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Strategic Design of Service Orientated Web-based Supply Chain Infrastructure

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Abstract. The traditional 'make and sell' attitude of industrial manufacturing organisations has now almost entirely given way to customer orientated 'sense and respond' service philosophies to the extent where this has become a major competitive key success factor in a global manufacturing industry. In order to become service orientated, manufacturing industry is increasingly dependent on efficient and effective supply relationships. This trend is compounded by needs for waste avoidance, minimal inventory, cost efficiency and appropriate service to the customer. This paper considers the strategic opportunities for large engineering project firms that have identified a need to establish advantages over their competitors by designing and implementing novel service orientated supply chain strategies, using internet technology. Rather than relying on functional hierarchy and command and control governance where a chain of commitments are poorly connected and difficult to reconfigure, this paper proposes more flexible strategic process designs around a 'state of the art' service based architecture. *Complexity reduction* is traditionally a philosophy widely used by industrial engineers that thus far has been also applied in attempts to enable efficient supply chain relationships between different manufacturing supply partners. However, in this work, those traditional industrial engineering ideas are challenged. When a supply chain is simplified, it is inevitable that it will not offer optimum performance, especially in terms of customer service because the complex nature of customer requirements is not reflected in its entirety. The architecture developed by the authors and demonstrated here explores ideas of *complexity absorption*. The architecture is built on the premise that necessary *complexity absorption* creates an organisation that is strategically superior because it becomes a complex adaptive system that is unique to a group of organisations that constitute a supply chain or supply network. A case study will be presented based on a major industrial gas pipeline procuring organisation that illustrates an application consisting of Manufacturing Portal and Service Orientated Architecture. This model is internet-based, has three main constituents of Web Services, Portal and Client Services and is described in detail in this paper. The authors conclude by discussing the unique competitive advantages that are achievable by designing unique, responsive and adaptive supply chain architecture in this way.

Keywords: Supply chain, strategy, service orientated, internet

1. INTRODUCTION

This research is concerned with the improvement of strategic supply chain management systems in industrial engineering. In particular, onshore gas transmission pipeline construction will be used as a major case study. Industrial engineering managers involved in large scale projects have traditionally relied on their own tacit knowledge and experience to manage supply processes. They draw on theories from project management to assist in the planning and control of major engineering projects, a typical example being the project management book of knowledge (PMBOK, 2003). Current production theory and practice are heavily influenced by the concepts and

techniques of project management. According to the PMBOK(2003) "a project is a temporary endeavour undertaken to produce a unique product or service." Any historical or strategic information relating to projects is usually stored only in the mind of the human project manager (Neto, 2002). This focus on product uniqueness and the project form of organization has dominated thinking about production in AEC industries, so far as to discourage learning from non-project industries such as product and service manufacturing (Koskela, 1992). This had led to much research by (for example) the Lean Construction Institute at Berkley, California, where the focus has been on the engineering procurement process itself, with the introduction of lean production principles

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into the process. For example, Koskela, 1992; Ballard, 2000, and others have studied large scale engineering projects as integrated lean supply chains. There is also a strong demand emerging in many engineering industries today for a more coherent strategy-based theory (see for example, work undertaken by the International Lean Construction Institute at Berkeley, California) and systems to support this theory.

This research uses as an example, gas transmission pipeline construction from a strategic operations management perspective and proposes some enhancements to the existing industrial engineering processes. Many authors have noted that large scale engineering is a complex and non-linear process (eg. Sterman, 1992), carried out under intense budget and schedule pressure. For example, it costs \$80k/ day to lay an onshore gas pipeline. Approx 6 km of pipeline/day is laid (GCI Kenny WA, personal communication.). Production management concepts based on the PMI (2002) project management control model have proven incapable of solving these problems. The PMI (2002) model follows traditional industrial thinking and is based on the assumption that the work to be done can be simplified into parts and managed as if those parts were independent from one another. This is fundamentally an industrial engineering mentality, which facilitates the management of production lines rather than the management of work flow through supply chains. If all supply partners meet their contractual obligations, the project performs successfully. Unfortunately, this approach is not robust. When something goes wrong, as it very often does, the entire structure is prone to collapse. Koskela (1992) confirms such poor performance by indicating that operational waste, in terms of poor quality, excessive use of labour and materials etc could be as high as 40% of the total cost. More recently it has been recognized by researchers that by considering the construction process as a total integrated supply chain, operational waste can be eliminated. This is in line with other areas of manufacturing research (see for example papers in *Lean Supply Chains*, Towill (2000); *Lean Enterprises*, Womack (2000)).

Many researchers (E.g. Porter, 1985; Gaither and Frazier, 2004), have noted operational effectiveness alone is not sufficient to gain a competitive advantage. In order to gain and sustain competitive advantage a strategic management approach must be adopted. From a strategic management perspective two approaches, or schools of thought have emerged: the enterprise-centric approach, which states that strategic advantage lies in clearly identifying and strengthening core competencies and capabilities within the firm; and the *coopetition* approach, where the approach to strategy focusses less on identifying capabilities within the firm and more on identifying opportunities to achieve competitive leverage by

mobilizing resources outside the firm. Using different labels—value nets and business ecosystems—Hamel III and Brown (2005) draw attention to the strategic advantages that managers can create by shaping and leveraging broader networks of resources beyond their individual enterprise. In attempting to develop a strategic approach that embraces *complexity* in a supply chain, an operations strategy that harnesses the complementary capabilities from all of the subcontractor organizations must be considered. Simply harnessing the capabilities of the supply network is not sufficient. As Hamel (2000) notes, 'to gain and sustain competitive advantage in the 21st century, executives must look to innovatory business concepts and models. That is, they must look beyond the product and service level to the underlying processes and how these processes accelerate capability building across the value network. Accelerated capability building is considered to be the most powerful source of competitive advantage in a global economy characterized by intensifying competition (Hamel III and Brown, 2005)'. The challenge is to convert the capability building within and across supply chains into performance improvement as quickly as possible.

In this paper the authors postulate that the strategic positioning of the case study pipeline construction supply chain is out of alignment with its operations. An e-operations strategy is proposed that will enable the acceleration and continuous building of the supply network's dynamic capabilities. The contribution of this research is that it presents a detailed and dynamic strategic architecture for managers to create a learning organization, by leveraging the tacit knowledge of all members of the construction value network. This strategy, unlike many manufacturing and industrial engineering strategies focuses on leveraging and building the intangible assets of the whole supply network. This will create value for the shareholders as well as the customers by eliminating waste and destructive rivalry between the supply partners.

2. RESEARCH DESIGN

The research used 'case study' as the main research strategy in investigating the planning and control process in onshore gas transmission pipeline construction. Yin (1994) defines "case study" as an empirical investigation into contemporary phenomenon operating in a real-life context. It is particularly valuable when there is not a clear delimitation between the phenomenon and the context itself. Therefore, this research strategy is the most suitable because it incorporates all the normal uncertain conditions faced by practitioners (Robson, 1993; Yin, 1994). This initial section gives a general view of the research design that shapes the contents of this paper. It describes the logic

used for getting from the initial research questions to the conclusions.

- a. Firstly, it was necessary to establish an overall theory in order to set up a 'benchmark' for onshore gas transmission pipeline construction planning and control. A theoretical framework was initiated at the outset of the empirical work. The theoretical framework evolved into an investigation into planning and control issues from an inter-organizational perspective, supply chain management and value stream analysis, and into studying the literature on the alignment of execution capabilities, including the planning and control requirements of the supply chains with the strategic positioning of the chains.
- b. A pilot case study of onshore gas transmission pipeline construction was undertaken, which was regarded as the 'explanation building phase'. With this approach the researcher looked for evidence that matched the theory, in order to build an explanation of the facts (Yin, 1994). The pilot case study that was undertaken was an international energy transportation company. A general description of the onshore gas transmission pipeline construction process was created, along with a study of present tools and technologies used in production processes, together with the type of resources and information required by supply partners as well as a study of the supplier organizations and their roles in the supply process.
- c. An in-depth case study of onshore gas transmission pipeline construction was then carried out. The particular emphasis was on the planning and control of the construction process from an integrated supply chain perspective. From this case study, waste in the planning and control process could be identified. Further literature reviews suggested that operational effectiveness by elimination of waste was not sufficient. The process had to be strategically aligned both within the organization, with strategic and tactical goals, as well as across organizations in the supply chain. For this purpose the case study then examined the overall strategic alignment of the construction process.
- d. Following the major case study, a detailed description of the gas transmission pipeline construction planning and control process was produced. This is believed to be the only comprehensive description of the pipeline construction management process available. The report was distributed and feedback obtained to ensure its reliability. Some minor case studies were then undertaken.

3. DATA COLLECTION METHODS

Executing a research strategy requires methods for data collection and analysis. The research methods available for case study, the research strategy adopted in this work were direct observation, documentary analysis, and interviews.

Observations: Due to the complexity of this research, observations were the first method used to gain data and develop a broad understanding of the organisations involved in the case study, and enabled the researchers to gain a high level view of the business process, and the interaction between suppliers and clients in that process.

Document Analysis : Within this research, document analysis was used to provide an in-depth insight into the process of pipeline construction, as well as the many documents required for monitoring and control of the construction process, such as the contracts, project planning documents, and many more. These documents were provided by Australian sub-contractor organizations involved in the gas transmission pipeline construction process and academics.

Semi-Structured Interview: This was the third and final method used to obtain richer and more complex data than simply using questionnaires (Cavana et al, 2001). This provided the interviewee the chance to introduce new topics. The interviews were conducted with various employees along each supply chain, gathering facts and perceptions relevant to the objectives of this research. They were used in conjunction with the observational studies to verify and gain a better understanding of the preceding results and to clarify any issues that arose previously. Interviews were conducted in person and by telephone.

4. DATA ANALYSIS AND EVALUATION

Reliability: Although the problem being studied is very complex, the sources used have all been treated carefully to reflect their true meanings and intentions. The majority of sources used are widely used in pipeline construction. The interviews were conducted with very reliable and well respected members of the supply organizations. However, the researchers are aware that in pipeline construction there are few overall standards for terminology and definitions, including documents, and data.

Validity: The study was performed in a way that it was reliant on the sources used for the study. The sources were the ones found in the time period of a research masters thesis and may not cover all aspects of the problem at hand. Also the terminology may change over time. The validity limitations of the study should be considered as an indicator to further investigation.

Representativeness: It is believed that the study itself is highly representative of not only onshore gas transmission pipeline construction in the Asia-Pacific region. This is evidenced by the fact that many of the studied supply partners work in this region involved in the many thousands of kilometers of pipeline presently being constructed and the geographical extent of these pipes, an example being the Eastern Gas Pipeline from New Guinea to Bass Strait.

5. RESULTS OF THE CASE STUDY

The following are a sample of some of operational shortcomings identified:

Information Access, Knowledge Management and Organizational Learning: Lack of timely, in depth, and relevant information to pipeline partners appears to be one of the causes of collaboration and control problems in pipeline construction. Information is fragmented and only hard copy information or scanned information is available and sometimes word-of-mouth only. Knowledge management is fragmented and out of date, and shared only on a limited basis. Knowledge is also restricted to single projects and phases. Knowledge gained by one design team for one project is not always recorded or passed on to designers from other projects. Experience gained on one project is not transferable to other projects, unless the same project manager is employed. There is at present no facility for a lessons learned (project history) database to be accessed by subcontractor organizations.. Learning is shared mostly at conferences and seminars and occurs sporadically. There is also little allowance for multilingual or multicultural aspects of information exchange. Information when available on the Internet is not selective by role or viewing device, resulting in too much or not enough information being communicated. Information is not personalized by role or viewing device, such as pocket PCs. There is no one point of access for all information from the various systems involved in pipeline construction.

Collaboration and Communication: Management teams and subcontractor organizations do not have the basic tools to collaborate with peers, regional management, and corporate offices. At present information and communication is largely by hard copy. This prevents development of a work environment that is open, and supports the breaking down of cultural barriers.. There is no efficient means of viewing and communicating what needs to be achieved among off- and on-site personnel. There is also no efficient way of sharing information and collaborating with head office or site office in real time.

Workforce and Relationship Management: The pipeline workforce could be considered to be made up of

the needs of management and the needs of the individuals but these are not distinguishable in the present system. At present, decisions are made sequentially by specialists and 'thrown over the wall'. There is no involvement of downstream players (supply chain partners) in upstream decisions.. There is a limited awareness and understanding of IT/Internet and its potential benefits to the project. This leads to misunderstandings and distrust between supply partners. The lack of inclusion of all participants in pipeline construction decisions leads to an arms length and often adversarial culture among the subcontractor organizations. This could lead to high turnover rates and unavailability of qualified personnel. Presently training is not provided on the job and is regarded as secondary because time away from work is costly. Current performance management systems are either paper based or standalone desktop PCs. This also has to do with information access. At present there is no facility where participants can view or update information from the field in a real time manner. From a human resource perspective there is no real time access to employees credentials and qualifications, suggestions, grievances, time sheets and so on.

Design: The present approach to product and process design is fragmented. The product design is outside of the project lifecycle and if drawings need to be accessed or changed during the construction process, this requires a long wait. There is no focus on concurrency of design, process, and supply chain. All product lifecycle stages should be considered in design to avoid downstream errors. There is no link between the supply chain design and the product design. If concurrency were considered, sourcing would be design-build. As it is, decisions about sourcing contracts are made separately from the product (and process) design.

Materials and Inventory Management: Because there are only manual processes or desktop systems used, there is a lack of visibility of stock flow, a lack of integration with maintenance and equipment service management, and equipment tracking. Participants build up large inventories to protect their own interests. There is a lot of surplus at the end of the project, which the project manager must sell or take to a new site. As mentioned elsewhere (Anderson, 2004), the 'built to order' pipeline requires a spontaneous supply chain with spontaneous inventory management, but there is a lack of focus on automatic restocking, for example, by using autonomic logistics. There is no automatic integration with other systems, such as General Ledger, Accounts Payable, Purchase Order, Job Costing, and Equipment Control.

Supply Chain Management: Supply chains are treated as separate organizations linked together through the market. They are fragmented, with limited communication between disciplines within a phase and between phases. In

some cases strategic alliance relationships between the primary supplier (contractor or consultant) and sub-suppliers based on pre-established relationships and experiences exist. The intent is to continue a working relationship. Electronic sourcing and procurement is not realized to its full potential. For example, the downloading and printing of tendering documents for estimating purposes; electronic funds transfer is not being used.

Project and Portfolio Management: The monitoring and control of all information relating to the project in an up to date manner is not possible using manual procedures, or limited desktop PC facilities. There is no central one point of access integrated way of enquiring and reporting on project progress. There needs to be a way of enquiring about contract status from different viewpoints, such as customer, project manager, contractors, or combinations of the above. There is no means to view contract value, billings to date, cost to date, variance, forecasted costs to complete, percentage completion and projected profit. This is because there is no integration with financial management systems.

The above discussion of the 'pain points' (shortcomings) identified across the pipeline project requires strategic capabilities supported by a mobile internet platform. Following is a summary of the current factors limiting strategic advantage and the strategic capabilities enabled by integration of Internet technology.

6. SUSTAINABLE COMPETITIVE ADVANTAGE THROUGH INTERNET DRIVEN SUPPLY CHAINS

The Internet enables sustainable competitive advantage through the innovation of business processes and concepts. This innovation comes about by leveraging the organization's dynamic capabilities. The tables below consider only a sample of the issues to be considered in the design of a 'competitive' supply chain. The following tables are extracts from the results of the investigation that illustrate the main factors limiting strategic advantage in comparison to the strategic capabilities enabled by the internet. (Space does not allow the full detail of the investigation to be reported here.)

Several design solution alternatives were considered. What is required is an open and robust technology framework that enables a 'to-order' construction environment. The proposed solution enables an on demand construction environment. Its purpose is to bring the business (systems, information, and knowledge) to the people who need it and in a form that is usable within the context of the work, or business process, they are performing. In so doing, it creates a cumulative benefit for all members.

Table 1: Information Access, Knowledge Management, Organizational Learning

Factors Limiting Strategic Advantage	Strategic Capabilities Enabled By Internet Technology
At present managers must divide their time between the 'back room' for meetings and the site. Electronic information from the site is delivered once a day to PCs in the back room or uploaded to a data warehouse	Create mobility for management teams by providing access to all relevant information from a multifunction wireless PDA device Enable real time field data capture using wireless and pocket PC

Table 2 Scheduling

Factors Limiting Strategic Advantage	Strategic Capabilities Enabled By Internet Technology
Creating the schedule involves a great deal of manual intervention and collection of information.	Have the scheduling system develop the core schedule on appropriate drivers from diverse departments and subcontractors, allocate hours and compare to budget. Provide tools for evaluation of schedule effectiveness.

Table 3: Workforce

Factors Limiting Strategic Advantage	Strategic Capabilities Enabled By Internet Technology
High turnover rates, unavailability of qualified personnel Predominantly on the job training, inconsistent learning Training viewed as secondary because time away from work is costly	Capture and view suggestions, issues, and grievances. Provide learning to employees electronically as needed, based on role. Include short briefings on products, regulatory or corporate policies, job instruction (issues and lesson learned and other learning information).
Current performance management systems either paper based or desktop PC based. Immediate feedback and counselling is poor.	Be able to log an employee performance issue with ready reference to appropriate policies and guidelines.

Table 4: Project and Portfolio Management

Factors Limiting Strategic Advantage	Strategic Capabilities Enabled By Internet Technology
Communications and job delegations are not always coordinated in corporate or site office.	View and access from one source all jobs and projects assigned.
Need ability to prioritize jobs and allocate employees dynamically. Need ability to adjust plans dynamically.	Assign jobs to employees with ability to remove, reassign, and update jobs on the work list. Incorporate emerging needs into job plan; adjust staffing to accommodate for unforeseen events.

Table 5: Collaboration and Communication

Factors Limiting Strategic Advantage	Strategic Capabilities Enabled By Internet Technology
Data entry is duplicated, or manual intervention is required, because related systems are not well integrated.	Information capture and routing of pipeline project information to and from management by electronic workflow.
Need more efficient means of viewing and communicating what must be done among the off- and on-site personnel.	View a list of jobs and meetings for the upcoming week. View and maintain a pipeline-level event calendar for all to see.

6. KEY FEATURES OF THE TO-ORDER ENVIRONMENT

The following section describes the main features and highlights recommended for the 'to - order' (sense and respond) large engineering project environment. The focus here is on a description of the conceptual architectures of the system. The proposal below is for a gas pipeline portal and service oriented architecture, which will integrate planning, design, delivery, and maintenance.

Role-based Partner Portal: A role based partner portal is proposed that allows one point of access to all systems. Here, all employees access knowledge and systems needed for their work. This model highlights the pipeline management team roles, but other roles can participate in and use the portal as required. The portal provides secure

access to all of the components in the system. The actual component functions presented will vary based on the defined role of the individual seeking access. The portal determines and adjusts the format of content to suit the characteristics of the user interface (device) being used during the session. To allow for location of critical information or knowledge, the portal supports a search function across all pipeline enterprise content. The portal also manages and coordinates the delivery of alerts that are generated by other systems. The portal enables companies to streamline their workflow by capturing payroll, equipment usage, material costs, and hired equipment data at the source, and update their corporate systems without the re-keying of data. This data is then transferred to the company server using wireless Internet access.

Table 6: Inventory and Maintenance Management

Factors Limiting Strategic Advantage	Strategic Capabilities Enabled by Internet Technology
Time-intensive manual processes related to managing inventory with focus on surplus.	Track materials in real time Track inventory quantities on hand, on order, and on reserve at any number of locations, for any number of subcontractors Automatically update the value of inventory - based on current average cost - each time a purchase or adjustment is made. Posts transactions in any unit of measure, and automatically converts them to a standard unit of measure for each item. Distribute inventory transaction costs to General Ledger account, to a job and cost code, or to a piece of equipment or component. .
Inability to manage stock outs.	Generate an automated alert and restocking job when site stock needs replenishing.
Lack of visibility of stock supply flow.	Modify an order for inventory before it is shipped, receive notification when it is shipped from supplier.
Poor feedback channels	Communicate to the head or site office, and cancel an incoming inventory shipment if necessary.
Time-consuming and difficult to locate stock to satisfy requirements.	Provide inventory search for selected items in nearby pipeline projects.
Lack of integration of maintenance and equipment service management	Provide an equipment module that keeps track of all company owned equipment, and costs associated with each piece of equipment and allocate costs to jobs or subcontractors. Provide reports on costs per hour of owning and operating equipment, age of machines, and all purchased and rental equipment
Lack of integrated repair and maintenance program for on site equipment	Provides a method of analyzing major vehicle and component repair requirements, and a means of budgeting for future expenditures.

Table 7: Key Performance Indicators and Alerts

Factors Limiting Strategic Advantage	Strategic Capabilities enabled by technology
Information is disparate across multiple sources and PCs, and so is time-consuming to put together. Islands of information exist. Information is often, fragmented, incomplete, not up to date, or information is too detailed.	Have a consolidated view of key performance indicators by role that are normally stored in different systems. For example, Corporate-, Customer-, Employee-, Project Manager-, Vendor-, or Contractor- Centres.
Information is not timely, thus not actionable. Local data collection on site is not integrated in real time.	Ability to register for notification when selected pipeline events (conditions, measurement points, and so on) occur, and receive notification of those events interactively with a PDA. Ability to monitor specific key events and provide analytics that sense out of range conditions to create actions to a manager for response, for example, statistical and real time process control.

Service Oriented Architecture: This research is proposing that all capabilities – design, plan, deliver, maintain – as an ecology of e-business services. 'Ecology' means that the construction process becomes a service provider to other organizations, but also a service broker and a service requestor. What is presently manual will become Internet based as a service, not simply as a transaction. The services will be implemented as web services. "The term *architecture* is widely understood and used for what it is--a top-down description of the structure of the system." (Rechтин, 1991). *Service-oriented architecture* presents an approach for building distributed systems that delivers application functionality as services to either end-user applications or other services. It is comprised of elements that can be categorized into *functional* and *quality of service*, as illustrated below (Ganci et al, 2001):

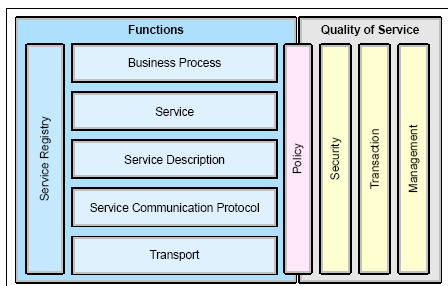


Figure 1: Elements of a Service Oriented Architecture (Ganci et al, 2001).

8. SERVICE ORIENTATED ARCHITECTURE AND WEB PORTAL

The above discussion described the advantages of a web services and portal architecture for gas transmission pipeline construction. In the present pipeline model as illustrated in Figure 2, most of the services in this model are manual, isolated transactions.

Instead of a linear over the wall approach as depicted in Figure 2, the integrated architecture would be in the form of a business ecosystem, as depicted in Figure 3:

Business processes will be offered in the form of e-business services (with or without facilitating goods). Referring to the transactions, these could be offered as e-business services, such as:

- Planning Services
- Inspection Services
- Survey Services
- Evaluation Services
- Contract Writing Services
- Materials and Inventory Management Services
- Procurement Services

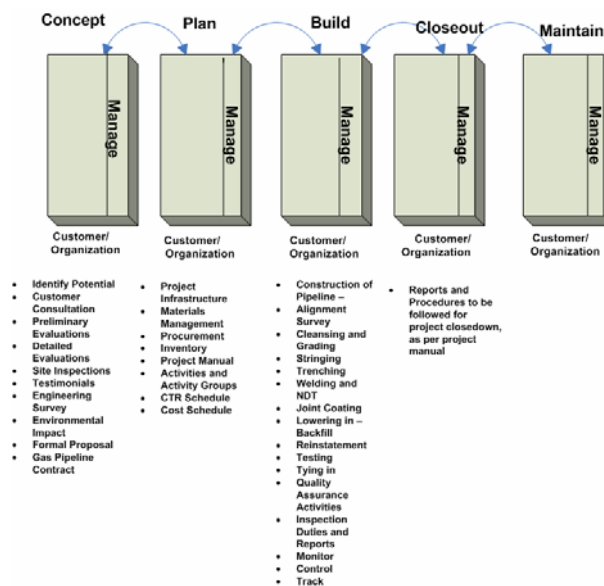


Figure 2: As Is Gas Transmission Pipeline Construction Business Architecture

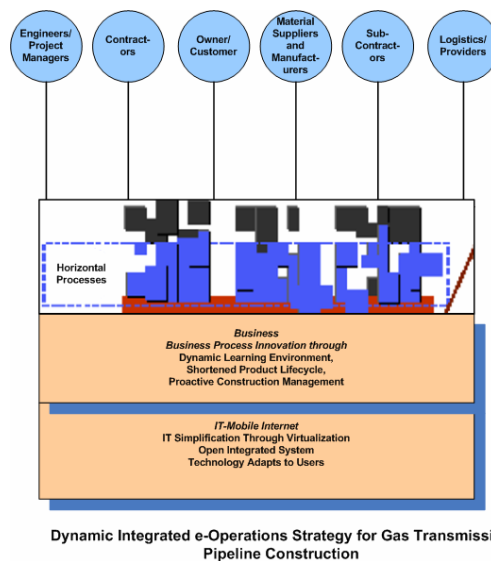


Figure 3: Pipeline Construction as an Integrated Process

- Tendering Services
- Bidding Services
- Welding Services
- Design Services
- Hydrostatic Testing Services
- Financial and Accounting Services

Each of these services would have an operational strategy, an IT component, as well as a physical product component. Where required a composite web service and

workflow could be utilized as illustrated below in Figure 4 as shown in part of a design example:

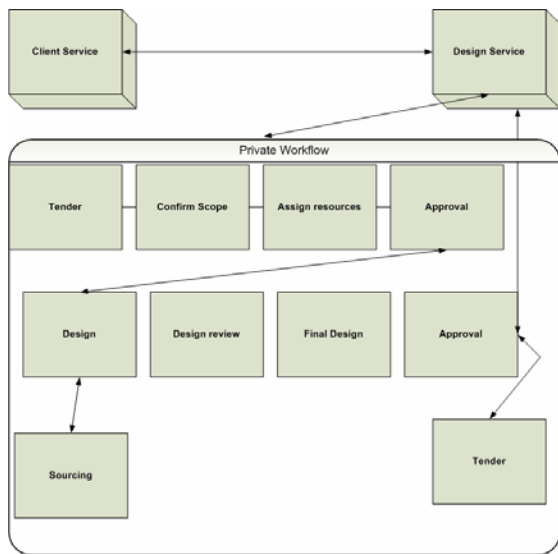


Figure 4: A Suggested Design Web Service For Pipeline Construction With Private Workflow

Finally, Figure 5 below gives an overview of the portal and service oriented architecture proposed.

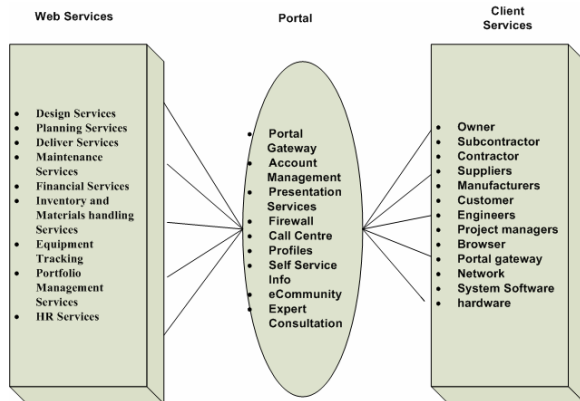


Figure 5: Proposed Pipeline Construction Portal and SOA

A model that is being proposed for gas transmission pipeline construction is a needs capabilities model. This model is dynamic and based on the notion of manufacturing as a sense and respond business, rather than a make and sell business. The operations strategy and architecture map easily to this model, which is depicted below in Figure 6.

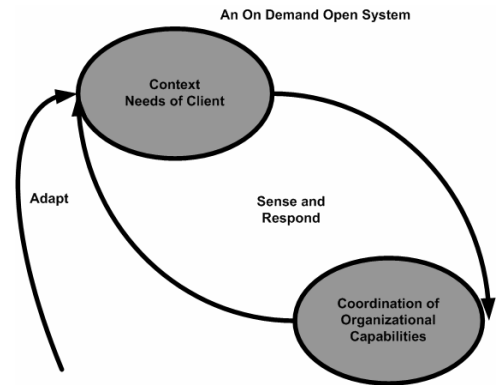


Figure 6: A Dynamic Needs/Capabilities Model

9. CONCLUSIONS

This paper has argued that recent developments in manufacturing philosophy will provide a benefit for large project engineering industries. This research has proposed that those industries work towards competitively superior Internet-based service orientated strategies that are able to embrace complexity, rather than the traditional Tayloristic industrial engineering strategies that have become the norm. This paper has also proposed a model to implement such strategy. This will provide a means of building dynamic capabilities in the organization to create a learning organization. Organizations that develop capabilities to participate in supply chains that achieve these processes will become more innovative, leading to sustainable competitive advantage.

By adopting a project-based business process, processes are dynamic and re-configurable to suit the requirements of the customer order. In other words, most manufacturing environment today are Build To Order (BTO). This work has proposed an appropriate operations strategy and tactical IT system to support this process. A model that is being proposed is a needs capabilities model. This model is dynamic and based on the notion of 'sense and respond' rather than a 'make and sell'. The operations strategy proposed here and architecture map easily to this model, and provide strategic opportunities for innovative players in large engineering project business.

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