IAN –
Seeing your way to successful inventory management

TOTAL LOGISTICS

5 Market Place
Wokingham
Berkshire
RG40 1AL
UK

September 2009

Introduction

There is no shortage of theory about the management of inventories. However, often the statistical methods are given without a credible account of practical application, for example in a business with many thousands of stock-keeping units. Alternatively, there are a number of software packages available that offer to solve inventory problems, but these are expensive and often the anticipated benefits are not fully achieved, perhaps due to the complexity of implementation. In fact, the power and flexibility of today's database analysis environments make it possible to build models that not only address these problems but are also highly configurable and produce output that is readily understood by managers. The approach described in this paper allows managers to:

- Gain visibility of current inventory policy and practice within their company.
- Fully understand the trade-offs between inventory holding and customer service.
- Calculate required stock-holding for a given service level and consider the result in terms of days' stock, value, cost, units and, importantly, cubic volume.
- Segment the product range according to value and velocity.
- Apply inventory and service-level policies selectively by segment.
- Determine optimal inventory parameters at the level of stock-keeping units.
- Interface with a storage and picking equipment selection model, leading to alignment of inventory policy with operations considerations e.g. appropriate unit load selection.
- Derive outputs that can be used to support logistics strategy decisions.

The modelling approach described in this paper was developed internally by Total Logistics and is known as IAN (Inventory Analysis Network).

Background

Organisations hold stock in order to bridge the gap between the service driven demands of customers and the economic batching of producers and suppliers and as a buffer against uncertainty both in demand and in supply lead times. Various forecasting methods have been devised, ranging from simple averages to models such as Holt-Winters, which try to account for trends and seasonality. None of these can predict the statistical 'noise' in demand, since this is essentially random in nature. Product life-cycles are becoming shorter, with the result that changes in demand are more pronounced, while the availability of historical data with which to predict them diminishes.

Rapid Workshop Based Transparency

Figure 2 shows the IAN modelling process.

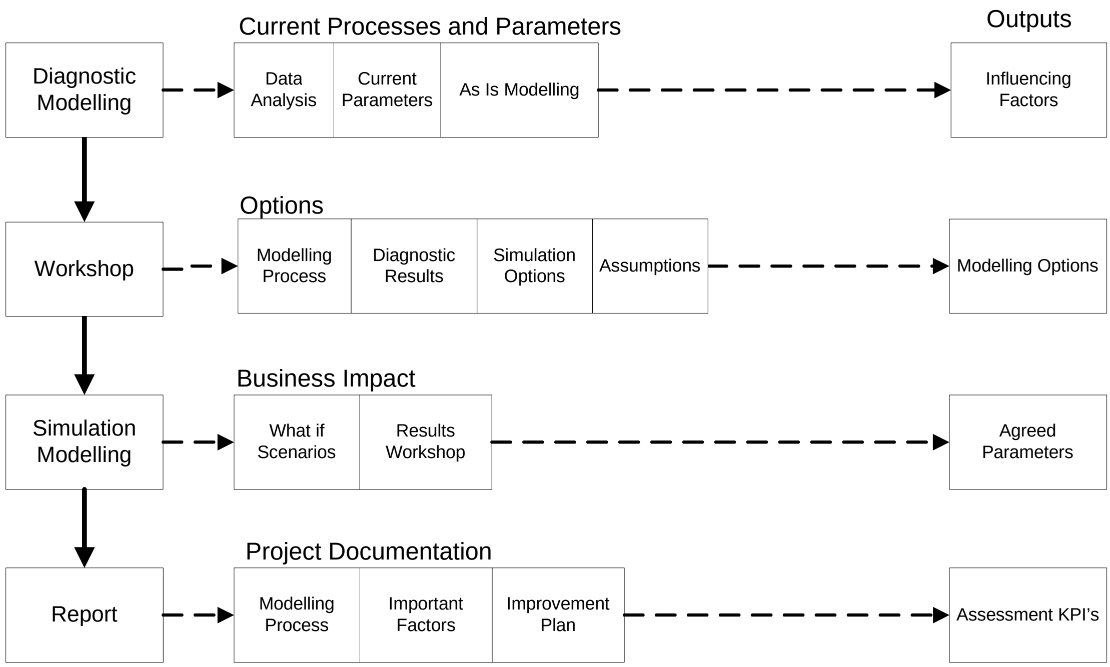


Figure 2 – IAN modelling process

Data Requirements

A demand file is required showing quantity shipped by date for each product. Twelve months' data is ideal, although the model can be used with data from a shorter period. Static product data is also required in the form of a table showing product code, unit value, lead-time, minimum order quantity, supplier pack size / order multiple and the current or average stock quantity.

The model can also accept a transfer file from TL's Storage Allocation Module (SAM). The process for integration of these two models is discussed below.

For the diagnostic modelling, purchase order and receipt history is required, along with other system parameters and history items that may exist such as:

- Safety stock levels
- System lead times
- Re-order points
- Stock adjustments

Initial Data Analysis Steps

The standard initial data analysis takes the data specified above and summarises into various outputs that can provide useful insight into the inventory issue within the client business. This data includes daily and weekly seasonality, Pareto analyses and order size analysis.

Diagnostic Modelling

The inclusion of diagnostic modelling in the approach leads to the following outcomes:

- Management understanding of the root causes of current problems in inventory management performance

- Identification of any divergence between system and actual parameters (e.g. lead times)

- Ironing out of any anomalies or unusual data characteristics

- Understanding of any special circumstances or requirements that need to be factored in to the inventory modelling

The diagnostic model gives a graphical output of the transactions and movements, i.e. purchase orders, receipts, despatches, over a period along with the prevailing inventory parameters i.e. re-order point, safety stock level. Typically this modelling is conducted for a representative range of products.

Workshop

Holding a workshop structured around the diagnostic model output helps to achieve all round understanding and management buy-in to the modelling concept and hence the stage is set for a successful project.

Following discussion of the results from the diagnostic modelling, the aim is to establish the high level options to take forward for simulation modelling. At this stage it is a good idea to have established a clear idea of the aims and priorities of the stakeholders in the process and how these relate to the business strategy. For example, desired outcomes might include:

- Reduced average inventory holding
- Improved customer service levels
- Reduced physical volume of inventory holding
- Reduced obsolescence
- Reduced number of purchase orders placed
- Balanced stock between distribution centres

The priorities attached to these aims and the approach taken to the inevitable trade-offs between them will vary according to the individual business, and the issues it is facing at the time of the study. For example, improving customer service might be a top priority for a business needing to satisfy the demands of the large multiple retailers, or trying to maximise returns from short life-cycle products. Reducing the physical volume of inventory holding could be important for a business approaching a 'trigger point' that could lead to a step change in fixed costs (i.e. the need for a new building or extension).

The IAN Service Calculator

The service calculator module is used to construct input tables for the simulation modelling; a separate table is created for each simulation option to be modelled. At this stage, we need to segment the product range in order to develop and test the options.

IAN will apply a different set of inventory management parameters to every user defined category provided. In the extreme case, each stock-keeping unit could be a category of its own. However, the aim is to establish realistic inventory policy rules and targets which can be achieved in practice.

The service calculator facilitates the necessary segmentation of the range by velocity (i.e. weekly sales units) and unit value. The cut-off points for the categorisation are configurable as percentages of the total number of stock-keeping units, although recommended levels exist based on experience to date.

The service calculator works on the concept of ‘current’, ‘suggested’ and ‘chosen’ parameters. The model automatically generates the ‘suggested’ target service level for each category, based on minimisation of total inventory cost (see figure 3). The user can specify a ‘chosen’ service level for each category. Method of safety stock calculation is also assigned at this stage by category. Options included are normal or Poisson probability distributions, ‘Peak’, which assigns safety stock based on a number of peak weeks’ demand, or a time based approach.

The projected stock value, units, turn and cubic volume are given for both the ‘suggested’ and ‘chosen’ service levels, and these can be compared with the current figures, which are also given.

The tables produced for each option are passed to the simulation model.

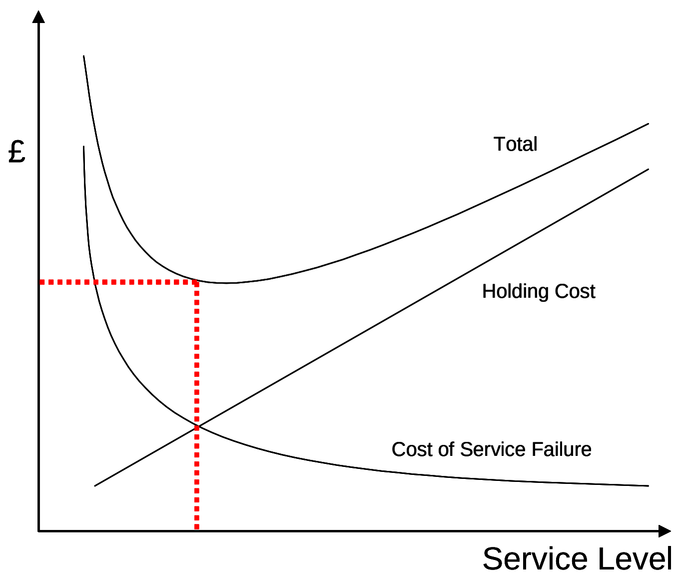


Figure 3 – Minimising Total Inventory Cost

Simulation Modelling

Following agreement of the best options to study in detail, these are run in a product level simulation.

This approach uses historical product level transaction data to model the effect of the selected re-ordering parameters. Results are provided both in statistical and graphic format.

This stage provides a robust simulation of the alternative strategies, to enable them to be “fine tuned” prior to implementation.

The simulation modelling produces parameters such as order quantity and safety stock level for all of the individual stock-keeping units, and models the effect of applying these parameters over a period.

Figure 4 shows a sample of the tabular and graphical summaries output from the simulation modelling. There are many more tables available covering, for example volumetric measures and cost vs. sales value.

A workshop is held to discuss results and agreement is reached as to the inventory policy to be used in the future.

Report

The report is compiled from the diagnostic and simulation model outputs combined with the workshop outputs. The main focus of the report from such a modelling process is on the production of an improvement plan, giving the recommended changes a clear path to implementation. Further, the modelling results allow key performance indicators to be set that can be monitor the revised inventory management process against expectations.

Interface with the Storage Allocation Module

The IAN model can be interfaced with Total Logistics’ Storage Allocation Module (SAM). The function of SAM is to determine the best storage media for reserve and pick-face storage at the level of stock keeping units. The decision is based on ‘whole life’ cost and includes the relative costs of picking and replenishment as well as the annualised capital cost of the equipment. This output can then be used when specifying the mix of equipment in the distribution facility.

We have integrated the inventory and storage design models using an iterative approach to optimisation, relying on the speed of the model to perform the calculations required for each assessment.

Methodology used for Calculation of Safety Stock

Movement	Value 1	2	3	4	5	
A		Normal	Normal	Normal	Normal	
B	Normal	Normal	Normal	Normal	Normal	
C	Normal	Normal	Normal	Normal	Normal	
D	Poisson	Poisson	Poisson	Poisson	Normal	
E	Poisson	Poisson	Poisson	Poisson	Poisson	

Was "Peak week"included in the Calculations

Movement	Value 1	2	3	4	5	
A		Y	Y	N	N	
B	Y	Y	Y	Y	Y	
C	Y	Y	Y	Y	Y	
D	Y	Y	Y	Y	Y	
E	Y	Y	Y	Y	Y	

Chosen Service Level

Movement	Value 1	2	3	4	5	Total
A		98.10%	98.60%	93.00%	98.10%	**95.59%**
B	95.00%	96.60%	97.20%	96.40%	97.30%	**97.03%**
C	94.40%	95.40%	96.40%	96.50%	96.80%	**96.46%**
D	90.80%	94.60%	95.10%	95.40%	95.50%	**94.92%**
E	83.80%	91.20%	93.10%	94.50%	95.80%	**92.28%**
Total	**91.30%**	**95.43%**	**96.87%**	**93.05%**	**98.07%**	**95.61%**

Time Safety Stock Calculation - "Number of Weeks"

Movement	Value 1	2	3	4	5	
A						
B						
C						
D						
E						

Average Stock Holding Units

Movement (1,000)	Value 1	2	3	4	5	Total
A	-	0.97	4.39	743.98	1,900.80	**2,650.14**
B	0.79	2.61	10.57	37.09	171.12	**222.17**
C	2.23	3.82	11.18	34.56	92.44	**144.22**
D	1.79	4.39	8.58	23.35	44.44	**82.55**
E	17.97	9.09	12.31	28.00	286.10	**353.47**
Total	**22.78**	**20.87**	**47.03**	**866.98**	**2,494.89**	**3,452.55**

Stock Turn (Based on Units)

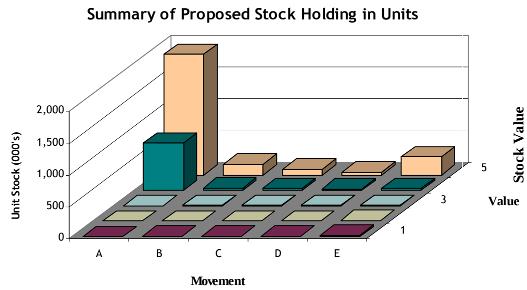
Movement	Value 1	2	3	4	5	Average
A		12.79	13.07	27.25	10.93	**15.51**
B	11.36	8.00	5.94	4.70	2.66	**3.25**
C	7.39	6.28	4.11	2.95	1.79	**2.45**
D	6.88	3.62	2.97	2.04	1.09	**1.81**
E	0.58	1.14	1.16	0.73	0.04	**0.19**
Average	**2.12**	**4.00**	**4.38**	**23.78**	**8.60**	**12.28**

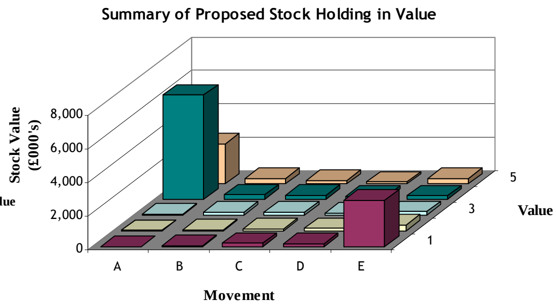
Stock Holding Value

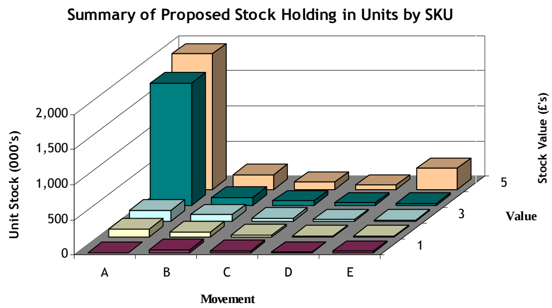
Movement (£ 1,000)	Value 1	2	3	4	5	Total
A	£ -	£ 33.2	£ 72.8	£ 6,256.5	£ 2,400.9	**£ 8,763.5**
B	£ 67.7	£ 82.5	£ 182.6	£ 285.7	£ 319.6	**£ 938.0**
C	£ 203.9	£ 135.2	£ 192.6	£ 267.0	£ 204.6	**£ 1,003.4**
D	£ 192.5	£ 144.3	£ 145.5	£ 185.2	£ 108.1	**£ 775.7**
E	£ 2,791.7	£ 345.8	£ 223.9	£ 216.1	£ 299.8	**£ 3,877.4**
Total	**£ 3,255.9**	**£ 741.0**	**£ 817.5**	**£ 7,210.6**	**£ 3,333.1**	**£ 15,358.1**

Stock Turn (Based on Value)

Movement	Value 1	2	3	4	5	Average
A		12.76	12.96	27.52	16.06	**24.20**
B	12.63	8.26	5.96	4.82	3.19	**5.35**
C	8.54	6.41	4.16	3.01	2.08	**4.62**
D	7.56	3.75	3.05	2.08	1.24	**3.82**
E	0.56	1.05	1.13	0.80	0.12	**0.62**
Average	**1.73**	**3.88**	**4.32**	**24.25**	**12.05**	**14.79**







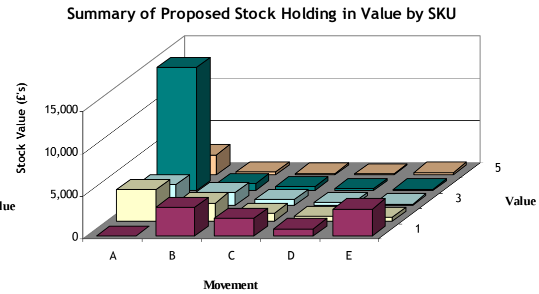


Figure 4 – Sample of IAN's tabular and graphical ouput

This approach has the following advantages:

- SAM calculates an individual storage cost for each product, which can then be used by IAN to give each product a unique inventory holding cost.
- SAM provides data on the bulk storage location including the number of items held within the location. IAN can use the location quantity to ensure order multiples are compatible with the storage i.e. via this iterative process, unit loads are optimised at SKU level using as a combination of inventory holding and physical storage considerations.

- Output from IAN to SAM will allow allocation of storage based on stock holding when the improved inventory management parameters have been adopted.

Interfaces with network strategy projects

Output from IAN, particularly when combined with SAM as explained above, can be very useful in sizing of distribution facilities. Further, by taking facility cost into account in the calculation of inventory holding cost, it is possible to model fully the implications of location decisions on inventory and service performance. Once again an iterative process is possible, complimenting the usual centre of gravity approach and moving network strategy modelling towards a more holistic view of total cost optimisation.

Global Sourcing

Arguably the biggest trend in supply chain management in recent years has been the adoption of global sourcing as a strategy for reducing unit cost. However, this policy has generally resulted in extended supplier lead times, exceeding the duration of the planning cycle, and hence re-supply decisions are often taken with several existing purchase orders in the pipeline. For a new product, the initial purchase order will always have to be planned to cover demand over a lead time. Shipping considerations may encourage purchasing in full container loads. Negotiation of unit price may therefore be based on larger batches than would be appropriate during the life of the product were inventory holding cost fully considered. Combine these factors with the reduction in product life expectancy and obsolescence risk is significantly increased. Furthermore, variability in lead time increases with its length and hence a further buffer is required.

The cost of inventory holding should be fully understood and accounted for in purchasing decisions. This cost element can be surprisingly high when everything is taken into account. Storage facility costs are only one element. Even if it is not owed to the bank, the capital tied up in inventory holding is real money that could be invested elsewhere. The real cost of financing the stock holding is the return that would be available from this alternative investment. Consider also the cost of stock write-offs due to obsolescence, damages and shrinkage.

Global sourcing is open to all as a means to reduce unit costs. The companies that manage to use this reduction to gain competitive advantage are those that make the best job of managing their inventory.

Case Studies

The case studies below are examples of projects where we have used the approach detailed in this paper to deliver significant improvements in inventory performance, within a variety of business strategy contexts.

Case Study 1 – Realising the potential of a post-merger supply chain strategy

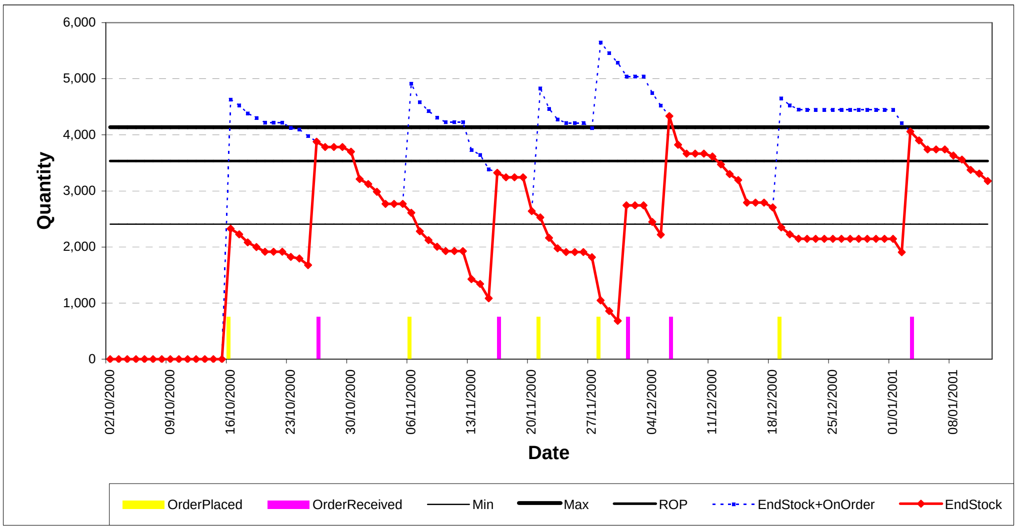
This project was undertaken for a wholesaler of office supplies that was implementing a revised network strategy following a merger.

Prior to the commissioning of the company's new central warehouse, it was identified that significant changes to the inventory management system were required. The network structure would change from branches ordering individually to a single order being placed on the supplier for delivery to the central warehouse with inter-depot transfers to the branch locations.

TL was retained to audit the existing ordering and inventory management process, and to define why levels of stock availability were below target, when the stock value was at the budgeted levels. Total Logistics' Inventory Analysis Network (IAN) modelled a wide range of products at all depots. This provided a visual record of inventory and order management policies including detailed analysis of each key transaction that occurred. The visual nature of the analysis (see figure 5) provided a clear, concise record of the inventory policy which could be understood by all management levels.

Branch Product Stock and Ordering Summary

Product Code	3M12881	**Branch Number**	1	**Demand Class**	1
Branch Name	Sheffield	**Description**	DISKETTE 3.5 DSHD FMTD IBM PK10 04412881		



External Orders Placed

Orders Placed in Period	5	
Stock in Pipeline @ PO Placement	**2,632**	
Max Stock	4,135	
ROP	3,534	ROP Max Zone
ROP - Sales in Review Time	2,693	ROP Min Zone
Min Stock	2,406	
Actual Product Leadtime	**11**	
Forecast Product Leadtime	6	
Days Variance	5	
Percentage Variance	177%	
Percentage of Order QTY within LT	0%	
Percentage of Order QTY on LT	0%	
Percentage of Order QTY over LT	100%	

Average PO QTY	**2,300**	
Estimate Size @ ROP	601	Max - ROP
Forecast PO Size (Max - Actual ROP level)	1,503	
Actual Sales in Actual Leadtime	**1,887**	
Forecast Sales in Forecast Leadtime	721	
Actual Sales in Forecast Leadtime	1,068	
Forecast Sales in Actual Leadtime	1,274	
Accuracy of Sales Forecasting	162%	
Stock Out Occurrence in PO Leadtime	0%	
Forecast Sales Per Month	**2,602**	
Forecast Sales per Day	120	

Figure 5 – Visual analysis of existing inventory policy

The study defined a large number of recommendations, many involving the adjustment of a key parameter or changing the review frequency. The implementation of the recommendations led to improved customer availability with no increase in stock levels and with no capital investment.

As part of the revised network strategy, the client was about to embark on a major network re-alignment to a central store feeding stock to a reduced number of regional branches.

TL assisted in this process by modelling inventory ordering and stocking methodology for the new operational solution. The network modelled involved the creation of entirely new inventory management systems and processes. TL again used the IAN analysis tool to model a range of options for safety stock, re-order policies and network interactions. The best alternatives were then simulated against the last three months' order volumes to assess the key metric levels. The chosen option was also modelled in each implementation step to ensure it performed in every scenario.

IAN's algorithms and parameters allowed the client to revise their inventory management systems, with only minor investment and allowed automation of the ordering process for most products. IAN enabled the client to work towards a significantly lower inventory target whilst increasing service availability from a reduced workload.

Case Study 2 – Integrated Approach to Warehouse Design and Inventory Planning

This customer is a world-leading marketer and distributor of electronic and maintenance, repair and operations (MRO) products, with over 250 000 stock keeping units. The business requires high levels of stock availability to fulfil its next day service promise to customers.

The company retained Total Logistics to review their existing warehouse and delivery strategy for mainland Europe. At that time, all orders were picked and despatched from a warehouse in the UK. A strategic review determined the optimal location for a warehouse in mainland Europe.

A detailed warehouse and operational design was constructed for the facility from the existing European volume and detailed growth projections. This information was used by IAN to calculate the inventory levels by product for the facility by utilising supplier details, transfer lead-times and customer availability targets. The inventory levels were integrated into SAM to define the warehouse sizing and costing by location, optimising the ordering and transfer quantities. This provided a complete warehouse and order management optimisation for each product across the complete supply chain.

Case Study 3 – Inventory System Design

This project was undertaken for one of the world's leading specialist distributors of electronic components and manufacturer's original spares. The company holds in stock over 90 000 products in a single warehouse facility.

Total Logistics were retained to design a flexible and appropriate inventory planning and ordering system. TL's approach was to analyse the existing methodology and then adapt IAN to offer a range of forecasting and scheduling techniques to enable the company to manage the inventory on an ongoing basis. A workshop was held to introduce and train the inventory practitioners in the new system.

The customer ran IAN alongside their existing system for three months prior to full implementation. IAN increased stock availability by 10% to achieve targets of over 90% customer line full, and reduced the stock value held by up to 25%. The system is continuing to manage stocks and currently is delivering the best performance of all of the UK divisions.

<u>Case Study 4 – Service level modelling</u>

The customer is a global food and beverage manufacturer requiring a service level calculator to enable them to optimise their inventory holding. TL's approach was to customise the stock calculate module within IAN to produce a business tool to define safety-stock requirement by SKU for a chosen service level. Average inventory snap-shots and summary by product group were configured to suit the needs of the client.

In order to align supply-chain objectives, the customer required an understanding of the relationship between forecast accuracy and stock cover, summarised in figure 6.

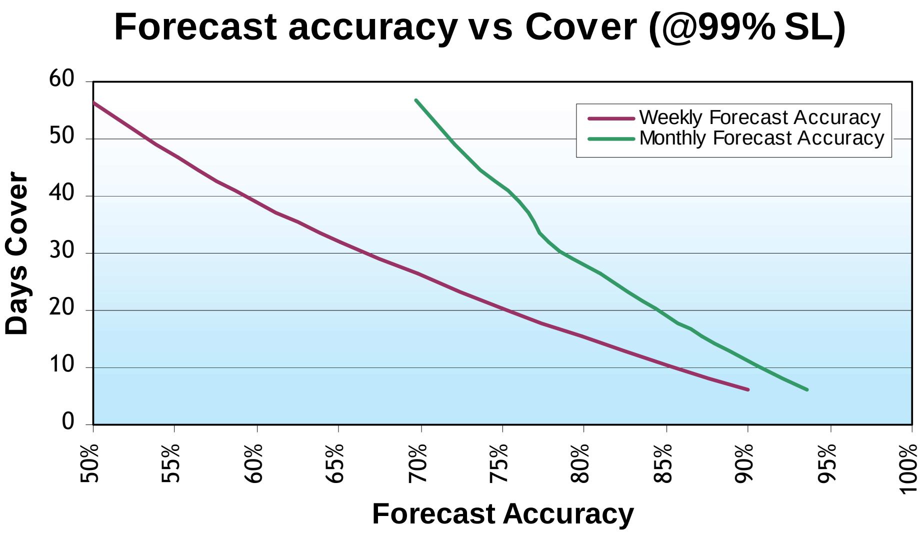


Figure 6 - Relationship between weekly and monthly forecast accuracy and stock cover at 99% unit service level.

The IAN business tool was used by the customer to establish the input parameters for SAP APO implementation. The transition went smoothly and delivered the desired balance of inventory and service.

Conclusion

The need for effectiveness in inventory management has never been more relevant to achieving competitive advantage. The approach outlined in this paper has a track record of delivering improvement and has the following advantages over other approaches:

- Diagnostic and improvement models give a clear view of issues, solutions and achievable benefits
- Transparency of all calculations and assumptions ensures buy-in at all stages and delivers results that bear management scrutiny
- Models are fully adaptable to suit the individual project circumstances
- Integration with storage media allocation and network strategy modelling provides a complete solution for supply-chain decision making.

Total Logistics is an independent management consultancy specialising in all aspects of commercial supply chains, from strategy definition to implementation and project management. For further information, please call +44 (0)118 977 3027. Our website address is www.total-logistics.eu.com.