knowledge of the business.

- Second, training can be provided to forecasters on data understanding, processing and interpreting as well as forecast methods, mechanism, tools and systems.

- Third, forecasters should be given training on improving their communication skills and interpersonal skills in order for them to perform better when discussing, explaining, negotiating the forecast throughout the business with different stakeholders, and to be able to educate the business when required.

2.5.4 Supply Chain Design

Choosing the right partners in a supply chain is essential to a business's success. They must have common goals and performance metrics which enable a collaborative platform for sharing information and making decisions that benefit the whole supply chains sustainability in the long run (Chase & Charles, 2013, p6).

Supply chain design focusing on simplified and optimized operation and logistics processes will also reduce forecast friction in exchange for an improved forecast accuracy. Klatch (2007) demonstrated this can be done through a thoughtfully re-designed liquid supply chain. This liquid supply chain has been modified from a product based process to a postponement strategy, the change is to push the packaging and product customization operation furthest down the supply chain to a point close to the consumer, hence simplifying the storage, transport and measuring processes, reducing the number of SKUs and eliminating obstacles that were caused previously by complex product specifications due to early customization of a product based supply chain. As a result, with fewer measuring units, easier methods of obtaining data, improved forecast volume calculation, simpler data conversion, information interpretation has become increasingly simplified. At the same time, logistics and operational processes have seen fewer constraints, hence relieving the forecast process from incorporating excessive rules and conditions.

2.5.5 Tools and Systems

Tools and systems are widely adopted in the supply chain world and sometimes require high investment to install and implement (Fildes & Kingsman, 2011, p483), such a big spend often

pushes the management away from supporting this kind of solution. However, when they are presented with the high savings along the supply chain coupled with better shared information and increased forecast accuracy, the decision is more easily justified (Ali & Boylan, 2010, p8, Fildes & Kingsman, 2011, p483).

FSS (forecasting support systems) refers to the various forecast related supporting systems adopted in practice. Among those, ERP and MRP systems with their strong features and capabilities, have been widely used in the past and at present especially in the manufacturing and distribution sectors, but no system is perfect, they can never deliver a 100% accurate forecast, hence various approaches have been taken to mitigate the forecast errors in order to achieve the most optimal forecast accuracy. Ho and Ireland (2012) tested and concluded that applying proper lot-sizing rules in these systems leads to a positive improvement in forecast accuracy. However, this has been found to be more focused on cost and value relationship and lack of ability to sense, shape and translate demand information (Chase & Charles, 2013, p7).

Designing or choosing the right tools and systems, as well as applying the right techniques in building forecast models can definitely bring benefits in improving the forecast accuracy. Lau, Ho & Zhao, (2013) demonstrated this through their mathematical approach in setting up a framework using MDL (minimum description length) to determine the most optimal forecast model, supplemented by a method using surrogate data to identify characteristics of demand data. Wang & Yeh (2009) have proposed a web-based DSS (Decision Support System), with its forecasting core consisting of a customer segmentation module to segment customer, then apply different forecast techniques to each segment accordingly in the forecasting module, and finally to integrate these forecasts into a unified final forecast which has historically proved to be efficient for collaborative planning and supply chain profit improvement. Fildes, Goodwin & Lawerence, (2006) reviewed literature on forecast and decision support systems, and have identified features that need to be included in the design of a future generation highly flexible, multifaceted FSS, in order that a high quality, accurate forecast result is delivered. The identified features range from: user friendly features; an appropriate range of flexible methods; and, applications and maximum support of integration of managerial judgement and system forecast. Such types of system are yet to be developed and may take some time, however, the right direction has been pointed out

and this is no doubt an enabler that will see significant improvement in supply chain forecast accuracy.

Although there are a large selection of options of software and systems available for supply chain forecasting, due to the relative high investment requirement and complexity to customise, small businesses are often deterred from these options. Zhu (2008), as a result of his consulting experience to small business concludes that Microsoft Excel is a much accessible and useful tool for forecast activities in these types of business. With it widely adopted as a standard desk top application, all employees in most cases have a reasonable to high degree of Excel knowledge, and by utilising improved more powerful functions and features that Microsoft Excel offers provides an ideal option for small business to aid forecast activities.

2.5.6 Motivation for Sharing Information and Improving Forecast Accuracy

Several studies have revealed that though information sharing always brings benefits to the manufacturers, in a make-to-order situation, it usually hurts the retailers by raising their risk of not being able to meet the actual demand when it fluctuates (Zhao et al., 2002, p333). In the situation where more customers are sharing one supplier, a customer tends to inflate his forecast to ensure he minimizes the risk of stock out. To discourage such behavior and motivate honest sharing of information, Zhao et al., (2002, p253/277/278) proposed the early order commitment technique, while the supplier will benefit the most from this solution by reducing uncertainties in their planning as well as saving cost, the customer does not receive true benefit but facing more risk of not meeting the actual demand by being honest with his forecast and making commitment to it. Hence, suggestions have been made to offer incentives to retailers to encourage true information sharing and compensate for potential loss (Mishra et al., 2009, p163). Solutions such as discount wholesale contracts are increasingly popular (Mishra et al., 2009, p158). Even in a make-to-stock situation, manufacturers can also introduce an incentive fee to obtain the most accurate forecast from the retailer as long as the forecast accuracy can bring justified inventory and operational savings (Mishra et al., 2009, p163). One other mechanism suggested is a two-part tariff where manufacturers and retailers share profitability obtained by sharing information.

Bargaining strength of each party determines how well this scheme works and if the retailer can get a desirable balance between their effort of providing unconditional information sharing and the profit share they get from the manufacturer for doing so (Mishra et al., 2009, p163). Yan & Wang (2012) demonstrated the same mechanism in a franchiser – franchisee relationship. Song et al., (2011, p15-18) also developed a three parameter contract as a coordinate mechanism to encourage accurate demand forecasts. Such contracts combine the features of a buy-back contract and a risk-sharing contract, it can arbitrarily allocate the profit between supply chain participants hence offers a positive balance between forecast accuracy and a supply chain participant's own interest.

Return policies are widely used in practice and researched academically. This is especially effective in an up-down approached forecast process where the manufacturer shares their demand information with retailers, and where the manufacturer then accept returns of the excessive products at the season end as a consequence of the inaccuracy or poor quality of information (Choi et al., 2013, p131). Such a methodology links the consequence with the party who is responsible for sharing the right information, hence ensuring one does not hurt themselves by what they did earlier in the forecast process, the more effort put into the forecast to improve the accuracy, the less loss likely to be incurred at the end. A properly used return policy will lead to a win-win result for both the supplier and retailer.

Durango-Cohen & Yano studied forecast commitment contracts in 2006 and 2011 from the both the suppliers and customers perspective respectively. The key feature of the forecast commitment contract is a two way commitment policy where the supplier commits to a portion of the customers forecast and customer guarantees to purchase a fraction of their forecast. Both parties will be subject to penalties if they fail their commitments. This policy has been proven to deliver a win-win result for both the supplier and customer, where the customer is encouraged to share the most accurate forecast in exchange for the suppliers increased commitment to fulfill the forecast as the supplier gets more confidence and less uncertainties in their planning activities based on the customers accurate forecast. A healthy cycle of forecast and delivery can thus be developed and maintained.

2.5.7 Monitor and Review Procedure and Mechanism

Changing (inflating or deflating) forecasts have long been an issue between supply chain parties, and it is difficult to prove one has done so as the forecast itself has a nature of fluctuation and uncertainty (Cachon & Lairiviere, 2001, p630). Introducing a monitor and review procedure will positively limit behavior of this type by focusing on learning from the past imperfections instead of pointing fingers or playing the guess and hide game.

Measurement in operational terms recommended by Dr. Gardner (2014, www.bauer.uh.edu) can provide management with a straight forward picture of how forecast accuracy is performing. These metrics include inventory investment on the balance sheet, purchasing workload and production set-ups, as well as customer service measures such as average back order delay time, percent of time in stock, probability of stock out and average dollars backordered.

A review of the forecasting process itself is also essential to continuously improve forecast accuracy. The processes such as S&OP, CFPR, VMI and QR are developed and introduced as improvement enablers, but they are not perfect solutions, over time they may bring new and unforeseen disadvantages and challenges to forecast accuracy as opposed to their initial intention. Oliva & Watson (2009, p150) identified such issues through their case study of managing functional biases in organizational forecasts, and urged the need to continuously monitor the relevant processes to keep them on the right track and deliver the most optimal result.

2.5.8 Summary

To improve forecast accuracy, collaboration and trust is the foundation. Originated from practice and studied academically, S&OP is a major process that can effectively build a collaborative environment based on trust to empower information sharing exchange and information quality improvement. Other types of collaboration approaches between supply chain participants such as CPFR, VMI, and QR etc. are being practiced as well for the same purpose. The use of: supportive training provided to enhance forecasters skills and capabilities; choosing the right tools and systems; adopting the right supply chain design; applying the correct motivation mechanisms and introducing a proper monitor and review

process; will aid supply chain forecast accuracy improvement and consequently improvement in the overall supply chain performance.

2.6 Summary of Literature Review

Forecast accuracy plays a critical role in improving supply chain performance (Onkal et al., 2012, p693).

Though S&OP, CPFR and VMI are studied separately in most literature and are often implemented individually in practice where S&OP focuses collaboration inside a supply chain entity, CPFR and VMI are used between supply chain partners to obtain wide range of relevant information in order to improve forecast accuracy (Vlčková, 2008, p337), there is definitely a need to closely link these two initiatives strategically together to achieve the most optimal result for forecast accuracy and overall supply chain performance (Baumann, 2010, p21-28).

To achieve the goal of improved forecast accuracy, all contributing factors and improvement enablers need to be considered comprehensively and investigated carefully in order to choose the most optimal solution or a combination of these solutions that suit a specific supply chains characteristics. For example, to deal with the highly volatile apparel industry, Thomassey (2010, p482) emphasized that together with implementing a suitable forecasting system, a re-structure or re-design of the supply chain is needed to reduce lead time and minimum order quantity, and both will contribute to the improvement of forecast accuracy.

Chapter 3 - Research Methodology

3.1 Introduction

This chapter illustrates the formation of the entire research process. First, research objectives are defined. Then the research design and the research method justification are explained. Next, the data collection methods are described in regards to the sampling decision, the development of the questionnaire questions, and the determination of interview questions. Followed this is the explanation of the data collection process which consists of the on-line survey and the telephone interview. Lastly, data analysis methods are explained and rationalized.

3.2 Research Objectives

One feature or purpose of business and management research is 'to develop ideas and to relate them to practice', the research is thus to engage both academic study and practice, develop topics that are meaningful to both sides and consequently add value mutually (Saunders, Lewis & Thornhill, 2009, p6).

The literature review related to this research has revealed the important role played by forecast accuracy in supply chain performance. The contributing factors to forecast accuracy and the improvement enablers for forecast accuracy have also been identified through the review. Therefore, interests have been developed naturally through this process to explore the understating and status of the same in the real business world, with a further intention to find gaps between academic research and the practice in order to bring benefits to both sides, i.e. discover good practices and issues from the reality for future research and provide meaningful recommendations to practitioners based on the literature review and research findings.

Hence the following objectives have been set:

- To evaluate the development of supply chain management and the recognition of the important role forecast accuracy plays in supply chain performance in the real business world.

- To identify the contributing factors to forecast accuracy recognized in the real business world and the related good practices and issues.

- To discover the improvement enablers for forecast accuracy recognized in the real business world and the related good practices and issues.

3.3 Research Method and Design

3.3.1 Quantitative Research vs. Qualitative Research

In general, there are two major types of research methodologies currently being applied. The first is quantitative research and the second is qualitative research. A review on the definition and nature of qualitative research and quantitative research gives an overall comparison on their respective characters and applications. Statements and definitions on qualitative research and quantitative research are made from different angles. In terms of the purpose of the research, Cooper & Schindler (2011, p.160 -161) defined qualitative research as "aiming to achieve an in-depth understanding of a situation." while "quantitative research attempts precise measurement of something". By looking at the type of questions answered by research, Barbour (2008, p.31) believes that qualitative research asks different sorts of questions – "not those relating to outcomes or strengths of association, but questions about processes, understandings and beliefs." By explaining the techniques and method used for qualitative research, Flick (2007, p.2) states that "qualitative research uses text as empirical material (instead of numbers), starts from the notion of the social construction of realities under study, is interested in the perspectives of participants, in everyday practices and everyday knowledge referring to the issue under study". Cooper and Schindler (2011, Exhibit 7-2, p.163) have done a comprehensive review on the distinctions between qualitative and quantitative research, from which the main characteristics distinguishing the two types of research methods can be summarised in the

following aspects, i.e. cost and time, flexibility and possibility to be adjusted, researcher involvement and impact on researcher, insights and meaning, data security, sponsor benefit.

- ***Cost and Time – Depend on Sample Size and Methodology***

"Qualitative research normally uses a smaller sample size" (Cooper & Schindler, 2011, p.164), this means fewer participants are involved, the total time a researcher spends on interviews usually is less than the time spent with quantitative research methodologies such as conducting a survey which involves a large number of participants which is typically time consuming. The cost associated with a limited number of interviews is lower too. The end result however coming from the information gathered can be very efficient because it has come from participants who are highly relevant to the research topic, their expertise, experience and knowledge in the related area are providing concentrated, high value input for the research.

Quantitative research on the other hand will take much more time and cost (Flynn, Kakibara, Schroeder, Bates & Flynn, 1990, p.252). Surveys and questionnaires from a large sample base are required in order to achieve a convincing result. The time spent on facilitating a survey, collecting data, entering data into computer system and analysing the data is significant, at the same time, cost will increase because more man-hours are involved in all these activities as well as the IT support often needed to carry out the survey. Even before surveys and questionnaires are conducted, preparing the right questions to be asked is a time consuming process as well.

- ***Flexibility and Possibility to be Adjusted***

Methodologies used by qualitative research such as interviews and focus groups are of an inductive manner. The researcher leading the interview or focus group will have a pre-designed question structure in mind but they do not have a firm idea of what information and conclusion the interview will provide because the purpose of qualitative research is to find out a reason or a way of doing things, so the research will be directed to the final answer as the interview progresses. Sometimes, in this process they may be presented with

new ideas from a different angle that leads to changes of the pre-designed questions, or the "change of original focus as data is generated and preliminary analysis suggests a new or slightly shifted emphasis" (Barbour, 2008, p.30). The research can still continue with the new focus taking place and the researcher carrying on the interview by taking into consideration the adjusted focus, modifying the questions and discussions during the interview process to get more relevant information to support or assist with the conclusion.

Quantitative research however commences with its pre-set questionnaire or survey, and once it gets started, it has to go ahead with no chance or adjustment. It is non-reversible unless started again from the very beginning. So with quantitative research the flexibility and possibility to adjust during the course of the research is very limited. A researcher should be very careful with the design of the questionnaire as there is only one opportunity to collect all necessary data. It is not possible to withdraw halfway through a survey, and neither can they make any change along the way.

- ***Researcher Involvement and Impact on Researcher***

Qualitative research requires the researcher to be part of the interview, to organise it, conduct it, and even share their personal experience and story to get the participants to a comfortable position to openly discuss the questions. It requires a high level of competence from the researcher in regards to their knowledge in the area of the research topic, because only someone with considerable knowledge of the topic can conduct and manage the interview successfully. It also requires the researcher to demonstrate a high level of interpersonal and communication skills in the interview to maximise the amount of useful information from the participants without putting them under pressure or in a zone of discomfort. Such requirement will see the researcher being involved at the emotional level. It requires more personal effort and the information they obtain from the interviews will certainly impact them physically and mentally. "Researchers do report feelings of exhaustion and tiredness when undertaking research interviews, often feeling quite overwhelmed by the nature of the data." (Dickson-Swift, James, Kippen & Liamputtong, 2009, p.71).

Researchers doing quantitative research will not need to immerse themselves into the research to the extent a researcher doing qualitative research has to. They design the survey, and then they can conduct it from distance with limited or without direct contact with participants. Today, a lot of surveys are facilitated via computer and the internet, and often analysed by software as well, hence the minimum involvement of the researcher. Even when the survey is conducted face to face, the participants will actually deal with the survey, not feeding information directly to the researcher. So, quantitative research will have less researcher involvement and less impact on researcher at the personal level.

- ***Insights and Meanings***

The methodologies applied by qualitative research usually offer better insights of the research topic. For example, benefits of case studies include the ability to examine a topic in greater depth. "Researchers can focus on a specific topics and/or company(s), allowing a thorough examination of numerous factors and nuances. Case studies provide a richness of description and first hand observation of phenomena in a natural setting. Often case studies yield unintended insights, which can lead to new avenues of inquiry. The best case studies provide a foundation for further examination." (Boyer & Swink, 2008, p.340)

Similarly, interviews will yield more in depth understandings and comments on the research topic as well, because the participants are often possessing great expertise, are high in professional skills and knowledge, and rich in experience in the area that the topic is focusing on. They will not only just simply answer the question, but will more likely also provide more valuable information, suggestions and ideas which may lead the researcher to view the topic from a new or different angle, extend the focus or give a much deeper understanding of the topic. Types of interviews range from structured, semi-structured and unstructured (Edwards & Holland, 2013, p2), with structured interviews being the more quantitative type of approach and the semi and unstructured interviews being more typical qualitative approaches.

Quantitative research, limited by the research methods it adopts, which usually is a survey, will not give the researcher the opportunity to come into close contact with the participants to get the level of detail and the amount of information that qualitative research can offer.

The receipt of the information is through the survey, which is one-off, one way communication, and where once the question is answered, it is done. Both the researcher and the participant will not have a chance to clarify anything further, the researcher gets a simple answer from either a multiple choice question, or just a few simple words which are then later coded and analysed. In some circumstances, the participants may give an inappropriate answer due to misunderstanding of the question, or lack of knowledge etc. The quality of the data collected through a survey can be limited by the simple and unified answers. This is why quantitative research is often used to answer the more straight forward 'what' and 'when' questions and not the more complex 'why' and 'how' questions.

- ***Data Security***

Qualitative research usually requires a small sample size with fewer participants involved. The participants are often selected because each of them possesses highly concentrated information, expertise, experience and knowledge closely related to the research topic. Due to the close relationship between the participants and the research topic or the research area, they have a better sense of what is highly confidential/sensitive, the importance of maintaining confidentiality, and are willing to be responsible for the sponsor's privacy. The small number of participants also makes it easier to keep the research activities from being leaked to the public or competitors.

Quantitative research on the other hand is survey based which means a large number of participants are involved. The participants may come from different background and business areas, and have little sense of what level of confidentiality is required by the research topic. The large number of participants involved also makes it difficult to maintain a high level of data security, as leakage can happen easily at any stage. Furthermore, conducting the survey often goes out in a more public manner, which is frequently more easily noticed by outsiders and the competitors (Cooper and Schindler, 2011, p.163), thereby giving out signals of the intention or purpose of the research which can be then decoded by competitors on what the sponsor is doing, and raise alert or awareness for competitors to look at the same area soon after or take actions accordingly.

- ***Sponsor Benefit***

In qualitative research, the sponsor can have the opportunity to take part in the data collection process of the research; this will give the sponsor some significant benefits. The sponsor with his earlier involvement in the data collection can get the information and feedback in a real time manner, or at a time soon after the interviews take place. They can also get first hand data without any coding, conversion or interpretation; this avoids the misinterpretation of the data, and enables the sponsor to pick up some minor details of high interest and importance which otherwise might be overlooked by the researcher or the data processor. The sponsor may also want to discuss further a specific topic with some participants if they prefer, this gives the sponsor the freedom and flexibility to investigate certain issues or topics along the way. The sponsor can also ask for a change or modification of the research direction based on the information they get while the research is progressing, and therefore this may avert getting to the end of the research only realise the research has gone wrong in some way.

In quantitative research, the sponsor does not have the luxury of being involved during the data collection process; they have to wait until all data has been collected, analysed and interpreted. It also means once the research has started, there's no opportunity to change and any flexibility for the sponsor to do any modification is not possible at all.

3.3.2 Evaluation and Decision on the Method and Design for this Particular Research

Having reviewed and compared the advantages and disadvantages of the two types of research approaches, clearly there's no absolute good or bad choice. The right approach is decided by the choice of research topic and purpose. Furthermore, instead of taking a single research approach, it's often beneficial to use one research approach to compliment the other. "Although qualitative and quantitative research answers very different questions, researchers often have common interests in seeking to understand a particular phenomenon and the two approaches can be complementary" (Barbour, 2008, p.11).

With the already established objectives in mind, the purpose of this research is to evaluate the importance of forecast accuracy recognized in the real business world, and further, to

examine the contributing factors and improvement enablers identified in practice. The benefits and limitations of both research methodologies have been evaluated in the following paragraphs based on those points discussed in 3.3.1.

This research had time, cost and sample size limitations which would challenge achieving convincing conclusions from quantitative research alone. The researcher considered it only feasible to access a reasonable smaller sample size and therefore a better approach would be to have follow-up interviews using qualitative methods to compensate for the limited number of responses expected from the survey, as it provides the opportunity to explore some questions of interest in greater depth.

A semi-structured interview approach is taken for this research, being in between a fully structured interview and a totally unstructured interview, semi-structured interviews are more controllable for the researcher in this case. Pre-defined questions ensure the interview stay on the right track, while the semi-structured approach provides a focused interactional discussion with greater flexibilities to explore more ideas and to achieve the best coverage of the topics (Edwards & Holland, 2013, p3&29).

The interviews also allowed the researcher in this case to take advantage of her past working experience and study. Compared to a sole questionnaire approach, more involvement of the researcher in the interviews helped her to understand the topic effectively and to ask meaningful questions.

In terms of obtaining insights and meaning, the questionnaire is helpful to find out what is the current status or the recognition of the importance of forecast accuracy, what do the practitioners think are the contributing factors and improvement enablers, what are their views, and what the practices are. The follow-up interviews add value to the research by providing the opportunities to explore why certain views are held and how the practices are done. In this research, two methods together, completed a full picture for the objectives.

Data security is better controlled in this research as the questionnaire is only sent to targeted samples instead of publically. And in this students research, there was no sponsor involvement but rather the pure researchers involvement only, which again allows the researcher to constantly review questions and topics to be asked in the interviews to effectively capture more valuable information.

Concluded from above, a decision was made to take a combined approach. The research starts with a questionnaire, then followed up by a semi-structured interview to take advantage of the benefits of the two research methodologies and reduce the weakness and limitation of relying on just one approach.

3.4 Data Collection Methods

3.4.1 Sampling

In general sampling is classed in one of two types, the first is probability sampling and the second, non-probability sampling. With probability sampling, each sample has a non-zero probability of selection, usually the larger the sample size, the more convincing the result (Cooper and Schindler, 2011, p.373/374), however, it is often time and cost consuming to achieve the desired number. Non-probability sampling, on the other hand, takes a more subjective approach with more practical considerations. It allows more flexibility in choosing samples that are considered to better serve the research purpose and the time and cost budget (Cooper and Schindler, 2011, p.384/385). Because first of all the purpose of this research is not to draw any statistical conclusion but to explore views, opinions and practices relating to forecast accuracy in the real supply chain environment, and second, since this is a student research project with limited time, budget, experience, and ability to access a large number of potential candidates, non-probability sampling has therefore been selected as a more realistic option. Of the various non-probability sampling methods, judgement sampling (Cooper and Schindler, 2011, p. 385) is considered the most appropriate approach based on the following considerations. Firstly, it gives a higher response rate with limited time and budget. Secondly, by selecting well-known businesses, a high quality input is assured. Lastly, because a follow up telephone interview is targeted, these subjectively selected participants are chosen with this in mind, so more expertise and experienced input can be obtained through the in-depth interview. The targeted sample frame has then been decided to mainly focus on the New Zealand market, and the potential participants are defined as those working in the supply chain or similar functions in these businesses.

Sample size involving qualitative interviewing is a difficult question to answer (Marshall, Cardon, Poddar & Fontenot 2013, p11), as the focus is the process of data generation not

the numbers. It is recommended that the sample size is be determined by the nature and design of the study and to then build the sample as the research progresses (Edwards & Holland, 2013, p5&7, Trotter II, 2012, p399). As there is lack of guidelines as to the sample size in qualitative research, Marshall et al. (2013, p12) suggested that a reference to the sample size of similar research and peer views would be a good measurement. Nevertheless, some rough number guides are still given in this regard as quoted by Edwards and Holland (2013, p66) and Marshall et al. (2013, p21), i.e. a mean of 20 to 30 for masters theses, and 30 to 50 for grounded studies. It has also been proved that statistically a sample size of 30 or more will give a convincing result as it enables a close match to normal distribution (Saunders, Lewis & Thornhill, 2009, p218). In this research, bearing these guidelines in mind, similar researches have been consulted and the view from the supervising professor has been obtained, the sample size is hence decided to be around 30-35.

The number of final interviewees is determined by the willingness of the participants completing the questionnaire, as the interview is directly related to the questionnaire and is intended to obtain more information on those topics. At the questionnaire stage a reasonable and achievable number of participants have been selected based on professional network in order to secure a good number of participants who are willing to complete a follow-up interview to provide sufficient information for the research topics. It must be acknowledged that it is challenging to obtain all of the desired participants and their inputs given this is a student research with limited budget, time and experience. The final sample result is considered acceptable given there are total 36 questionnaire responses received with 35 fully completed and one partially completed. Among those, 14 respondents agreed to participate in the follow-up interview.

3.4.2 Questionnaire

Research questions identify things the researcher wants to understand and they need to begin with certain goals and based on substantial experience and theoretical knowledge (Maxwell, 2013, p73&77). This questionnaire is developed based on the literature review completed which studied supply chain forecasting and forecast literature in general. The

importance of forecast accuracy, the contributing factors and the improvement enablers to forecast accuracy are summarised and concluded from these academic studies and research. The goal of this research is to investigate the practice in the real business world, and then compare those with the academic studies, to identify gaps between these two sides and generate meaningful research topics to the researches, while on the other hand to convey the research findings and suggestions to the real business world to realize their value. The research starts with a questionnaire comprising relevant questions.

The questionnaire is divided into three parts. The first part contains general questions about the sector of the business, size of the business, the development of supply chain management function, business focus on forecast accuracy, and, the perceived impact of forecast accuracy and the related measurements. The purpose of these questions is to understand the current development of supply chain management and focus on forecast accuracy in the real business world, and to get a view from the practitioners on what are the impacts and what kind of associated measurements have been or will be set-up. The second part of the questionnaire focused on the contributing factors. Questions were asked on what are the contributing factors recognized by these practitioners, and if they hold the same view as the related literature. For each of the factors, questions were specifically designed to examine the opinions and practices held in the real business world. The third part of the questionnaire was all about the improvement enablers; similar to second part, questions were raised based on literature review findings aiming to capture the views and practices held in practice.

To best capture the responses and effectively obtain the most meaningful input, the questions were designed in different forms including single choice, multiple choice, rating, grading, weighing, and filling blanks. Many questions were given open-ended options for the participants to add their comments and describe their specific practices. In this regard, this survey is not a simple quantitative research questionnaire any more, with a considerable number of open-ended questions to capture ‘words’, it is already incorporating qualitative methodologies.

To accompany the questionnaire, a cover letter was presented to each participant taking the survey. The cover letter introduced the background and purpose of the research, explained the value and potential benefits of this research, and the reason for choosing the participant.

Both the draft questionnaire and the cover letter have been reviewed by the supervising professor for error proofing purposes, suggestions and recommendations were given to improve the clarify of both. Adjustment were applied accordingly before the final version of questionnaire and cover letter were sent out.

3.4.3 Interview Questions

Interview questions collect the data a researcher needs to understand the topics (Maxwell, 2013, p77). In this research, interview questions were aimed to obtain wider and deeper information on the research topics to achieve a better understating of those subjects, it was also taken as an opportunity to obtain clarification on some of the answers to the open-ended questions in the previous questionnaire. The semi-structured interview has a prepared list of possible questions relate to each of the questions in the questionnaire, but not all questions were asked to each individual interviewee. What to ask is determined based on the interviewee's response to the questionnaire, then interview questions are selected and adjusted accordingly in order to get a deeper understanding of the particular questions, or to obtain more information and clarification on those topics.

3.5 Data Collection Process

The potential candidates for the questionnaire were contacted via e-mail to obtain their agreement to participate in the survey. Once agreed, a formal e-mail was sent with a cover letter and the link to the on-line survey. The cover letter explains the background and purpose of this research, as well as the value and the potential benefits. Assurance on confidentiality concerns was given in the letter as well. For further communication, the researcher and the supervisors contact details were provided.

Most of the surveys were facilitated via the on-line survey tool. The web-based questionnaire is chosen for its ease of use, low cost involvement and high efficiency (Cooper and Schindler, 2011, p.254). There were three participants who asked to examine the questions first before deciding if they want to participate, so draft questionnaire were sent via e-mail for this purpose. After viewing the questionnaire, they were all comfortable in

taking part in the survey and without asking for the on-line survey link they chose to fill in the questionnaire straight away and send back via e-mail. These three inputs were later fed into the survey tool by the researcher herself in order to host all information in one place for easy review and analysis later.

The interviews were taken mainly via telephone conversation. Though, audio recording was considered initially as it has become standard recently (Edwards & Holland, 2013, p69), however, due to technical concerns as well as a cautious consideration not to further stress the interviewees, it was eventually decided to record these interviews by hand written notes. Lack of face to face contact in telephone interviews is sometimes seen as a disadvantage of not being able to fully observe the participants' emotion, non-verbal communication and physical expression. However, other studies also proved it can be an advantage in terms of obtaining greater articulation from both the researcher and the participant in the exchange (Edwards & Holland, 2013, p48). Telephone interviews do provide the convenience of overcoming the geographical distance barriers and time constraints as both were major concerns in this research.

In regards to the steps of starting an interview as recommended by Edwards and Holland (2013, p71), the interview begins with an introduction of the research background and the purpose of the research, followed by reassurance of the business confidentiality concerns, then a verbal consent is obtained. The first few interview questions are focused on the clarification of general information, after that, the interview gradually goes through detailed questions on importance of forecast accuracy, the measurements of the impacts, and the contributing factors and improvement enablers for supply chain forecast accuracy. Interviewees are given opportunities to ask and clarify questions at any stage of the interview as well as before the interview finished. Finally, the interviewee was thanked again at the end of the interview and any questions they asked have been answered with best attempts. Each interview took 20-30 minutes in general.

3.6 Data Analysis Methods

Data is the foundation of any research, without data, research cannot stand. However, raw data often does not reveal anything meaningful without proper analysis. "Before

quantitative data has been processed and analysed, it conveys very little meaning to most people" (Sounders et al., 2009, p.414). "It is difficult, if not impossible, to draw conclusions from empirical data and to generalize them, without the assistance of statistical evidence." (Flynn et al., 1990, p.264). There are various types of data as well as the method used to analyse it. Properly chosen methods of data analysis will turn the raw data rightly into meaningful findings and conclusions. In the recent years, the gap between qualitative and quantitative research has been narrowing and a combined qualitative and quantitative research approach is drawing more attention and interests as the two complement each other to produce a more accurate and reliable result (Trotter II, 2012, p398). "The strength and the value of this mixed methods approach is that it provides researchers with a broader set of analysis and a more substantial way of data interpretation. Qualitative data collection, combined with quantitative data analysis will lead to potentially more robust results." (Muskat, Blackman & Muskat, 2012, P.18). In this analysis, several data analysis methods were used to assist with the combined research approach. The researcher started with quantitative data analysis, then used qualitative analysis methods to further supplement and examine the findings. The combined data analysis methods ensured more reliable and valid findings and conclusions for this research.

3.6.1 Quantitative Research Data Analysis

Generally quantitative research data can be defined into categorical data and numerical data. Categorical data can then be further categorised into descriptive or nominal data and ranked or ordinal data. Numerical data can also be further categorised into continuous data and discrete data. For different types of data, different analysis methods will be applied. Furthermore, every research has a purpose; it can be identifying the trend, the frequency distribution, the proportion, the percentage, or the relationships etc. To best serve a particular research purpose, the most appropriate analysis method should be identified.

Once the data types have been determined and the purpose of research has been thoroughly considered, the next step is to do an exploratory data analysis. In short, it's called EDA. As the name suggests, the EDA is to turn boring looking and seemingly meaningless data into easy to read graphs or tables. It will give the researcher the

opportunity and the starting point to explore the data from different angles, do all sorts of rational comparisons, look for trends and relations of the data and even find out new pathways to unexpected findings or topics. It leads the researcher to further discoveries and deeper understanding of the data, and assists with further more complex analysis that will focus on more specific points, and eventually helps the researcher to reach the desired findings. The EDA can be presented in different forms such as, diagrams, charts, line graphs, and pie charts etc.

A popular and convenient tool for doing EDA is Excel. "The tools available in Excel include sorting, auto filtering, custom filtering, targeted data identification and corresponding record selection, and consolidating data from multiple work sheets. All of these represent core skills for exploratory data analyses" (Palocsay, Markham & Markham 2010, p.194). Using Excel is a convenient and cost effective way to do analysis, which also means the method and the result can be easily communicated to and received by the audience as they are more likely to be familiar with Excel.

The first part of this research is a questionnaire. Most information captured is quantitative data. The purpose of the research is to explore the recognition of the importance of forecast accuracy in practice, the contributing factors and the improvement enablers considered by practitioners, while at the same time, identify good practices and concerned issues. By considering the data type and the research purpose, the exploratory data analysis is deemed appropriate and sufficient. Excel has been chosen as the main data analysis tool because of the convenience and effectiveness it provides.

There are different types of Excel tools and graphs that can be used for EDA. In the analysis for this particular research, tools, tables and graphs have been selected and utilized according to their features and advantages.

First of all, a pivot table was created, which allows flexible ways of viewing and comparing data for multiple or large number of variables and cases. The researcher was then able to manipulate the display of the data to explore all kinds of possible comparisons and relations based on her preferences and assumptions. The items can also then be dragged into columns or rows to create the most meaningful display. Once the relevant data sets have

been selected for a certain topic, it could then be turned into tables and graphs for further analysis and display.

A simple Excel spreadsheet can be used for all data types to make the reading of data easy and straight forward in a structured manner. In the analysis for this research, it was used to present information such as the titles of each participant for a straightforward display of the wide coverage of their responsibilities and expertise; or to list the different opinions on a certain topic such as the ratings for data providers credibility; and for the usage of different means of information sharing.

Bar charts can be used for presenting categorical data as well as discrete data for one variable to show the range of values, how it's spread out, and the trends. Using more complex analytical methods, a multiple bar chart will work for multiple variables for the similar purpose. Stacked bar charts will show the total of all variables within the same category. In this analysis process, simple bar charts were often utilized to display the findings such as the spread of the participants' opinions, or the weighted rankings etc.

Line graphs can be used for all types of data to show trend or to compare trends and conjunctions when there are more than one variable. In this analysis, line charts were used to illustrate the gap between the status of recognition of impacts and the status that actual action taken to put measurements in place to monitor those impacts.

Pie charts can be used for the same data types and purpose as bar chart; the advantage is the pie chart also shows clearly the proportion or percentage of each category of the variable. In this analysis, pie charts were widely used to demonstrate the proportion or percentage of the findings.

There are further tools and features in Excel such as the frequency table, histogram, scatter graph, plot, radar, polygon, surface donuts, bubble etc. However, the previously mentioned tables and charts are found sufficient for the analysis in this research based on the data types and the purpose. More advanced statistical analysis software and tools have not been considered in this analysis either as no necessity has been perceived.

3.6.2 Qualitative Research Data Analysis

Qualitative data is in the format of words not numbers or categories, so this is difficult to be categorised or grouped. Statistic methods used for quantitative data are of no use processing such data types. Qualitative data analysis is a complex process, "particularly when large volumes of research evidence is gathered and when the researcher is new" (Carcary, M. 2011, p.10). Qualitative data analysis is done manually in most cases, especially in the past, however nowadays, CAQDAS is developed to help the researcher through the use of computer analysis.

There are usually three types of data analysis used for qualitative data; summarising data, categorising data and structuring data, and two approaches which are deductive and inductive (Saunders et al., 2009, p491-493).

Summarising data is to make the large qualitative words data pool into some concentrated meanings. This is better utilised for the inductive approach where in the process of summarising, the conclusion will emerge at some stage and become more clear and definite as the process goes further and deeper.

Categorising data is to group data into categories. During this process, categories containing more frequently appearing elements will become the focal point as the process progresses and finally a conclusion is drawn for an inductive approach. Or, the merging of the major categories will explain or confirm the hypothesis for a deductive approach. Categorising data can also be done in layers, that is to say, the first round categories may contain fairly large items which may be not clear enough to make conclusion or show the trends, and these categories can then be grouped for a second round to fewer but more generic categories and there may be more rounds until the picture has become clear.

Structuring data is to follow the participants' stories or comments from the interview and extracting the skeleton by narrating the story. The structured data can be then used deductively to support the hypothesis or inductively to reach a conclusion.

In this analysis, the comments from the open-ended questions together with the information obtained from the interviews were mainly analysed using the summarising approach complemented by the categorizing and structuring methods. In the situation where a complex explanation or description was given through interview, the information

was first structured by narrating to form bulletin points, then categorized together with all other information into different groups. Finally, information from the same group was summarised to compose the findings.

Chapter 4 - Survey Results and Discussion

4.1 Introduction

The survey results and the interview findings are displayed, analysed and discussed in this chapter. It starts with the general information of the participants and the companies they represent, followed by assessment on the current status of supply chain management and its focus on forecast accuracy. Then it goes on to investigate in reality what are the impacts forecast accuracy has on each individual aspect of supply chain performance as well as the overall supply chain performance; the status of measurement set-up and the actual application of these measurements. The next section is focused on the contributing factors to forecast accuracy from the practical point of view. Each factor is analysed and discussed separately in a sequence from most important to least important based on the rankings obtained from the survey results. After this, the improvement enablers based on views and opinions from the survey and interviews are discussed in depth, again from the real business point of view. Lastly, is a section that summarises the findings captured in the interviews that are beyond the coverage of the survey questions which were designed based on literature review, these findings will help to compose a more complete picture of this study.

4.2 General Information of the Participants and the Companies they Represent

4.2.1 The Participants

There were a total of 36 questionnaire submissions received, among those, 35 fully completed and one partially completed. Further to this, 14 follow-up interviews have been completed to gain in depth views on various aspects based on the related survey response. All the analysis and discussions following in this chapter is based on these responses. The partially completed questionnaire does have the first 25 questions completed, so these valid answers have been utilized for individual analysis on those questions.

Questionnaire Completion Status	Total
Complete	35
Partial	1
Grand Total	**36**

Table 4.1 Questionnaire Completion Status

All participants are from the supply chain function or similar functions such as operations and logistics of their business. Their responsibilities range from director or vice president of supply chain at the senior level down through the planners and specialists at the tactical and operational levels.

Nearly half (17, 47%) of the participants are holding manager titles and covering a wide range of functions within supply chain, such as logistics, procurement, purchasing, optimisation, customer service, operations, planning and distribution, which all have involvement in the forecasting process. Sitting at the middle management level, these managers have a good understanding of the supply chain processes and activities from the tactical point of view, at the same time, integrating strategic guidelines and long term plans, as well as having sound awareness of the operational obstacles and issues. With this good coverage of the supply chain functions and comprehensive experience and expertise, input from this level of management provides solid insights for the objectives of this research.

The rest participants are from three groups, i.e. the director, vice president and head of supply chain (5, 14%), general managers of supply chain (6, 17%), planners and specialist (5, 14%). The participants' percentage of these three groups are similar.

The director, vice president and head of supply chain group and the general manager group provide input from the senior management level, with strategic views, guidelines and long term plans in mind, their contribution give this research a dimension at the strategic level, especially when commenting on the improvement enablers of forecast accuracy questions such as S&OP process, supply chain design and redesign, system investment, new business objectives, motivation schemes etc.

The planner and specialists group on the other hand, add a dimension from both the tactical and operational angles. Being the first hand executors and practitioners of the forecasting

and planning process, as well as the systems and tools, they provide detailed views on the obstacles and issues, as well as best practices.

There were two participants that did not input there position title when completing the questionnaire, their titles however were found through e-mail communication and added to the data base for analysis purpose. There were another three participants that did not specifically advise their business titles but did however indicate they were from the supply chain department, and through further review of their inputs, it appears that they are most likely from the planning group within their respective businesses. In the following analysis and discussion in this chapter, their input will be treated as if it is from this group where comparison between groups required.

In summary, there is a good spread and coverage of expertise throughout the whole supply chain network, consequently this has ensured a high quality input for this research.

Figure 4.1 is based on 'cleansed' summarised data, as the original titles have a variety of slightly different names. For ease of reference, a list of the original titles is also provided below (Table 4.2).

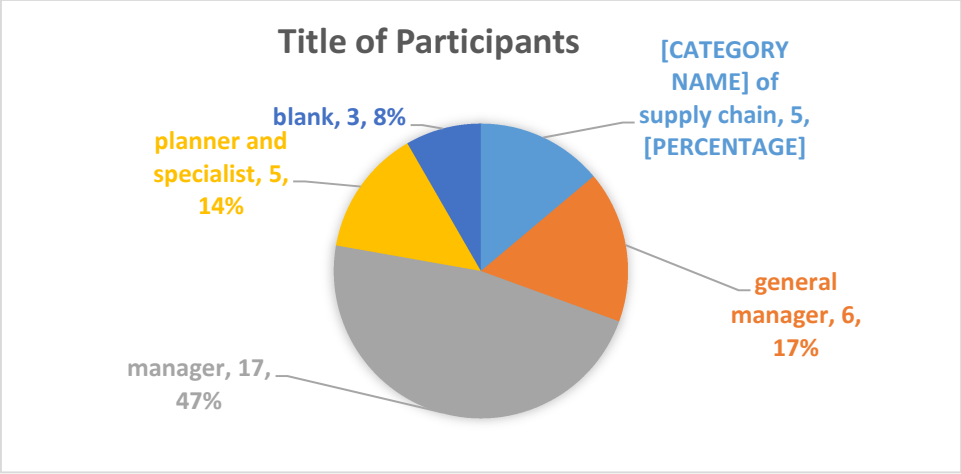

Figure 4.1 Titles of Participants

Title	Total
Blank	2
Commercial Operations	1
Customer Service and Operations Manager	1
Demand and Product Specialist	1
Demand Planner	1
Distribution Manager	1
Director	1
General Manager Manufacturing & Supply Chain	1
General Manager Supply Chain	1
General Manager Supply Chain	2
Head of Supply Chain	2
International Logistics Manager	1
Logistics Procurement Manager	1
Manager - Planning & Customer Services	1
National Supply Chain Manager	1
Operations Manager	1
Production / S&OP Planner	1
Purchasing Manager	1
Regional Optimisation Manager	1
Supply Chain & Distribution Manager	1
Supply Chain Department	2
Supply Chain Director	2
Supply Chain Manager	6
Tactical Distribution Planner	1
Tactical Logistics Planner	1
Vice President Supply Chain	1
Grand Total	**36**

Table 4.2 Titles of Participants

4.2.2 Companies Segmentation by Activities in the Supply Chain

The question 'where in the supply chain are you?' was asked to find out which part of the supply chain each company belongs to. Four major supply chain segments are provided as options, i.e. manufacturing, distribution and wholesale, service, and retail. And an 'other' option is given for participants to specify their position where they do not belong to one of the four given options. Seven participants have chosen 'other' and specified their position, among those, three are indicating cross segmentation supply chain activities. While the other four appear to have misunderstood the question by answering based on their personal roles as logistics, planning, sales and operation and supply chain (table 4.3).

Based on the majority of valid answers, the analysis result still provides a good indication of company segmentation by activity in the supply chain. As per figure 4.2, 17 (47%) companies are from manufacturing, and 9 (25%) from distribution and wholesale. Collectively these form the main portion of respondents, with a further 2 (6%) from retail and 1 (3%) from the service segment adding the extra dimension for sample completeness. The spread of the activities reflected from this survey result corresponds well to what had been previously observed in the literature. As such, findings from this research are seemingly consistent with past research and as such should be viewed as reliable and convincing.

Table 4.3 shows the response count in numbers, and table shows the answers specified when the 'other' option was chosen.

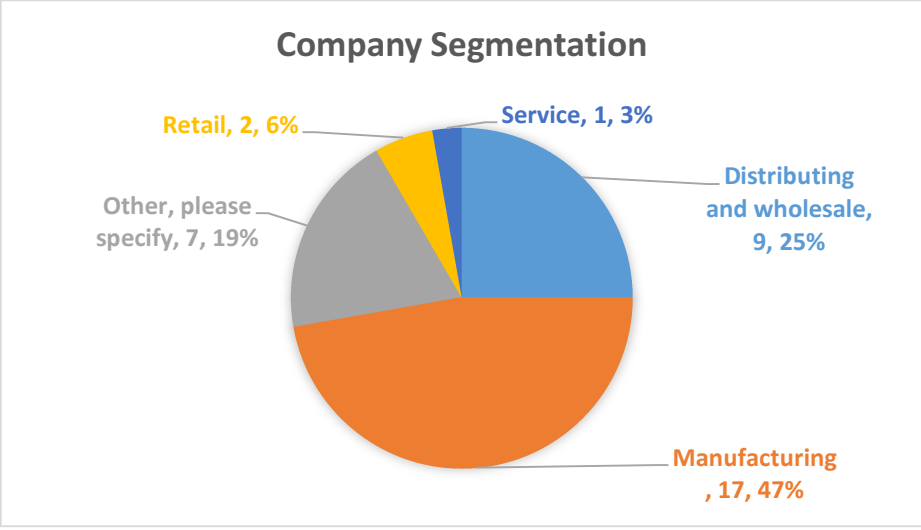

Figure 4.2 Company Segmentation

Other, please specify: (Where in the supply chain are you?)	Total
All of the above four areas fall under my responsibilities	1
Both manufacturing and distributing	1
Distributing, wholesale and service	1
Logistics	1
Planning	1
Sales and Operations	1
Supply chain	1
Grand Total	**7**

Table 4.3 Other Segments

4.2.3 Companies by Industry and Country

Participants were asked to identify their companies by industry, with four major industries to choose from and an 'other' option to specify if none of the four given options suited. Based on individual judgement, some people from the same company have chosen different categories. One example is participants from the same dairy company have chosen Agriculture and Others (Dairy) respectively. In this situation, they have been grouped into the Agriculture sector. Another case is where two people from the same information and communication technology company have chosen energy sector for some reason, this has been rectified after verifying the same via the company's official website. Figure 4.3 and table 4.4 below show the results after these reconciliations.

Results show that major industry have been well covered with 11 (31%) from agriculture, horticulture and forestry sector, 8 (22%) from FMCG, 7 (20%) from information communication and technology, 3 (8%) from pharmaceutical and 7 (19%) from other sectors.

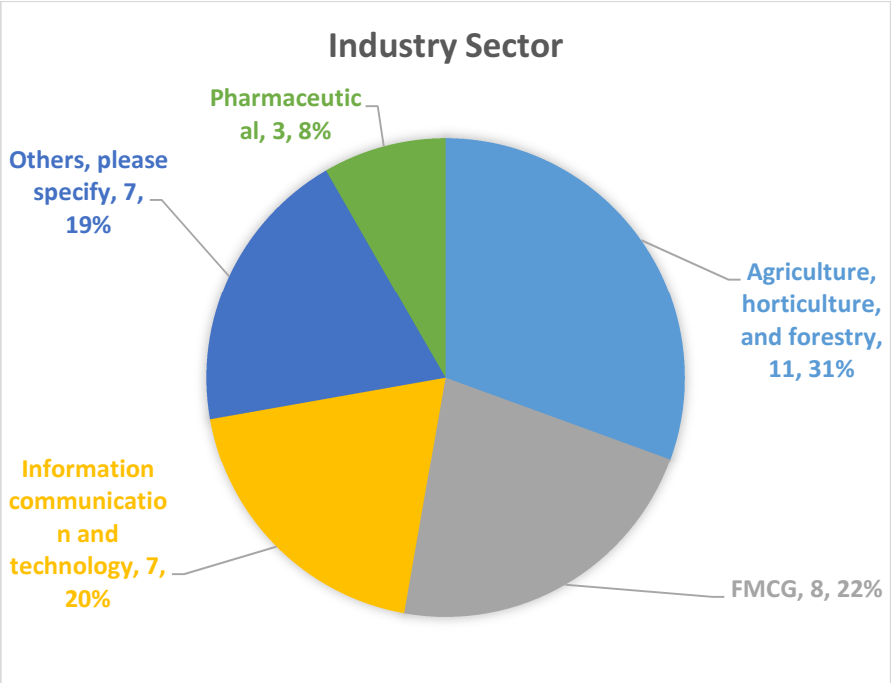

Figure 4.3 Industry Sector

Others	Total
Apparel	1
Automotive	1
Chemical Manufacturer	1
Commodity, Raw materials	1
Print and Media Communications	1
Retail	1
Steel	1
Grand Total	**7**

Table 4.4 Other Industry Sectors

Participating companies are mainly from New Zealand (31), with another two from South Africa and three from China (table 4.5). Consequently, the results and findings from this research are mainly New Zealand focused which also means that this is a limitation of this research.

Country	Total
China	3
New Zealand	31
South Africa	2
Grand Total	**36**

Table 4.5 Company Location

4.2.4 Company Size by Annual Turnover

The survey result has shown that all 36 companies have an average annual turnover above $10 million (table 4.6). Referring to all industry benchmarks 2011-2012 (www.ird.govt.nz, 2014) from IRD and Statistics NZ, all companies are classified as large businesses by annual turnover, consequently, the results and findings in this research are large business focused, which again on one hand, may also be considered a limitation of this research.

What is your average annual turnover?	Total
>$10million	36
Grand Total	**36**

Table 4.6 Company Average Annual Turnover

4.2.5 Establishment and Status of Supply Chain Management

Out of 36 companies, 34 have defined supply chain management functions established, forming a very high 94% of the sample surveyed (figure 4.4). This result is a strong indication that the supply chain and supply chain management have been widely recognised as a vital part of a business's management and development, echoing the high focus and interests supply chain and supply chain management received in the research and literature field through the last two decades.

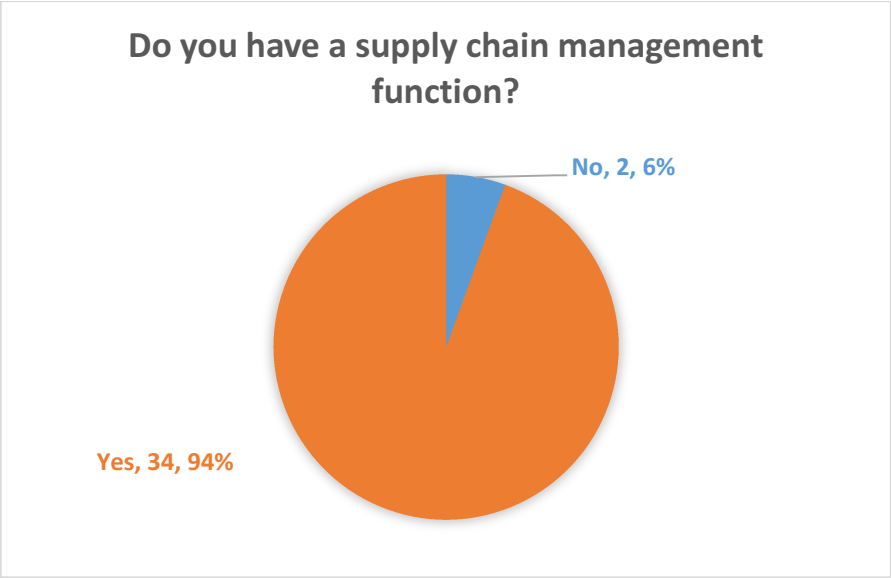

Figure 4.4 Establishment of Supply Chain Management

The companies that answered 'yes' to having a supply chain management function were then asked to advise when the supply chain management function was established. Referring to results in figure 4.5, there is one early pioneer that had set up supply chain management in 1980. This company is a world leading chemical company. Another 2 were set up in the period of 1990-1999, and of these two, one company again is a world leading confectionary and food company, the other one is a leading pharmaceutical company in Oceania. Though not a statistically strong evidence due to the limitation of sample size of this research, these three examples do indicate a positive link between company development and performance and the use of supply chain management, i.e. a high performing leading business always has a strong focus on the supply chain and supply chain management. However, it must be pointed out that the opposite cannot be proved in this analysis. The majority of the companies set up their supply chain management in the last 15 years since 2000, consisting of 76% of the sample total. This is again in line with the literature which highlighted that the most rapid growth and development of supply chain management has happened in the last two decades.

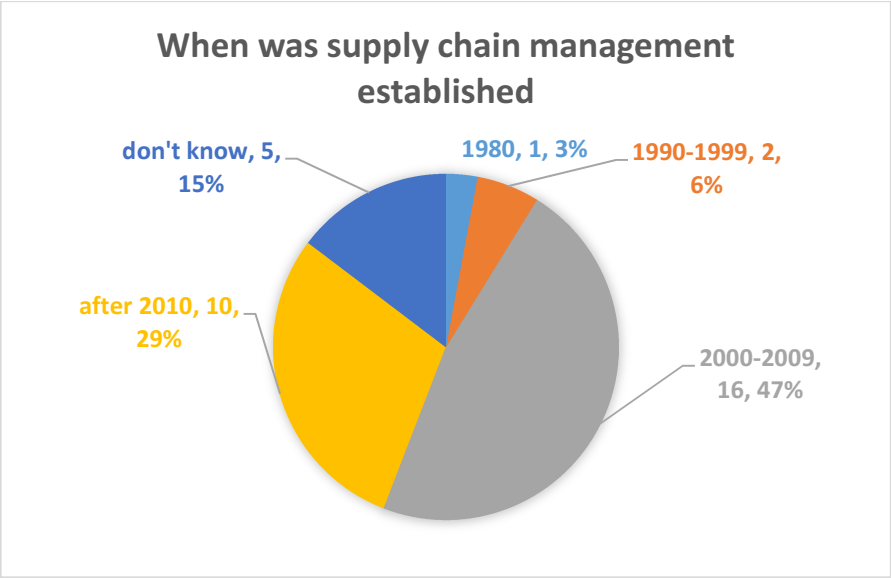

Figure 4.5 Time of Establishment of Supply Chain Management

4.2.6 Focus on Supply Chain Forecast Accuracy

Out of 36 companies, 32 (89%) indicated yes, they do have a focus on supply chain forecasting and forecast accuracy. It is an encouraging sign that the majority of the supply chains do have a focus on forecast accuracy. This is again echoing what has been previously identified in this research field. Of the 4 who responded with a 'no' answer, further detailed analysis has identified that, two were from the same company with the other two who have chosen the yes answer. Since the two participants giving a 'no' answer have also participated in the follow up telephone interview after their questionnaire completion, a further review of their interview responses has been carried out in order to find out the reason. It was noticed that both are from the planner and specialist group of participants, sitting at the tactical and operational level of the business and being the executers and practitioners of the forecasting process and systems, they have both complained about lack of focus on forecast accuracy from the company in terms of acknowledging issues and taking sufficient actions. The two participants who chose 'yes' answers are one from management level of the same company and one also from the same planner and specialist group as the other two with 'no' answers. A review on the company background information has revealed that this is a complex massively sized business which has continuously gone through dramatic changes and development in the last 10-15 years. Considering the company situation, the conflicting answers from different people in the same company can

be seen as a result of the constant change, which has led to the inconsistency in the management focus as well as the execution of strategy and operation management, especially within supply chain management. It is then easy to conclude that without effective supply chain management, forecast and forecast accuracy cannot obtain the required focus. It is also interesting to find out that one of the four 'no' answer was from the leading chemical company who was a pioneer in establishing supply chain management among all participating companies in this research. Without further verification of this answer, no conclusion can be drawn.

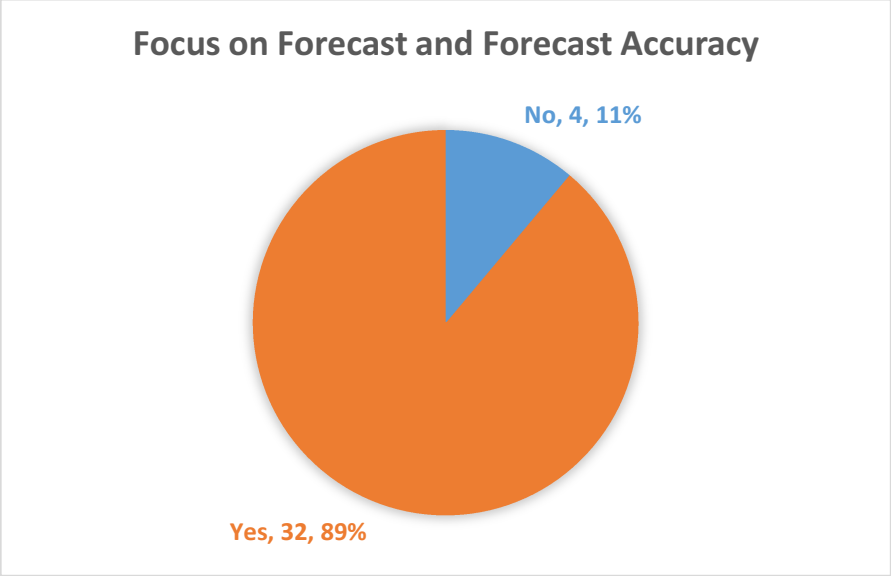

Figure 4.6 Focus on Forecast and Forecast Accuracy

4.3 Importance of Forecast Accuracy and its Impact on Supply Chain Performance

4.3.1 The Impacts of Forecast Accuracy on Supply Chain Performance

To find out what impacts forecast accuracy has on supply chain performance, participants were given 5 multiple choice options including production decision, pricing decision, inventory status, overall supply chain performance and others to provide their views. The findings are displayed in figure 4.7.

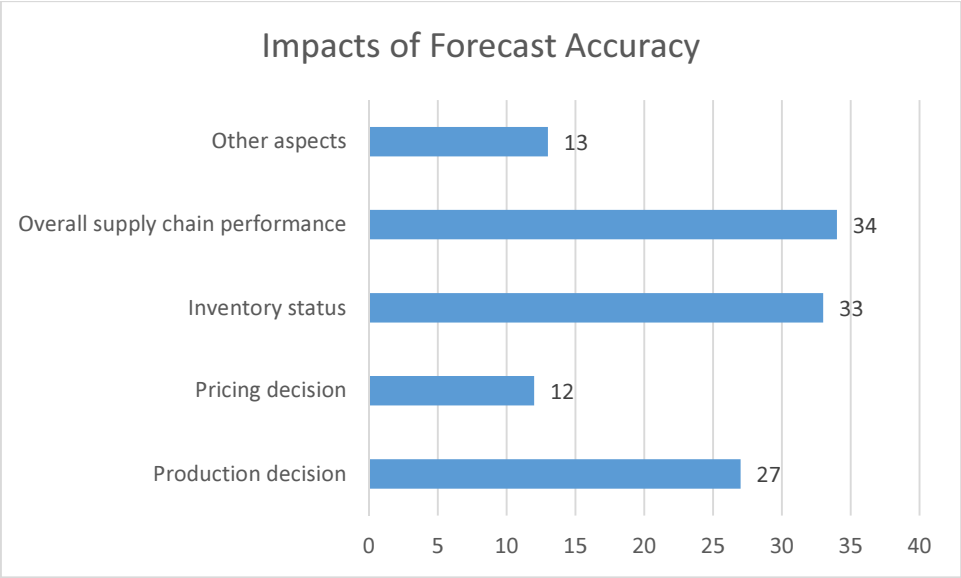

Figure 4.7 Impacts of Forecast Accuracy on Supply Chain Performance

- **Impacts on Production Decision**

27 (75%) participants agreed that forecast accuracy has an impact on production decision. Interviews have revealed such impact from different angles.

  - **What to Make**

Inaccurate forecast results in wrong products being made, which consequently increases the risk of not meeting the customers demand with the right product of the right amount at the right place and right time. Inaccurate forecast also causes longer lead time for the right product demand to be fulfilled due to the wrong production decision being made.

  - **Product Mix**

The forecast also impacts the product mix decisions where each product has different profit margins. A high quality forecast will ensure the most optimised product mix being made which then typically leads to higher sales. One participant from a 24/7 nonstop operating manufacturing business has made the following statement, “with the manufacturing running at full capacity, and the business selling what they make, i.e. a push supply chain, forecasting plays a crucial role in deciding what to make and when to make it to be most profitable, and how to prioritise between markets with different profit margins”.

- **Production Schedule and Capacity**

For supply chains of a manufacturing nature, good forecasts have supported operating a much tighter production schedule, which means higher utilization, lower waste and shorter lead times. For supply chains with manufacturing suppliers, poor quality forecasts was said to have impacted the suppliers' manufacturing capacity. However, in cases where the suppliers do their own forecasts, the core business supply chain does not have a concern of the forecast accuracy's impact on the manufacturer's production decision and planning, but rather is more concerned about having the right production in stock, on time and at the right level. This does appear to be a more localised approach which may need to be reviewed bearing in mind the global interest in the whole supply chain network. Collaboration and partnership can be beneficial in such circumstances and will be discussed later in section 4.6.

- **Impacts on Pricing Decision**

12 (33%) participants admitted forecast accuracy impacts pricing decisions, however, this appears to be a business sensitive topic that one interviewee clearly advised that he would not provide detailed information on this, while other interviewees avoided discussion in this regard.

- **Impacts on Inventory Status**

33 (92%) participants believed forecast accuracy impacts inventory status. This is the highest ratio of consistency in the opinion on the impact of one single aspect of the supply chain. The result clearly indicates that inventory status is a focus of supply chain management, and forecast accuracy is commonly recognized as a key factor that influences the inventory status in a very tangible way. Further analysis on the measurement of such impact will be discussed in section 4.3.2 which can be seen as an evidence of such tangibility.

The impacts that forecast accuracy has on inventory was also one of the most commented on areas in the interviews. Interviewees have given explanation from different angles based on their business nature and their expertise.

- **Finished Goods Inventory and Raw Materials Inventory**

The impacts on finished goods inventory as well as raw materials inventory have been referred to by many of the participants from businesses with a manufacturing nature. Inaccurate forecasts first cause wrong production planning with the wrong type, and volume at the wrong time, which lead to incorrect stocking of finished goods inventory and raw materials, resulting in either shortage or excess status. Good forecasts however are believed to reduce raw material levels as well as finished goods inventory levels directly.

- **Safety Stock Level**

One participant from the agriculture sector stated that poor forecasts cause increases in safety stock levels. Bigger buffers have to be introduced to ensure product availability to meet customer demand. Another participant from the wholesale and distributing FMCG sector seconded the same, commenting that more accurate forecasts make small batch sizing achievable, and reduces both out of stock frequency as well as the need to expedite orders.

- **Aged Stock Level**

Aged stock level is also said to be impacted by the level of forecast accuracy. This is especially evident in businesses where the products have limited life spans.

- **Impacts on Other Aspects of Supply Chain Performance**

Apart from the impacts forecast accuracy have on the above three major aspects of supply chain performance, which have been extensively discussed in related literature, there are a few other aspects impacted by forecast accuracy observed in the questionnaire responses as well as the interviews. They are summarised in the following paragraphs.

- **Procurement and Sourcing**

Inaccurate forecasts have considerable negative impact on procurement and sourcing as commented by some participants. Procurement and sourcing is actually an important component of supply chain management, procurement supports the production activities as well as other activities such as inventory storage, and delivery processes involving logistics services. Poor quality forecasts put pressure on the procurement and sourcing process. For

materials with longer lead times, the impact was found to be more significant, and the risk is higher on not being able to carry out the production activities in time to provide the right product with the right amount at the right time and place to fulfil the customer's demand. At the same time, such situations were found to raise procurement cost, which sometimes can be considerable.

- **Freight and Delivery Planning**

This issue was raised by a printing service company. The participant referred to a situation where large peaks strike without proper forecasts, even though the business can cope with the spike in terms of production capacity, however, obtaining adequate freight to deliver the product in full and on time poses a big challenge. As the capacity in the freight market is relatively fixed during a certain period, extra capacity cannot be introduced within a short period of time due to the nature of the market, where increasing capacity requires long term high value investment in assets such as trucks, train, containers, planes and ships, it takes a considerable long lead time and tangible long term demand to acquire extra capacity.

- **Sales Contractual Obligation and Product Promotion**

One participant has mentioned the impact on sales contractual obligations as a result of inaccurate forecasts, and another company raised the issue where inaccurate forecasts made meeting product promotional schedules challenging.

- **Impacts on Overall Supply Chain Performance**

34 (94%) participants admitted forecast accuracy has an impact on the overall supply chain performance. Such uniformed answers are strongly indicating the importance of forecast accuracy, reflecting a high level of recognition of the critical role forecasting is playing in the supply chain management practice. And 29 of these 34 participants have also agreed that forecast accuracy has impacts on more than one of the three individual aspects, i.e. production decision, pricing decision and inventory status, with inventory status (62%) being the most identified element and pricing decision the least mentioned (5%).

Interview responses have given a good insight of how forecast accuracy impacts overall supply chain performance. It is often explained by what negative impact happens as a result of bad or inaccurate forecasts.

- **The Starting Point**

Considered the starting point of major supply chain activities such as production planning, procurement, manufacturing capacity and scheduling, bad forecasts have a significant impact on all downstream activities by putting pressure on some or all of them. One participant concluded that if forecast is wrong, then everything is wrong. The same is emphasised by another participant from a forecast driven supply chain, claiming that the forecast is the key driver for all other activities, thus a wrong forecast has a negative impact on all the related supply chain activities.

- **Service Level**

Service level has been commonly considered one of the key indicators of overall supply chain performance and as the ultimate goal of a supply chain is to deliver the right product of the right amount to the right place at the right time for the customer. Inaccurate forecasts lead to wrong inventory levels of finished goods and raw materials; puts pressure on production capacity and scheduling; results in wrong products being produced at the wrong time, and even with the wrong volume. Another impact of inaccurate forecasts is the longer lead time required to react to customer's actual demand with the right product and right volume. All of these negative impacts have the same consequence, providing poor service levels to the customer, which is quoted by the participants as 'inability to serve the customer', 'not being able to meet the customer's demand', 'poor order fulfilment performance'. Not surprisingly good quality forecasts have been constantly related to a high order fulfilment performance with a reliable delivery consistency, and increased customer satisfaction level.

- **Cost**

Cost is another performance indicator for supply chain management as stated by several companies. It is an indirect result caused by inaccurate forecasts, i.e. of all the impacts inaccurate forecasts bring about, an increase or waste on cost which is the end result behind the scene. Excess of inventory of finished goods or raw materials means an excess of

working capital tied up unnecessarily, locked investment also increasing the cash to cash cycle. More expediting of orders drives higher production cost as well as more expensive delivery service. Also, as a result of inaccurate forecasts, product unavailability means a business is not able to meet customer demand, consequently they lose and waste opportunities which in the end is a cost or loss of profit to the business.

- **Profit**

Set aside non-profitable organisations, profit is usually the goal of a business and supply chain performance contributes to this goal in a significant way. Product mix optimisation and sales optimisation have been mentioned by businesses that are impacted by forecast accuracy. Forecasts with high accuracy can positively contribute to the optimisation process thereby contributing to leading to both higher sales and profit gain.

- **Business Sustainability**

As claimed by one participant, good forecast accuracy increases the responsiveness of the whole supply chain, enables meaningful conversation with customers, benefits both suppliers and customers, and enables proactive approaches along the whole supply chain. It encourages the growth of a more collaborative supply chain network which benefits all of its participants and partners, an ideal win-win situation can eventually be achieved by all parties involved.

The impact on closed loop supply chains or reverse supply chains has been investigated in several academic studies and has not specifically been referred to by businesses involved in this research, which is an indication of lack of focus in this aspect.

- **Exceptions**

Despite the consensus recognition on the importance of forecast accuracy and the apparent desire to improve it, exception does exist. One company who used to be driven by forecasts has claimed they are now moving away from use of forecasts to drive the business. The interviewee has explained that with long lead times, for their company, the inaccurate forecasts have always had a negative impact on inventory levels and service levels. Instead of pursuing the seemly impossible mission to achieve a desired level of accuracy in forecasts,

they've turned away to build production planning based on historical sales data with the sales history data reviewed twice a year or even more frequently based on stableness, variance and seasonality, i.e. the nature and characters of that data. The participant has also advised that they are applying a lean manufacturing philosophy towards a complete customer demand driven supply chain. But he also stated that forecasts are still used for long-term planning. Such comment has brought up some interesting points. First, it does highlight the challenge to achieve a high level accuracy in the forecasting process. Second, it reflects a somewhat different understanding of what forecasting is in practice. Because even though the company claims it's moving away from forecasts, their practice of producing production planning based on sales history is in fact still a forecasting activity. It appears what they think they are getting rid of is a forecast provided from the sales team. Thirdly, as the company is moving towards a lean manufacturing program, which is a supply chain driven by actual customer demand, then it becomes true that the forecasting process is being removed at the short term operational level. Finally, forecasts can never be completely disposed of, because even in a business like this where it is not favoured for short-term planning, recognition is still given on its positive contribution to long-term planning.

4.3.2 Measurements for the Impacts

Following the question that finds out what impacts forecast accuracy has on different aspects of supply chain performance, further questions were asked to discover how many companies have taken actions to assess and monitor these impacts by putting measurements on them, and to clarify what measurements are they.

Figure 4.8 shows the result of the number of companies that have applied measurements for the impacts forecast accuracy has on different aspects of the supply chain performance.

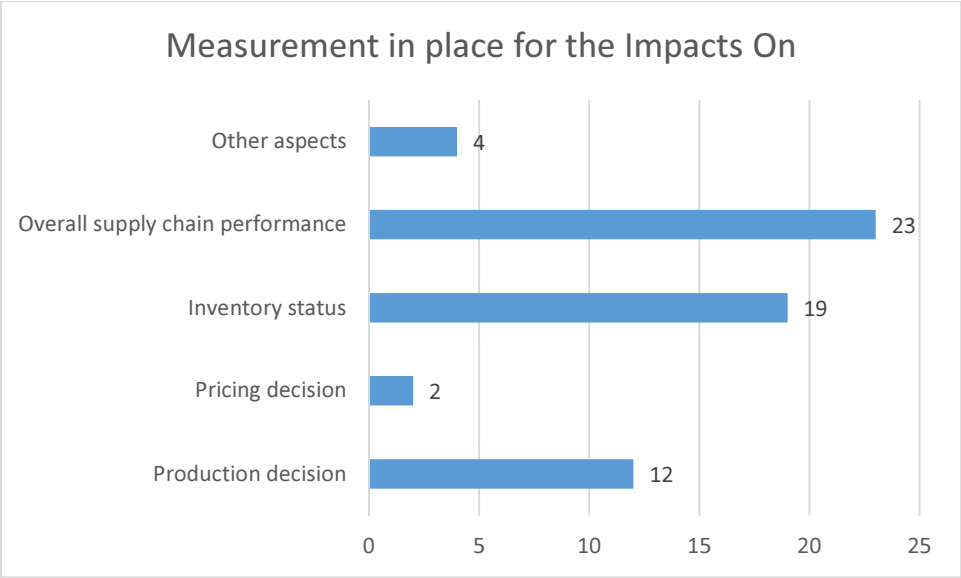

Figure 4.8 Measurement in Place for the Impacts

23 (64%) participants have set up measurement for the impact on the overall supply chain performance; 19 (35%) have measurement for the impact on inventory status; 12 (33%) have measurement for the impact on production decisions; only 2 (5%) have measurement for the impact on pricing decisions.

4 (11%) companies have also set up measurements on other aspects of the supply chain performance. Cash forecast, delivery performance, sales optimisation and purchasing have been mentioned in this regard.

Since a 'no measurement' option has not been provided, participants have chosen either to leave the question blank to indicate no measurement for the impacts, or have ticked the open-ended question 'other aspects' and left comments as 'no measurement', these responses count a total 10 (28%).

Figure 4.9 is a comparison between the result of the impacts acknowledged and the result of actual measurements put in place. It shows a trend that the more an impact has been recognized, the more focus has been put on taking action to put measurement in place. However, it also needs to be pointed out that there is a clear gap between the recognition of the impacts and the action taken. For example, 34 companies admitted forecast accuracy has an impact on the overall supply chain performance, while only 23 have said they have measurement for this impact. The existence of the gap indicates that even though there's

an awareness of the impacts that forecast accuracy brings to the supply chain, the follow up action taken to assess and monitor the impacts for future improvement is lagging behind.

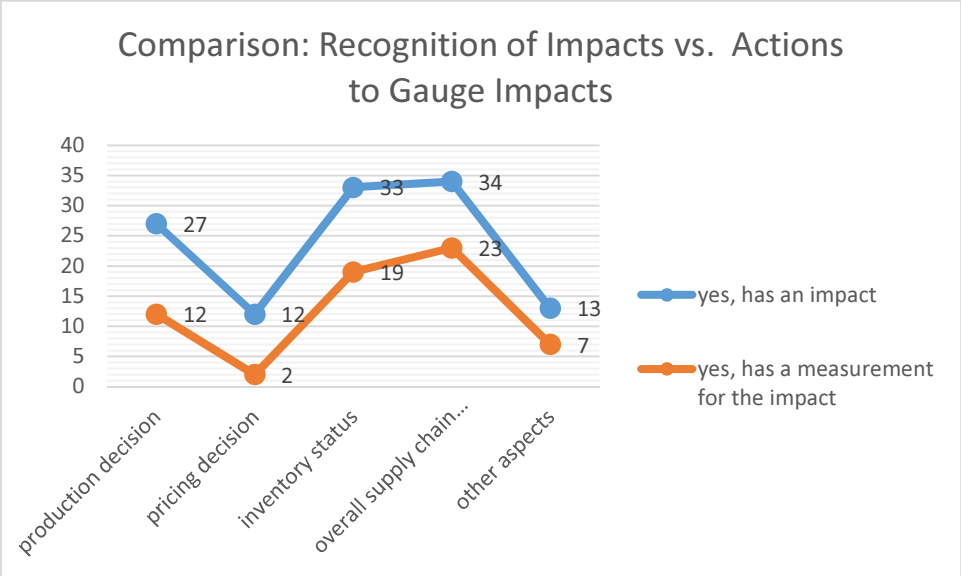

Figure 4.9 Recognition of Impacts vs. Actions to Gauge Impacts

Further analysis has been carried out by looking into the presenting relationship between these measurements. As per table 4.7, it appears to be a rather random spread of whether a company has single measurement or multiple measurements or both. They have then been grouped and graphed as per figure 4.10, the results show that 50% of companies have measurement on impacts for overall supply chain performance as well as other individual aspects; 14% however, only have measurement on impacts for overall supply chain performance; 8% only have measurement on impacts for individual aspects. This is reflecting a status in practice that the businesses have varied degrees of development and achievement in regards to effectively measuring the impacts of forecast accuracy on supply chain performance.

Production decision measurement	Pricing decision measurement	Inventory status measurement	Overall supply chain performance measurement	Other aspects measurement
yes		yes	Yes	
yes		yes	Yes	
yes		yes	Yes	
yes		yes	Yes	
yes	yes			
			yes	
			yes	
		yes	yes	
yes		yes		
		yes	yes	
		yes	yes	
			yes	
yes		yes	yes	
yes				yes
yes		yes	yes	yes
		yes	yes	
yes		yes	yes	yes
			yes	
		yes	yes	
		yes	yes	
yes		yes	yes	
		yes	yes	
yes	yes	yes	yes	
		yes	yes	
			yes	
		yes	yes	

Table 4.7 the Spread of the Measurements

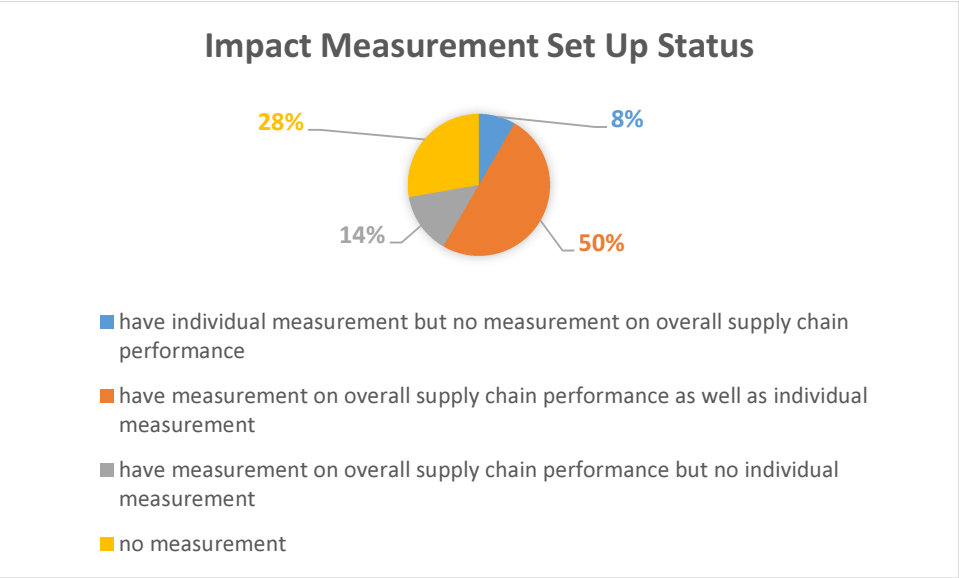

Figure 4.10 Impact Measurement Set Up Status

4.3.3 Application of Measurements

- **Measurement on Forecast Accuracy Itself**

As expected, the measurement of forecast accuracy itself is the most mentioned measurement of all.

  - **Measure Forecast Against Actual Demand or Supply**

Depending on the purpose of the forecast, from the demand and supply point of view, companies are measuring forecasts against actual sales, actual received goods by customer, actual demand and/or actual supply to evaluate the forecast accuracy level, and it is often drilled down to a by customer and market, by item and category level. For businesses with a massive range of products, it is said to be impossible and inefficient to measure each item by customer/market, good practice has been identified to focus on the top 20% products which usually forms 80% of the total sales, or as another company elected, to focus on the top 50 most complex products with long lead time components and large variances.

  - **Measure Forecast against Actual Production**

In relation to production planning, it is measured by comparing actual production to plan where the production plan is obviously driven by forecasts. Such exercise is usually carried out regularly in order to form an effective monitor and review process. One company has

explained in detail the process, where production to plan and forecast vs. plan is measured three months from the production date and one month out in a continuous manner for ongoing review and improvement. Another company has mentioned the same application by measuring production to plan accuracy, and it is also done by S&OP grade to provide a more strategic view, here S&OP grade is clarified as aggregated SKU (stock keeping unit) categories. The company has a process to review in monthly buckets on an 18 month horizon with the same intention to achieve continuous review and improvement. More statistically, some companies use forecast bias measured by total business, customer and product segment to make adjustment and improvement to the forecasting process.

- **Pricing Forecast Accuracy**

Pricing forecast accuracy has been mentioned by one company, where the actual sale price is compared to the forecasted price, this approach appears to be further related to the financial budgeting and forecasting process.

- **Forecast Coverage, Frozen Periods and Stability**

These terms have also been identified as a measure for forecast accuracy, without further clarification on these terms, it can only be presumed to be a measure on how long and how well a forecast can stay valid without any dramatic change, i.e. it measures the reliability of the forecast.

Taking one step further, root cause analysis has been adopted by some companies. The analysis result is feedback through the upstream functions for review and continuous improvement. This will be discussed further in section 4.5.7 where, improvement of forecast accuracy is discussed.

- **Measurements on Various Aspects of Supply Chain Performance**

Various measurements have been quoted in the questionnaire responses and the interviews. They are summarised and listed below.

- **Over All Inventory Status**

Inventory turnover is often mentioned to measure the inventory status in general, where better forecasts are supposed to translate into a more favourable inventory turnover. This as a performance indicator is also monitored against different type of inventories, such as raw materials, work-in-progress and finished goods.

- **Stock Related**

Stock age profile/aging stock, weeks and value of SOH (stock on hand), aged stock write offs are measurements often used by businesses where products have a limited lifespan such as food, wine, pharmaceutical, electronic goods, information technology equipment etc.

Stock cover by days and value is also measured to evaluate the impact of forecast accuracy, where high levels of accuracy favour a desirable stock cover level. Days out of stock, stock outage are measures from the opposite angle for the same purpose.

Product availability, stock on hand/on site, % of goods supplied from stock and safety stock levels are also widely applied. One company has given details on how this is practiced in reality. They used a measure called dynamic SSQ (safety stock quantity) to measure forecast accuracy, in this process, forecast vs. actual is captured for a certain time horizon, a trend analysis is then used to track the changes and trends, safety stock levels are then adjusted accordingly. Further to this, a review process is carried out monthly to make it a continuous improvement task.

All of these stock related measurements are calculated in either quantities or in dollar values or both by different companies in order to obtain the most informative picture of the impacts of forecast accuracy. One example is the use of 'moving average cost' indicator by one company, where other cost related factors such as exchange rate and discount to the customer are also incorporated to capture the most accurate result.

- **Capacity Related**

These measurements are quoted as production capacity, storage capacity and despatch capacity utilization. Through these methods, the impact of forecast accuracy is reflected by

the utilization of the various capacity, i.e. a better forecast leads to a more optimal utilization result that is not too much over or under the desired level.

- **Cost and Finance Related**

These measurements put the impact of forecast accuracy into a more straight forward dollar value which is more closely linked to the supply chain performance and the ultimate business goal. In practice, various methodologies have been identified. One company mentioned they measure the % of un-forecasted demand and the related cost. Another company measures expediting costs. Finance related measurements are also common in practice, one company has advised they do not have a fixed budget target but a rolling 12 months financial plan which is based on the forecast, and the measure is to see how well the target has been hit. Another company measures working capital which includes finished goods, raw materials and packaging. And there is also a company that measures compliance to working capital forecasts as well as financial forecast against plan.

- **Customer Service Level**

In this regard, service level is one of the most recognized overall supply chain performance measure and has been widely adopted to measure the impact of forecast accuracy. DIFOT (delivery in full on time), DIFOTIS (delivery in full on time in specs), OLOT (order line on time) are the most quoted measurements. Some companies do not use the exact term, but their measurement is based on shipment size and date bears the same concept. Validating orders against forecast down to SKU level by customer is another application in practice quoted by one of the participants. From a different angle, back orders and returns are also two important customer order fulfilment performance measurements. They are adopted in practice by various companies, and some even take a step further by doing root cause analysis on these cases, as well as measuring the cost related to back orders and returns.

It must be pointed out that there are still a number of companies who do not have effective measurement for forecast accuracy and its impact. Being a new business which has not been able to set up everything properly is one reason mentioned. And some already established businesses remain in a process of reviewing and setting up a new business objective system which also covers forecast accuracy measurement review. And companies

driven by customer demand, or working towards a lean manufacturing philosophy are not focusing on forecast accuracy but rather obtaining information and trends from customers directly.

4.4 The Contributing Factors of Forecast Accuracy

The next section of the questionnaire asks questions related to the contributing factors to forecast accuracy. The aim is to explore opinions and views in this regard from the practical point of view, together with findings of the improvement enablers to conclude meaningful solutions and recommendations for businesses as well as discovering any gaps for researchers to carry out further studies.

4.4.1 Rankings of the Contributing Factors

The participants were asked to rank the major contributing factors to forecast accuracy (1 being the most important and 7 being the least). These factors were summarized from the literature review. An 'other' option has been given to capture any other missing factors apart from the provided ones, allowing the participants to add more inputs from their practical experience perspective. The rankings were then applied weightings and analysed as per below (figure 4.11). The following analysis will be arranged by the ranking result to discuss the factors one by one.

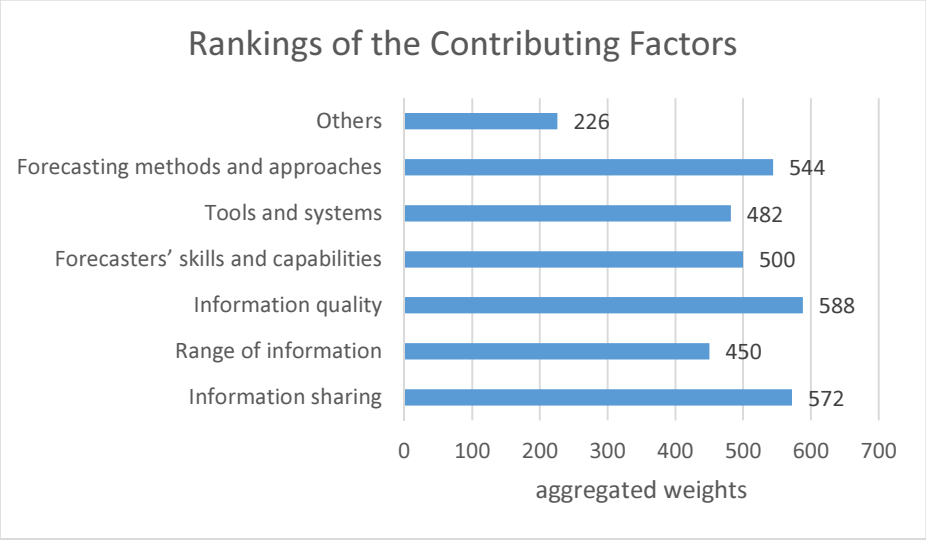

Figure 4.11 Rankings of the Contributing Factors

4.4.2 Quality of Information

- **Rank of Information Quality**

Information quality has been rated the no.1 important factor for forecast accuracy. 11 (31%) participants have rated information quality as most important; 9 (26%) ranked it second most important and 7 (20%) ranked it third important. In total, 27 (77%) participants rated this factor as one of the top three contributing factors. The consensus responses indicate that quality of information is indeed very important, not only emphasized within the literature but also recognized in this research study.

The rest 8 (23%) participants did not think the same way, and rated this with lesser important rankings including 4, 5 and 6.

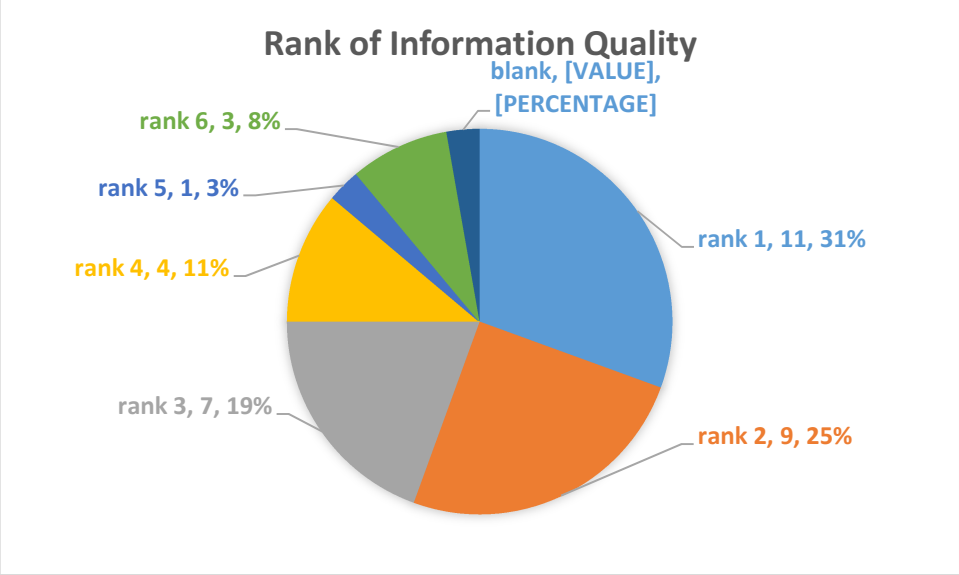

Figure 4.12 Rank of Information Quality

It is interesting to notice that one participant did not even give a rank to this factor but picked only 3 other factors and the 'other' option. Further investigation has found that this is the same company that claims they are moving away from the forecasting process towards a lean manufacturing model driven by customer actual demand. Looking at the factors he has chosen, they are: forecasters' skills and capabilities (no.1); forecasting method and approaches (no.2); information sharing (no.3); and, other (no.4) which is timeframe and horizon. It appears in this case, the human factors and systems are considered more

influencing to the level of forecast accuracy instead of the characters of the information itself. The most possible rational to this stance can be explained as to this business, the main information they utilize is the true demand information from the customer which is usually of high accuracy hence this poses less quality concerns for the company. Instead, the focus of the business is on how to interpret the information and react to it, which requires the right skills, capabilities, methods and systems to achieve that goal.

- **Satisfactory Level of Information Quality**

Since information quality is believed to be the most important factor for forecast accuracy, it is necessary to find out to what extent in reality businesses are satisfied with the level of quality. A question was asked to rate the four main characteristics of information quality, i.e. in time, accuracy, access convenience and reliability. Figures 4.13 - 4.16 below show the survey results of the satisfaction levels of these characteristics.

In time – 31 (85%) participants feel they receive the required information in time, with majority 'OK' (15, 42%) rating, or 'high' (12, 33%) and 'very high' (4, 11%) ratings.

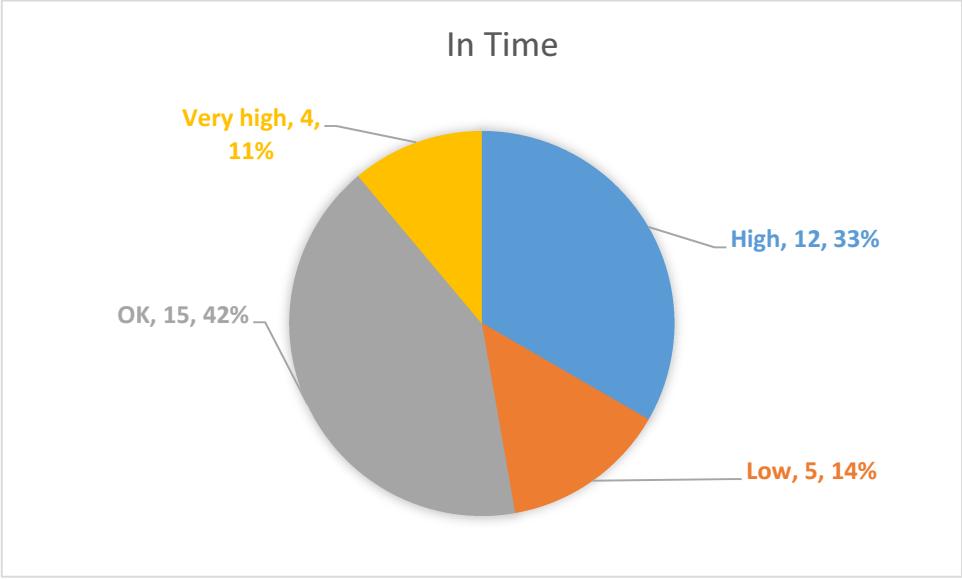

Figure 4.13 Rating of Information Quality – In Time

Accuracy – 26 (69%) participants rated this character Ok or above, with 11 (31%) 'OK' ratings, 13 (36%) 'High' ratings (majority) and 2 (5%) 'Very high' ratings. However compared with the satisfactory level for 'in time', accuracy has gone lower with 8 (22%) rated it 'low', and 2 (6%) rated it 'very low'.

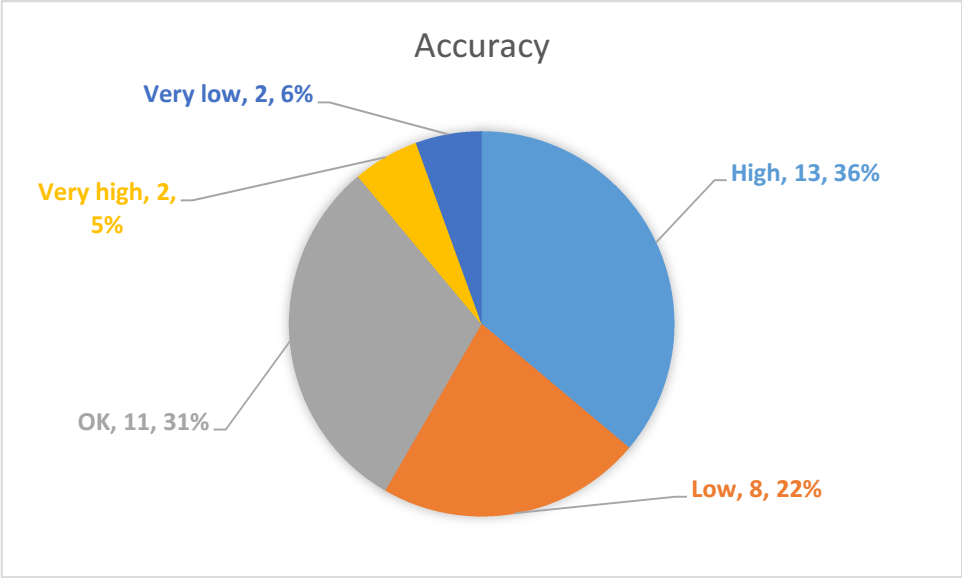

Figure 4.14 Rating of Information Quality – Accuracy

Access convenience – 29 (81%) participants rated this character Ok or above, with majority 'Ok' ratings (17, 47%), less 'high' rating (11, 31%) and 1 (3%) 'Very high' rating. 7 (19%) rated this 'low' and there is no 'very low' rating.

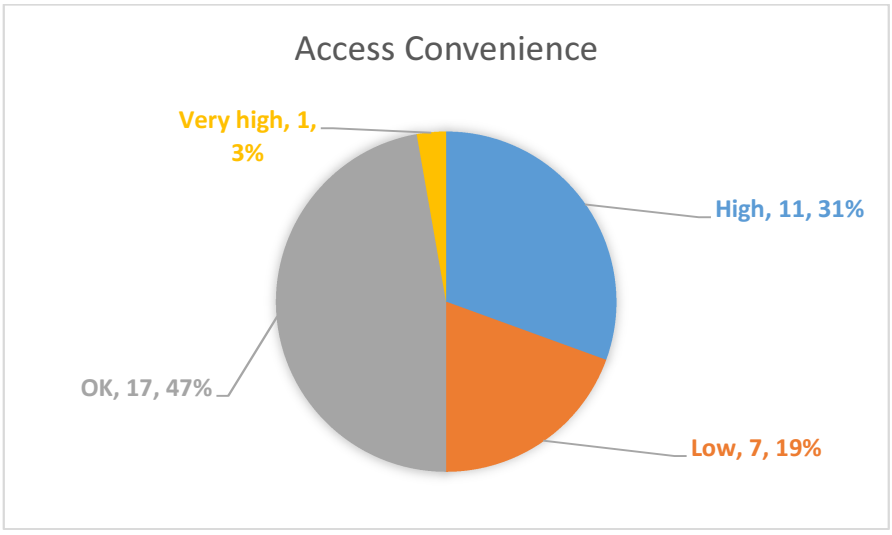

Figure 4.15 Rating of Information Quality – Access Convenience

Reliability – Again 29 (81%) participants rated it Ok or above, with majority 'Ok' ratings (16, 44%), and 12 (33%) 'High' ratings, 1 (3%) 'Very high' rating. 6 (17%) rated it 'low' and 1 (3%) rated it 'very low'.

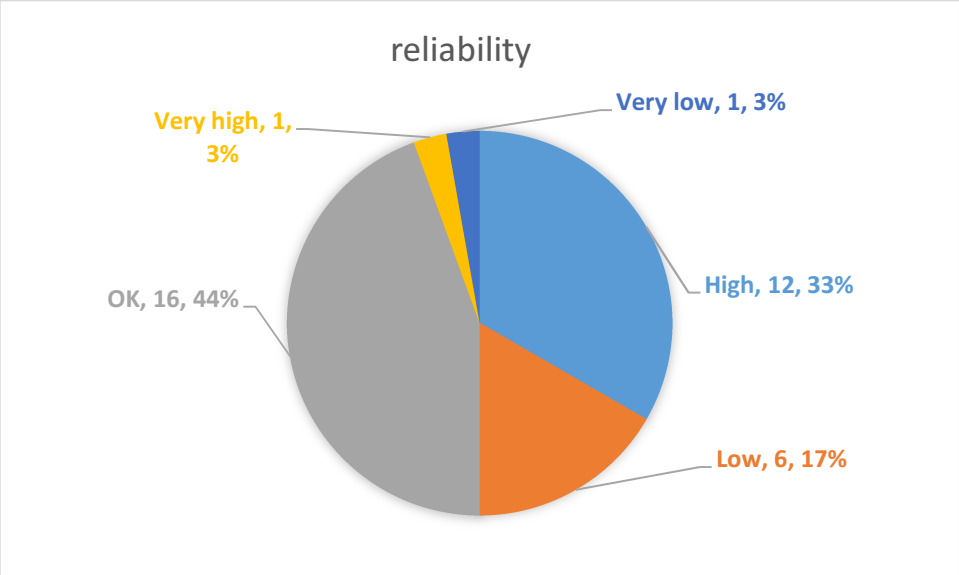

Figure 4.16 Rating of Information Quality – Reliability

Even though across all four characters, the ratings are looking to be at a rather satisfactory level, however, there are still some alarming signs to be noticed. First, it must be noticed that the majority ratings are sitting at the 'OK' level, leaving quite some room for further improvement. Second, when reviewing individual participant ratings, it was noticed that 13 (36%) participants have either given more than two 'low' ratings, or no ratings above 'ok', this is convincing evidence that almost a third of the businesses are not satisfied with the current information quality level, again calling for further improvement.

In time	Accuracy	Access Convenient	Reliability
OK	High	Low	OK
High	High	High	High
Very high	High	High	OK
OK	OK	OK	OK
High	Low	High	OK
Low	Low	OK	Low
OK	OK	High	High
Low	Low	Low	High
Low	Very low	Low	Low
OK	Low	OK	High
Low	Very low	Low	Very low
High	High	High	High
OK	Low	OK	OK
High	OK	OK	Low
OK	OK	OK	Low
OK	OK	Low	OK
Low	Low	OK	OK
High	High	OK	Very high
High	OK	Low	High
OK	High	OK	OK
High	High	High	OK
OK	OK	OK	OK
OK	Low	OK	OK
High	OK	High	High
OK	OK	OK	OK
Very high	High	High	OK
OK	High	Low	Low
OK	Low	High	Low
Very high	OK	High	High
High	High	OK	High
OK	High	OK	OK
High	High	OK	High
OK	OK	High	OK
High	Very high	OK	High
High	High	OK	OK
Very high	Very high	Very high	High

Table 4.8 Rating Details on Information Quality ***(Ratings with more than two 'low' or none above 'OK' are highlighted in green. Totalling 13 counts).***

- **Relationship between Number of Handovers and Information Quality**

To find out how the times of hand overs of information will impact the quality of data, the participants were asked to advise how many hand overs or interfaces happen before a set of information reaches the final forecasting systems or the forecaster themselves. Also considered was whether they also saw a direct link between the number of handovers and the quality of the data.

Figure 4.17 shows an overview of the number of data handovers. 6 (17%) companies have direct input. 20 (56%) companies have one or two handovers, and 8 (22%) have three to five handovers. 2 (5%) said they don't know. In total, 26 (73%) companies have two or less hand overs happen to their information before the forecast is made.

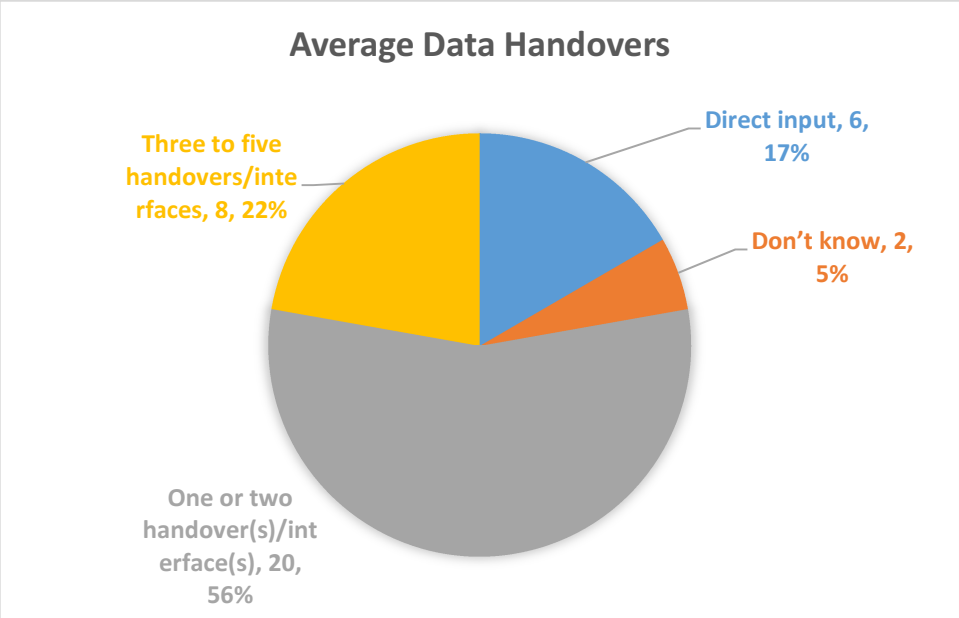

Figure 4.17 Average Data Handovers

When asked to identify if there's a direct link between the number of handovers and the information quality, as per figure 4.18, 21 (58%) said 'yes', 14 (39%) said 'no' and one did not answer this question.

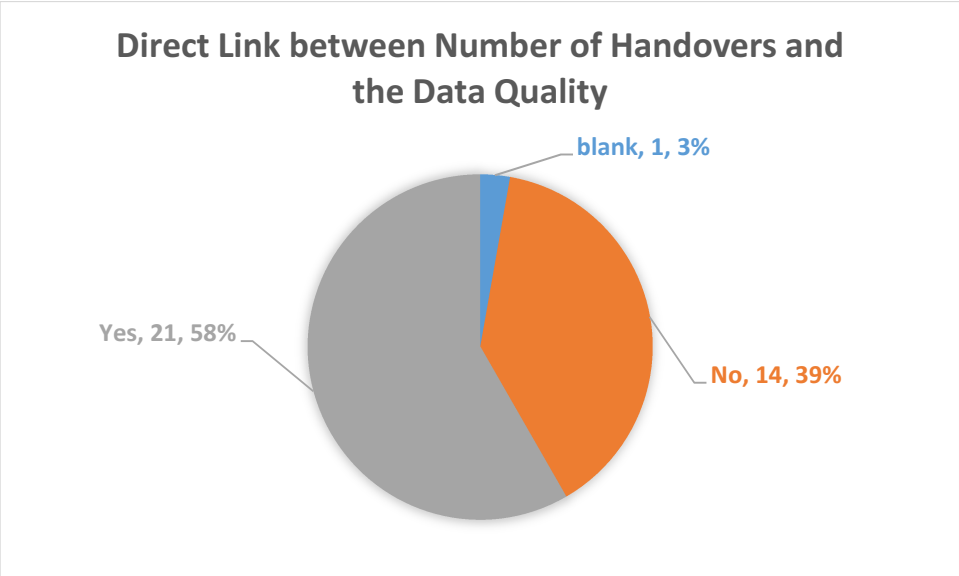

Figure 4.18 Relationship between Number of Handovers and Information Quality

Results from these above two questions do highlight that in practice most companies have a relatively low number of handovers in data transmission, and most of them believe that less handovers reduce the impact on information quality. However in this research an attempt to find the connection between the opinion and the practice has failed. For example, companies having less than two handovers in data transmission do not always answer 'yes' to the question of whether a direct link exists between the number of handovers and data quality, which can be explained that sometimes people exercising good practice do not fully realise the true rational. On the other hand, companies having more than three handovers have both 'yes' and 'no' answers to the question of whether a direct link exists between the number of handovers and data quality, indicating either they have not realized such relationship or they may have realized but have not been able to improve the situation.

- **Data Providers Credibility**

To find out how businesses perceive their data providers credibility in providing high quality data, the same question was asked, having the participants put a rating on this. Results are shown in figure 4.19, 12 (33%) rated 'OK' which form the largest portion of ratings. Followed by 9 (25%) rated 'good', 5 (14%) rated 'poor' and 2 (6%) rated 'very good'. The other 8 (22%) advised that credibility varies between different data providers. The total of 23 (64%)

combined ratings of 'OK', 'good', 'very good' indicates that overall the data providers credibility is deemed satisfactory. However, with only 2 (6%) being 'very good' and still 5 (14%) being 'poor', there is still significant opportunity for improvement. Furthermore, with 8 (22%) businesses declaring credibility varies between different data providers, the consistency level of different data providers credibility poses a concern. Some data providers are obviously performing less satisfactory than others, raising a question on how to bring them up to a higher standard.

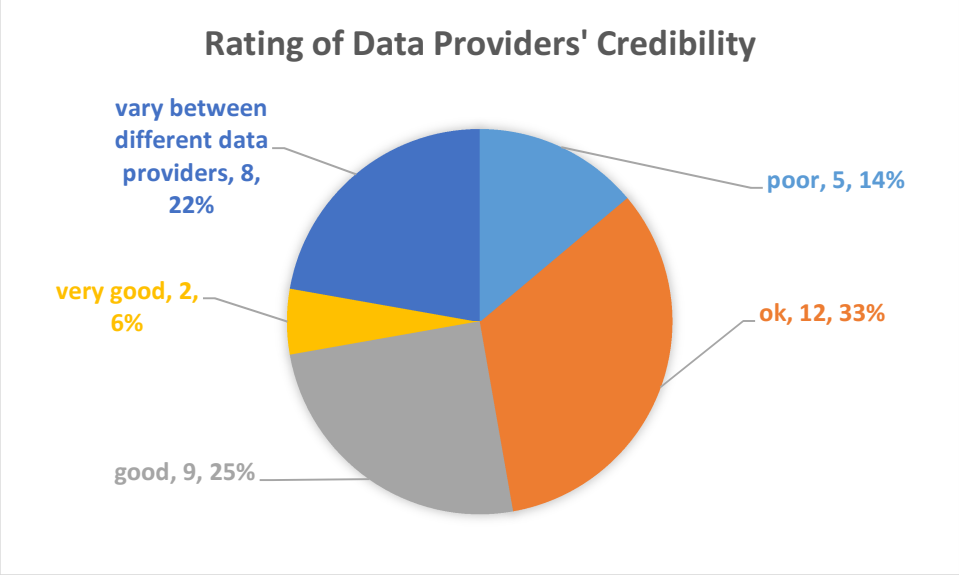

Figure 4.19 Rating of Data Providers' Credibility

4.4.3 Information Sharing

- **Rank of Information Sharing**

Information sharing has been ranked the second most important factor for forecast accuracy. As per figure 4.20, 10 (28%) participants have rated information sharing as most important; 5 (14%) ranked it second important and 10 (28%) ranked it third important. In total, 25 (70%) participants rated this factor as one of the top three contributing factors. This result is again echoing the literature review result where information sharing has been regarded as one of the most important factors to ensure a high level of forecast accuracy.

The rest 10 (28%) participants did not think the same way, and rated this as a less important factor with rankings of 4, 5 and 6.

Again one participant did not give a rank to this factor, but she has ranked all the other factors which makes it unusual that it was missed out. However, further investigation did not provide a rational explanation to this result. Without further clarification, it is hard to draw any conclusion at this point.

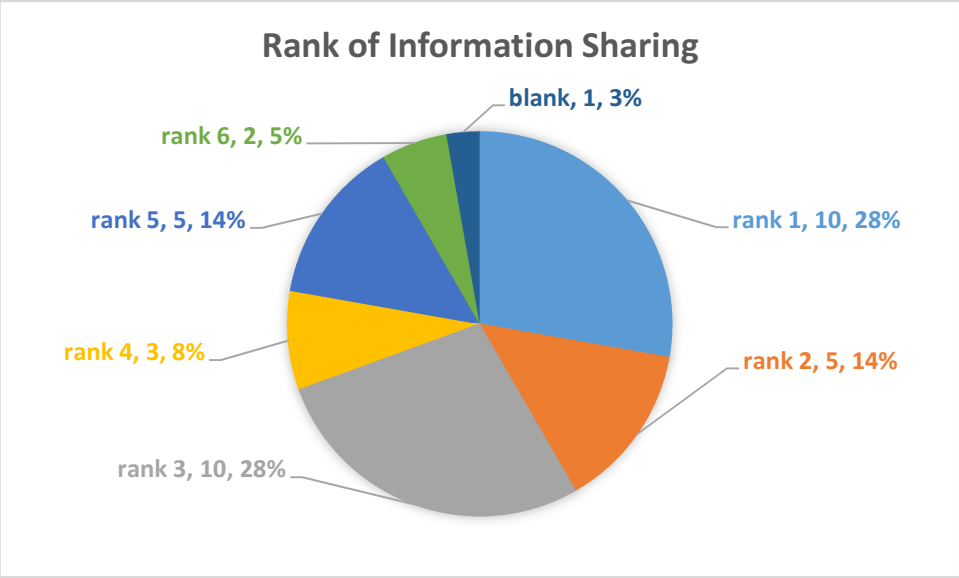

Figure 4.20 Rank of Information Sharing

- **Adoption of Different Information Sharing Methods and Approaches**

To find out how well different information sharing methods and approaches are actually being adopted in practice, a question was asked to have the participants advise the methods they are using. The result is shown in figure 4.21. It was found that 33 (92%) businesses are sharing information through the S&OP process and/or other cross functional collaboration programs, 32 (89%) are sharing information through the exchange of excel files or similar and 24 (67%) are exchanging information through system interfaces. Though 6 (17%) have mentioned other methods, by looking at the comments closely, they can be all classified as a different form of the three existing methods. For example, 'clients meetings', 'collaborative planning with key customers', 'wholesaler feedback' and 'vendor managed inventory' are all different forms of collaboration programs. And 'website information sharing' is similar to system interface. Such a high percentage of utilization of these methods, especially the use of excel files and the use of S&OP and other collaboration programs is indicating that information sharing is not only recognized as one of the most important factors contributing to forecast accuracy, but also has had actions taken in this regard to make it happen. Being

the lowest utilized methods of the three, system exchanges and interfaces appears to be an area of opportunity where increased focus and development might add further value.

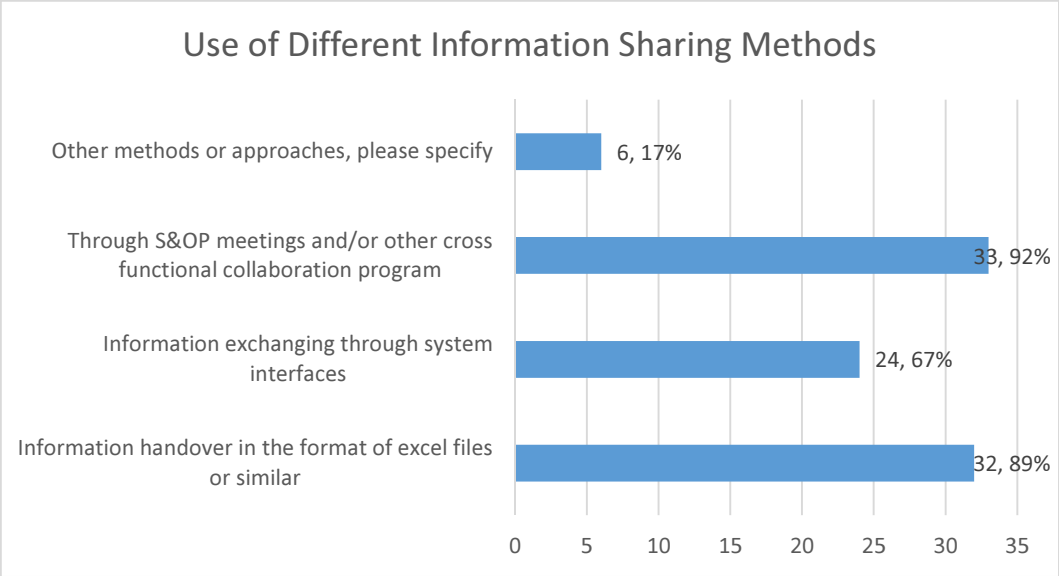

Figure 4.21 Use of Different Information Sharing Methods

Figure 4.22 shows whether a company is only using a single method to share information or multiple methods. Only 3 (8%) are using a single method, while the majority 33 (92%) have been using two or all three ways to share information. The high percentage of companies utilizing multiple information sharing methods and approaches demonstrates good recognition and practice in this regard.

However, investigation on the 3 single method users raised some concerns. One was indicating 90% of information is exchanged in excel files, and she advised in the interview that these information is provided by customers and then input into the system by sales. Comparing with input from the other three participants from the same company, one had stated 70% use of excel files, while the other two have contradictorily indicated 65% and 70% use of system exchange for information sharing. Further investigation on the company has revealed this is again a massive sized business with complexity and different divisions (mini companies within a company), the different input on the same question may indicate some inconsistency in respect of the ways information sharing is conducted among different business units or functions and how this is managed. Another single method user is indicating 100% usage of excel files to share information, whether this is a satisfying

situation for this business is unclear without further clarification with this participant and his company, however, considering the majority of companies are utilizing more than one method, 100% reliance on excel to exchange information does raise a concern. And the third one appears to be a false answer, as this manager has picked all three methods when answering the next question to allocate a percentage on each method they use.

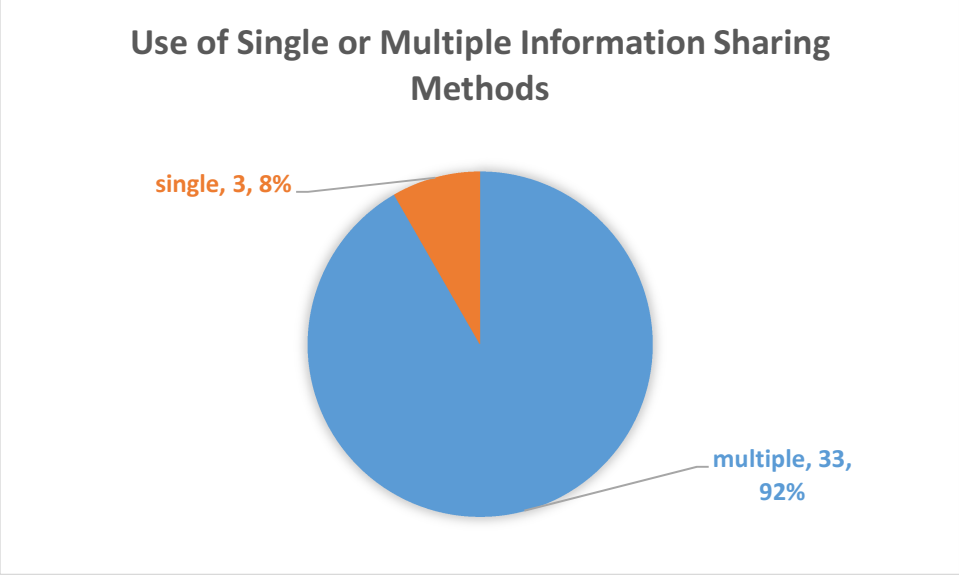

Figure 4.22 Use of Single or Multiple Information Sharing Methods

A further question was asked to find out the extent of usage of each different method. Input varies between different companies and does not represent any clear trend of using one method much more over any of the other ones. For some companies, system exchange and interface is the main method of information sharing, and for others, S&OP and other collaboration programs is the main method, 100% use of excel is also noticed, and for some companies, extent of usage of two or three methods and approaches are quite evenly spread. Details can be seen in table 4.9. Figure 4.23 provides a picture of on average, the extent of usage of each method. One can easily tell that information sharing through excel files (or similar) and information sharing through S&OP and other collaboration programs are both widely adopted and have similar extent of recognition and popularity (36% and 37% respectively). Information sharing through system exchanges and interfaces has a relatively lower extent of usage (25%). This could be explained as on one hand implementing new systems or maintaining and upgrading existing systems takes time and cost, while on the other hand, people do have concerns of the value and effectiveness of such systems.

Information exchanging through system interfaces %	Information handover in the format of excel files or similar %	Through S&OP meetings and/or other cross functional collaboration program %	Other methods or approaches %
0	90	0	0
10	30	60	0
20	10	70	0
40	20	40	0
20	30	50	0
25	50	25	0
70	20	10	0
10	45	45	0
0	30	70	0
40	30	30	0
60	25	15	0
20	20	58	2
20	20	60	0
10	70	20	0
50	25	25	0
0	50	50	0
30	60	10	0
0	70	30	0
20	40	40	0
65	25	10	0
5	15	35	45
0	50	50	0
10	10	80	0
20	68	5	7
15	15	70	0
10	50	40	0
0	100	0	0
50	10	40	0
0	20	80	0
30	10	40	20
20	30	50	0
50	30	20	0
20	60	20	0
50	50	0	0
10	10	80	0
90	0	10	0

Table 4.9 Extent of Usage of Different Types of Information Sharing Method

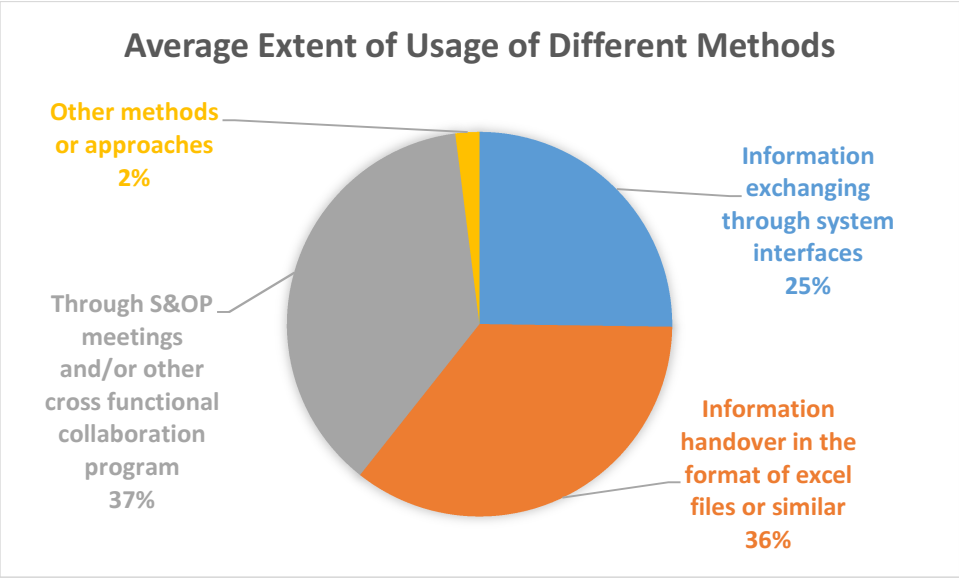

Figure 4.23 Average Extent of Usage of Different Types of Information Sharing Method

- **Further Findings from Interviews on Information Sharing**

Interviews have provided more insights on the benefits, issues and concerns of various methods of information sharing.

On the efficiency of the information sharing method, though a number of companies have indicated up to 70 or 80% of information sharing happens in S&OP meetings or through other collaboration programs, some companies do have issues on the quality of the information shared and expressed the desire for improvement on the information quality. On the other hand, companies favouring this method have pointed out that initiating more frequent communication and discussion with sales and other concerned parties in addition to S&OP meetings and collaboration programs will ensure more accurate information is shared. Or, a more frequent S&OP meeting schedule will bring the same result by gathering all parties at the same table, discuss issues, constraints and reach agreement, here the S&OP meetings with high frequency act as a platform for exchanging information and changes timely and widely among all concerned parties. It is also commented by some companies that depending on the nature of the business unit, a push supply chain model requires the manufacturer to be more active in sharing information with their customers, while a pull supply chain model or a demand driven supply chain on the other hand requires more efforts to keep customers engaged in the information sharing process, and educating the

customer on the value of sharing information is crucial in obtaining their buy in and cooperation.

Excel as another major information sharing method is also widely utilized. Excel is especially favoured in a businesses with narrow product ranges and small numbers of customers, the simplicity and straightforwardness are taken as advantages of excel, supplemented by constant communications between parties to capture any changes, excel works well in this case. However, the biggest concern on the use of excel is the amount of human handling it allows, which may lead to more 'artificial' information as one commented. One company currently sharing 50% of information in this way advised that more human handling leads to more errors and that they are working towards integrating more information through tools and systems.

Tools and systems are commonly believed to reduce human errors and be better in providing the same set of data to all parties. However, the down sides were also outlined in the interviews. One company pointed out that system data can be artificial as well, he further explained this with an example that as sales do the input in the system with demand information, they may have assumptions at the time of input, and there may be changes after the input, if this information is not corrected and updated in time, then the data in the system loses its value and becomes inaccurate. Here, constant and honest communication is said to be beneficial in terms of improving the accuracy of the information. Another participant addressed the same point by stating 'more timely feedback on information' is needed.

4.4.4 Forecasting Methods and Approaches

Forecasting methods and approaches ranked as the third most important of all factors for forecast accuracy. 6 (17%) participants have rated forecasting methods and approaches as most important; 6 (17%) ranked it second most important and 4 (11%) ranked it of third importance. In total, 16 (45%) participants rated this factor as one of the top three contributing factors. On the other hand, 20 (55%) participants ranked this factor as 4, 5 or 6. This is a rather even spread of this factor being considered top 3 important ones by slightly less than half of the participants, and the bottom 3 by the other half of the participants.

From another angle, 11 (31%) people ranked it as number 4 which is the highest number of people agreeing on one specific ranking.

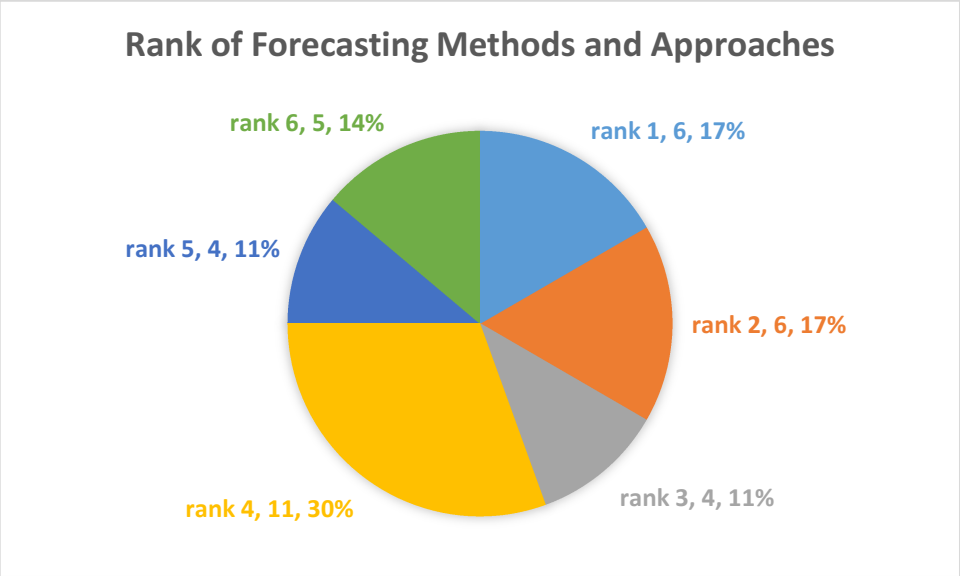

Figure 4.24 Rank of Forecasting Methods and Approaches

Of the three main forecasting approaches, top-down has 7 (19%) adopters, followed by bottom-up 5 (14%) and middle-out 3 (8%). It can be seen that starting from strategic forecast then cascading down to operational level forecast is the most prevailing approach in practice.

Of the major forecasting techniques, 14 (39%) companies adopt the rolling forecast method, and only 2 (6%) are exercising methods based on ordering quantity and lead time. Under the 'other' options, two companies advised they use a combination of two or more techniques and approaches. Other answers include 'sales history', 'sales forecast and bill of materials', 'MRP planning tool', these answers do not really correspond to the purpose of this question, indicating either the question has not been clear enough, or a lack of knowledge or awareness in this aspect. It may also explain why this question has had rather evenly spread answers, as people may have interpreted it in different ways.

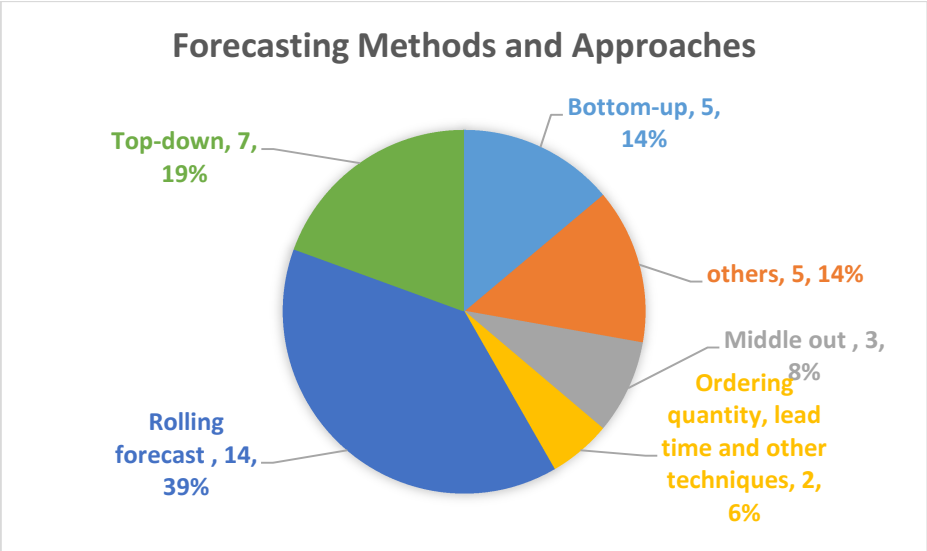

Figure 4.25 Forecasting Methods and Approaches Adopted in Practice

4.4.5 Forecasting Capability – Human Factor and Tools and Systems

- **Forecasters Knowledge, Skills and Capabilities**

Forecasters knowledge, skills and capability ranked as fourth in importance of all factors for forecast accuracy. However, refer to figure 4.26, there are still 3 (8%) participants that have rated this factor as most important; 5 (14%) ranked it second in importance and 4 (11%) ranked it third most important. Half, 18 (50%) of participants ranked this factor as either 4th or 5th in importance, forming the largest group of ranks. The rest of participants ranked this factor least important as 6th (4, 11%) and 7th (2, 6%).

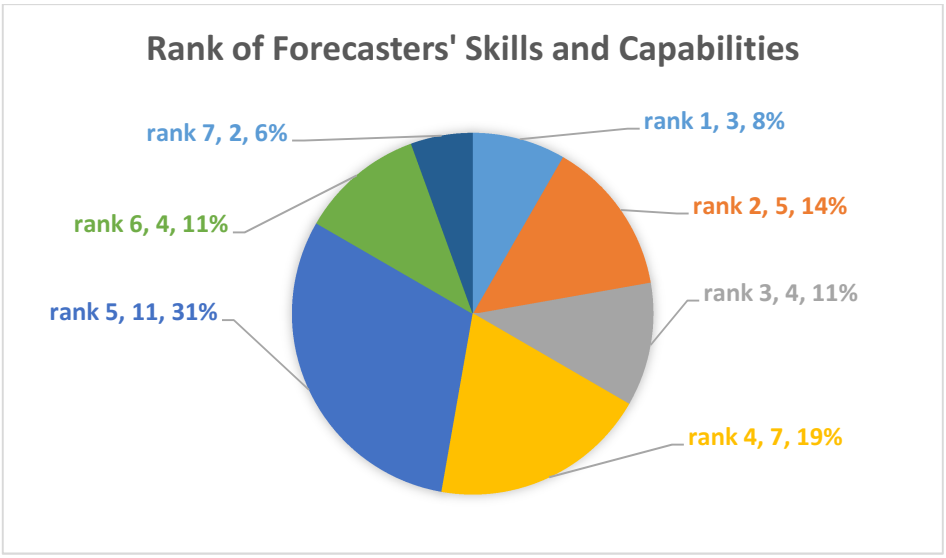

Figure 4.26 Rank of Forecasters' Skills and Capabilities

When asked to identify the knowledge, skills and capabilities a forecaster should ideally have in order to produce high quality forecasts, the participants expressed high consensus in all the items given. Figure 4.27 shows that all of the five aspects have gained high recognition, i.e. over 89% agreement on four of them, with the fifth gaining 28 (78%) agreement as the lowest. The result shows a unanimous acknowledgement on the importance of forecasters knowledge, skills and capabilities to forecast accuracy, and on what in particular this knowledge, skills and capabilities should be. Such belief forms a solid base for recruiting, training and developing high competence forecasters.

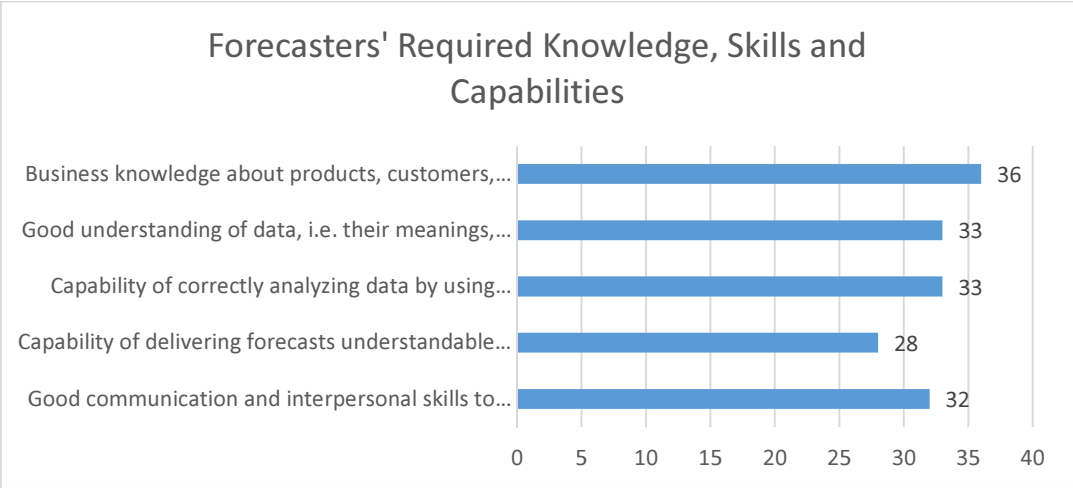

Figure 4.27 Forecasters' Required Knowledge, Skills and Capabilities

- **Managerial or Judgemental Adjustment**

Refer to figure 4.28, 31 (86%) companies confirmed they incorporate managerial or judgemental adjustment in the forecasting process. 5 (14%) do not use at all. However, opinion on the value brought by managerial/judgement adjustment differs among these companies. As per figure 4.29, though 14 (45%) are positive on the value added, the majority 16 (52%) do not always see the desired value of such adjustment. Participants were asked to explain why they chose a specific answer and further interview questions were proposed as well to obtain more insights on this subject. The comment is analysed and summarise below.

Managerial/judgemental adjustment can add good value to forecast accuracy usually at the time when some special events happen, because special events are not happening regularly, and is difficult to be captured or incorporated in the forecast modules. In such circumstance,

managers' and experts' experience, expertise, knowledge etc. play a significant role in adjusting the forecast to reflect the changes needed for those special events. The special events mentioned include new product launch, promotions, one off sales.

Then the question was asked to explain when and why managerial/judgement adjustment does not add value as it is supposed to be, most explanation are focused on the negative impacts. One major issue with such adjustment is the various opinions it can attract. Different people may possess diverse types of experience, expertise, with varying strength levels. They may also suggest adjustments driven by different interests, sometimes even conflict interests such as 'meeting budget', 'leveraging outcomes for target achievement' etc. Consequently, for the same forecast, how to make the adjustment may pose great challenge. As some managers commented, this raises the 'noise' level during the decision making process and 'causes distraction'. And the other comment highlighted the issue where imbalanced influencing powers may result in adjustment decision made to benefit one party instead of the whole business. Another negative impact was mentioned with concerns on the nature of human adjustment, where it always involves subjective decision making, and depends on the persons personality, the interests they focus and even their mood, 'assumptions may not be true' as one mentioned, thus decisions can sometimes 'cloud the objective assessment'. The third issue referred to was the situation where 'the market is volatile', it can be interpreted as the adjustment made, may not be good enough to reflect or cope with the volatility, adding no value or maybe negative value.

Some participants are not sure about the value added because it has not been properly analysed yet.

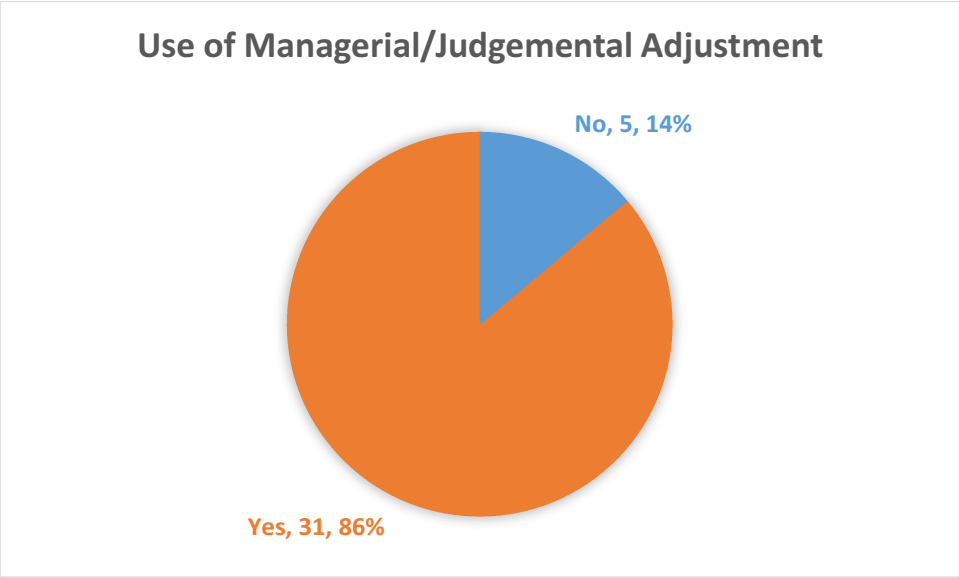

Figure 4.28 Use of Managerial/Judgemental Adjustment

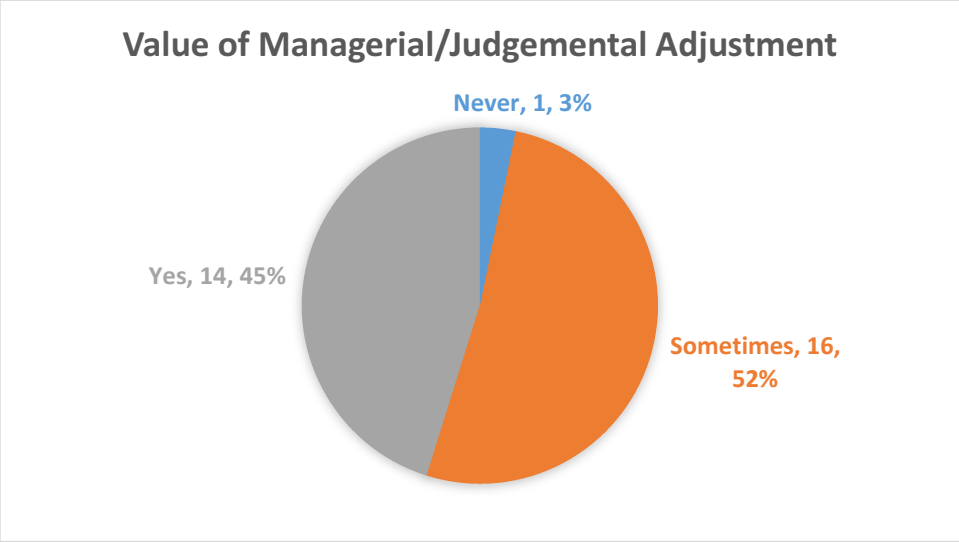

Figure 4.29 Value of Managerial/Judgemental Adjustment

- **Forecasting Tools and Systems**

Forecasting tools and systems ranked as the fifth most important of all factors for forecast accuracy. However, as per figure 4.30, similar to forecasters skills and abilities, there are still 3 (8%) participants rating this factor as most important; 5 (14%) ranked it second in importance and 6 (17%) ranked it third most important. More than half, 19 (52%) of participants ranked this factor as either 4^{th}, 5^{th} or 6^{th} in importance, forming the major group of rankings. And the rest of participants ranked this factor least important as 7^{th} (2, 6%). An

attempt to find the relationship between the rankings and the sector or the size of companies did not come up with any convincing result.

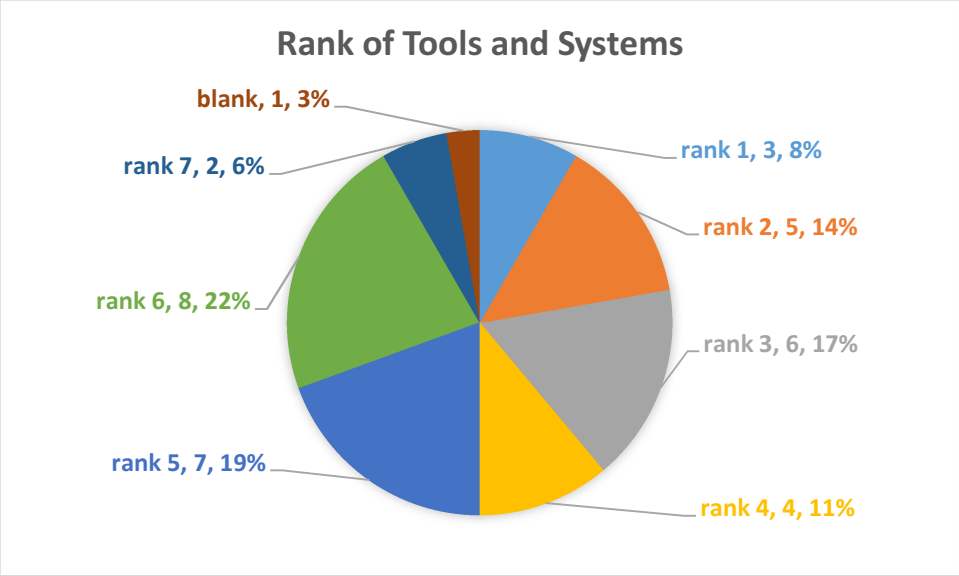

Figure 4.30 Rank of Tools and Systems

Participants were then asked to advise if they do use tools and systems in their forecasting process, how do they think they add value and why. Results in figure 4.31 and figure 4.32 show that majority 30 (83%) companies are using tools and systems in their forecasting process, but less companies 25 (69%) think tools and systems are actually adding value. So further analysis has been done to investigate the reason why sometimes people think tools and systems are not adding value as they are supposed to be.

- Tools and systems not providing required functionality or not being utilized to their full potential are identified as one reason of their value not being realized. Some participants commented 'there is better functionality in our system that is currently unused' or 'the functionality of the system does not support the required forecasting task'. Another person raised the issue that people have 'poor understanding of how the system works' and they would rather use Excel which is more straight forward. A third participant advised that the systems are only used to 'house large amounts of data rather than any projection'. Other situations mentioned in this regard are sometimes there are 'systems that people don't even know', and 'systems do not talk to each other'.

- The other down side of tools and systems is if they still allow adjustment by users, when adjustment or manipulation is done without any good justice or to the favour of some parties interests instead of the overall goal, then the value disappears.

- On the extreme side, there is also belief that 'nothing is more reliable than human being, tools and systems can never replace human beings', in this case, Excel is the main method used for forecasting. However, the same company does utilize certain types of tools to manage certain business activities, here the tool is used to host one set of promotional information by product and customer. It is however unclear if the further analysis and forecasting is done with the tool as well or outside the tool in Excel again.

- How much value tools and system can bring also depends on 'Industry sector and the complexity of the products or the business'. This is commented by a company with narrow product range and small number of customers, in this case, tools and systems which often involve considerable investment do not present any necessity. Excel works fine and efficiently for this type of businesses. The 'level of maturity of the business' is another similar reason where tools and systems are not valued because Excel is easier to use.

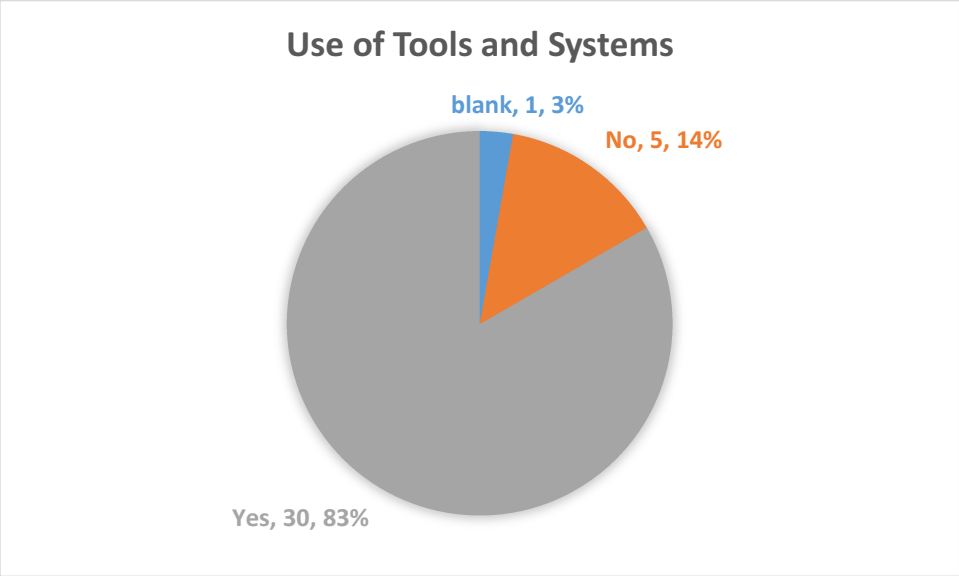

Figure 4.31 Use of Tools and Systems

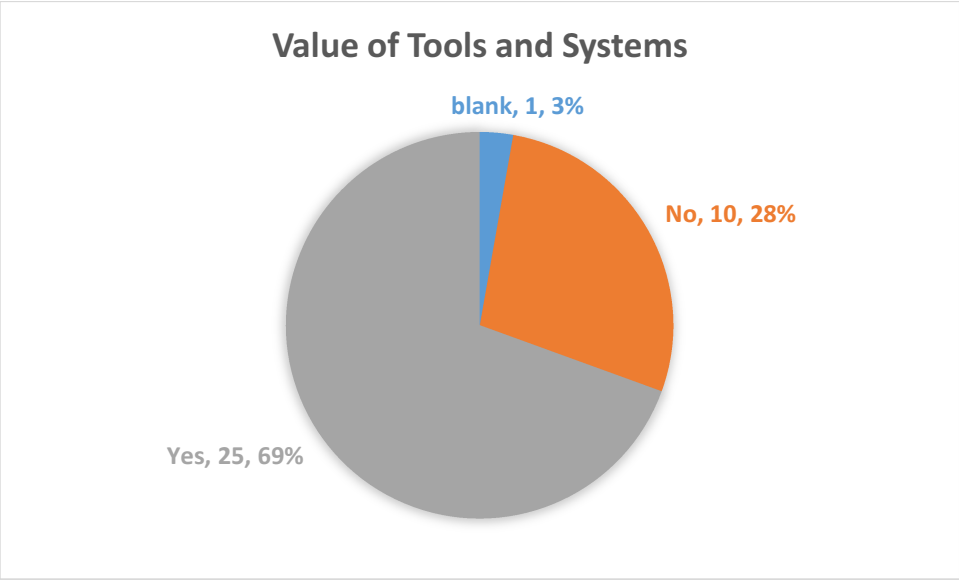

Figure 4.32 Value of Tools and Systems

- **Excel**

As per figure 4.33, 24 (67%) companies are using Excel in the forecasting process, among those 19 (80%) are using tools and systems at the same time. The result is a good evidence that Excel is widely adopted either exclusively or to supplement tools and systems. Again analysis of the comments from the questionnaire responses and interviews provides more insights.

First investigation is on why some companies choose not to use Excel at all. As expected, in these companies, various tools and systems are used in the forecasting process, which makes using Excel unnecessary.

Then the analysis focused on why Excel is used in the forecasting process. Reasons have been summarised as below.

- Ease of use has been commonly recognized and people find it effective as well.

- To take advantage of the various functions of Excel is another main reason. In some cases, data is exported into Excel for analysis and manipulation, and in other cases, data with various formats are combined and standardized with Excel. Excel is also believed to be effective for communication purpose, such as presenting and reporting.

- Companies already using tools and systems are using Excel as a supplement to the systems. For example, one company advised Excel is used in circumstances such as new product launch where tools and systems do not have the data available to draw the forecast from. One other example is when a company is growing fast, while its tools and systems are not upgraded in time to keep up with the business growth, Excel comes in handy and effective to produce forecast before the system is capable of doing the same. Excel also comes to the rescue where systems do not function well or lack the capability to do certain tasks, cases that have been mentioned highlighted 'lack of integration', 'no ERP function available yet', 'missing data from systems' etc.

- Sometimes, in an undesired situation, Excel was the only option left to use. One participant said 'this is the only tool I have at the moment', and another commented 'that's the only tool our stakeholders accepted'. Both are expressing the need of raising awareness, obtaining management attention and gaining consensus from stakeholders to deploy more sophisticated tools and systems.

- In some circumstances, Excel is exclusively used instead of tools and system for good justified reasons. A business where the nature of its product range is narrow and it has a limited number of customers to whom it is primarily selling through contracts, then sophisticated or complicated tools and systems were found not to add any significant value to the forecast process, not to mention the substantial investment they required. A seasonal business with a nature of discount driven demand, does not see the value of sophisticated tools and systems either, here human prediction and adjustment based on communication, knowledge, experience is believed to be more effective and favourable.

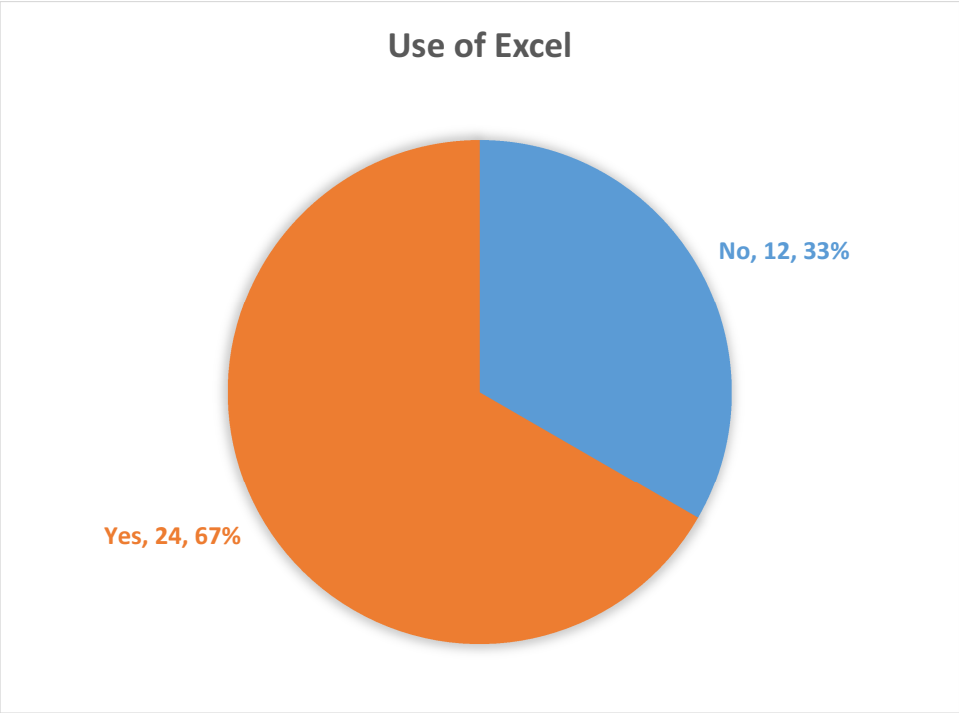

Figure 4.33 Use of Excel

4.4.6 Range of Information

Range of information ranked as the sixth most important of all factors for forecast accuracy. However, refer to figure 4.34, there are still 2 (6%) participants that rated this factor as most important; 6 (17%) ranked it second most important and 4 (11%) ranked it third in importance. Again half, 18 (50%) of participants ranked this factor as either 4^{th}, 5^{th} or 6th in importance, forming the major group of rankings. 3 (8%) participants ranked this factor least important as 7^{th}. Finally, 3 participants did not rank this as a factor at all, one participant again is from the company moving away from forecasting towards lean manufacturing. Range of information does not seem to be a concern as they believe they get the information from the actual customer demand, where the customer is responsible for what information they provide. As for the other two responses that did not rank this factor, no rational explanation can be detected from relevant information, the conclusion hence leans towards either they truly do not recognize this as a contributing factor, or they have somehow overlooked this answer.

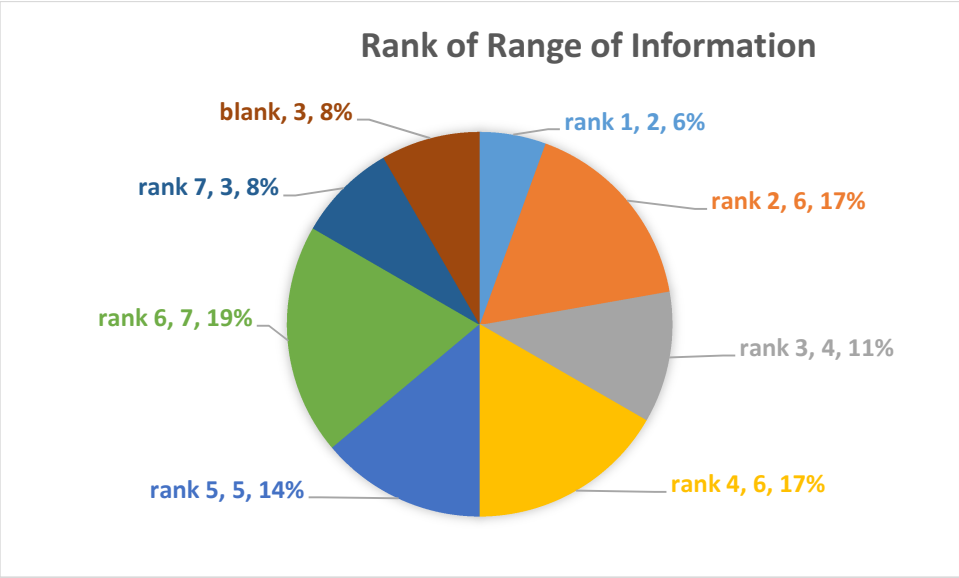

Figure 4.34 Rank of Range of Information

A further question was asked in order to understand what types of information have been utilized in the forecasting process. 10 defined options have been provided with the 11th as an open-ended question for the participants to include any missing answers. Figure 4.34 shows the result of the popularity of each type of data used in the forecasting process.

28 (78%) companies are utilizing market information in the production of the forecast, this has made market information the most often used information for forecasting regardless of which sector a business belongs to. Such a high attention on market information is indicating that most businesses are market driven, and they do perceive such information as crucial to an accurate forecast outcome.

The next three following information types are seasonal data (27, 75%), internal and external data (25, 69%) and upcoming events (23, 64%). By reviewing the supply chain segmentations and industry sectors, it appears the companies responding in this way are widely spread among all different segments and sectors, suggesting these types of data are also commonly considered necessary in the process of producing forecasts.

17 (47%) companies are utilizing distribution centre data, 16 (44%) are utilizing point of sale data, and 11 (31%) are utilizing both point of sale data and distribution centre data. Again, no clear evidence shows these companies are from certain sectors, so from a general point of view, these two types of data have not had same focus as the earlier mentioned ones.

13 (36%) are using internal data only, however, 10 of these companies also ticked 'other types of information', it seems the wording of this question has caused some confusion that people did not pay much attention to the word 'only', as the intention of this question is to see if a company uses only internal data with no other information are being used. These 10 companies obviously think they do use internal data as well as other types of data. Consequently, the analysis in this regard made less sense. Only 3 (8%) chose the 'internal data only' as the only answer to this question, indicating they do in fact use this type of data only for their forecast, it seems not ideal at first sight, whether these companies find the only usage of internal data sufficient enough needs further investigation.

13 (36%) companies care about competitor movements. Only 11 (31%) companies have considered both local and global economic environmental influences.

Among the 4 'other' answers, one was left blank, the other three are mentioned as 'using last year's sales as default data', 'media campaigns' and 'promotional plans', they are not truly different from what has been listed, as 'last year's sales data' is a kind of internal data, 'media campaigns' and 'promotional plans' are related to upcoming events data. As a result, the 'other' options did not reveal any new findings.

Lastly, 3 (8%) companies are using weather forecasts for the next 3-10days, it is interesting to find out what they use it for, as this original idea came from a case study during the literature review, where a brewing company is utilizing the short term weather forecast to improve short term forecasts in order to maximise sales. Only one of the 3 companies has been interviewed, and it was advised that the 3-10 day weather forecasts are captured and analysed on a rolling basis to find out the weather pattern, as the products of this company are farm activity related, so weather pattern has an impact on the demand trends of the product. Without further interviews, the reason why the other two companies are using 3-10 day weather forecast data is vague, one being an information and telecommunication company, and correlation of using a short term weather forecast is unclear. The other company being a dairy company, it is understood that weather may have an impact on the immediate milk supply and is therefore a potential forecast indicator.

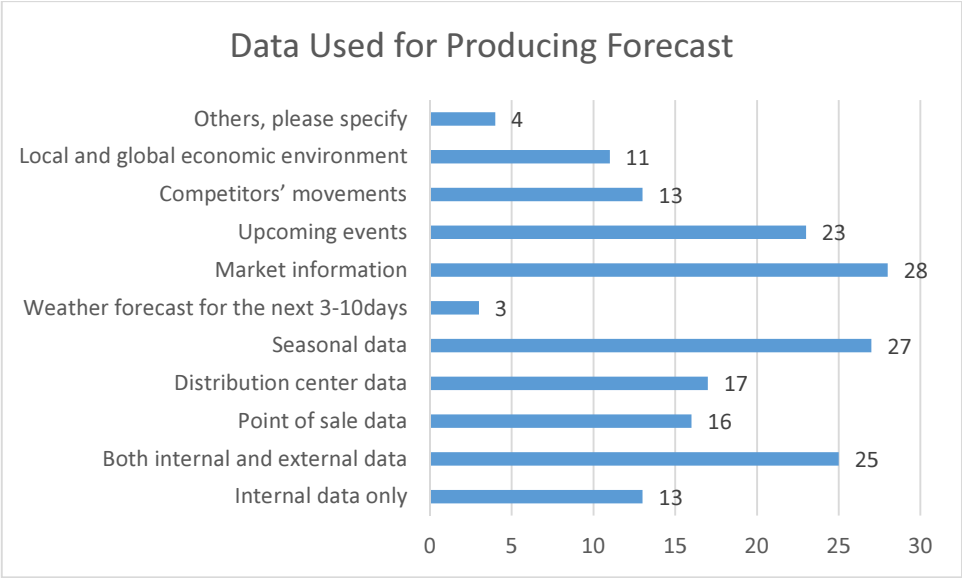

Figure 4.35 Types of Information Used in Forecasting

4.4.7 Other Factors Contributing to Forecast Accuracy

23 (64%) participants have chosen the 'other' option, but half of them did not mention what other factors they were referring to specifically. 12 respondents have specified the 'other' factors they think also contribute to the level of forecast accuracy, and the result is discussed as below.

- Some participants from the manager and senior manager groups have added valid comments from the management point of view and their comments are highly rational. Creating and maintaining a unified awareness and consensus on the importance of forecast throughout the entire business is crucial to achieve a high level of forecast accuracy. They have raised such points as 'buy in from other stakeholders', 'total commitment across the business', 'collaboration between stakeholders', 'solid cross functional collaboration process', 'clearly defined and understood business objectives and rules to establish a compliance framework to enforce stick to plan' and 'reduce un-planned / un-forecasted demand'. One manager even ranked this factor as being of number 1 importance, advocating the extreme significance of this factor.

- Performance management is another focus area with several managers quoting effective KPI management on forecasters and other parties involved in the forecasting

process is crucial. 'Good robust exception management' is also called for to minimise the variance between forecast and actual demand. A further step also is to establish a 'cause and effect orientation', or as another manager mentioned 'to document/review/adjust and learn from assumptions', these are in fact composing a monitor, review, learning and education process. These factors are indeed crucial supplements to the 6 listed options.

- Another valid point revealed is as quoted by one participant 'the quality of capacity planning to meet the forecast'. Indeed, to realize a forecast to meet actual demand, a solid support from operations is required. Production capacity, storage capacity, logistics capacity etc. are impacting the capability of delivering the forecast. Without such support, even when the forecast is accurate to actual demand, it is difficult to see it fulfilled. The rest of the factors mentioned under the 'other' option are more or less related to those factors already listed. A few examples are quoted as follows. One participant mentioned 'market intelligence, understanding key market drivers, competitive environment and their implications on the forecast'. These aspects are actually related to the forecasters knowledge, skills and capabilities. Another factor is raised as 'econometric modelling to look for substantial correlations to understand demand drivers' which is more relevant to forecasting methods, approaches, tools and systems. Comments such as 'the vendors ability to supply the information', 'frequency and data format supplied' and 'historical trends' are related to the range of information and information quality. 'Forecast timeframe and time horizon' is also raised as a factor, as explained by one participant. The shorter the timeframe, the less accurate the forecast, especially with a long lead time. This is to some extent related to forecasting methods and systems, however, it is still challenging to minimise the impact of this factor even with advanced methods and systems.

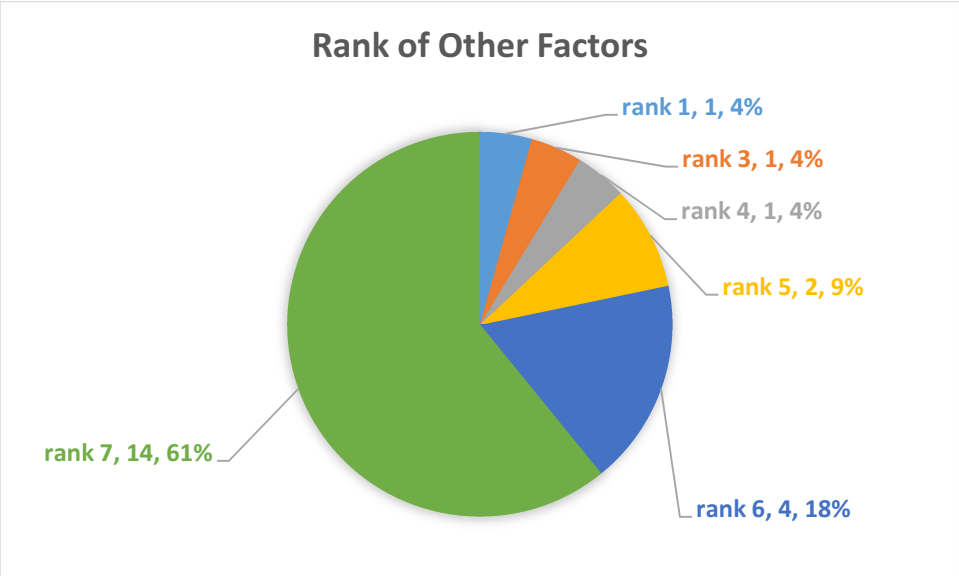

Figure 4.36 Other Contributing Factors to Forecast Accuracy

4.5 The Improvement Enablers of Forecast Accuracy

The third part of the questionnaire was designed to explore the improvement enablers of forecast accuracy. The valid survey responses for this part are 35, as there is an uncompleted survey with this part left unanswered.

4.5.1 S&OP Process and the Improvement It Brings to Forecast Accuracy

- **The Current Situation of S&OP Process**

Firstly, questions were asked to examine the current situation of the S&OP process. 29 (83%) companies have confirmed the presence of a S&OP process (figure 4.37).

In terms of time of establishment, as per figure 4.38, 12 (34%) were set up during 2000-2009, and another 11 (32%) were established after 2010. Only 1 (3%) have a S&OP process established as early as 1990. This early S&OP process establisher is again a world leading chemical company who also is the earliest of all participating companies to set up supply chain management. From the fact that this company took 10 years from setting up supply chain management to establishing a S&OP process, it is evitable that in the early days, development of supply chain management and related research and practice is slow. Table 4.10 shows the years difference between when a company set up supply chain management

and when it also set up a S&OP process. The average difference is 3.9 years with some companies setting both in the same year while others taking as long as 10 years in between. It can be noticed that the progress has then become faster since the 1990s and that most companies have realized the importance of supply chain management by setting up this function in their business and adopted a S&OP process not long after. It is also interesting to find that some companies have taken a different order, i.e. setting up S&OP process earlier than the supply chain management function, and some companies adopted S&OP process without setting up a formalised supply chain management function at all. These cases may be explained that supply chain management and S&OP process do not necessarily have to either both exist or be set up in a certain order for a business to benefit from either or both of them.

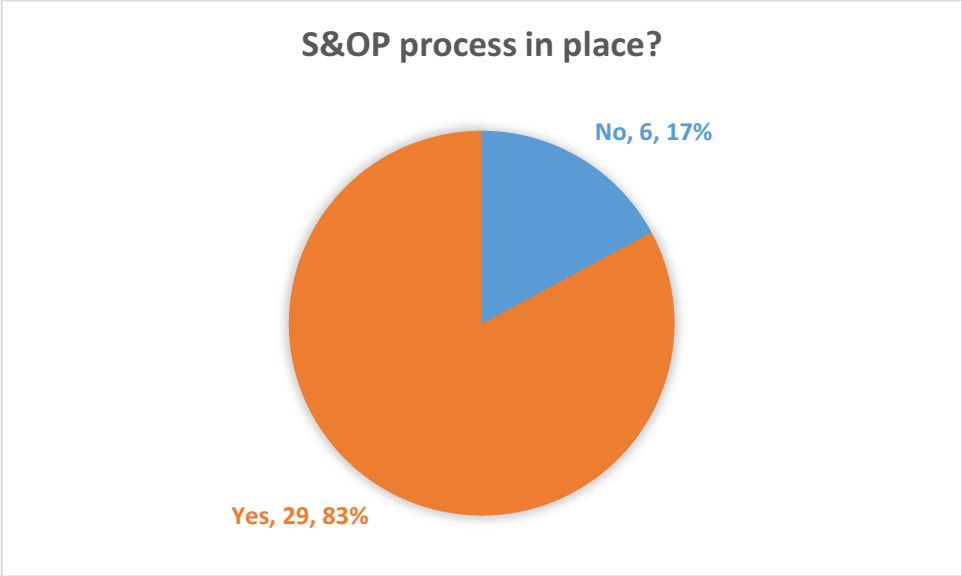

Figure 4.37 Presence of S&OP Process

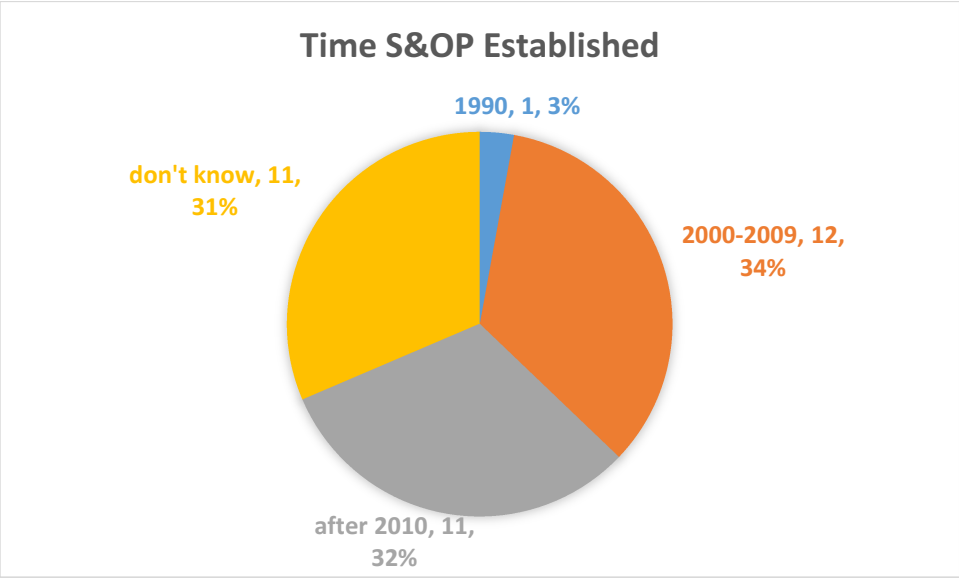

Figure 4.38 Time S&OP Established

Establishment of supply chain management	Establishment of S&OP	Difference (in years)
2005	2011	6
2009	2011	2
early 2000	2012	10
2010	2012	2
2013	2013	0
2007	2012	5
2008	2008	0
2000	2013	3
2001	2001	0
2001	2003	2
1997	2007	10
2011	2011	0
1995	2008	13
2010	2010	0
2013	2014	1
2000	2009	9
	average -->	3.9

Table 4.10 Time Taken From Establishment of Supply Chain Management to Establishment of S&OP Process

- **The Improvement S&OP Process Brings to Forecast Accuracy**

Survey participants were asked to rate the improvement S&OP process brought to forecast accuracy. Figure 4.39 shows the result. 22 (63%) said the improvement is significant, 8 (23%) said there is some improvement seen but not significant, and 3 (8%) said little improvement is evident, 1 (3%) respectively said either not relevant or not sure. It is clear that majority agreed that S&OP does have a positive impact on the improvement of forecast accuracy, either significant or in some way. Such consensus from practice provides strong evidence to the same conclusion drawn by previous academic research and studies.

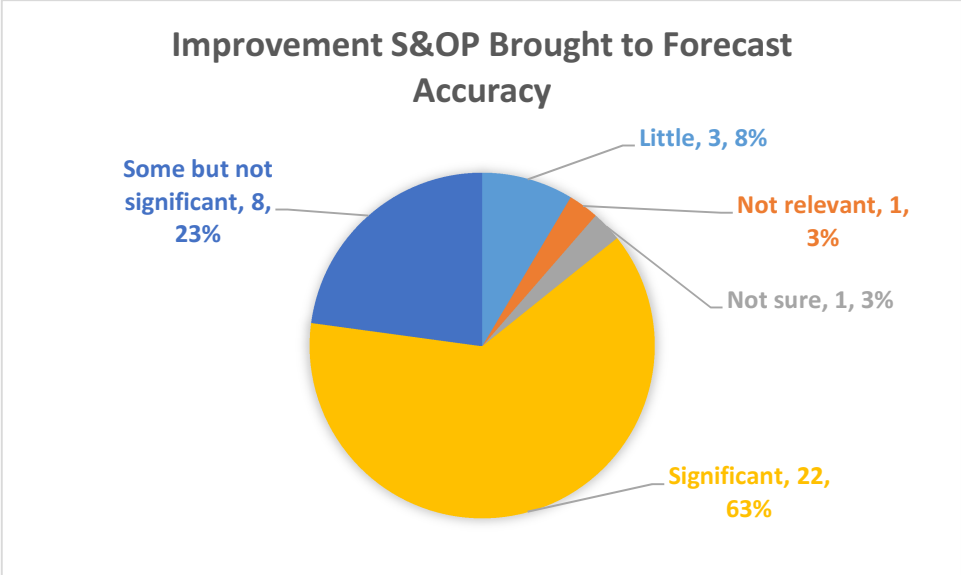

Figure 4.39 Improvement S&OP Brought to Forecast Accuracy

Interviews have provided more insights on various specific benefits S&OP process brought to forecast accuracy. The points are summarised below.

- Better communication and more transparency are frequently mentioned by many interviewees. S&OP meetings provide the best one single place for timely and effective communication in two ways or multi ways across all parties. Issues such as 'demand and supply balancing', 'capacity constraints' can be discussed and resolved at the same table, same time and by all parties involved. Information can be shared in a timely manner in these meetings where sales can provide the latest changes in demand and operations teams can raise any issues and constraints, such that last minutes changes can be

reduced and timely reaction is achieved. One participant mentioned in the past, the production starts when the orders come through, with a S&OP process in place, the forecast is enabled to become a meaningful task and as a result production can start earlier based on the forecast. Significant pressure has thus been taken off the production planning activities. The other participant acknowledged the benefit S&OP meetings brought to new product launches in particular, where all parties are brought together to exchange information, discuss issues and constraints, and agree on plans and actions to take. Here better coordination across all teams is also achieved.

- A further finding is that people are more engaged and disciplined as one participant described. In S&OP meetings, all parties are supposed to work with the same set of information, with the same goals in mind to agree on one single plan. Sales engagement is frequently mentioned as a major benefit, as S&OP meetings can effectively hold sales 'accountable' for the information and forecast they provide. 'Better alignment with budget and finance forecast/plan' is another cited benefit. S&OP meetings are also said to be a good place to 'initiate hand over meetings between teams', where further more specific plans and actions are discussed and agreed, plans concluded from S&OP meetings are carried out and executed throughout the business in this way.

- Raising awareness and obtaining focus is also a major benefit thought to be brought by the S&OP process. This is especially the situation when management and senior management are involved in the process. Here issues, constraints, changes and conflicts are presented, discussed and escalated in front of management, attracting attentions and obtaining the required authority and strategic guidance to achieve the most favourable plan for the whole business. In this regard, awareness can be explained in two ways, issues and constraints are going one direction from the operational level to the management level, and strategic views and guidance are going the other way down through the business to create more sensible understanding of the future plan. More discussions on management involvement will be found in the next section.

- **Level of Management Involvement**

The question was initially designed with only three options and missing the choice of multiple level involvement. Though this option was added when the issue was realized half way through the survey, the result was still unclear. Attempts never-the-less have been made to interpret the data in a meaningful way. As per figure 4.40, only 2 (6%) companies have only functional teams in the S&OP meetings, 18 (51%) companies have middle management involvement and 15 (43%) businesses have senior management involvement, while 7(20%) companies claimed to have multiple level involvement. It is still evitable that the of majority businesses do have a certain level of management involvement and indeed sometimes multiple levels of management are engaged.

More effort was then made to try to gain further understanding on this topic through interviews, and this was focused on the level of senior level management involvement. Two major and opposing opinions have been discovered. While some companies do value the involvement of senior management, the others to the contrary do not see the necessity.

- In the group that favours the involvement of senior management, the value of sharing views in between senior management and operational teams are highly appreciated. One participant holding the supply chain director title sees great value by commenting 'it is definitely valuable to share the outcomes and the views'. And more appreciation is found through people from the middle management, specialists and planners group. The input of senior management is seen to add value in providing guidance and a fuller picture with long term strategic views, making critical calls on balancing conflicts and making prioritisations, and backing up the decisions with crucial financial impacts. Senior management involvement also is believed to ensure decisions are made with the overall business goal in mind, minimising localised and self-centred decisions.

- On the other hand, the relatively smaller sized business or simple structured businesses did not see much value from involving senior management in the S&OP meetings. As one participant commented, in their business which is of a relatively smaller size to the others, senior management are actually actively involvement in daily business activities already, so input into a S&OP meeting is not necessary as their influence is seen everywhere throughout their everyday participation in all the business activities. In

other words, they are already seen to be more approachable and more directly involved. Also there are opinions that believe S&OP meetings are usually only operational focused, and on this basis senior management involvement is not necessary, with their input only needed for more critical formalized decisions.

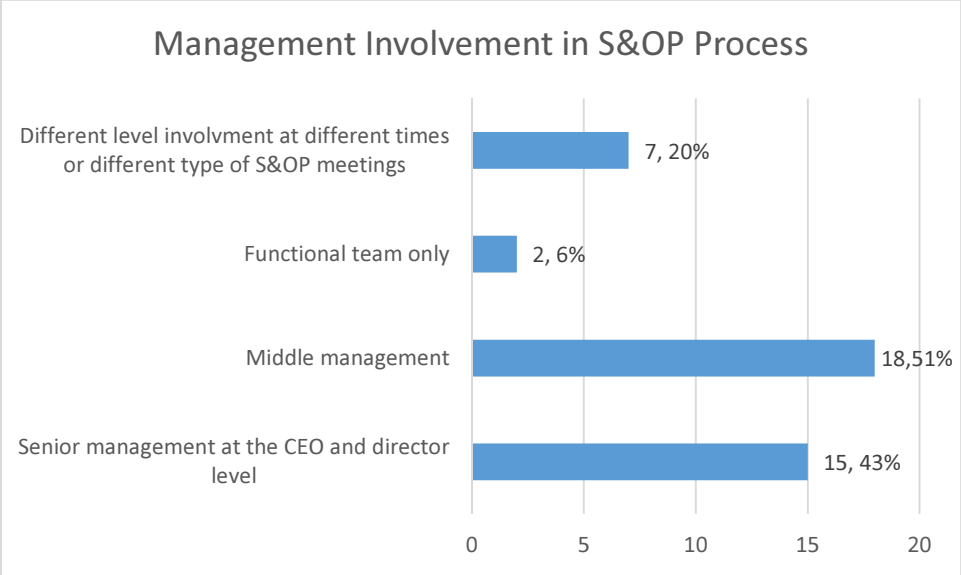

Figure 4.40 Management Involvement in S&OP Process

- **Departments and Functions Involvement**

Figure 4.41 shows the result of departments and functions involvement in S&OP meetings. Supply planning surpassed all other functions to become the most represented function in S&OP meetings. Logistics planning (24, 69%), production planning (25, 71%) and sales (26, 74%) are ranking 2nd to 4th in terms of presence. These are expected outcome and reflect what was found in the literature review, as they are the most directly involved functions in operations as well as forecasting process. Following this group was marketing (15, 43%) and finance (14, 40%). Customer service (10, 29%) and warehousing (11, 31%) are even less frequently represented 6 (17%) participants advised there are other functions involved as well. In this respect, manufacturing, new product development, category management and technical department are mentioned. The reference of 'category management' raised some interests, as the same participant agreed to attend the interview as well, so the opportunity was taken to ask for further explanation on this function. It was thought to be related to procurement, however, in fact, in this business, category management is a performance management type of function based on product category. Each category manager will

monitor and review the sales performance of the products in their category, then undertake analysis and make adjustment to maximise the performance of the products in their category. This appears to be a good practice to incorporate performance management in the S&OP process as it associates performance closely to operational activities such as planning, forecasting, manufacturing as well as finance and customer service.

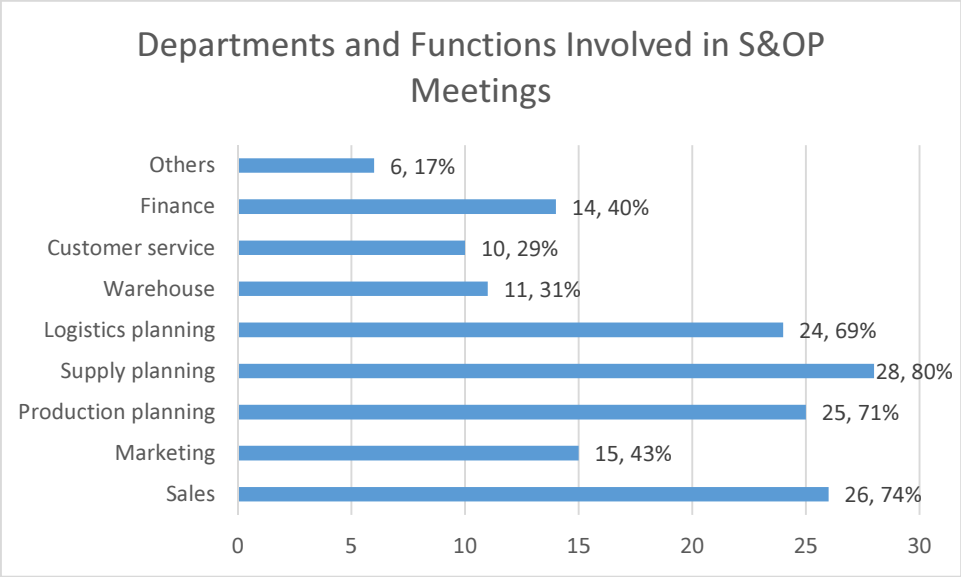

Figure 4.41 Departments and Functions Involved in S&OP Meetings

- **Frequency of S&OP Meetings**

A question about the frequency of S&OP meetings was asked to explore what is the most preferred or most effective frequency in practice. Results are shown in figure 4.42, with the majority of companies (27, 77%) working with a monthly frequency, 1 (3%) company is holding quarterly S&OP meetings, and 3 (8%) companies are exercising weekly S&OP meetings. Two companies have chosen the 'other' option, one is doing bi-weekly (fortnightly) S&OP meetings, and the other one is also holding bi-weekly meetings but with more flexibility to organise more when required by individuals or by teams.

Interviews on this topic has again provided more insights about the real situation. Some people are happy with the current status, others advocate that changes and improvements are needed. These opinions are summarised below.

- It appears companies with longer planning horizons are quite happy with the monthly frequency. For example, a company with a 3-18 month planning horizon confirmed that

monthly frequency is 'about fine'. They did mention if the planning horizon is shorter, more frequent S&OP meetings are needed. One participant in a planner role doing planning with a 6-8 weeks cycle confirmed their movement from monthly to twice monthly S&OP meetings, this can be seen as further evidence of the relation between the planning horizon and the frequency of S&OP meetings.

- The stableness of the business and/or the market is also believed to a determining factor in the frequency. One company mentioned in their current stable situation, monthly S&OP meetings is found to be sufficient.

- Effectiveness is also seen to be closely related to the frequency of S&OP meetings. As one participant commented, as long as it is effective, the monthly meetings are sufficient. They see the effectiveness as the key and not the frequency.

- Various attempts have been made by companies who find monthly S&OP meetings to not be sufficient. Moving towards bi-weekly or even weekly is one solution, however, this has frequently been found easier said than done. Challenges have been expressed, such as lack of buy-in from relevant stakeholders, inconsistency in the communication and the process, and lack of education throughout the business on the importance of S&OP meetings. Initiating small scale informal meetings outside the formal S&OP process is another solution, or even sometimes not necessarily in the form of meetings but rather frequent information exchanges and updates in any form was deemed to be very helpful.

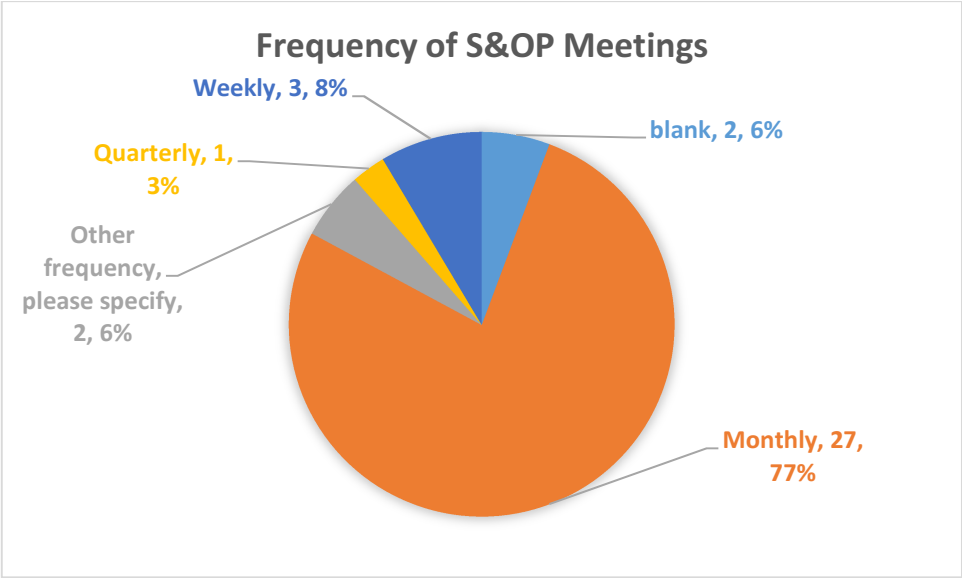

Figure 4.42 Frequency of S&OP Meetings

4.5.2 Other Types of Collaboration Programs

Apart from the S&OP process, the research looked to explore and investigate the application of other types of collaboration programs in practice. Participants were asked to identify if any of these programs are in place in their supply chain. Figure 4.43 shows the result.

VMI (vendor managed inventory) and CPFR (collaborative planning, forecasting and replenishment) are both found to be widely adopted in practice, each have 17 respondents utilising these methodologies, mainly from the manufacturing, distribution and wholesale, and retail sectors. This result is in line with findings from academic research which has already discovered these two programs are the most utilised in practice.

CPR (continuous replenishment program) has had 9 practitioners. It has been observed that all the 9 respondents have either a CPFR or VMI program co-exists with their CPR program, or sometimes, all three of them are being practiced simultaneously (refer to table 4.11). Without further clarification and investigation, it is difficult to tell whether this is just a result of different understanding and confusion of these programs due to their similarity, or in fact, they are indeed mixed purposely to complement each other to bring an even more favourable outcome.

QR (quick response) and ECR (efficient consumer response) have 2 and 1 adopters respectively, considering these two programs were originally developed primarily for the

apparel and grocery industries, while majority of the businesses involved in this research are not from these two sectors, the result may not be able to represent the full picture. However, the three practitioners of these programs are from agriculture tools and technology, food manufacturing, and, raw material wholesale and distribution sectors respectively. Such fact, on the other hand is also an indication that these programs have increasingly been recognized outside the original sectors they developed from.

Kanban system is also mentioned as one of the cross functional programs by one company. Interestingly, the company found to have the most multiple programs in place, operated S&OP, CRP, VMI and CPFR as well as SSQ (safety stock quantity), MRP (Material requirements planning), and DRP (Distribution resource planning) systems. How these systems are managed, how they complement each other, and how efficient they are, remain some of the questions to be further investigated. Considering the company advised they are undergoing a business process review project, it appears the existence of such a proliferation of programs, practices and processes, may not be the most desired situation.

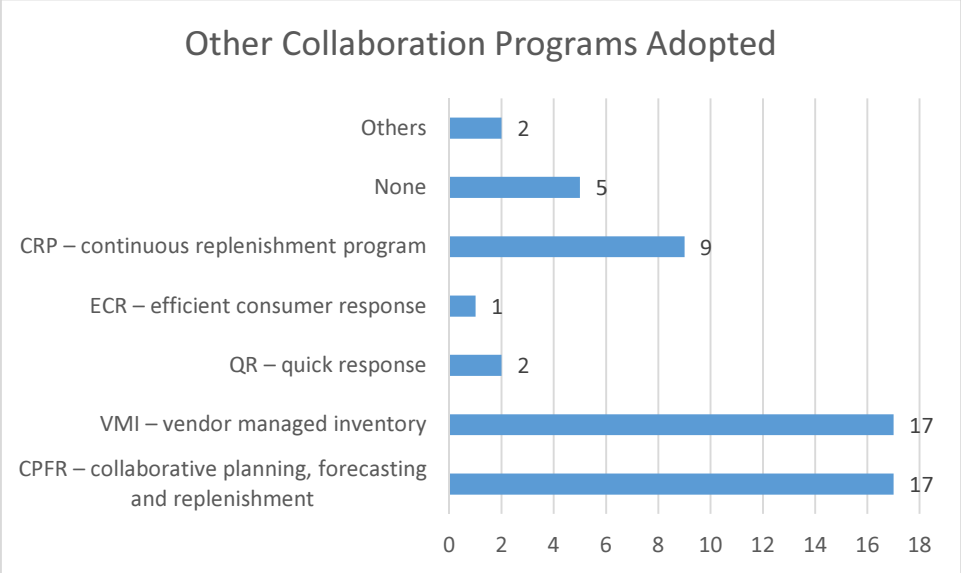

Figure 4.43 Other Collaboration Programs Adopted

CPFR	VMI	QR	ECR	CRP	Others
yes					
	yes			yes	
yes	yes				
yes	yes				
yes	yes			yes	
yes	yes			yes	yes
		yes			
yes	yes			yes	
	yes			yes	
yes	yes				
yes					
yes					
yes					
yes				yes	
	yes				
			yes		
	yes				
yes					
				yes	
yes					
	yes				
	yes	yes			
	yes			yes	
yes				yes	
	yes				
yes	yes				
yes	yes				
	yes				
yes					

Table 4.11 Display of the Situation of Various Collaboration Programs Adopted

4.5.3 Forecasters' Training

Since a forecasters knowledge, skills and capabilities are important factors in forecast accuracy, it is of interest to explore how forecasters training is managed by businesses in practice. An open ended question was asked to obtain maximum insights on this topic. Results are shown in figure 4.44.

Almost half (16, 46%) of the companies left this question blank, answered 'none', 'not sure' or 'don't know'. Such an outcome clearly indicates a lack of focus in this area.

The most common type of training was found to be, on-the-job training and mentoring. 10 (29%) businesses stated this type of training is in place for their forecasters. However, how the training is managed displays a varied level of strength and attention.

- **One-on-one coaching and mentoring on the job**

Some companies only have basic one-on-one coaching or mentoring to facilitate knowledge transfer and skills development. Tools and systems training usually happens in this process as well. Only in 6 (15%) cases, tools and systems trainings were specifically mentioned.

- **Training with wider business knowledge**

Others will supplement with training provided by functional managers relating to end-to-end supply chain management techniques, demand and supply knowledge, collaborative planning concept and skills, order lifecycle management techniques, product and customer related knowledge etc. The intention is to widen knowledge and create a more globalized understanding of the wider business. These training methods were specifically quoted in 3 (8%) cases.

Self-led learning through internal on-line courses is also mentioned by one participant as a main method of training. Company information indicates this is a world leading confectionary and food company, the size of the company and level of maturity of the business lend a logical explanation to the ability of providing such advanced learning environment to its employees.

As a further step exercised by some businesses, supply chain management consultants are invited to provide external training, and in other cases, external courses, certificates,

workshops and seminars are provided and supported as well. Companies conducting this type of training only counted as 4 (10%).

Last, in a situation where 'forecasts are completed by market managers and not a specific demand manager', the market mangers who produce the forecast are viewed to already have the knowledge of sales and the market activity, and all they need to do is to feed the information into the system and then let the system do the forecasting job with one of a number of 'statistical based forecasting packages', so no training is needed. Such opinion does seem to have a valid point at first glance, however, questions need to be asked on how knowledgeable and skilled these managers are, how well the forecasting packages are designed, and if there is any review process on the accuracy level of the forecasts produced by such process and system.

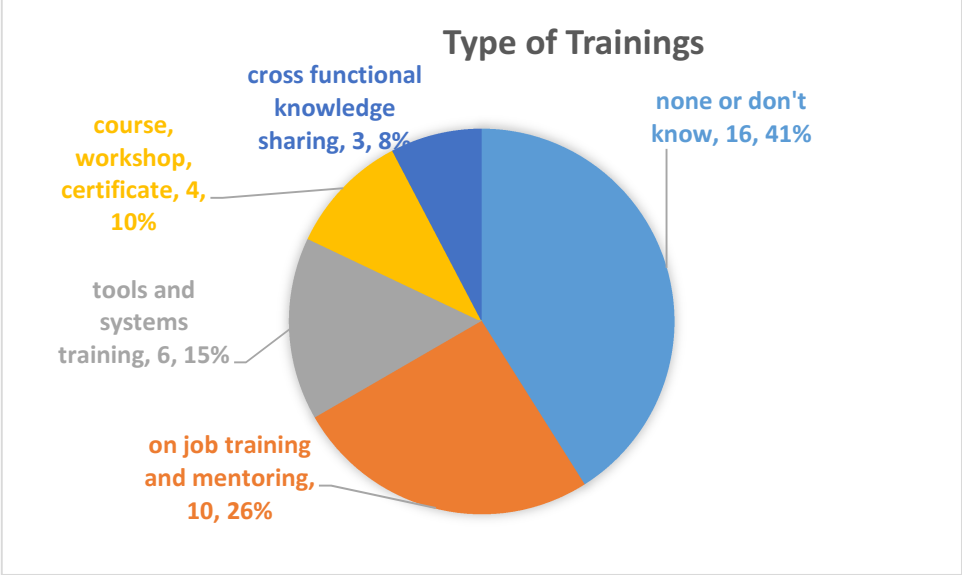

Figure 4.44 Trainings Provided to Forecasters

4.5.4 Supply Chain Design and Redesign

Under this subject, participants were asked for their opinion on the positive relationship between forecast accuracy and supply chain design/redesign. As per figure 4.45 an overwhelming 32 (91%) companies admitted the design and/or redesign of supply chain has a positive impact on forecast accuracy, i.e. it improves forecast accuracy. Such a high level of consensus shows a wide and uniformed recognition in this aspect.

However, recognition is one step, taking actions to make it happen is a much harder further step. Of all the companies that believe supply chain design/redesign will have a positive impact on forecast accuracy, more than half of them 18 (51%) have not been able to take any action yet.

14 (40%) companies on the other hand have had various practices taking place, and consequently received benefits from those efforts. There are some good practices that have been identified.

- One participant commented as the supply chain design/redesign 'brings responsibility and accountability to the forecasting process', though no actual activities have been mentioned to have led to this outcome, it is interpretable these efforts are most likely related to performance management. Another participant stated more clearly that 'changes in roles and responsibilities' have seen forecast accuracy improved.

- 'Collaborative planning and working to one plan' is more of a supply chain mentality change that creates a collaborative environment for all to work towards one plan.

- 'Consolidation of supply and freight partners, strategic partnering, and process realignment' are mentioned as well. This is in fact a restructure of the supply chain participants and a redesign of the processes with overall supply chain interests in mind. In the follow up interview, this manager has explained in further detail on how 27 freight providers were reduced to 5 and then extended on a national scale, and with technical support, 1 to 2days have been taken out of the supply chain, a significant cost reduction has been achieved, and with less freight supplier to deal with, stronger partnerships were built. On the customer side, efforts were also made to obtain partnerships in order to engage customer working towards the same goal. More committed partners ensure a stronger trust level across all supply chain participants. More streamlined processes enhanced information sharing and maintains information quality throughout the sharing process, in the end increasing the forecast accuracy as an outcome of this process.

- A supply chain designed to deliver a high level of customer service is seen having a potential benefit on forecast accuracy and vice versa. As explained by one participant, high reliability on delivery performance gains more trust from customers, reduces the risk they perceive received from such supply chain, hence enabling the removal of the safety buffer they put in the ordering process. Less artificial orders with healthy patterns will in turn lift the accuracy level of supply chain forecast. The other company explained from an alternate angle, as they buy products from their own factories around the world, a well-designed supply chain provides optimal plans on the right place to buy the right product, in the right package with correctly assessed manufacturing and shipping capacity to ensure the best delivery performance, in the end customer satisfactory will lead to a higher level of engagement and trust in the forecasting process, consequently forecast accuracy is improved, which in turn ensures a smoother operation in the future, couple with a healthy cycle connecting forecast and physical delivery.

- Supply chain software redesign in the form of system replacement, upgrade or re-alignment as well as improved skill set is also believed to be able to improve forecast accuracy.

- Simplifying a supply chain by removing middle layers such as 'delivering to customers directly instead of through a warehouse' improves forecast accuracy significantly as well as providing cost benefit. In another example, 'reducing the complexity' of the supply chain shortened lead times, which consequently improved forecast accuracy. In another situation, a VSO program is mentioned to reduce complexity and remove waste from that supply chain.

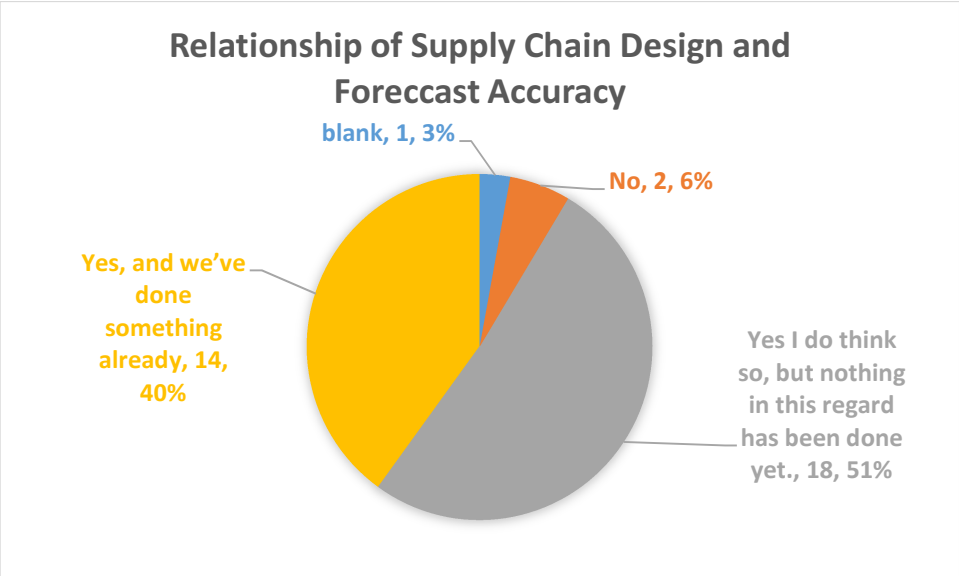

Figure 4.45 Relationship of Supply Chain Design and Forecast Accuracy

4.5.5 Tools, Systems and Associated Investment

Tools and systems are not only contributing factors to forecast accuracy, they are also improvement enablers as viewed by studies of a number of researchers. Questions have therefore been asked in the survey to see if the same view is held in practice.

- **Planned Implementation of Tools and Systems**

The first question asked, is about whether there are plans to implement more tools and systems in future to improve forecast accuracy. Figure 4.46 highlights that nearly half, 17 (48%), of businesses confirm such plans, while the other half 17 (48%) are strongly of the opposite opinion, i.e. no plans of introducing more tools and systems. Such evenly spread answers of two opposite opinions exhibit conflicting views on this topic by practitioners. Referring to earlier findings on peoples view on the value brought by tools and systems, 10 (28%) did not think tools and systems added value and a variety of reasons were given for this. This could logically explain why half of the businesses do not plan to implement more tools and systems in future. The other reason of not getting more tools and systems could be interpreted as either current tools and systems are satisfactory, or pending investment justification which will be discussed later in this section.

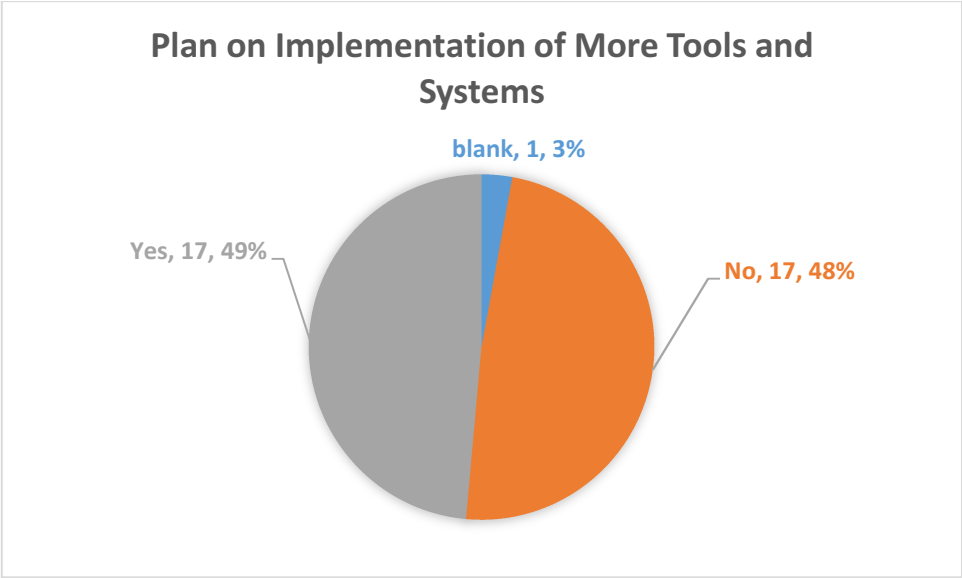

Figure 4.46 Plan of Implementation of More Tools and Systems

For those respondents who indicated 'yes' that they plan to implement more tools and systems in future, an open-ended question was asked to explore what kind of tools and systems coupled with the purpose of them. Findings are summarised below.

- APO - Advanced Planning Optimisation is mentioned by a company who has had SAP just implemented recently. It advised that the APO tool will be deployed in the next three months to follow the recent SAP implementation, and that this is expected to serve the business's forecasting and planning needs by being 'more user friendly and combine trending analysis from sales history to generate better forecasts'.

- Another company has advised SAP implementation is on the way. Referring back to earlier questions on the current systems and their value, this company confirmed they do have existing systems in place, but answered 'no' to the question about the value of such system. It is logical to conclude that the upcoming SAP system is to replace the current system with an expectation to bring more value to the business.

- CRM (customer relationship management) systems were also mentioned as a tool once implemented that would better engage international customers. This company plans to use it to host 'all information of the customers such as order and sale history in the last 3 years and to generate a long term future forecast for the next two years.' Then specified objectives are associated to each customer such as 'X% growth in the next

year'. 'Regular reviews' are to follow, then 'structured talks and discussion' are initiated with customers. This system is also expected to hold all information in one place, within a global business set up. Such a system provides access to information to all employees without any time zone barrier, reducing information hand over via e-mails and avoiding delays.

- Demand planning tools either to be built within current systems, or as a whole new demand management system with more advanced forecasting tools are planned by some companies. In some cases, specific system names were not mentioned, but rather the expected function of such systems and tools was discussed.

- One purpose of such tools and systems is to supplement the current tools and systems with more effective functions. Some of these expected functions are: 'identifying problems and enabling root cause analysis', followed by 'generating reports and feedback to the market'; 'measuring forecast accuracy with the ability to drill down to product item, quantity and period details'; 'statistical forecasting at scan data level'; and, 'trend reporting to identify product over/under selling'.

- Another purpose of such tools and systems is to bridge gaps between current different systems. One company mentioned a system to build 'closer links to the finance system', and another company mentioned a tool or system to 'integrate data from the sales system and customer's system'.

- Not surprisingly, a training tool is also in some company's plan indicating the recognition of the importance of training to forecast accuracy. Aside from individual systems or tools, some companies are initiating or developing projects with wider business views to either pursuing 'continuous improvement' or build a new 'integrated business planning process framework'. Such framework is expected to reinforce 'a better process orientation', assist with 'defining roles and responsibilities', perform 'gap analysis' and provide 'consultations'. Finally, there are some companies who are just at the starting point, 'investigating specific solutions'.

- **Justification on the Cost of Tools and Systems Being Implemented**

Developing new tools and systems usually involves a considerable amount of investment, therefore whether this is of concern is asked of the participants. As per figure 4.47,the majority of companies (30, 86%) expressed that a concern is indeed existing, while 4 (11%) did not have any concern. Again, for those respondents indicating concern, an open-ended question was asked following this question to find out the primary focus of these concerns. The findings are summarised below.

- As expected, cost versus benefits or returns are the most commonly focused aspect. Whether the tools or systems are worth the investment; how much benefit it can bring; how long before the benefit can be seen; and, what is the cost of failure, are some of the major concerns raised. All these are difficult to quantify in the form of dollar value. For example, most tools and systems that are expecting to improve either process efficiency or forecast accuracy will eventually improve the customer satisfaction level, however, increased customer satisfaction is difficult to quantify in financial value. Therefore, justification of the investment presents a true challenge.

- Even where the investment is well justified, the cost itself is frequently a challenge for the business to take on financially. Some companies simply cannot afford the financial spend on sophisticated systems even where they are deemed to bring substantial benefit. Limited cash or capital budgets are the main constraints. Sometimes, as a prerequisite, excessive I.T. investment poses a challenge to the business as well.

- Small or simple projects that do not require massive I.T. or software/hardware investment attract less concerns. The focus is then on whether they can bring any benefit, and the necessity to quantify the benefit is less intense.

- Justification is also not a major concern for subsidiary companies where the same has been done by the parent company already. Apart from the cost and benefit focus, some other concerns on introducing new tools and systems are also highlighted.

- 'Culture change' is one concern associated with implementing new tools and systems. In this case, sales function is specifically mentioned. Because they are the ones that bring the demand information into systems and the forecasting and planning process, how they cooperate with the process as well as the relevant teams adds direct impact onto the final outcome. Attitude need to be changed from self-centred to system complied and process driven. Focus need to be moved from individual sales goals to overall supply chain goals.

- Whether a tool or system can retain and protect IP (intellectual property) is also raised as a justification point. Here tools and systems are expected to retain and perform human knowledge and skills, incorporate such intelligence into its process and over time retain the IP within the business. The benefit is seen as less impact caused by personnel changes, and an improved consistency in terms of performance.

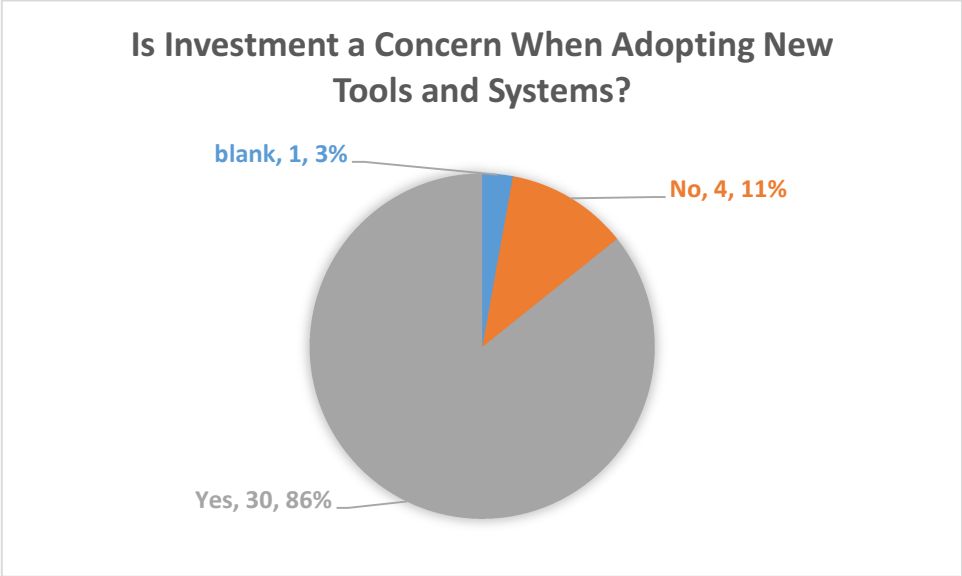

Figure 4.47 Concern on Investment of Tools and Systems

4.5.6 Motivation and Incentive Schemes

Under this subject, the question that was asked of participants was to identify any motivation and/or incentive schemes that have been practiced especially those which do not directly benefit from the improvement of forecast accuracy. Figure 4.48 shows the result. Over half (20, 57%) of the businesses answered 'no' to this question, while 13 (37%) said

'yes', with 2 (6%) leaving this question blank. From the result, it can be concluded that there is a lack of focus in this area in the real business world.

A further open-ended question was asked in order to discover good practice in this area. Out of 13 companies who confirmed having such motivation and incentive scheme in place, 12 answered the open-ended question with details of such scheme. Findings are summarised below.

- Performance management linked to bonus has been mentioned the most. MBO (managed business objectives), KPI (key performance indicator), and personal objectives are the most constantly mentioned performance management techniques. A further step is taken to link performance to a bonus scheme, where obviously a higher performance is associated with better bonus. In this way, people who do not get direct benefit from improved forecast accuracy can be motivated effectively. For example, a sales person whose performance is only measured by his own sales target may not be interested in contributing to forecast accuracy, while if he puts effort in providing high quality in time information to assist with forecast accuracy improvement and he gets rewarded through his bonus, he is more likely to be engaged and cooperate. One example was given to explain this technique in detail. In this company, the sales or account manager have a KPI of keeping stock older than 90 days below 10%. In this situation this is then linked to an X% of quarterly bonus. A similar situation was found with other forecasters and the like.

- 'Priority supply against forecast accuracy' is another method to encourage forecast accuracy improvement. In this situation the demand with most accurate forecast gets priority in being met with supplies. This should work well in situations where supply is in deficient to demand in terms of time or quantity.

- 'Internal training' is also mentioned, without further clarification, one can only presume that in this situation better performance in forecast accuracy will be provided with more training opportunities internally.

All of above schemes are based on either quantifiable or tangible incentives. One participant has viewed this from as 'a higher moral level'. He claimed, everyone in the business benefits from improved forecast accuracy even if not directly. Education is the key. Here raising awareness, engaging people, building and increasing accountability, creating an environment that values and promotes the overall business goal will see people more self-motivated in contributing to forecast accuracy improvement.

There is also business that has just started to realize the necessity of motivation/incentives, and they are 'designing this under a wider business process review'.

However, it must be noticed all of these techniques and initiatives are focusing inside of the business. Nothing have been mentioned on how to motivate suppliers, customers and other participants who are outside the core business but making up crucial components of the end to end supply chain. In this aspect, it appears practice is well behind the academic research and studies.

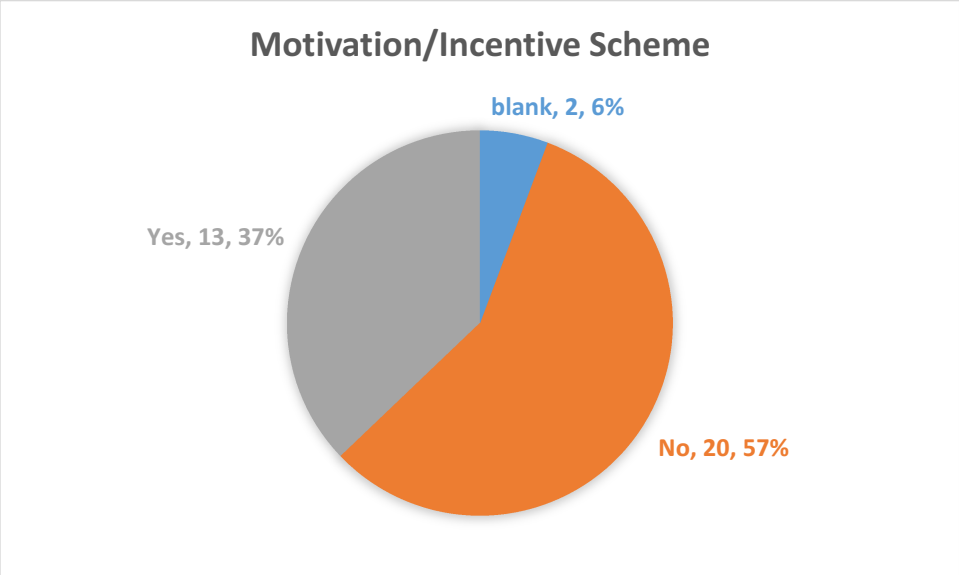

Figure 4.48 Motivation and Incentive Scheme

4.5.7 Monitor and Review Process

Along with the intention to explore motivation and incentive scheme applied in practice, monitor and review process is also a subject of interest to investigate in the real business world. Hence, similar questions were asked, first question is about whether a business has a monitor and review process, and then an open-ended question is asked to capture the

various processes adopted in practice in order to discover good practice as well as assessing development against academic research and study.

Refer to figure 4.49, an encouraging number of 23 (66%) companies have confirmed the existence of a monitor and review process, compared with only 13 (37%) that have motivation and incentive schemes in place. It appears supply chain management for these businesses is a more mature aspect. Never-the-less, there are still 9 (26%) companies that do not have a monitor and review process in place, and 3 (8%) did not answer this question indicating most likely they do not have such process either.

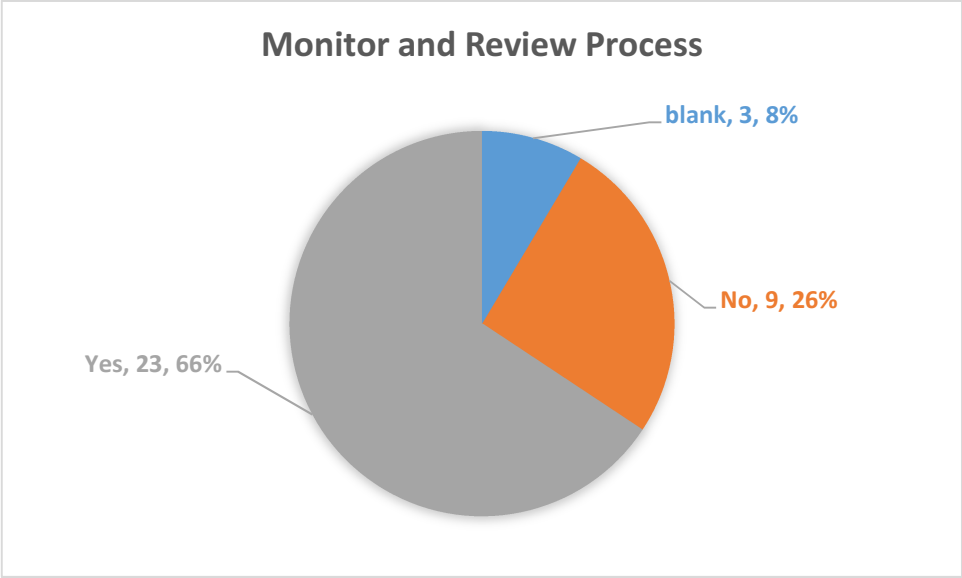

Figure 4.49 Monitor and Review Process

The open-ended question in this instance asked, what is the monitor and review process, 19 companies have provided brief descriptions of their monitor and review process and their comments are reviewed and summarised below.

- Monitor and review process tied in with S&OP process is one major solution. Nearly half of the businesses are taking this approach. One company has further described this process as 'monthly KPI leader board by sales account manager, and demand reviews with each account manager and marketing manager'. Here the KPI leader board is a way of monitoring performance, and the demand reviews are in fact a review process. In terms of the specification of KPIs, some companies have provided further details of the setup, in this case, KPIs are broken down to category level, divided by market, and

even drilled down to item level. It is also found that the review cycles are often aligned with the S&OP meeting frequency, i.e. 'monthly' is the most adapted interval.

- Other companies also have various reviews in place without mentioning any connection with the S&OP process. Again, a monthly frequency is the most popular cycle of these reviews. One approach is to monitor and review against pre set-up KPI's. Another approach is to measure the forecast accuracy and forecast bias statistically, then to undertake some level of root-cause analysis to identify reasons and obtain further understanding. Feedback is then provided to concerned parties, and other actions and plans are followed to reduce the causes of negative impact, which ultimately results in forecast accuracy improvement.

- Continuous review or improvement was also being referred to. Instead of a clearly defined frequency, this type of review process takes on a real time and 'when is needed' approach. Presumably there is still time intervals between reviews, but of a more frequent and casual manner. In some cases, companies do not formally set up such processes, but in fact are performing such reviews on a 'case by case' basis. Root-cause analysis is also taken to find the reasons, trends and patterns, followed by improvement initiatives. Finally, some businesses were just at an early stage of setting up these processes, and advised, 'it is under development'.

4.6 Other Findings from the Interviews

Both the questionnaire and follow-up interview questions were designed based on observations from the literature review. In order that there was opportunity to capture anything that may have been overlooked as a consequence of this approach one extra question has been asked in the interviews. The question was of a general nature, asking: if the participants and their companies have any other comments on forecast accuracy improvement, any issues, any plans, and desires etc. Some valuable findings have been discovered and summarized below.

- **Desire from the specialists and planners group**

In this group, some participants have expressed the urge of being supplied with 'more technical support, guidance and resource for the forecasting process.' Inadequate management focus and support in this area has become a serious concern. Without effective management support, maintaining and improving an efficient forecasting process is 'mission impossible', as one respondent described, 'people are just running around to get the job done'. The quality of the job then becomes questionable, consequently, the forecast accuracy is negatively impacted and the overall supply chain performance will decline. Additional to management focus, correctly designed measures on forecast accuracy as well as good quality training was also desperately desired by these specialists and planners.

- **Raising awareness and changing attitude**

As has been referred to in previous discussions, raising awareness and changing attitude among the sales and marketing team on the importance of forecast accuracy is urged desperately. For some businesses, demand information is mainly coming through the sales and marketing team, because they are at the front dealing directly with customers and gathering all relevant information. If they have a sound understanding of the significant impact on the forecast accuracy by the quality of the information they provide, focus and efforts can then be put on their information collecting process, and with high quality information, the accuracy of the forecast is protected. In other businesses, success of engaging sales has already been achieved, the sales team is seen constantly improving, and a mature and robust forecasting process has been realized as well. Further to engaging the sales and marketing team, obtaining buy-in from other people throughout the supply chain, reinforcing education on the crucial value that forecast accuracy brings to overall supply chain performance, increasing peoples responsibility and accountability are all mentioned to be fundamental to forecast accuracy improvement.

- **Cleaning data**

For businesses utilizing complex systems, the data housed in such systems may have been integrated from other old systems, and in various formats that have not been correctly standardized. Here, 'analysing data errors and cleaning up of master data' have been

specifically mentioned to be essential for the system to perform better and produce more sensible output.

- **Collaboratively working with suppliers and other partners along the supply chain**

This is addressed again in general to be critical for enhancing understanding between partners throughout the supply chain, which forms a foundation for sharing high quality meaningful information in order to improve forecast accuracy. Some critical issues are also identified. One company referred to the situation that the biggest customer does not provide a forecast. This is typical in a supply surplus market where customers are in a more powerful position which allows them to take advantage of the competition among suppliers, trying to get the most benefit with least effort. For this particular business, deploying a CRM (customer relationship management) system is believed to assist with engaging customers more and building stronger relationships.

- **IBP (integrated business process)**

From a process perspective, though S&OP is the most adopted program to enhance collaboration across the supply chain, the emerging IBP (integrated business planning) concept has been taken on by some businesses as well. IBP is believed to be able to 'go beyond S&OP' with more strategic focused broader cross functional coverage, combining strategic planning, operational planning and financial planning all together (www.oliverwight-eame.com, 2014).

- **Transiting to demand driven**

Some businesses are strategically transitioning to a demand driven model, in this case, information exchange becomes more critical to a successful demand driven supply chain, as demand information is essentially a true forecast that drives the whole supply chain. However, even though some participants mentioned that the forecast is not adding value for short term planning with long lead times, it is still seen as useful in long term planning tasks to provide meaningful assessment and guiding the businesses overall direction.

- **Forecast accuracy improvement should be an on-going task**

As one participant correctly pointed out, getting close to 100% is the goal, but it can never be fully achieved. Continuously improving forecast accuracy will ensure a business stays on the right track.

- **Choose the right solution**

It was also stated that as a supply chain is industry specific, there is no right or wrong solution and approach, and a business should always examine the individual supply chain to develop the best suitable solution.

Chapter 5 – Conclusions and Recommendations

5.1 Introduction

Through earlier literature review and the findings from the survey and interviews, this chapter draws conclusion in section 5.2 on the objectives set out by this research. Recommendations to practitioners are provided in section 5.3, then limitations of this research are declared in section 5.4. Finally, section 5.5 provides suggestions for potential future research.

5.2 Conclusions

There were three main objectives set out within this research:

- To evaluate the development of supply chain management and the recognition of the important role forecast accuracy plays in supply chain performance in the real business environment.

- To identify the contributing factors to forecast accuracy recognized in the real business environment and the related good practices.

- To discover the improvement enablers for forecast accuracy recognized in the real business environment and the related good practices.

Conclusions drawn are presented below.

5.2.1 The Development of Supply Chain Management and the Important Role Forecast Accuracy Plays in Supply Chain Management

Echoing the findings within the literature review, the research result showed an overwhelming 94% of businesses have had a supply chain management function set up in the last two decades. With most of these businesses being New Zealand located, it demonstrates a healthy development of supply chain management in the real business

world in New Zealand. With 89% businesses advocating a focus on forecast accuracy in this research, it is encouraging to see the importance that forecast accuracy has attained and that it has been highly recognized among New Zealand businesses.

Such importance, is widely acknowledged through the impacts that forecast accuracy has had on various individual aspects of supply chain performance as well as on overall supply chain performance.

In terms of impacts on individual supply chain performance, inventory status is the most concerned area in the practitioners eyes. Followed by the production decision and pricing status. Other impacted aspects identified are procurement and sourcing, freight and delivery planning, sales contractual obligations, and product promotion.

The impact on the overall supply chain performance has been recognized by 94% companies. It has been associated to service level, customer satisfaction level, cost and profit. It is acknowledged that being the starting point of all downstream supply chain activities, the forecast and its degree of accuracy play a critical role in assisting with procurement and sourcing activities, initiating sound production planning, maintaining optimal inventory status, and consequently ensuring satisfactory deliveries to customers. High forecast accuracy in fact is the backbone of a supply chains responsiveness, reliability and ultimate success. It also encourages healthy collaboration between trusted supply chain partners, brings mutual benefits to all supply chain participants and eventually creates a win-win result.

Various measuring approaches and methodologies have been discovered through this research.

Forecast accuracy is the most commonly adopted measure for monitoring the level of accuracy itself. In reality, this depends on the purpose of the forecast, where accuracy is measured against actual production, actual delivery, actual sales, actual pricing, actual supply and demand etc. to identify the gaps. Usually followed by one further step, that of root cause analysis, coupled with a monitor and review process being initiated. In some cases, advanced analysis drilled down to per customer, SKU, and market level is exercised for more effective review and improvement.

Alongside forecast accuracy, are those measurements focusing on different aspects of supply chain performance. Research results have exhibited a wide range of such measurements either evaluating the overall inventory status, or assessing certain characteristics relating to stock, capacity, cost and finance. Also service level is found to be the most commonly adopted measure for overall supply chain performance, with either clearly defined terms such as DIFOT, DIFOTIS, and OLOT etc. or other similar approach without such fancy terminology. Measuring back orders and returns also had some adopters. The cost and finance related measures are often calculated directly in dollar value forms. For other types of measures, in most cases, they are calculated statistically, or in quantities. Only a small number of companies have managed to translate some of these measures into dollar values which is encouraging to see.

However it must be noted, even though the majority of the businesses do recognise the significant impacts of forecast accuracy, there are many less companies who actually have measurements in place to assess and monitor the impacts, not to mention the effectiveness of these measurements. The existence of such a gap is a clear indication that actions are lagging behind in terms of measuring and monitoring the impacts for future improvement. Furthermore, analysis of the survey results on the status of the application of measurements has shown that businesses in practice have varied degrees of development and achievement in regards to effectively measuring the impacts. Some do not have clearly defined measurements in place at all, some are at the initial stage only applying some basic methodologies, and few businesses seem to be at a more matured status with advanced and effective measurements set up. There was only one business that expressed that they were very satisfied with their current forecasting process.

Though most businesses are currently still forecast driven and focusing on the relevant impacts and measurements for improvement, exceptions do exist. It was discovered through this research that turning away from forecast driven to a lean manufacturing approach is chosen by some business. In this situation, the seemingly never ending and never effective enough forecast accuracy improvement process has been given up to pursue a true demand driven supply chain model. However, it must be pointed out that this is still in fact a forecasting activity based on true customer demand instead of other types of

information. The long term forecast however, is still in favour to guide the direction of the business strategically.

Finally, the importance of forecast accuracy to closed-loop supply chains or reverse supply chains has been studied academically but there has been limited practitioners in this research, indicating lack of awareness in practice in this regards.

5.2.2 The Contributing Factors to Forecast Accuracy

Opinions and views on the contributing factors to forecast accuracy have been successfully identified through this research.

- **Information Quality**

Information quality has been considered the most important factor to forecast accuracy. Survey results also showed that in general, the information quality is satisfactory in terms of the four main characters, i.e. in time, accuracy, access convenience and reliability. However, it is notable that most of the ratings are at the 'OK' level and there are still a third of the participants who did not give any rating above 'OK'. Both findings are indicating a need for further improvement. In regards to the relationship between data handovers and the quality of information, though the majority (73%) of businesses are practicing less than two handovers in the data handling process, fewer companies (58%) recognized the direct link between data handovers and information quality, this is indicating a lack of awareness in this regard. Data providers credibility is considered satisfactory, again, with most ratings at the 'OK' level, further improvement is still desired.

- **Information Sharing**

Sharing of information ranked as the second most important factor to forecast accuracy. Sharing information through the S&OP process and other collaboration programs, via system interfaces and via excel are all utilized by businesses in one way or another. In most cases, multiple methods are adopted. In terms of extent of usage, system interfaces as a method is lagging behind collaboration programs and Excel, it is believed to be due to the investment

involved and the concern on the value and effectiveness of such systems. It is also concluded that no single method is perfect, each has their advantages as well as downsides. How to get the best out of each method or use them to complement each other to maximise the effectiveness is the key. It must be highlighted that compared to the enormous attention from academic studies on information sharing, there is still plenty of opportunity for works and improvement to be done in practice.

- **Forecasting Methods and Approaches**

Forecasting methods and approaches is classed as the third most important factor to forecast accuracy. Top-down is found to be the most prevailing forecasting approach which starts with the strategic forecast cascading down through tactical and operation levels. It is followed by bottom-up then middle-out approaches. Rolling forecast is identified as the most popular forecasting method in practice followed by techniques such as lead time and ordering quantity.

- **Forecasting Capabilities**

Forecasting capabilities have been divided in two dimensions in this research, one being the human factor, the other one being the tools and systems.

- **The Human Factor**

In relation to human factors, forecaster knowledge, skills and capabilities ranked as the fourth most important factor. All participating companies had high consensus agreement on the five aspects of knowledge, skills and capabilities that forecasters should possess to enable them to deliver a high quality forecast. Such awareness level forms a solid foundation for recruiting, training and developing competent forecasters. Managerial adjustment (or judgemental adjustment) received two opposing perceptions. On one hand, values are recognized as the adjustments are based on managers and experts knowledge, experience and expertise, with such adjustment seen as a valuable supplement to system produced forecasts especially in situations where special events occur. On the other hand,

the limitation of such knowledge, experience and expertise, the risk of focusing on local interest instead of overall supply chain interest, the imbalanced influencing powers and the nature of being subjective in this type of adjustment are all being raised as concerns.

- **Tools and systems**

Tools and systems ranked as the fifth most important factor. Although 83% of companies confirmed they are using tools and systems for forecasting purposes, only 69% found them adding real value. Issues captured include: tools and systems are not providing the required functionality; not being utilized to its full potential; lack of knowledge and skills to operate tools and systems; and, lack of recognition of the value and capability of tools and systems. It is also pointed out that when tools and systems allow manipulation by its users, the quality of the output becomes more questionable. There are also supporters who claim tools and systems can never replace human inputs. Such varied perceptions on tools and systems showed inadequate recognition and knowledge about tools and systems, their advantages and disadvantages, and their capabilities. Clearly more effort and focus need to be given in this regard.

- **Excel**

The use of Excel is also examined in this research. It is found that Excel had popular acceptance in practice by either using it exclusively or to supplement tools and systems. Excel is highly recognized for its ease of use, low investment and good range of functionality. It is often a preferred alternative option where systems are not capable of certain tasks. Using Excel for presenting and reporting is also found to be convenient and effective. Under certain circumstances, such as a business with simple product mix and limited number of customers, Excel is believed to be the best option because the functionality is sufficient, the cost associated are low and it is easy to use. In this case, sophisticated tools and systems do not seem to be appealing. In other situations, Excel is reluctantly accepted as the only method to facilitate creation of a forecast. Desire for more advanced tools and systems cannot be recognised or realized due to lack of management focus or stakeholder buy-in.

- **Range of Information**

Range of information appears to be a less concerned factor by practitioners, as it was ranked as the least important among the provided options.

- **Other Important Factors**

There are also several other important factors discovered in this research. Most of them are raised from the management point of view. Raising awareness on the importance of forecast accuracy and creating a collaborative environment to obtain commitment across the whole business is considered an important factor for improving forecast accuracy. Performance management is also considered a factor for improving forecast accuracy, this is closely linked to the monitor and review process which is studied as an improvement enabler in this research. Similarly, root cause analysis and review is also mentioned. Again, this is studied as an improvement enabler in this research. Furthermore, robust exception management is believed to effectively manage changes in order to maintain forecast accuracy. From the operations point of view, high quality capacity planning is considered crucial to ensure the forecast is fully delivered.

5.2.3 The Improvement Enablers for Forecast Accuracy

- **S&OP Process**

Not only just being intensively studied academically, the S&OP process has also gained overwhelming popularity in practice. 83% of businesses have confirmed the establishment of a S&OP process. In most situations, the S&OP process is co-existing with supply chain management. Cases do exist where the S&OP process is adopted without establishing a supply chain management function. This is evidence that S&OP and supply chain management are not dependent on each other to provide benefits.

86% businesses confirmed that the S&OP process has brought improvement to forecast accuracy either significantly or to some extent. Such acknowledgment strongly supports similar conclusions drawn from related studies. The specific benefits brought by the S&OP process have been referred to as: better communication; increased transparency; more engaged and disciplined stakeholders; raising awareness; and, obtaining/creating focus.

The majority of the businesses have different levels of management involvement in the S&OP process, and sometimes, multiple management involvement is in place. Management involvement is said to be beneficial in providing strategic guidance, escalating constraints and seeking authority for balancing conflicts, and supporting critical financial related decisions. Such involvement is especially valued in businesses of larger sizes and complex structures. Smaller sized or simpler structured business do not hold the same view, in these cases, management is often well engaged in daily business activities, being more approachable makes it less necessary to participate in the S&OP meetings which are more operational focused.

Participants in S&OP meetings cover a wide range of functions across the business. Supply planning is the most quoted participant, followed by logistics planning, production planning and sales. The conclusion corresponds to what found in the literature review, where operations and planning are the most referred participants. Marketing, finance, customer service, warehousing are the less quoted functions, with manufacturing, new product development, category management and technical department least mentioned. The result that some functions have higher presence than others raised a concern that S&OP meetings with fewer functions attending may not be as efficient as they could be. Performance management is only mentioned in one case which appears to be good practice, as direct involvement of performance management in S&OP meetings will see stakeholders more engaged and committed. Also with direct input from other functions, the right KPIs can be more easily set-up, and performance review becomes more meaningful and effective.

Businesses with longer planning horizons or those in a stable situation found monthly meetings are sufficient. Those businesses with shorter planning cycles, or who were in more complex situations seemed to benefit from more frequent S&OP meetings, either bi-weekly or weekly. Perceived effectiveness also impacted on the desired frequency of S&OP meetings, where highly effective meetings allow longer intervals in between, less effective meetings call for more frequent review and changes to be made. To compensate for ineffectiveness of the S&OP meetings or the less desired frequency, alternative approaches have been taken. Initiating informal more frequent discussions and meetings outside the formal S&OP meetings is found beneficial; establishing more frequent information exchanges and updates in various forms are acclaimed to be helpful.

- **Other Types of Collaboration Programs**

Corresponding to conclusions from literature studies, VMI (vendor managed inventory) and CPFR (collaborative planning, forecasting and replenishment) are the two most exercised programs in practice. CPR (continuous replenishment program) is the next most popular program adopted, and often it is found co-existing with either VMI or CPFR programs or both. Whether the existence of multiple collaboration programs are beneficial needs to be investigated further as a definite conclusion cannot be drawn from findings of this research. However, it does appear to be a not so ideal situation as one of the companies who has the most multiple collaboration programs in place has advised that they are undergoing an overall business process review. QR (quick response) and ECR (efficient consumer response) do not have much popularity among businesses participating in this research, with only 2 and 1 adopters being found respectively. It may be due to the industry sectors of those participating businesses, as the majority of respondents are not from grocery nor apparel sectors where the two programs were originally developed from. Some other programs were also identified through this research, however these only had minimal users.

- **Forecasters Training**

Although there is a high degree of agreement on the importance of forecasters knowledge, skills and capabilities and its contribution to improved forecast accuracy, only half of the participants confirmed there is in fact some sort of training in place. A lack of focus on forecasters training is apparent. Most of the businesses are only providing basic on the job training. Only a small number of companies have more comprehensive training available including: cross functional knowledge sharing; external consultant training; internal on-line training courses; and, external courses, certificates and seminars.

- **Supply Chain Design and Re-Design**

Supply chain design and re-design is highly regarded as an improvement enabler for forecast accuracy with 91% participants supporting this statement. Again, similar to forecasters

training, fewer companies have taken actions in this area. Overall, some good practices have been captured through the survey and interviews.

- From a performance management point of view, a re-design of roles and responsibilities will see people more engaged and responsible in the forecasting process, which will improve forecast accuracy ultimately.

- Education across the business on the importance of forecast accuracy will see a mentality change which contributes to a more collaborative environment, again, forecast accuracy will benefit from such change.

- Restructure of supply chain participants and building stronger partnerships will also help to engage all parties in the same supply chain working towards one goal. More committed partners ensure a stronger trust level across all supply chain participants. Improved streamlined processes enhance information sharing and maintains information quality throughout the sharing process, ultimately increasing forecast accuracy as an outcome of this process.

- Design of a supply chain to deliver the best possible customer service is also seen to benefit forecast accuracy improvement. Here, highly satisfied customers are more willing to cooperate and provide high quality demand information in the forecasting process, hence improving forecast accuracy. In turn, better forecast accuracy will ensure a smoother run of the supply chain and a more satisfactory customer service. As such, a healthy cycle is established to bring mutual benefit to both the core business and the customer.

Other supply chain design initiatives captured include simplifying supply chain structures by removing unnecessary layers, reducing complexity, removing waste, systems re-design and re-alignment, and building the right skill set.

- **Tools, Systems and the Associated Investment**

Though many researches and studies have focused on designing or introducing tools and systems to improve forecast accuracy, opinions from practice do not completely support this stance. Two opposite groups of views have been found through this research.

The supporters seeing the value of tools and systems confirmed various plans of introducing new tools, systems for different purposes. They are ranging from small scale solutions focusing on specific functions to large scale systems intending to re-structure the way the business operates.

Return on investment proved to be a major concern when introducing new tools and systems. Justification must be made to get buy-in for implementation of new systems. However, obtaining justification especially translating the benefit into straight forward dollar values is considered a significant challenge. Further to this, justified plans are often constrained by limited business budgets. Small scaled solutions involving minimal investment on the other hand attract less concerns.

How to get stakeholder buy-in, and whether tools and systems can retain business intelligence properly are also some of the concerns raised.

The non-supporters of tools and systems usually do not see the value of them. Or current tools and systems are satisfactory and introducing new ones is unnecessary.

- **Motivation and Incentive Schemes**

Through the literature review, motivation and incentive schemes are thought to be helpful for improving forecast accuracy by encouraging the good behaviours and good practices in the forecasting process. However, lack of focus in the real business world was also found through this research. Only a third of the businesses have had such focus at various levels. Nevertheless, some good practices have still been identified via the survey and the follow up interviews.

Performance management techniques such as managed business objectives, KPIs and personal objectives are the most common way to monitor performance, and a further step

to link the performance review with bonus scheme ensures people involved in the forecasting process are rewarded for good behaviours and practices.

In a situation where supply is in deficit to demand, good contribution to forecast accuracy is motivated by being supplied with priority over others.

And in some other cases, it appears outstanding forecasting contributors are provided with more future training opportunities for continuous development.

Further to these quantifiable and tangible incentives, from a higher moral level, it has been pointed out that an environment that values and promotes the right behaviours contributing to the overall business goal is most important. Raising awareness through education, engaging people and building accountabilities are all essential to creating such environment. As a result, people will be more morally engaged and constantly self-motivated to deliver the best.

In regards to how to motivate other supply chain participants outside the core business, such as the suppliers, customers, etc. no specific focus or good practice has been identified through this research.

- **Monitor and Review Process**

Compared with lack of focus on the motivation and incentive schemes used, existence of monitor and review processes have been confirmed by 66% of the businesses indicating greater progress in this area. Again, some good practices have been captured through the survey and interviews.

Tying the review process with a S&OP process is the most adopted approach with half of the businesses practicing this. It appears S&OP meetings serve as an ideal platform for the review process, where all involved parties are presenting at the same time at the same table, so effective communication is enabled, feedback is given and action plans can be drawn. Monitor and review processes not tied with S&OP meetings are also common, where a similar approach is taken. In both cases, monthly review is the most adapted frequency.

Continuous review and improvement with no clearly defined frequency is also seen in practice. With such an approach, reviews are on an ad-hoc basis. Root cause analysis is

often used to investigate major variances between forecast and actual performance, with results being fed back to relevant parties, and improvement plans are then developed.

5.2.4 Other Valuable Findings

Further to the above three pre-set up objectives, effort has also been taken to explore more valuable views and practices beyond the reviewed literature through this research. They come from experienced practitioners directly and presented further insight and value.

Management focus is highly desired for acknowledging issues, providing support and ensuring improving initiatives are realized. Management is also believed to play a key role in creating a collaborative environment for effectively raising awareness and obtaining commitment across the whole business and beyond with other supply chain partners such as suppliers and customers.

Technical aspects such as cleansing data hosted in current systems, especially the more complex ones is fundamental to a high quality output, not just for forecast accuracy but anything generated from such system.

With respect to process, further to a S&OP process, a new concept is being valued and received by some businesses. IBP (integrated business planning) claims to be able to go beyond the capability of a S&OP process, taking a more strategic approach across the whole business.

Taking a continuous improvement approach is claimed to be essential to keep forecast accuracy at a satisfactory level. There is no single right or wrong approach to tackle forecast accuracy issues, it needs to be evaluated against the specific situation of a certain business.

5.2.5 Summary

In summary, corresponding to the relevant studies and research in the academic areas, the survey results and interviews have confirmed forecast accuracy plays a crucial role in supply chain performance. Directly or indirectly, forecast accuracy significantly impacts major supply chain activities such as procurement and sourcing, production planning, inventory

status, pricing decisions, freight and delivery, sales contractual obligation, product promotion as well as the overall supply chain performance. Lagging behind, are the actions taken to put effective measurements in place for monitor, review and improvement.

Contributors to forecast accuracy concluded from other academic research are well acknowledged in practice. Though each individual participant has a different view on which factor is more important than the other, in general, these factors can still be ranked from most important to least important in the following order, i.e. information quality, information sharing, forecasting methods and approaches, forecasters knowledge/skills/capabilities, tools and systems, range of information. In addition to these factors, practitioners have raised some other valid points. Raising awareness through education on the importance of forecast accuracy, creating a collaborative environment to obtain commitment across the whole supply chain, establishing robust exception management to cope with changes to maintain the forecast accuracy, and, seeking sound capacity planning to ensure accurate forecast is fully delivered, are some of the highlighted statements. Performance management, root cause analysis and a structured review process are also being addressed as they are more related to the improvement of forecast accuracy.

The improvement enablers for forecast accuracy have also been explored with practitioners via survey and interviews.

Having reviewed past research and studies in respect to its value, a S&OP process is both well received and exercised in practice. Better communication, increased transparency, more engaged and disciplined stakeholders, raising awareness and obtaining focus are the major benefits acknowledged. Varied level of management involvement exists in these S&OP processes being practiced. Opposing views on the value of management involvement was identified. Echoing findings from the literature review, a wide range of functions are confirmed as attending and being involved in the S&OP meetings and process, however, there appears a big variance between one business and another on who the specific participants of such meetings are. Frequency of S&OP meetings is believed to be decided by its effectiveness, the stableness and complexity of the business and the market, and the forecasting and planning horizon. It ranges from monthly to weekly, with some businesses happy with the current status, while some are seeking continued improvement. Other types

of collaboration programs were also identified such that some programs co-existed in some businesses therefore posing questions on their effectiveness.

Lack of attention has been constantly found on the other improvement enablers such as forecasters training, supply chain design and re-design, motivation and incentive schemes, monitor and review processes. Other good practices were at the same time also discovered. Conflicting views exist in practice on the value of tools and systems to the improvement of forecast accuracy. Justification on investment, supportive budget planning and related education are keys for implementing new tools and systems.

5.3 Recommendations

Drawn from all previous literature review and research findings, recommendations to practitioners in a commercial environment are made below.

- **Management Focus is Key**

First of all it is essential that management acknowledges the important role forecast accuracy plays in supply chain management and how it influences various aspect of supply chain performance as well as the overall supply chain performance. Only with the desired focus from management, initiatives and plans on forecast accuracy improvement become meaningful and possible. Management support is the key to raising awareness and obtaining collaborative commitment across the whole supply chain and beyond to achieve forecast accuracy improvement, and eventually the overall supply chain performance improvement.

- **The Contributing Factors and Improvement Enablers are Closely Related**

The contributing factors and improvement enablers are not exclusive to each other, these elements are interactive. The S&OP process and other similar programs serve as a platform for all parties to collaboratively work together to facilitate efficient information sharing, exchange a wide range of higher quality data at one place and one time. Training of forecasters provides them with the opportunity to improve their knowledge, skills and capability to contribute to the improvement of forecast accuracy. Evaluation and justification before a new tool and system is introduced ensures the best possible decision is

made and that there is the greatest probability of the desired value being delivered. The value of managerial adjustment (or judgemental adjustment) can only be realised by competent managers who possess the right knowledge, experience as well, and the right mind-set to focus on the overall business interests. Monitor and review of processes is crucial to identify issues, find root causes and initiate action plans for future improvement. Accompanying this is consideration of motivation and incentive schemes, from which right behaviours and practices are encouraged, with a consequent outcome of improved forecast accuracy.

- **Measurements**

Setting up the right measurements is critical to gauge the issues, deviations, trends and variance. Be it inventory turnover, stock related, capacity related, cost and finance related, or performance related, seeking to quantify measurement and translate into dollar values is the most efficient approach. The impacts reflected in straightforward dollar amount will present a clear picture to the concerned parties. However, this is frequently easier said than done. How to correctly quantify the measures for many businesses poses a significant challenge.

5.4 Limitations

As with any research, this research has its limitations. Firstly, due to the majority of the participants being New Zealand based, the findings and conclusions from this research are constrained within this market. Also, as all involved businesses are large sized, whether the same findings and conclusions apply to small and medium sized businesses cannot be verified. Secondly, due to the time frame and budget limitations, some issues have not been explored in greater depth, and some are pending further clarification and investigation. Thirdly, the purpose of the research is to obtain an overview of the forecast accuracy subject, hence, findings tend to be general with little individual in depth investigation having been carried out.

5.5 Further Research

Forecasting accuracy has been considered one of the sensitive topics of supply chain management, especially in the eyes of practitioners. Hence, future research in this area is highly desired. Exploring and defining the right measurements and investigating effective means to translate the same into dollar value is one immediate task. How to develop competent forecasters and how to deliver structured training is another area of opportunity. Furthermore, methodologies relating to monitor, review, motivation and incentive schemes need to be further developed. Also, more studies focusing on supply chain design and re-design and associated benefits need to be carried out.

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APPENDIX A

A Survey on the Contributing Factors and Improvement Enablers for Supply Chain Forecast Accuracy

Company name: _____

Your name and title: _____

Phone contact details: _____

Survey conductor: Maggie Rong Lu

Instructions

Please circle or tick the answer(s) and write your answer(s) in the specified area when asked. Please kindly ensure each and every question is answered fully. Thanks in advance for your valuable input and your precious time!

Part I: General information on supply chain management and forecast accuracy

2 **Where in the supply chain are you?**

a. Manufacturing
b. Distributing and wholesale
c. Retail
d. Service
e. Other, please specify _____

3 **Which of the following industry sectors do you belong to?**

a. Agriculture, horticulture, and forestry
b. Construction
c. Energy
d. FMCG
e. Information communication and technology
f. Pharmaceutical
g. Others, please specify _____

4 **What is your average annual turnover?**

a. <$1million
b. $1million – 10million
c. >$10million

5 **Do you have a supply chain management function? If yes, please specify when it was established?**

a. Yes, in year _____.
b. No

6 **Do you have a focus on forecast and forecast accuracy?**

a. Yes b. No

7 **Does forecast accuracy have an impact on any of the following aspects of your supply chain management? (multiple choice)**

a. Production decision b. Pricing decision

c. Inventory status d. Overall supply chain performance

e. Other aspects, please specify _____

8 **Do you have measurement(s) for the impacts of forecast accuracy on any of these aspects? (multiple choice)**

a. Production decision b. Pricing decision

c. Inventory status d. Overall supply chain performance

e. Other aspects, please specify_____

9 **Further to question 8, what kind of measurement(s) are they? (please describe briefly below)**

Part II: Contributing factors to forecast accuracy

10 **Please identify the factors below that you believe contribute to the forecast accuracy. And rank them in a sequential order with 1 being most important, 7 being the least important?**

( ) Information sharing

( ) Range of information

( ) Information quality

( ) Forecasters' skills and capabilities

( ) Tools and systems

( ) Forecasting methods and approaches

( ) Others, please specify below

11 **In terms of information sharing, which of the following methods or approaches have you adopted? (multiple choice)**

a. Information exchanging through system interfaces

b. Information handover in the format of excel files or similar

c. Through S&OP meetings and/or other cross functional collaboration program

d. Other methods or approaches, please specify

12 **Could you allocate a % for each of the methods and approaches mentioned above (in 2.2) to indicate their extent of usage in the process of information sharing?**

___% Information exchanging through system interfaces

___% Information handover in the format of excel files or similar

___% Through S&OP meetings and/or other cross functional collaboration program

___% Other methods or approaches, please specify

13 **What types of information are being collected and utilized in your forecasting process? (multiple choice)**

a. Internal data only
b. Both internal and external data
c. Point of sale data
d. Distribution center data
e. Seasonal data
f. Weather forecast for the next 3-10days
g. Market information
h. Upcoming events
i. Competitors' movements
j. Local and global economic environment
k. Others, please specify

14 **How would you rate the following characters of your information to be used for forecasting? (please tick one of the five options presented in the brackets)**

a. In time – available before or when it's needed (*very low, low, ok, high, very high*)

b. Accuracy – minimum error (*very low, low, ok, high, very high*)

c. Access convenient – in the correct format, easy to be converted, minimum reprocessing needed etc. (*very low, low, ok, high, very high*)

d. Reliability – information does not expire soon after forecasts are produced (*very low, low, ok, high, very high*)

15 **On average, how many handovers or interfaces happen before a set of information reaches the final forecasting system or the forecaster himself?**

a. Direct input
b. One or two handover(s)/interface(s)
c. Three to five handovers/interfaces
d. Over five handovers/interfaces
e. Don't know

16 **Do you see a direct link between the number of handovers on information and the level of accuracy of the forecasts based on those information?**

a. Yes b. No

17 **How do you rate your internal and external data providers on their credibility in providing high quality data?**

a. Very poor b. poor c. ok
d. good e. Very good d. Vary between different data providers

18 **Do you agree forecasters' knowledge, skills and capabilities have an impact on forecast accuracy?**

a. Yes b. No

19 **Which of the following knowledge, skills and capabilities do you think a forecaster should ideally have to be able to produce high quality forecasts? (multiple choice)**

a. Business knowledge about products, customers, markets and competition environment
b. Good understanding of data, i.e. their meanings, validity and alignments
c. Capability of correctly analyzing data by using tools and systems, and knowing when and how to make sound adjustments
d. Capability of delivering forecasts understandable to their intended audience at different business levels and from different functions
e. Good communication and interpersonal skills to interact with different stakeholders when presenting forecasts, negotiating for agreement and educating the business
f. Others, please specify below.

20 **Do you use judgmental adjustment or managerial adjustment when producing a forecast?** (Judgmental and managerial adjustment are adjustments done by experts or management on purely system produced forecasts with an intention to make them more accurate.)

a. Yes b. No

21 **If you said yes to above question (20), do you find it always adds value to the forecasting process?**

a. Yes

b. Sometimes, please specify when you find it does not add value at all, and why (if you know).

e. Never, please specify why

22 **Do you use any tools and systems in your forecasting process?**

a. Yes b. No

23 **Do you think tools and systems are always adding value to the forecasting process?**

a. Yes

b. No, why? Please explain below.

24 **Do you use Excel to make forecasts?**

a. Yes, why?

b. No, why?

25 **Which of the following forecasting methods, approaches are you currently using?**

a. Top-down approach (driven by strategic forecasts, then cascade down to operational level)

b. Bottom-up approach (start from operational forecasts, then aggregate up to strategic level)

c. Middle out approach (start from tactical level, then develop both ways up to strategic level, and down to operational level)

d. Rolling forecast (rolling over a specified time horizon)

e. Ordering quantity, lead time and other techniques

f. If not listed above, please specify below

Part III: Improvement enablers for forecast accuracy

26 **Do you have an S&OP process in place?**

a. Yes, and it was established in _____year b. No

27 **How do you rate the improvement the S&OP process can bring to forecast accuracy**

a. Not relevant b. Not sure c. little d. Some but not significant e. significant

28 **What management level involvement is in place for your S&OP process?**

a. Senior management at the CEO and director level

b. Middle management

c. Functional team only

29 **Which of the following departments or functions are attending the S&OP meetings? (multiple choice)**

a. Sales
b. Marketing
c. Production planning
d. Logistics planning
e. Supply planning
f. Customer service
g. Warehouse
h. Finance
i. Others, please specify below.

30 **How often do you hold S&OP meetings?**

a. Quarterly b. Monthly c. Weekly

d. Other frequency, please specify _____

31 **Which of the following programs are in place within your supply chain?**

a. CPFR – collaborative planning, forecasting and replenishment

b. VMI – vendor managed inventory

c. QR – quick response

d. ECR – efficient consumer response

e. CRP – continuous replenishment program

f. Others, please specify below

g. None

32 **What kind of training is being provided to your forecasters in terms of improving their knowledge, skills and capabilities? Please list them below.**

33 **Do you think supply chain design or re-design can have a positive impact on forecast accuracy?**

a. Yes I do think so, but nothing in this regard has been done yet.

b. Yes, and we've done something already, please specify what you've done below.

c. No

34 **Are you planning to implement more tools and systems to assist with the forecasting process and improve the forecast accuracy?**

a. Yes, please specify what kind of tools and systems and their purposes.

b. No

35 **When adopting and implementing tools and systems, is investment a concern?**

a. Yes b. No

36 **Do you have a motivation/incentive scheme or method in place to encourage people to improve forecast accuracy when they do not get direct benefit from what they do?**

a. Yes, and what are they?

b. No

37 **Do you have a monitor and review process in place for improving forecast accuracy?**

a. Yes, and what are they, please specify below.

b. No

Last question☺ - Would you like a summary of my research results when these are finalized. Y/N

APPENDIX B

Sample Interview Questions (the numbers in front of each question are corresponding to the question number in the on line questionnaire):

7. **How** does forecast accuracy impact your production decision (you also mentioned tactical production planning), pricing decision (wholesale price etc.), inventory status, and order fulfilment strategies? (e.g. When to start production, what to produce, how much to produce, sourcing materials and the materials cost, scheduling, work over time etc.)

7.1 **How** does forecast accuracy impact **overall supply chain performance**? (Return on investment, cash, inventory, customer satisfactory, cost etc.)

8. What are the measurements used for measuring the impact of forecast accuracy on production decision, tactical production planning, pricing decision, inventory status, and order fulfilment strategy?

8.1 Please could you explain what is SSQ settings, and how does it work? Is it quantifiable? (x% cost increase, etc.)

8.2 You've mentioned measurements such as DIFOT/OLOT, back-order management, safety stock settings/adjustment/performance, please briefly explain how these measurements work.

10. In regards to establishing a compliance framework to regulate the unexpected demand and a robust exception management process, what is exactly a 'cause and effect' orientation? Is that referring to raising awareness of the importance of forecast and its impact? Do you have any good practice in this aspect?

12. 50% of your information sharing is in excel files, understand this is the only tool your stakeholders accepted so far, how satisfied are you with excel as the main information sharing method? Any plan of changing or improving?

13. Interesting to know how does 'weather forecast for the next 3-10days' assist with your forecast?

20/21. When managerial adjustment raises 'noise' levels in the business on occasions, how do you resolve it? What is usually the end result? Any good practices to improve the situation?

27. What are the benefits S&OP brought to the improvement of forecast accuracy?

28. Is there an intention to involve senior management in the S&OP process in future? Why and when?

30. You currently have a monthly S&OP meeting, happy with that? Any intention to change to more or less frequently, and why?

34. In terms of 'you are scoping an integrated business planning process framework', is that a system built from scratch or based on some existing systems? Do you have a brief description of the framework?

36. Can I have a brief description of the motivation/incentive scheme for improving forecast accuracy that you are currently designing with a wider BP review process?

37. Can I have a rough idea of the monitor and review process that's under development in your supply chain?

37.1 Do you have any future plan in improving forecast accuracy? What are they?