Beyond CRM: A System to Bridge the Gap between the customer and the Global Manufacturing Supply Chain

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Abstract

Increasingly industry realises that the key to achieving superior customer value is not only in the creation of new products or new product packages specific to particular market segments but also in achieving process excellence by integrating and coordinating different functions within the business and across the global supply chain for efficient fulfilment and service delivery. However, there is still a gap between the customer and the global supply network despite evidence that support this realisation. In this paper we present the design of a system that enables this integration by linking demand processes with supply processes to create a 'seamless demand pipeline' and control fulfilment. The aim of our paper is to discuss our approach for addressing the problem by presenting design requirements and our design framework, illustrate application with a case study example and by doing so inform industry and developers to stimulate further research in the area.

1. Introduction

In today's world of key account management, and the constant search for innovative ways to creating superior customer value, companies increasingly realise the criticality of re-engineering business processes and implementing inter-functional coordination. could collapse under the potentially disruptive influence of the following business drivers [9]:

- Volatile marketplace that demands differentiated products and services
- Worldwide outsourcing of non-core activities to subcontractors.
- Formation of global alliances and channel partnerships.
- Increased competition, which leaves very short windows of opportunity to manufacturers to attain higher margins out of their new products.
- Supply/demand mismatches due to attempt to satisfy conflicting objectives. A typical example is the attempt to maintain high customer service levels while minimizing expenses and inventory.

Increasingly both the research community [5] and industry realise that the key to achieving superior customer value is not only in the creation of new products or new product packages specific to particular market segments but also in the integration and coordination of different functions within the business. This realisation has led to efforts in placing customers at the centre of many business processes. These efforts potentially enable these businesses to respond quickly to their needs and by doing so create a

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competitive advantage in the marketplace.

Customer relationship management (CRM) as a process and the various software packages developed to support it, have been well received by industry as enablers for these efforts. CRM entails all aspects of relationships a company has with its customers from initial contact, pre-sales and sales to after-sales, service and support related. Zablah et. al. [19] define CRM as a process at the macro-level that “involves the development and leveraging of market intelligence for the purpose of building and maintaining a profit-maximising portfolio of customer relationships”. CRM software provides functionality to support the process and this includes capturing customer contact, capturing purchasing data etc. The data these systems capture are used to segment the customer base and help in personalising value propositions and to integrating marketing channels using advanced features such as data mining and other knowledge capturing and management technologies.

However, superior customer value propositions cannot by themselves guarantee a sustainable competitive advantage but they have to be supported by a unique underlying business system that ensures realisation of those [6, 5]. This business system comprises of a configuration of activities that create, produce and deliver the value proposition and is no other than the supply chain. Srivastava, Shervani, and Fahey [17] define CRM, SCM and new product development as three core business processes that contribute to sustainable customer value. However, despite the strong potential for an integrated approach, in many businesses the supply side is still disconnected from the demand side with sales and marketing managers having little idea of the up to date capabilities of the supply chain, while supply chain managers have very little knowledge of the drivers behind customer demands [5].

Modern infrastructure technologies such as the Internet, Java and J2EE application servers, Microsoft’s .NET framework, XML, intelligent agent software and other middleware technologies such as CORBA, RMI etc. can interlink heterogeneous and dispersed systems across different geographic locations. However, what is currently missing, are shared models and tools to facilitate this integration by providing the knowledge, understanding and actionable information relating to the supply side and demand side of a business at the right context for specific user groups and roles in the organisation.

In this paper we present the design of a system that enables this integration by linking demand processes with supply processes to create a ‘seamless demand pipeline’, a term used by Bechtel and Jayaram [1], where the end customer drives the global supply chain. In the past, researchers suggested a research agenda for supply chain management emphasising the need for the supply chain to begin with the customer [1]. For example to respond to customer requests with exact product availability, precise delivery times and competitive pricing, companies need to be able to access information on resource availability and any supply constraints across their supply chains [9, 10]. Further to this, proper priorities have to be given to individual order requests considering various factors such as customer priority, constraints of items, profit margin of items and so on. Owing to such complex issues, many solution providers have taken up the challenge and as a consequence many new tools have emerged. However, the current commercial offerings do not address the challenges of integrating the demand and supply sides of businesses especially when global supply chains are concerned.

The aim of our paper is to discuss our approach for addressing the problem with the presentation of the design requirements and architecture of our system. This system although it is based on an advanced algorithmic framework for solving large scale optimisation problems, it has been designed to also address the integration challenges between customer and supply chain operations and support decisions that are both profitable and also serve the needs of customers. Although this design was originally inspired to solve problems in make-to-order businesses [20], as implied in section 4, it can also apply to make-to-forecast businesses as well. This is possible by deploying only the inventory allocation, fulfilment coordination and process integration elements of the system only and not the capability analysis functions, which are more suited to production operations. Such businesses can include retail networks as well. The paper also aims at presenting an initial reference framework backed by an illustrative example of usage in a real life scenario for achieving this integration, aiming at informing both researchers and industry and stimulate further work in the area.

This paper is organised as follows. In section 2 we review the current research on the integration between the demand side and the supply side both from a marketing management perspective and from the supply chain management perspective and related technologies. In section 3 we present the key requirements and the design of our system. Finally, in section 4 we present an illustration of the usage of the system.

2. Integrated approaches to demand chain and supply chain management

There is a large potential to gain competitive advantage when companies integrate effectively their demand chain and supply chain operations because they achieve differentiation not only on the products and services they provide but also on the underlying fulfilment processes [5, 9, 10]. By doing so, they build into their operations the capability to satisfy customers with different needs by adjusting supply chain capabilities. Consequently they can adjust prices on their offerings on a customer-by-customer basis and ensure value delivery to their customers [5].

Currently however, there is a lack of frameworks on how to achieve this integration. A few researchers have tried to define such frameworks and approaches. A recent approach is that of Demand Chain Management (DCM) which almost captures synergies between supply chain management, demand chain operations and marketing. Heikkilä, [4] defines DCM as a synergy between SCM and marketing starting with specific customer needs and designing the chain to satisfy these needs. Vollmann and Cordon [18], in their work argue that DCM starts with the customer working backwards through the entire supply chain. This is in contrast to starting with the supply base and working forwards as it is an approach that prevails in the supply chain management literature. The DCM approach is critical in today's business environment as it benefits the customer by allowing real time access to their accounts, making changes to their specific product configurations and specifying individual service requirements.

In their work [5] define a conceptual DCM framework that comprises of three integrative themes: (1) Process — managing the integration between demand and supply processes; (2) Configuration — managing the structure between the integrated processes and customer segments, and (3) Social interactions — managing the working relationships between marketing and SCM. They further support their framework with data gathered from fieldwork they conducted. Other contributions mainly come from research in supply chain management stressing that SCM is the integration and management of key business processes across the supply chain and identified three demand side activities related to SCM as [5] identified. These are CRM, customer service management and demand management, whereby customer's requirements are balanced with the company's capabilities.

However, only a few companies have engaged in initiatives to integrate demand and supply sides and even fewer achieved this integration to date [3]. Industrial attempts at the moment are not based on consistent frameworks but are only best practice examples and are based on a patchwork of ad hoc links of bespoke tools with external systems. As [5] discovered in their study, companies which designed their ERP implementations for example to enable all departments to access the same information from their ERP they found that this was not adequate to achieving such an integration because the data available in the ERP system was not in the right context for all departments and that led to uncoordinated actions and it rather inhibited integration than facilitate it. Furthermore, many companies which have implemented both SCM and CRM systems rarely integrate those [5].

Other efforts include the addition of algorithmic approaches implemented into tools that leverage ERP data. These include techniques such as available-to-promise (ATP) and capable-to-promise (CTP) [9]. Collaborative planning forecasting and replenishment (CPFR) has been developed as a technique to increase the accuracy of demand forecasts and replenishment plans, necessary to lower inventories across the supply chain and attain high service level of the right product at the right locations. This again is a complementary technique to existing planning approaches in supply chain management, although it does suggest a certain level of collaboration with the customer.

In the SCM literature, academic research has focused on solving supply-chain problems from an operational research perspective. However, very few have presented a comprehensive software architecture designed for solving this integration problem with real-life industrial applications in mind. Sadeh et al. [15] developed an architecture for dynamic supply chain coordination. This architecture although focused on the ATP/CTP problem is said to have significantly improved the accuracy of ATP/CTP decisions, which in turn can translate into significant improvements in profits and supply chain performance. A system was developed, tested and validated in the context of a business environment requiring coordination between a machine shop and a tool shop at Raytheon. However, their work did not address the demand-chain/supply-chain integration or the challenges for coordinating the global supply chain.

Finally, the shortcomings of packaged ERP-type applications have been widely reported in the literature. In particular [21] and [22] discuss a few of these issues including reduction in efficiency encountered by businesses which implemented such systems and the potential problems such packaged applications can present to businesses. Unlike ERP the proposed system is not a packaged application. It comprises of components that can be flexibly integrated and business process flows can be altered as the requirements of a business grows. Our design however, does suggest integration but unlike ERP systems, our design integrates heterogeneous data sources including enterprise application and different versions and implementations of those including ERP to leverage operational data for coordinating and optimising fulfilment and supply chain operations.

3. Design of the system

3.1. System requirements

A company not capable to deliver the individual promises made to individual customers due to the lack of support capabilities and a badly designed and executed fulfilment process will loose credibility quickly as customer satisfaction decreases [5, 9, 10]. Problems include under delivering and even over delivering or loosing customer or sales opportunities if the company cannot capitalise on satisfying differentiated customer needs [16]. The system presented in this paper provides the infrastructure and tools to enable integration and coordination of the demand chain and supply chain operations and thereby can support strategic initiatives and models that aim at differentiation on both process and, product and service offerings. As Juettner et al. [5] and Payne & Christopher [12] distinguish, demand processes are all processes at the customer or market interface which aim at responding to customer demands through value creation, whereas supply processes comprise the tasks and actions necessary for fulfilling demands. Thus a key requirement is to provide support to strategic functions that are found in demand processes and supply processes which depend on each other. The model developed by [5] will be used to present the rationale and design requirements of the system.

The model shown in Table 1 is an adaptation of their model which highlights the functions our system integrates and supports. In addition the following key design requirements have been considered:

(1) Differentiated demand for products is a key input to supply chain

management. Hence any consistent and timely demand information should flow and immediately become visible to create a seamless demand pipeline that is accessible in the right context to all decision makers involved.

(2) Provide a thorough understanding of the total costs of delivering an order on a customer by customer basis. If such information is known at the time of the customer request then account managers can decide how to provide preferential treatment and make commitments or even propose service packages that serve both customer needs and also the value to the company [3, 5, 9, 10].

(3) For many businesses, demand and also resource availability are uncertain and this should be taken into account in decision making.

(4) Different users, according to their role, should access information at the right context and therefore role-specific tools and user interfaces should be available to allow this.

(5) Customer demands must be transformed into relevant requests for each manufacturing node or service node in the supply chain to be handled appropriately. Those should then be compiled back into specific responses to those requests with alternative supply scenarios and fulfilment options and, allow customers certain flexibility in making their purchasing decision.

(6) Allow customers real time access to their accounts and the ability to alter the configuration of their products before delivery.

(7) Once a commitment is made, there should be full traceability and

Table 1: The adopted integration framework from [5]. The highlighted areas denote the functions the system presented in this paper integrates and supports.

Customer Buying Cycle	Demand Process	Supply Process
Evaluation	• Forecasting • Micro Segmentation (Needs, Preferences, Profitability)	• Design Of Supply Chain Responses • Propose Service Packages • Propose Fulfilment Scenarios • Supply Chain Configurations
Decision	• Value Proposition	• Order Receipt • Order Fulfilment
Purchase	• Transaction • Delivery Services	• Physical Distribution Services • Traceability
Consume	• "Serving The Value" • Cross And Up Selling Offerings	• Physical Distribution Services • Revised Service Package Propositions • Fulfilment Package Propositions
Awareness	• Market/Customer Analysis • Macro Market Segmentation • Target Market Definition/Approval (this is supported by supply chain design and planning models available in the system)	• Monitoring The Supply Network

visibility of the fulfilment process and the ability to predict potential delays to allow key account managers to alert their customers. Also there should be tools that allow the search for alternative solutions and together with their customers select those that are mutually acceptable.

(8) Be able to handle large volumes of multiple requests from multiple channels and identify satisfactory yet profitable fulfilment scenarios.

(9) Be able to identify alternative supply chain configurations to satisfy customer demands and coordinate actions across the global supply chain.

(10) Provide models algorithms and tools to reduce or eliminate the bullwhip effect [7, 2].

(11) Enable identification of which channel the order came through, including catalogue, call centre, web site, e-Marketplace, sales order entry system etc.

(12) Provide a comprehensive model that links customer operational information such as history of confirmed orders and their status, profitability, configurations, agreed purchase prices, plans past orders were fulfilled, along with supply chain, costing and resource information. Such a model should thus coordinate information across procurement, manufacturing, suppliers, logistics, channel partners and other multi-channel customer interaction data, as also argued by [5]. Importantly, this model, which should be implemented in using an enterprise class IT infrastructure, should offer the capability to design and deliver differentiated service to different customer segments.

(13) Be able to handle large volumes of data sourced from multiple and disparate sources in seamless information and capacity models.

(14) Be able to find ways to rapidly adjust supply to better match demands by balancing customer requirements with supply capabilities and thereby enable demand-driven supply chain management [9, 10].

(15) Allow the implementation of Key Performance Indicators (KPIs). This is important as conflicting KPIs between supply chain and demand chain processes can negatively affect business performance whereas those which are linked can enable cross-functional cooperation.

The design presented in this paper is based on the original system's commercial version by Orion Logic Ltd [11]. More specifically, this design builds on the Common Services layer the company markets originally targeting manufacturing and supply chain optimisation applications (see figure 2).

3.2. Design framework

A key benefit from linking the demand chain with the supply chain is the ability to respond accurately and timely to customer requests. This entails accurate responses comprising of exact product availability, precise delivery times and competitive pricing. To provide such information up-to-date knowledge of the state and capability of the global supply network must be available. A multitude of such requests must be serviced at a time and to service them effectively, the system must automatically assign priorities considering various factors such as customer segments, past history and contribution of the customer to account portfolio, potential for profit of the specific request, product configurations and many others [9, 10]. To compile such responses information that resides in multiple systems must be sourced in a timely manner and handled in shared models and tools.

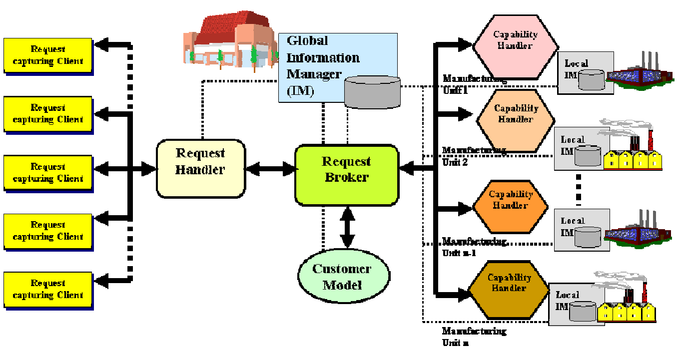

Figure 1: Deployment across the global supply chain

The system delivers the following key functions:

- ***Demand-driven functionality***: Upon the occurrence of an external request, all components work together to determine a feasible fulfilment plan.
- ***Collaboration***: the system allows the right information to be exchanged and translated at the right context according to the role of particular users.
- ***Fulfilment***: Capability and resource availability searches are performed to satisfy requests in a timely manner.
- ***Planning***: Actions are determined and global as well as local plans are updated accordingly.

As shown in figure 1, the system comprises three components structured in three-level hierarchy:

- ***Request handler***: this component customer handles requests across multiple channels including direct entry, CRM, e-marketplace, web store or even an order processing module of an ERP.
- ***Request coordinator and broker***: it acts as an intermediary and coordinates fulfilment options and related actions across the global supply chain. A request is broken down into its components. Then for each component, coordinated and time-phased fulfilment actions are calculated using a cooperative algorithm between this level and the level below.
- ***Capability handler***: each request component is matched against local resource availability and capability for a manufacturing node taking into account policies and capacities.

The Request handler handles specific demands as they occur with complete owner identification. Such an owner could be planners, key account managers or the customers themselves.

A request (that is a demand order in the system) can be fulfilled by a supply-type requirement (i.e. a manufacturing order or a purchase order), or can be fulfilled from available inventory quantities. Each supply-type requirement links to a plan that includes one or more plan steps. That is, specific instructions on how to fulfil the request.

The request handler supports customer interactions with the company and the supply chain using a data structure that employs a variety of different specialisations of the Order class including, Firm sales order; Purchase order; Request of Quotation; Stock movement, which represents stock movements between warehouses or vendor-managed inventory (VMI) replenishment requirements; Direct back-to-back sales, which automatically creates a purchase order for goods to be shipped from a supplier or partner directly to the customer; and Forecast order.

As requests and confirmed orders are linked, any changes can propagate upstream and downstream across the supply network according to set rules and policies. Other services include the creation and management of alternative what-if scenarios before a particular plan to satisfy a request is committed.

The request broker is responsible for coordinating the planning and fulfilment of requests across the supply network. It does this by changing supply chain configuration by identifying alternative supply chain nodes which can handle the requests, by identifying alternative or substitute parts and by allocating temporally constraint time slots to request components.

The request broker uses an approach similar to finite domains in constraint programming. It employs a local search algorithm to determine the best allocation to supply chain nodes and/or alternative parts for a demand order. Local search is proved to be highly applicable to real-life industrial applications since it provides acceptable solutions in short time [8]. During each iteration, the request broker creates a combination of supply chain nodes and alternative parts. It then sends a request to each supply chain node to check if the request can be handled. After each node evaluates the request, it either accepts it with a cost, or rejects it or determines an alternative sequence of actions to fulfil. This is a negotiation process that takes place until a satisfactory solution is reached.

Capacity models at that level can be very detailed. However, the information that is exchanged is only basic and non confidential. This ensures accuracy and autonomy in decision making and also confidentiality. Furthermore, as data is locally managed, there is no need to engage in expensive and time consuming data collection exercises to feed centralised models as it has been the practice in the past.

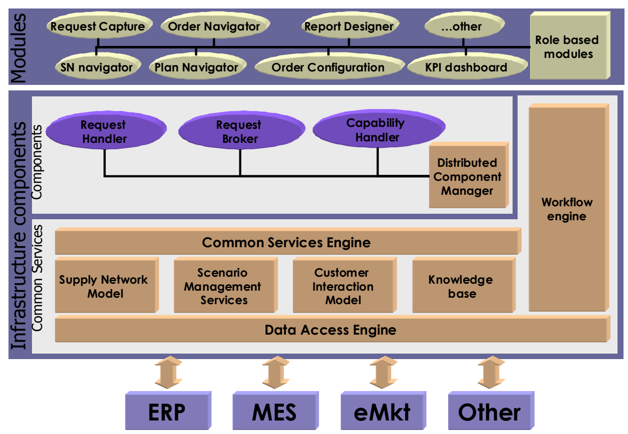

Figure 2: Architecture the system

Figure 2 shows the architecture of our system. All components are fully integrated and are deployed on several instances of J2EE compliant application servers. At each level a specific software module implements the request handling, brokering and capability handling functions. Any number of instances can co-exist and cooperate to solve complex or simple requests. Those components are supported by an object-oriented data store, also deployed on a J2EE application server that is responsible for collecting and maintaining relevant structural and transactional data from external sources and combining this data into meaningful information. Also this data store also provides an API and tools for role specific access to up to date information of the global supply chain.

4. Illustrative scenario of the process

To illustrate the usage of the system a fictitious case study scenario is presented [10], which is based on an actual semiconductor manufacturing company. Simake is a global semiconductor business. It has four facilities in Europe, subcontractors in Korea and Taiwan, and sales offices and distributors in the US, Europe and Korea. The company has grown from a number of recent acquisitions.

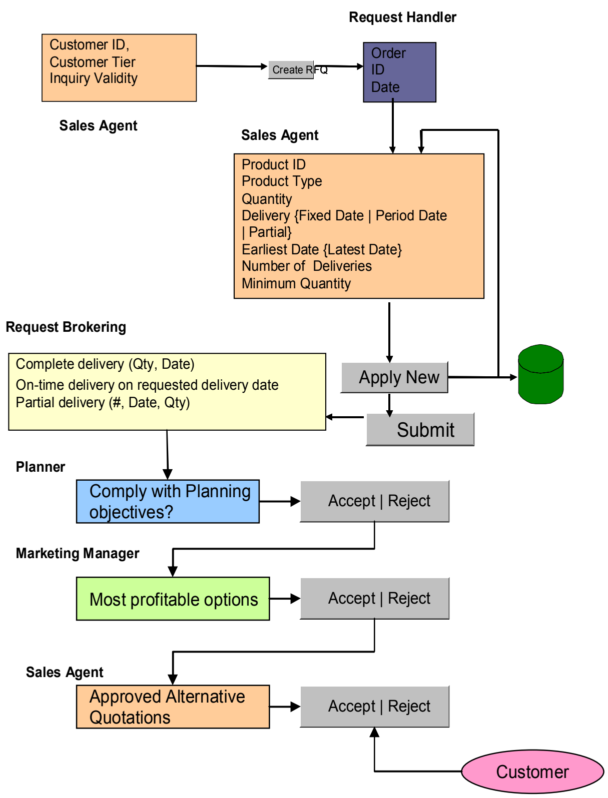

Figure 3: Illustrate workflow

Each facility operates different instances of the same MES and different ERP systems, and the acquired companies still operate different business processes. The subcontractors operate their own systems but they provide information to Simake through weekly updates using FTP (file transfer protocol). Each sales office has also a different legacy customer database. Simake's products require four different stages for production, each taking place on a different shopfloor with different technology requirements:

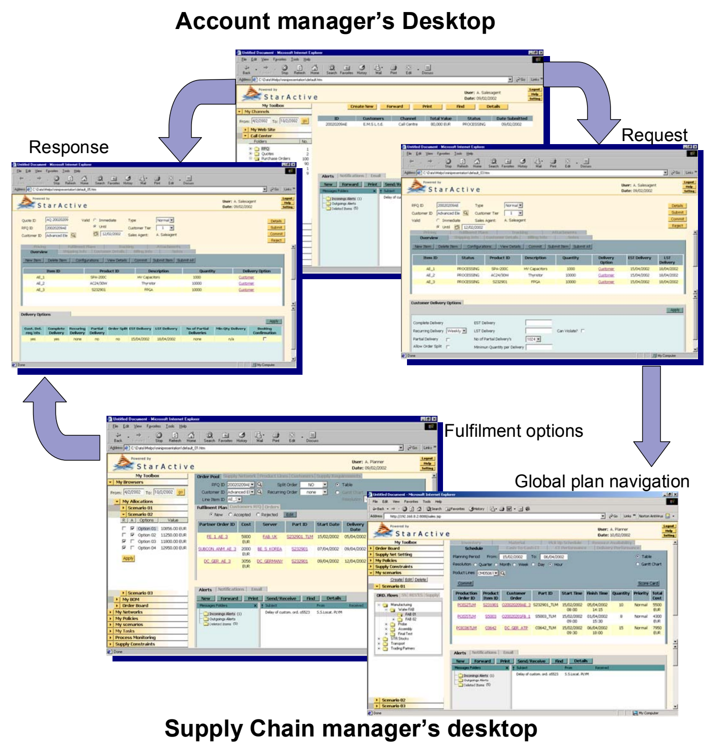

Figure 4: Sample screenshots (courtesy of Orion Logic Ltd.)

- Simake receives 1,000 customer order requests each day. Simake wants to cut down the order quotation lead-time.
- Simake must utilize information that comes from different ERP, MRP, MES and legacy systems.
- Simake needs one intelligent platform to integrate those disparate

processes and fit within this diverse IT environment.

Simake needs to provide accurate responses to their customer requirements while at the same time coordinate fulfilment and modify their forward production plan accordingly.

The system pulls together information across Simake's network to support Simake's sales staff, marketing staff, production planners, subcontractors and distributors to generate feasible alternative fulfilment options as follows:

(1) The workflow begins with the sales manager logging the customer requests.
(2) RFQs are sequenced automatically according to customers' profiles.
(3) The request broker starts the search and negotiation process with each capability handler in the network. It does this by breaking down each order item into its component parts and performs a rough allocation to all relevant supply chain entities and generates alternative production and fulfilment options. At this moment no definite commitments have been made.
(4) Planners from the various manufacturing units can evaluate those alternative options for quantities and decide how to best match actual capability including work-in-progress inventory to requirements by evaluating suggestions by the capability handlers. Planners register their recommendations by accepting the alternatives that best match their planning policy. This process can also be done automatically.
(5) Key account managers review generated options and decide on the most profitable alternative scenarios, based on the planners' recommendations.
(6) Once this cycle is complete, the sales manager finally advises the customer about the approved alternative fulfilment and delivery options, giving the customer the option to select the one that best matches their needs.
(7) The sales manager then raises a customer order and provisionally books capacity until the customer's final confirmation or payment. This reservation is based on the final agreement between the customer and the sales person.
(8) Upon final confirmation and payment, the order then becomes a firm order, actual capacity is committed and fulfilment starts.

Figures 3 and 4 show an overview of the process outlined above and sample screenshots respectively.

5. Conclusions

In today's marketplace it is critical to understand requirements not only of particular customer segments but of individual customers and respond accordingly with a product and service package that is relevant to their needs. To do this however, requires process excellence, which nowadays means process integration internally and also across the supply chain. Perhaps the biggest opportunity for achieving this is the integration of demand chain operations. However, this requires support from next generation systems and tools. In this paper we presented such a system and aimed at informing industry and researchers about developments in the area. This was done by discussing key requirements and the design framework of our system.

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