

# Engineer-to-Order Service Supply Chain Organization

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## 1 SUMMARY

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A case study on an Oil & Gas Exploration & Production company working in an engineer-to-order service setting to determine the needs of a supply chain organizational structure for such an environment.



Muhammad Farhan Syed was born in Karachi, Pakistan. Before enrolling in Masters in Supply Chain Management program at Malaysia Institute for Supply Chain Innovation (MISI) the MIT Global SCALE Center in Shah Alam, Malaysia, the author earned an undergraduate degree in Computer Engineering with honors cum laude from NUCES-FAST Karachi, Pakistan and a Master of Business Administration degree with majors in Marketing from Institute of Business Administration, Karachi, Pakistan. Upon graduation he plans to resume his professional career.

## 2 INTRODUCTION

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Over the years companies have made the transition from a silo based structure in which respective departments focused only on their part of the world to one which is centralized and allowed for better coordination and communication between functions. Organizations adopted various structures such as functional, matrix, integrated line and project-based based on what suited their needs. Globalization is an aspect of businesses that pushes them to revise their organizational structure. When a company's geographical, vertical and horizontal scope expands, the organizational structure also should evolve in order to meet the new needs of the business. The supply chain organizational structure also can be affected based on those scope expansion and also the product characteristics and process technology. To facilitate better control corporations feel a need to have greater degree of specialization which drives efficiency and productivity and formalization an hierarchy are the factors for giving more or less control to management within functions of the supply chain such as procurement, materials management and logistics. This thesis focuses on such an organization; a leading oilfield service provider supporting exploration and production (E&P) activities of oil and gas companies worldwide. This enterprise handles multiple engineer-to-order (ETO) projects in different geographical markets worldwide. As far as the questions of availability of literature is concerned for managing ETO service organizations? There is limited literature obtainable to understand and optimize the operations of companies in terms of ETO or service organizations individually; however, there is no existing literature that factors all the elements in terms of the different design characteristics that this firm possesses.

This made this thesis project a challenge not only from practical implementation point of view but also from a literary perspective. Other than a literature review, the research methodology for this thesis focuses on using the company operations in South East Asia as a base for conducting a case study. As part of the case study an assessment of types of projects handled by this company in this region, classification of items procured for supporting these projects, interviews of functional heads to better understand the challenges at the organizational level, review of existing policies, procedures and practices and evaluation of KPIs for their potential misalignment at field level has also been conducted. This thesis, steps into uncharted territory of conducting an exploratory case study, to ultimately develop a framework which enables companies with similar requirements, to come up with an organizational structure and information flow pattern to aid them in effectively managing the supply chain activities across well-established functions while working in a global setting.

Based on the findings we can say that needs of a service oriented supply chain are inherently different from a conventional supply chain. Here the customer and when the engineer-to-order can only be processed once it is received and once engineer-to-order (ETO) perspective is brought into the mix of things it makes the task all the more challenging. This paper provides a framework which companies can adopt to check compatibility of their supply chain organization structure while working in such an environment and also define level of customer involvement depending upon the nature of the service being provided. In addition to that based on literature review techniques such as flexibility, time-compression, information management, supply chain integration and improvement of new product development process have been presented which can be employed to enhance effectiveness & efficiency of ETO service supply chains.

### 3 CONCEPTUAL FRAMEWORK

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If we look at the various factors considered under literature as to which factors contribute the most to the success of a supply chain organization working in an ETO service environment, the following aspects appear to be having the most impact:

- Structure of the supply chain organization as elaborated by (Kim 2007) with the addition of one additional factor “Standardization”.
- Nature of offering by the company and corresponding horizontal, vertical and geographical scopes.

Most of the other factors explored as part of the literature review process were fall under one of these two. For instance strategy, culture, project management all fall under the purview of structure while customer involvement and service aspects are entirely dependent on the company’s end offering. Let’s explore these all-encompassing factors one by one.

Based on the work of (Kim 2007) we know that he has defined supply chain organization structure based on three variables formalization, centralization & hierarchical relationship. Based on the interplay of these variables (Kim, 2007) has identified the following organizational structures which exist in the real world.

Organization type	The strategic position of SCM department	The business control area of SCM department	Theoretical background	Representative firms
Non SCM-oriented organization	Exclusive SCM department does not exist or lies under the existing departments including IS department	SCM department executes a limited group of traditional SCM activities which are managed across business units. The primary SCM activities are operated independently by each function with no single executive and organization. The planning and utilization of SCMIS is executed under the responsibility and authority of the existing IS department	Lambert and Stock (1993) Bowersox and Daugherty (1995) Bowersox et al. (2002) Monczka et al. (2002) Head (2005) Jabnoun and Sahraoui (2004)	Rohm & Haas Company, US Steel Corp., TRW Inc., Dana Corporation, SPX Corp., Denso Manufacturing Inc., Continental General Tire, Inc.
Functional Organization	Exclusive SCM department lies as a functional area equal to the existing functional areas including IS department	SCM department controls the existing traditional SCM activities and SCM related activities executed by each function. SCM department and IS department have jointly the responsibility and authority of SCMIS planning and utilization	Lambert and Stock (1993) Bowersox and Daugherty (1995); Johannessen and Solem (2002)	L.G. Cisco, Benetton, Eli Lilly, Corning Glass, Honeywell
Matrix channel organization	Even though SCM department has a equal position with the existing functional departments, it plays a role not as a function but as a program and coordinator	SCM department focuses on activities for coordination and connection with other departments or with other channel members on a channel basis. This type places a high priority on the adjustment of primary SCM activities within an organization including SCMIS and the linking with external SCM activities	Pritsker (1997) Johnson (1997); Huang and Lin (2002) Monczka et al. (2002) Johannessen and Solem (2002) Bowersox et al. (2002)	Texas Instrument, Shell Oil Daewoo Matsushita, SONY Hewlett-Packard General Motors ABB
Process Staff Organization	Even though SCM department has a higher position than the existing functional departments including IS department, it plays a role not as a function but as a staff or overall coordinator of the functional areas	Even though SCM department assists and coordinates overall SCM activities within and outside of a corporation, the practical operation on each SCM activity is executed under line functions including IS department	Benita et al. (1992) Lambert and Stock (1993) Bowersox and Daugherty (1995) Johannessen and Solem (2002) Monczka et al. (2002)	Toyota Nike, BMW, Motorola, Benetton, Dell Computer General Motors General Electronics
Integrated line organization	The existing functional areas including IS department are subordinate to SCM department, and SCM department controls overall functional areas and SCM activities with practical responsibility and authority	SCM department integrates and manages overall SCM functions within and outside of a corporation including IS department as a value added chain	Monczka et al. (2002) Johannessen and Solem (2002) Jabnoun and Sahraoui (2004) Head (2005)	Samsung Electronics Whirlpool Corp. Hooker Chemicals & Plastics Corp. Johnson & Johnson

Table 1: Supply Chain Organization Types Identified by Kim (2007)

The ETO operating environment the supply chain has to be able to manage the flows for various type of product namely make-to-stock, make-to-order, assemble-to-order, purchase-to-order and design-to-order. All these parts and components have distinct issues and challenges for procurement and managing the flows up to the point to be consumed in a project. This would mean that an organization operating in an ETO context should have the ability to handle all these different types of arrangements. If we look at the supply chain organization structures proposed by Kim (2007) look at the company operations under consideration, if we consider the company’s operations in South East Asian region alone they have a strong functional orientation with the absence of a custodian supply chain department and if we look at the company’s global operations they appear to mimic a matrix organizational structure. As elaborated in Kim (2007) matrix structure is also the structure of choice for oil & gas companies such as Shell. However, when we consider the fact that Shell is predominantly a company operates primarily in the midstream and downstream sectors and their offering is also completely different from that of the company under consideration. Which raises the question that are any of the structures proposed by Kim (2007) capable of handling supply chain organization requirements while working in an ETO service environment? Based on the framework developed below and using primary data from interview and secondary sources we will try and answer this question through triangulation of results.

### 3.1 FORMALIZATION

According to Kim (2007) formalization of SCM department refers to the degree to which decisions and working relationships are governed by formal rules and standard policies and procedures Daugherty et al., (1992), and in this study, it was measured by three items such as the degree to which goals, rules, policies and procedures for logistics activities are precisely and explicitly formulated Bowersox et al. (1992), the extent that roles and role relations are prescribed independently of the personal attributes of individuals occupying positions in the structure Scott (1981), and the participation level of SCM managers in strategic planning process. When we bring in the elements of ETO and service nature of the offering into the mix high degree of job complexity as elaborated by Grabenstetter & Usher (2013) requires more stringent controls to maintain consistency and hence a higher degree of formalization for better management of the overall process. A high level of formalization should also correspond with broad horizontal, vertical and geographical scopes and vice versa.

### 3.2 CENTRALIZATION

The centralization of SCM function involves the locus of authority to make decisions on SCM related activities Dalton et al. (1980) and spans of control within an organizational entity Bowersox et al. (1989, 1992). According to Kim (2007) centralization can be measured with regards to three items:

- The extent to which the power to make logistics decisions is concentrated in the organization
- The number of subordinates who report to a single superior
- The degree to which logistics activities are grouped together in the same organization or organizational sub-unit.

In the context of an ETO service organization centralization is an important parameter as it determines the speed at which things are done within an ETO service organization. Moreover, at the same time it also effects the level of coordination and communication across all functions within an organization which are vital of the effective and efficient execution of the supply chain organization. A high level of centralization maybe desirable when needing a higher degree of control while keeping in view standardization and horizontal, vertical & geographical scopes.

### 3.3 HIERARCHICAL RELATIONSHIP

The hierarchical position of SCM department was measured by three items:

- The extent to which decisions are made at relatively high levels in the organization
- Hierarchical distance between logistics decision-makers and senior executives who make more global decisions on an organization-wide basis Chow et al. (1995).
- Organizational position of the top SCM manager. The position of the top manager was measured in seven categories such as plain clerk, deputy manager, section chief, deputy director, director, vice president, and above president.

Again in the context of an ETO service organization hierarchical relationship of the supply chain functions in comparison with the rest of the function determines the level of scope and control such a

function has over the activities carried out to support provision of the end offering by the organization. When dealing with ETO service products it also helps in maintaining visibility across various functional silos at the very least within the organization if not across suppliers as well as customers.

Again when dealing with a high level of uncertainty and it's important to maintain focus on supply chain decision making which could only be made possible by having supply chain functions being treated at the same level as with other important organizational functions.

### 3.4 STANDARDIZATION

In addition to these the nature of the company's product offering and its level of standardization also plays a vital role in supply chain performance. A company's offering can either be a product or service and multiple products or services could be employed for provision of the end product or service.

A service unlike a product cannot be stored and is only rendered once the request for the same is received from the customer. Moreover there might be fewer layers of people involved in provision of a service when compared with a product. This makes the management of a service when compared with a product inherently different. According to (Giannakis, 2011) the level of intangibility of services has been used extensively to describe potential impacts on their production and delivery. It has been used, for example, to determine the complexity of the service design, as well as the difficulty in evaluating the service exchanged, which in turn can determine the necessary 'closeness' of a relationship and the perceived risk of customers (Zeithaml & Binter, 1996). It is generally acknowledged that it does not follow a 'Boolean' either/or concept but is rather a continuum (McDougall & Snetsinger, 1990). Not all services have the same level of intangibility a medical diagnosis, for example, is more intangible than logistics.

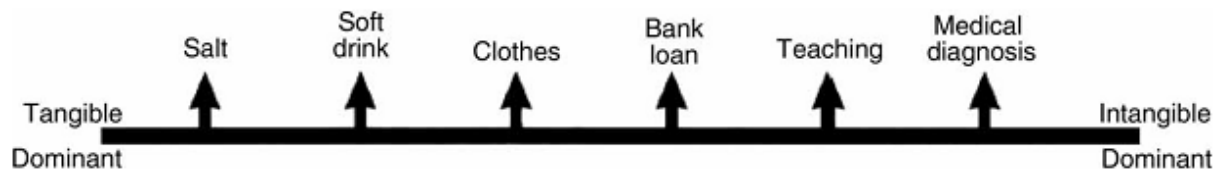


Figure 1: The Continuum of Intangibility McDougall & Snetsinger (1990)

Within these two categories of product or service an offering can be a generalized offering with a high level of standardization or a one of a kind custom configured solution tailor-made to match the needs of the customer.

A generalized offering will have a higher degree of predictability in terms of provision to the customer and will be representative of a highly standardized and refined methodology having being used for its provision. While on the other extreme an ETO offering as will be the result of a process where the customer order decoupling point is located at the design phase of the development life cycle as highlighted in the literature. This degree of customer involvement is not required for a generalized offering.

### 3.5 HORIZONTAL SCOPE

As explained by (Gosling et al., 2013) while working in an ETO environment companies face a lot of uncertainties to counter this companies need to first identify uncertainties to create uncertainty profile. Then classify them using tools such as the uncertainty circle could be used to gauge uncertainty in terms of supply, demand, control and process aspects of the supply chain as explained by (Gosling et al., 2013) to create categorized generic profiles and then lastly identify severity to create complete positioning matrix of uncertainties to determine course of action for configuration of the supply chain organization while working in an ETO context.

In the context of a company complexity of supply chain increases with the number of SKUs and their types. Moreover for a service in this environment the company need to manage various flows which are inherently different for procures which may be used in provision of the service. These procures may be make-to-order (MTO), make-to-stock (MTS), assemble-to-order (ATO), purchase-to-order (PTO) or design-to-order (DTO) types. This implies a very wide range of flows in the supply chain to deal with and is reflective of a wider horizontal scope while operating in an ETO service environment.

These uncertainties increase with reduction in the level of standardization and increase in the range and diversity of ETO services provided by the company.

### 3.6 GEOGRAPHICAL SCOPE

Expansion in terms of the geographical scope also adds another layer of complexity when operating in an ETO environment. As degree of uncertainty is already higher in dealing with ETO service supply chains as materials or services required for provision of an ETO service need to be custom-made to cater to the needs of the customers. When we take that complexity and expand the horizon of possibility to involve global procurement of materials and services and worldwide provision of ETO service it complicates overall company supply chain further.

### 3.7 VERTICAL SCOPE

In addition to the factors uncovered from literature review, supplier relationships also play a vital role in the success of an ETO service organization. As discussed in the framework presented by (Gunasekaran & Ngai, 2005) partnerships must be built with external entities in the context of Built-to-Order (BTO) supply chains based on core competencies, strategic nature of procures. The exact mode of relationship can be determined based on the needs of the business segment.

A company can choose to have an external or internal suppliers for acquisition of procures which it uses in provision of the end offering. Moreover, even amongst these categories the supplier has the option to having a variety of different relationship arrangements ranging from arm's length relationship to a strategic partnership. What it chooses to do depends upon the level of uncertainty, cost and criticality associated with what is being procured. On top of that these modes of relationship exist for all the types of procures being handled by the company for provision of the end service which makes the task even more complicated.

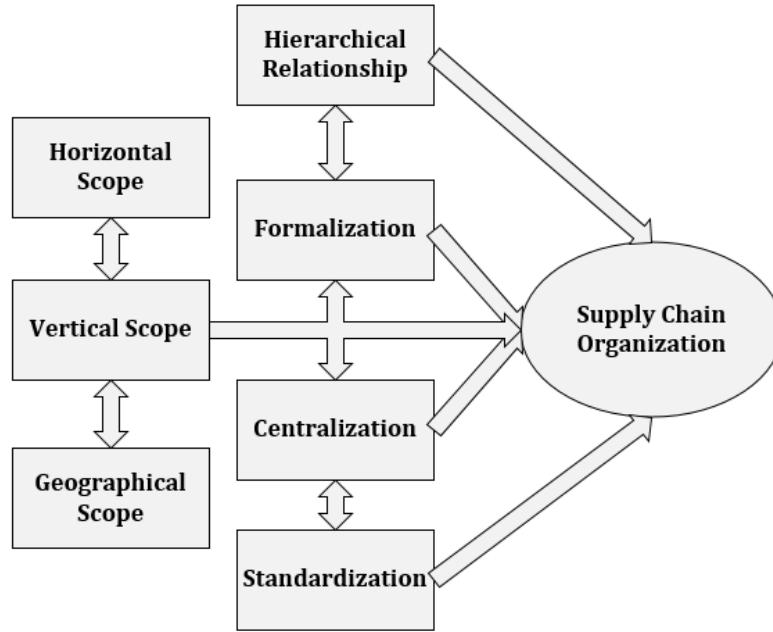


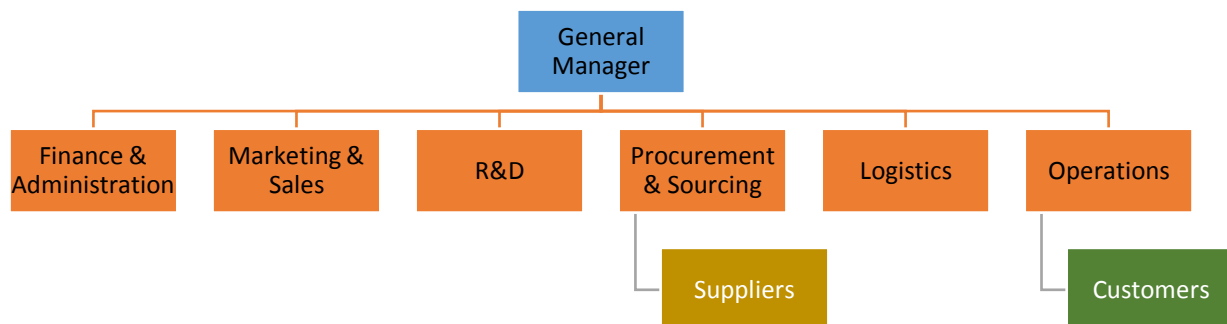
Figure 2: Framework Depicting Relationship between Supply Chain Organization and its Contributing Independent Factors, Source: Author

## 4 DISCUSSION

### 4.1 SHIFT BETWEEN SUPPLY CHAIN STRUCTURES

Considering the ETO service nature of the business the supply chain needs to adopt a process flow with shared services such a procurement and logistics being centrally managed to ensure effective and efficient execution of business operations with reduction in slack time.

Even though the organization currently has a matrix structure at an international level at the regional level it has a strong functional orientation at the regional level without the presence of a supply chain department as such which brings in the silo mentality and limits visibility and the ability of personnel to look at the bigger picture as shown in the chart below. This issue has also been pointed out from the interview findings as well as to how the split between different supply chain functions have made coordination and communication across functions a challenging task.



*Figure 3: Functional Supply Chain Organization at Regional Level*

Kim (2007) in his paper on supply chain organizational structure has identified Matrix organizational structure as a structure of choice by global vertically integrated oil companies such as Shell. However in the context of our company which operates primarily in the upstream oil industry in an ETO service environment a pure matrix structure which supports coordination and communication across various intra firm functions as well as with external parties such as suppliers and customers can prove to be counterproductive as it will limit the possibility of functional domain expertise development for procurement and operations functions who are dealing with suppliers and customers directly at the moment. Additionally, addition of another entity between these dyads will only make the process slower and less effective and efficient.

## **4.2 SUPPLY CHAIN INTEGRATION**

From the company data we can infer that a large number of high volume low value items are procured from external suppliers which is a source of potential risk and operational disruption for the company due to which it can incur losses due to penalties and delays which can have a domino effect on other projects being done in parallel by the company. This issue was also highlighted in meetings with company personnel.

## **4.3 INFORMATION MANAGEMENT**

During the interviews it was highlighted that at project timelines as well as those desired for the delivery of procures utilized in provision of the end service are at times unrealistic. Moreover the company doesn't have a system in place to enable upstream and downstream integration to allow the people on the field interacting with the customers to make informed decision. Also currently the company has a limited amount of visibility into customer operations which makes a task a bit more challenging.

## **4.4 BUSINESS SYSTEMS ENGINEERING**

During the interview it was found that currently a large reorganization effort is taking place at the company to centralize shared services such as procurement. The company realizes that it can increase the bottom line by saving from what it spends. This is a good omen for the company as successful implementation of the same will enable the company to remove excess fat from its supply chain where possible.

## **4.5 FLEXIBILITY**

In order to avoid operational disruptions the company culture is such that it generally favors having more on hand than less. This leads to high physical cost of the supply chain when dealing with procures used in provision of the end service.

## **4.6 TIME COMPRESSION**

In the interview it was found that the company doesn't have any long terms with any suppliers based on quantities. This is a big source of uncertainty as well as delays for the company as at times it has to go on the lookout for components which are required for provision of the end service. With customers



becoming more and more demanding with regards to project timelines any reduction in lead time will prove to be helpful.

## 4.7 CUSTOMER ROLES IN SERVICE SUPPLY CHAIN

In literature review there were eight roles identified that customer can play in the context of a service supply chain. Let's look at their applicability in context of the company.

### 4.7.1 Customers as Component Suppliers

As elaborated by Fatodu (2013) company customers assume this role a lot because they are owners of the sight at which the company is performing operations. In addition, the customers does provide materials which could be classified as generics. The risk here is that customers may provide materials and equipment for use by company and this may affect negatively affect company operations so the company needs to be careful in this regard.

### 4.7.2 Customer as Complementary Human Resources

Based on works of Gronroos (2008) due to high degree of customer involvement based to ETO service nature of the offering the customer needs to be at sight and many times may need to be part of the team carryout out the operation playing mostly a supervisory part hence this role has applicability in context of our company. This role can have both positive and negative aspects on company's performance. It might be positive as it will allow the customer to develop faith and trust in the company's ability to perform the task overtime yet at the same time it may prove to be counterproductive as customer involvement may limit company's ability to perform tasks with flexibility based on changing ground realities. Under such a scenario and integrated project management offering may prove to be the better choice.

### 4.7.3 Customers as Design Engineers

Customers do play the role of design engineers in company's services. Customers have acquired experience over the years to have other companies perform tasks for them. This makes them an expert Chase and Aquilano (1995), giving them ability to provide operational instructions and advice to company at services site. But this involvement will curtail ability of the company to deploy new technologies as customers might be more reluctant to try out new things even if they promise to be better than tried and tested methodologies.

### 4.7.4 Customer as Production Manager

Again this role has applicability in the context of the services provided by this company as according to Namasivayam & Hinkin (2003) customers can give direction during service encounter. Company's customers play the role of production manager through their staff control this company's people by ensuring that the services operations proceed according to specification and timeline decided by the customers. Again this role can cause challenges for the service provider as it may be responsible for creating overly excessive pressure on the company to perform its tasks based on a tight deadline which can lead to mistakes. Hence it's imperative for the service provider to ensure that such decisions are taken mutually against realistic timelines.

#### 4.7.5 Customers as Quality Assurance

Company's customers play this role by giving instructions at times on type of materials (including brand name) to be used at various stages of execution of a project/contract. According to Kelley et al (1990), customer's role as quality assurance entails both what service outcome is delivered and manner/process of its delivery. Webb (2000) adds that customers influence both service process and outcome quality, therefore, it can be concluded that company customers assume role of quality assurance in its drilling engineering and well services operations. This role does affect cost of provision of the service.

#### 4.7.6 Customers as Inventory

Customer assumes this role whenever they wait for themselves, their possessions, or their information to be processed Sampson & Spring (2012). When company causes customer to become inventory, customer charges the company penalty fee. Company keeps multiple units of equipment at customer site to respond promptly to any equipment breakdown or system failure. Either keeping multiple units of equipment on site or not, but allowing downtime increases the cost of executing a project. Thus company needs to investigate further to know how much inventory of procures it needs on hand to avoid disruption in service to avoid penalties.

#### 4.7.7 Customers as Competitors

Company's customers become competitors when they use their own in-house service companies for strategic reasons and cost savings purposes and perform task themselves which they outsourced historically to the company Lusch et al, (1992); Bitner et al. (1997); Sampson & Spring (2012). But because of depth of technical-know required few companies among those who have attempted to become competitor have been successful. However, it's only a matter of time that they will be able to overcome that barrier hence it's imperative for the company to use its domain expertise to keep itself at the cutting edge of technology in the discipline at the cutting edge of the technology curve and therefore ahead of the competition.

#### 4.7.8 Customer as Logistics Provider

One new role elaborated by Fatodu (2013) tells us that customers also assume the role of transporter, specifically marine transporter in service operations of the company. Customers do this by conveying materials and equipment from various places and delivering them to a desired location. In accordance with Sampson & Spring (2012), in this instance, customers could be considered to assume role of transporter.

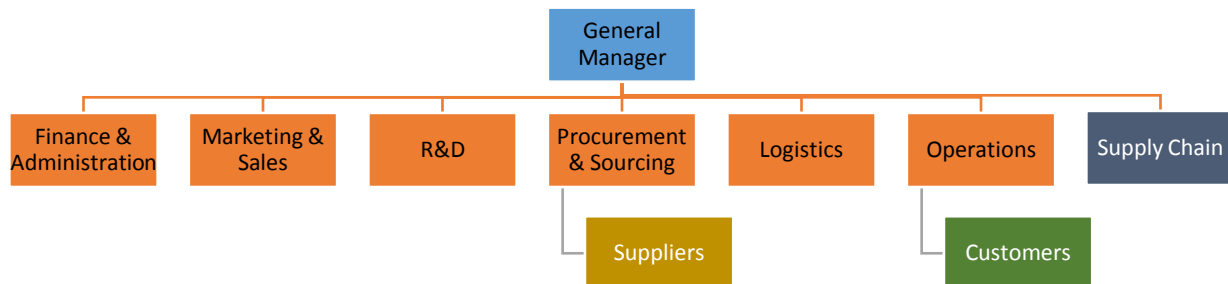
### 4.8 NEW PRODUCT DEVELOPMENT PROCESS IMPROVEMENT

With ever changing business needs and with resources being found in more remote parts of the world customer requirements are becoming more complicated. Hence it is absolutely vital to understand them fully the first time they are communication to reduce chances or errors and rework. Because of domain expertise and knowledge capital of the company no evidence of any issues in this regard were found from any of the sources.

## 5 RECOMMENDATION

### 5.1 SHIFT BETWEEN SUPPLY CHAIN STRUCTURES

- To counteract the challenges being faced by the company it need to adopt KPIs which will ensure cross functional integration at the regional level.
- Moreover to facilitate the process procures used in provision of the end service needs to be modularized to whatever degree possible to allow greater degree of standardization and hence enable postponement in the final definition of the product. This will also enable the company to counteract uncertainty and reduce cost and lead-time of the overall ETO service supply chain.
- This is also reduce the percentage of procures termed as ETOs used in provision of the end service by converting them to assemble to order (ATO) nature parts.
- Also the company can modify its existing functional structure at the regional level to include a supply chain department to improve coordination and communication within functions within the organization. Such a supply chain department will not directly take part in company operations and will only exist to facilitate communication and coordination of process across functions. This will enable functions to develop independently yet at the same time resolve the issues pointed out during the interviews by company personnel.



*Figure 4: Proposed Supply Chain Organizational Structure at Regional Level*

- At the global level if we look at the matrix structure proposed by Kim (2007) as in the following figure. We can see that the role of the supply chain function is to not only improve coordination and communication intra organization but also improve inter organization coordination and communication with suppliers as well as customers.

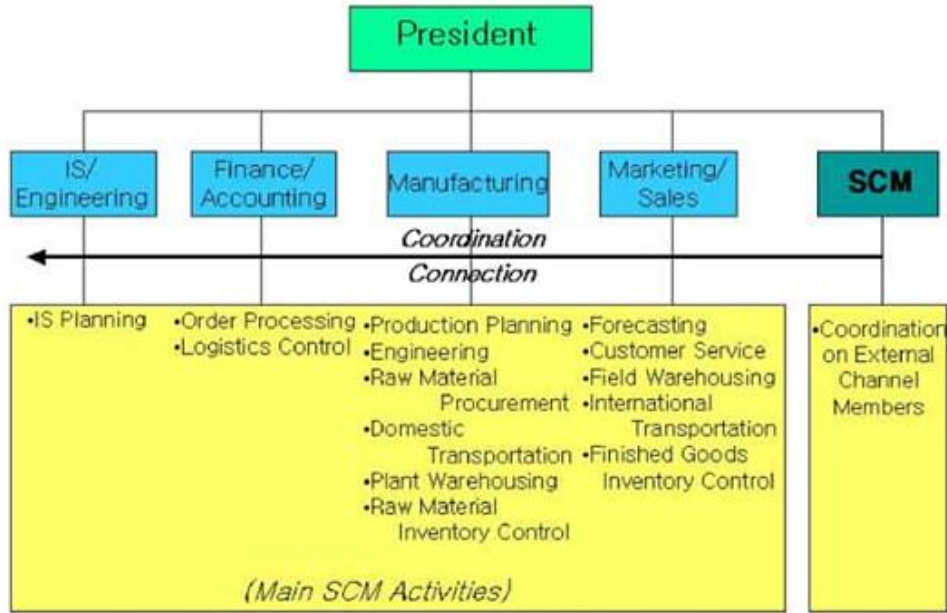


Figure 5: Matrix Channel Organization Structure Proposed by Kim (2007)

- However as explained in the discussion phase. Such a role at organization boundary can prove to be counterproductive in the context of the company under consideration. To have both the benefits of having a supply chain department to improve functioning of the supply chain organization yet at the same time mitigating the downsides of having such an entity in place the company could limit the role of such a supply chain department to improve coordination and communication within intra-organizational functions.
- Additionally, such a department based on its understanding of problems encountered on a daily basis from a process perspective can also give possible suggestions for improvement of activities across functions.

## 5.2 SUPPLY CHAIN INTEGRATION

- To avoid problems in this regard the firm should improve the interfaces between itself, suppliers and customer.
- Additionally, it can undertake supplier development initiatives for high volume procures as highlighted in the analysis phase. And the high volume procures could be further segregated depending upon their urgency, demand regularity, power regime and importance and lean or agile strategies could be adopted upon their nature.
- For instance an agile approach maybe better suited for high urgency and high importance procures which a just in time approach maybe better for a lesser low urgency and importance procure. This way the company will also be able to reduce the overall physical and transaction cost of the supply chain.

- A part which is currently being produced abroad and has a high frequency of procurement can also be internalized or procured from a closer location from another supplier or from the same supplier if willing to relocate based on guaranteed business.

### 5.3 INFORMATION MANAGEMENT

- Information visibility can help in reducing the probability of having unrealistic timelines for delivery of the ETO service projects.
- This will enable operations personnel dealing with customers to commit to better more realistic timelines yet at the same time it will give the customer an overview of company operations to plan its own activities better creating a win-win for all participants of the supply chain.

### 5.4 BUSINESS SYSTEMS ENGINEERING

- The company needs to continue deployment of Business process improvement (BPI) and Business process reengineering (BPR) from time to time as such as these are required from time to time to ensure that the company follows through phases of evolution followed by revolution once incremental changes are no longer possible to keep its competitive edge in the market.
- Though such initiatives in an ETO context have proven to be more successful when run within the boundaries of a given function however cross functional BPR or BPI initiatives have historically proven to be a more challenging task with lesser known success rate based on the research which has been conducted thus far. It is definitely an area which needs to be explored more in the coming years.

### 5.5 FLEXIBILITY

- A company can deal with uncertainty in one of two ways either embrace it as a necessary evil or reduce it. A high level of centralization can prove to be helpful in this context as it would enable seamless communication between different functions.
- The smart approach in this regard should be to first attempt to reduce the uncertainty if possible and if not embrace it.
- Currently, the focus of the company has been on embracing uncertainty before even trying to reduce it and this attitude needs to change. This will enable the company to benefit through reduction in the physical cost of the supply chain.

### 5.6 TIME COMPRESSION

- According to Towill (2003) in ETO projects 40% reduction in project time can lead to a 25% reduction in total work undertaken and costs. This is something which can be facilitated by a high degree of standardization.
- In particular, procurement and the competitive bidding, as well as the design stage have been highlighted as being time bottlenecks for ETO supply chains any step undertaken such as concurrent engineering, lead time reduction, postponement etc. to do away with these as well

as other sources of delays can significantly improve supply chain performance. More research could be undertaken in this direction to unearth ways of compressing time while working in an ETO service environment.

## 5.7 DEALING WITH CUSTOMER ROLES

- Company should make efforts to promote and enhance customers' roles where they are productive for the company and try to limit customer involvement in activities where they can prove to do counterproductive. The concept of formalization could be employed here to clearly define customer touch point and level of involvement in the overall process of provision of service.
- For instance a customer maybe playing the role of a supplier at customer's sight providing materials which the company is using in provision of the service. Under such a situation if the materials are as per specification and being provided at a fair price the company should promote use of such a role however that is not the case the company should discourage the performance of this role of the customer.

## 5.8 NEW PRODUCT DEVELOPMENT PROCESS IMPROVEMENT

- Company should take initiatives to avoid rework and build quality into the new product development process. This can be achieved by a high level of formalization of the process and a high level of centralization of supply chain functions and limiting their hierarchical distance from the top management.
- However in this regard according to the literature most of the existing frameworks are not applicable in ETO context and more research needs to be done in this regard to come up with a framework which will prove to be helpful in this perspective.

# 6 CONCLUSION

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Managing an ETO service supply chain is a complex task. The fact that it is a service ensures that it cannot be buffered in any way makes the task all the more challenging hence a company needs to have a structure which will facilitate management of services additionally it is required to be continuously evolving to keep pace with constantly changing service requirements. This paper presents a framework which should help companies working in such an environment to strategize according to the business needs and define the roles a customer can play depending upon the nature of the service being provided. In addition to the factors presented by (Kim, 2007) which included formalization, hierarchy and centralization other factors such as vertical scope, horizontal scope, geographical scope and customer roles also are factors which help in determining the structure for an ETO service organization. The end offering can be an ETO product or service with a varying level of standardization, complexity and tangibility. By conducting an analysis of existing company's supply chain operations we can see that the sheer breadth of requirements for managing an ETO service supply chain renders most of the structures presented by Kim (2007) in his paper ineffective. The structure of the ETO service organization under review for this case study had a very strong functional orientation at the regional

level despite having a matrix structure at the global level. In addition to the factors identified by Kim (2007) and standardization definition of a supply chain organizational structure while working in an ETO service context is incomplete without considering the impact of horizontal scope, vertical scope and geographical scope. All these factors add to the complexity for a supply chain organization while working in an ETO service environment because of added diversity, frequency and breadth in the types of information flows which an organization has to handle. Moreover, if we consider the impact and importance of Formalization, Centralization and Hierarchy in this ETO environment these too however important are affected by the interplay of levels of standardization, horizontal, vertical & geographical scopes. Proof of this was evident from primary as well as secondary sources of data analyzed as part of this case study.

Additionally, in terms of the structure after consideration of the problems encountered by the company it was recommended that the company could benefit immensely from the presence of a supply chain function to improve coordination and communication across intra-organization functions. Such a department is not to participate in day to day task by departmental functions, communicate with external suppliers or customers and will solely exist to improve coordination and communication within the company and suggest process improvement based on its observation of activities overtime. Moreover as we have found out from literature such as Gosling, Naim & Towill (2013) the levers which can be employed while operating in an ETO setting to increase the flexibility to respond to variations, compress time to enable faster response, share information to increase visibility reduce variability and improve supply chain integration to improve control and reduce supply chain physical and marketability costs in an ETO context. However, an assessment of their applicability in a pure ETO service context is again something which could be taken up as a future area of research. Based on triangulation the suggested organization structure gives a very basic idea of a structure which may work in the context of an ETO service organization but its applicability in a real life context remains to scientifically proven and could be taken up as an area of future research.

## Bibliography

- S. W. Kim. (2007). Organizational structures and the performance of supply chain management, *106*, 323–345. doi:10.1016/j.ijpe.2006.07.010
- Appelbaum, S. H., Nadeau, D., & Cyr, M. (2008). Performance evaluation in a matrix organization: a case study (Part One). *Industrial and Commercial Training*, *40*(5), 236–241. doi:10.1108/00197850810886469
- Giannakis, M. (2011). Conceptualizing and managing service supply chains. *The Service Industries Journal*, *31*(11), 1809–1823. doi:10.1080/02642069.2010.503879
- Gosling, J., & Naim, M. M. (2009). Engineer-to-order supply chain management: A literature review and research agenda. *International Journal of Production Economics*, *122*(2), 741–754. doi:10.1016/j.ijpe.2009.07.002
- Gosling, J., Naim, M., & Towill, D. (2013). Identifying and Categorizing the Sources of Uncertainty in Construction Supply Chains, (January), 102–111. doi:10.1061/(ASCE)CO.1943-7862.0000574.
- Grabenstetter, D. H., & Usher, J. M. (2013). Determining job complexity in an engineer to order environment for due date estimation using a proposed framework. *International Journal of Production Research*, *51*(19), 5728–5740. doi:10.1080/00207543.2013.787169



Gunasekaran, a, & Ngai, E. (2005). Build-to-order supply chain management: a literature review and framework for development. *Journal of Operations Management*, 23(5), 423–451. doi:10.1016/j.jom.2004.10.005

Hobday, M. (2000). The project-based organisation: an ideal form for managing complex products and systems? *Research Policy*, 29(7-8), 871–893. doi:10.1016/S0048-7333(00)00110-4

Kim, S. W. (2007). Organizational structures and the performance of supply chain management. *International Journal of Production Economics*, 106(2), 323–345. doi:10.1016/j.ijpe.2006.07.010

Kumar, S., & Wellbrock, J. (2009). Improved new product development through enhanced design architecture for engineer-to-order companies. *International Journal of Production Research*, 47(15), 4235–4254. doi:10.1080/00207540801939030

Morrison, J. M., Brown, C. J., & Smit, E. M. (2008). The impact of organizational culture on project management in matrix organizations, 39(4), 27–37.

Neverauskas, B. (2011). THE THEORETICAL SUBSTATION OF PROJECT MANAGEMENT CHALLENGES, (1999), 1013–1019.

Roh, J. J., Hong, P., & Park, Y. (2008). Organizational culture and supply chain strategy: a framework for effective information flows. *Journal of Enterprise Information Management*, 21(4), 361–376. doi:10.1108/17410390810888651

Sieke, M. a., Seifert, R. W., & Thonemann, U. W. (2012). Designing Service Level Contracts for Supply Chain Coordination. *Production and Operations Management*, 21(4), 698–714. doi:10.1111/j.1937-5956.2011.01301.x

Stavroulaki, E., & Davis, M. (2010). Aligning products with supply chain processes and strategy. *The International Journal of Logistics Management*, 21(1), 127–151. doi:10.1108/09574091011042214

Fatudo, Olaiya (2013): Role of Customers in Service Supply Chain, MISI Research Thesis

Baltacioglu, T., Ada, E., Kaplan, M., Yurt, O., & Kaplan, Y. (2007), A New Framework for Service Supply Chains, *The Service Industries Journal*, Vol.27, No.2, , pp.105–124

Yin, R. K. (2003): Case Study Research – Design and Methods, 3rd edition, Sage, Thousand Oaks.

Danxia S., Ying, X., & Weilai, H., (2007), Service Supply Chain: the Tendency of Supply Chain Management", *Proceedings of 6th Wuhan International Conference on E-Business*, Vol.IV, Wuhan, pp. 2954-2960.

Stuart, I., Mc Cutcheon, D., Handfield, R., McLachlin, R., & Samson, D. (2002): Effective Case Research in Operations Management: A Process Perspective, in: *Journal of Operations Management*, 20(5): 419-433.

Sekaran, U. (1992). *Research methods for business: A skill-building approach* (2nd Ed.) (pp. 114–147). New York: John Wiley & Sons, Chapter 5.

Fowler, F.J. & Mangione, T.W. (1990). Standardized survey interviewing: Minimizing interviewer-related error. Newbury Park, CA: Sage Publications.

Tharenou, P., Donohue, R., & Cooper, B. (2007), Management Research Methods, Cambridge University Press, the Edinburgh Building, Cambridge CB2 8RU, UK



Given, L., (2008), The Sage encyclopedia of qualitative research methods, Vol 1&2, SAGE Publications, Inc., 2455 Teller Road, Thousand Oaks, California 91320

Ellram, L., (1996), the Use of the Case Study Method in Logistics Research *Journal of Business Logistics*. Vol.17, No. 2, 1996

Wisner, J., Tan, K., & Leong, K. (2012), Principles of Supply Chain Management: A Balanced Approach, 3rd Ed., South-Western, 5191 Natorp Boulevard, Mason, OH 45040, USA

Mersha, T. (1990), Enhancing the Customer Contact Model, *Journal of Operations Management* (9:3), August, pp. 391-405.

Bitner, J., Faranda, T., Hubbert, R., & Zeithaml, A., (1997) Customer Contributions and Roles in Service Delivery, *International Journal of Service Industry Management*, (8:3), pp. 193-205

Sampson, S. & spring, M., (2012) Customer Roles in Service Supply Chains and Opportunities For Innovation, *Journal of Supply Chain Management*, Volume 48, Number 4

Fitzsimmons, A., & Fitzsimmons, J., (2004) Service Management: Operations, Strategy, and Information Technology, 4th ed., Irwin/McGraw-Hill, New York

Lusch, F., Brown, W., & Brunswick, J., (1992) A General Framework for Explaining Internal vs. External Exchange *Journal of the Academy of Marketing Science* (20:2), Spring, pp. 119-135

Sampson, S. E. (2001) Understanding Service Businesses: Applying principles of the Unified Services Theory, 2nd Ed. John Wiley & Sons, New York.

Mason-Jones and Towill (1998) Shrinking the Supply Chain Uncertainty Circle, Logistics Systems Dynamics Group, Cardiff University, UK.